TERPSICHORE: A SOFTWARE MUSIC INTERFACE FOR PEOPLE WITH MENTAL DISABILITIES ON THE AUTISM SPECTRUM

A Thesis submitted
in partial fulfilment of the requirements
for the degree of
DOCTOR OF PHILOSOPHY
in MUSIC AND TECHNOLOGY

GEORGIOS KYRIAKAKIS
University of Kent, Faculty of Humanities
School of Music and Fine Art (SMFA) – Centre for Music and Audio Technology (CMAT)

CHATHAM, KENT, UNITED KINGDOM: 8 SEPTEMBER 2020
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DECLARATION

I certify that I have read the University Degree Regulations under which this submission is made. In so far as the thesis involves any collaborative research, the extent of this collaboration has been clearly indicated; and that any material which has been previously presented and accepted for the award of an academic qualification at this University or elsewhere has also been clearly identified in the Thesis.

I additionally certify that all uncited material in this Thesis constitutes personal work and argumentation; all work and opinions expressed by third-party authors have been properly referenced and paraphrased or quoted, in line with the University's regulations regarding academic integrity and plagiarism.

Insofar as the word count of the Thesis is concerned, this refers exclusively to the core text, and does not take into consideration supplementary material, in accordance with Paragraph 4.4 of the University's 'Instruction to Candidates for the Examination of Research Degrees (including the Postgraduate Diploma by Research and Training)', accessed from the link below:
kent.ac.uk/teaching/documents/quality-assurance/regulations/research/pgdipresc.pdf.

GEORGIOS KYRIAKAKIS
TUESDAY 8 SEPTEMBER 2020

ACKNOWLEDGMENTS

The current Thesis and accompanying practical material are the result of my full-time studies in the United Kingdom and at the University of Kent, where full-time Doctoral studies in Music and Technology were preceded by a year-long Master's Degree in the same discipline. Therefore, I would firstly like to express my sincere gratitude towards my two Supervisors throughout my research degree: Dr Aki Pasoulas from the School of Music and Fine Art, and Dr Colin Johnson from the School of Computing. I would specifically like to thank and commend them for their pronounced eagerness to provide guidance at all stages of my degree. It is also thanks to their experience at this level of Higher Education, transmitted to me through regular supervisory meetings, that I was progressively capable of taking independent initiatives towards optimising the quality and future applicability of my research. Considering that a productive relationship between Supervisor and Student is critical to the finalisation and eventual success of a doctoral degree, I am particularly grateful that both my Supervisors always followed my research progress and addressed potential issues. Aki and Colin, I totally and frankly appreciate your invaluable assistance and contribution all these years.

A special 'thank you' message is directed to the three professional special educators to which the *Terpsichore* software was distributed for testing and research purposes. These are: Ms Persefoni-Alexia Sergi, Mrs Panagiota Kyriakidou and Mrs Chrysoula Papakirykou, all employed by institutions in Piraeus and the broader Attica region of Greece, with a focus on education and treatment for adolescents and adults with special needs. I would like to thank them, from the bottom of my heart, for agreeing to conduct this important research part despite their hectic schedule and increased employment commitments, and for supervising the necessary number of participants for practical research to yield substantial results.

I am also especially grateful for the Faculty and Staff of the University with which I interacted and shared opinions regarding the nature of my research. Special thanks are addressed to Shona Illingworth, who participated alongside my Supervisors during all the Progression Reviews related to my thesis, for her valuable recommendations in ensuring that completion of my Thesis adheres to the official timeframes of full-time doctoral study in the UK. I additionally feel that I would not have maintained an acceptable standard in my Thesis without the contribution of Dr Charles Hutchins, my module convenor in the Advanced Audio Techniques module of my

Masters course, whose knowledge and experience in the SuperCollider programming language was indispensable to my endeavours in building a comprehensive script employed as a basis for the *Terpsichore* software interface. Moreover, I would like to thank Dr Paul Fretwell and fellow Music and Technology PhD student Ioannis Papadatos, with both of whom I had the chance to discuss my research and exchange opinions on academic and professional development related to my analysed subject matter. Finally, I appreciate the assistance and contribution of Sian Anderson, Senior Student Administrator, for informing me when necessary about the required procedures and steps I had to follow depending on the different research and write-up stages her suggestions pertained to.

In addition, I would like to address my special gratitude to the A.G. Leventis Foundation (Zurich, Switzerland / Athens, Greece / Nicosia, Cyprus), for the faith shown in my research proposal and progress demonstrated by the Foundation's agreement to partially fund the last two years of my doctoral study.

Lastly but most importantly, I would like to express my utmost feelings of gratitude to the most priceless individuals a student can have in such a difficult and critical pathway for his prospective career: my parents and grandfather, to whom I also dedicate this Thesis from the bottom of my heart. Caring and respectful families are indispensable to the encouragement and development of a person's personality, and in the case of my family this is no exception. The support I received from the day my proposal was accepted until the milestone moment of Thesis submission was infinite and continuous, especially considering my need to complement my devotion to research with miscellaneous time-consuming employment activities for the coverage of living expenses. I greatly appreciate my family's endeavours in ensuring a carefree and peaceful environment that would reduce possible anxiety and stress while completing my research and preparing my Thesis, as well as their willingness to lead me towards productive pathways and prevent unnecessary distractions from hindering my goal in achieving the first step towards entering the world of academia. Mom, Dad and Grandad, thanks a lot for being an inextricable part of my endeavours and life decisions.

ABSTRACT

The current Thesis concentrates on the construction and efficiency assessment of *Terpsichore*, a software interface designed to assist individuals with autism spectrum disorders (ASD) in developing their competence, and ideally independence, in composing original tonal and soundscape-based music. It does not only serve educational purposes, but also exhibits a therapeutic nature consistent with the accomplishment of non-musical goals, implying a reciprocal relationship between music education and music therapy. It is also distinguishable in its evidence-based character, as its construction is based on a broad spectrum of personality traits. The software consists of two educational modes (*Tonal* and *Soundscape and Indefinite Pitch*), in which constituent levels are arranged to reflect a process comprising three thematic sections: sound component identification and reproduction, minor amendments to existing musical material, and composition of musical patterns from point zero.

To best determine the efficiency of the interface components in a wide variety of situations, a bilateral approach was adopted, which consists of a bibliographical case study approach and a practical research component. In the case study involving nine individuals from the relevant autism and music therapy literature, various *Terpsichore* areas were carefully suited to the personality, condition and particularities of each learner, while observations were extracted through critical bibliographical analysis of interface components and their role in music interventions for ASD. Practical research involved a series of tutor-administered sessions in four different special education institutions in the Attica region of Greece, where twenty-eight participants were instructed to employ both modes of the software. Responses and trends were measured via a comprehensive questionnaire addressing multiple areas of music education and therapy and how these evolved throughout the software instruction process.

The Thesis demonstrates that *Terpsichore* addresses a broad variety of cognitive and treatment aspects, assists in a meaningful and rewarding creative musical occupation without unnecessary structural complexity, and generally contributes in a positive manner to mental condition treatment as a result of the music education components incorporated in the interface. The software also possesses a potential to treat various lapses in communication, behaviour and concentration, while rendering the music and sound composition process more comfortable, especially in the pitch-defined music domain, thanks to the increased understanding of tonal relationships. Findings from this study are useful in encouraging caregivers, music therapists, psychologists and relevant practitioners to incorporate and further develop *Terpsichore* in everyday music and general learning schedules for individuals with ASD.

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INTRODUCTION

One of the most important breakthroughs in the contemporary music composition and production industry, mainly from the start of the 21st century onwards, was the construction and distribution of software platforms that function as conventional instrument equivalents. More specifically, increasing endeavours have been made by programmers and music professionals to adapt the characteristics of actual instruments or earlier bulk hardware equipment to more convenient software structures, where the aforementioned characteristics are reproduced and embedded into what the relevant industry regards as a 'plug-in' (Collins 2003a: xxi). Moreover, the software adaptations of instruments and music production devices may be encountered in various different formats, such as RTAS and TDM for ProTools or VST for Steinberg (Souvignier 2003: 112), popular nowadays in diverse operating systems (Kenlon 2012: 71). Recently released plug-ins allow the user to extract similar sounds to the ones of a grand piano (Collins 2003a: 352-4) or a guitar (Truesdell 2007: 510), not to mention the capability of manipulating sound signals in a similar manner to what conventional guitar amplifiers can perform (Ibid.: 401-7). Despite possible deficiencies in the final quality that such interfaces provide, virtual instruments have generally served as particularly useful tools in the arsenal of a music producer or enthusiast.

The above information fully applies to typically developing (TD) musicians, whose mental function allows them to harness, after relevant music education and practice, the versatile and creative power of such interfaces. However, a person suffering from a recognised mental or learning disability will naturally not possess part of a non-disabled individual's competence in understanding and taking advantage of the complex elements and structures contained in any music production interface or sequencer. The important value that enables a disabled person to integrate musical and similar recreational activities in his quotidian life is *simplicity*. This means that the structure of the software that the learner should be provided with, in his endeavours to learn how to compose musical segments, should be as plain and specialised as possible, whilst also minimising the risk of provoking negative feelings, adverse conduct, or a severe disability aggravation, due to a learner's potential incapacity of performing productive tasks within the software.

A number of conditions that characterise individuals with an impaired non-physical functionality can be classified into the broader 'mental disability' category, as long as they actively influence the integrity of their brain or psychological disposition, according to the relevant text contained within the Ellis Act (San Francisco Tenants Union 1985) pertaining to household ownership. It may also be possible that the existence of such a disorder results either *from* or *in* a degree of incompetence in developing existing knowledge and grasping new information, as summarised within the term ‘learning disability’ conceived in the USA in 1964 (LDA 2017). From the above, it may be assumed that the procedure of attempting to instruct any computer program, let alone one pertaining to music composition, becomes challenging either because of the learner’s incapacity to effectively engage in educational practices, or because of his occasionally uncontrollable behavioural or emotional patterns. These are the main reasons why the attainment of the above *simplicity* goal, to the highest possible extent, is indispensable.

Notable digital audio workstations and sound modification plug-ins, originally constructed for neurotypical individuals, may frequently exhibit a complexity level that is unmanageable for people whose condition involves abnormalities caused by a mental impairment. This has led to a significant restriction of such software’s clientele, given the report of Burns (2009) according to which an approximate 8% of the global population are diagnosed with an unfavourable mental health condition. To increase software appeal to the wider target group of individuals with mental disabilities, it would be more sensible to construct a computer-centred system whose role would extend beyond the restricted boundaries of practical music education, helping the learner externalise one’s emotions more effortlessly, increase his aptitude in behaviour control, improve his concentration and motivation levels, and perform everyday tasks with greater fluency. In short, the *therapeutic* nature of such an endeavour should be considered seriously with regard to its potential worth.

The question as to how interested a mentally disabled person would get in contact with a software platform for music education and production can be initially answered through recent research findings. Ockelford (2013b) contends that young age individuals display a passionate interest in music, both as a sequence of signals or ‘words’ and phrases, similar to a standard linguistic pattern (Ibid.: 19-20), and as a succession of environmental or everyday sounds that largely enhance a youngster’s appreciation (Ibid.: 14). Ridder (2005: 81), who refers to older age groups that mainly suffer from such disorders as dementia, illustrates that attempts to treat such people through musical interaction not only include a significant degree of importance, but are also crucial in improving the behavioural patterns and motivation of the learners, even though it may be possible that they initially lose interest in undertaking any activities involving music. Furthermore, a recent study by Van der Krieke et al. (2013) related to learners with ‘psychotic disorder[s]’, lists active treatment through musical interaction amongst the alternatives that would help such individuals make informed life choices. Although this proposal was later abandoned due to inadequate resources, the solution finally chosen entails computers as a predominant tool; therefore, a potential combination of informatics and music therapy would be regarded as a combination assisting in a more comprehensive interaction with music in mental disability contexts.

Another concern that arises upon deciding to initiate such a practical project is the risk of excessively generalising its nature or enlarging its size. Generalisation represents an interface that would comprise some important foundations of applied music composition, fundamentally understood by people with a limited learning or emotion control capacity, but would very probably contain additional elements to which specific categories of impaired individuals would respond negatively or indifferently. Despite the need for an interface design to explicitly address the above areas, the choice of overly expanding the project structure while attempting to avoid generalisations, would lead to a highly sophisticated product, allegedly catering for the needs of various learners with mental impairments but not certainly accomplishing this objective in the long run. Three serious problems arise from such an approach, preventing it from becoming feasible in the process:

- The existence of numerous panels and objects would cause confusion to both the learner and his assisting tutor, as to which proposed solution would best alleviate the negative conditions associated with each different disability (or, in frequent cases, combination of disabilities).
- The interface, as an integral entity, would still be comparably complicated to other software platforms – for TD individuals – currently available on the market, even if the formation characterising each of the panels is sufficiently simple to be understood by an individual suffering from a mental disability.
- The requirement for maximum efficiency and active learner response would lead to such a project becoming potentially time-consuming, especially in the attempt to rectify possible irregularities in the planning and testing processes, considering the contrasting particularities amongst mentally disabled individuals.

The two risks described above may be relatively decreased by directing the project to a constrained category of learners, diagnosed for instance with dementia or Down syndrome only. For the purpose of the current research, the disabilities chosen may be collectively categorised under the term *Autism Spectrum Disorders (ASD)*, which generally affect similar areas of social interaction, behavioural control, everyday activity and cognitive integrity (APA 2000; APA 2013) due to irregularities in the human nervous system (Yapko 2003: 24-26; Betts and Patrick 2009: 11-13). A principal reason why ASDs are chosen as a point of discussion over other disability forms is their versatility, given that the intensity with which each of the aforementioned irregularities appear vary from person to person and are not always associated with a typical profile. This justifies the term *Pervasive Developmental Disorder* (PDD) used to both describe ASDs and distinguish them from such forms as psychotic disorders (APA 2000: 65-6; Findling et al. 2001: 11). Of course, PDD-compliant characteristics may appear in disabilities normally outside the autism spectrum, including dementia (Evans 1986: 204; Burd, Fisher and Kerbeshian 1989; Campbell 2004: 176) or cerebral palsy (Goodman and Graham 1996; Kilincaslan and Mukaddes 2009). However, the high popularity of music therapy as a treatment method amongst individuals with ASD (Reynolds 2016) as opposed to increased emphasis in medication-based treatment in dementia (Svansdottir and Snaedal 2006; Vink 2013) or other mental disabilities (Jensen 1999: 44; Sweeney-Brown 2005: 49 etc.) is a main reason behind the selection of ASDs as an impetus for a more detailed analysis.

In an effort to find the 'golden section', or reasonable compromise, between oversimplification and excess complexity of the interface, it is vital to initially examine, in detail, the causes and symptoms of autism spectrum disorders, the interest level of the respective learners in music combined with its role in shaping their everyday lives, and the manners in which music education and therapy are beneficial in controlling and improving these people's condition. Through the information gathered, along with its critical evaluation, it will be subsequently possible to determine the points of convergence between different, and frequently contradicting, mental health conditions. These common elements will be subsequently adapted to the structure of the software and the accompanying tangible object projected to provide hands-on external control, and any specific points of attention regarding selected learner categories will also be taken into close account and transmuted into plain but meaningful interface enhancements. The software designed to serve the above purpose, for a broad spectrum of ASD learners, is named *Terpsichore*, after the Muse of dance and musical theatre, in ancient Greek mythology.

The objective of the above method, employed through *Terpsichore*, is to assist the learners in composing their own melodies at their own pace, and not worry about any problems that might interfere with the seamless learning process. Obviously, it should not be expected that musical literacy is achieved to the highest possible level, after bringing the research to a close. Instead, it is much more important to encourage learners in embedding music routines within their everyday schedules, while simultaneously exploiting such an occupation to externalise their emotions, regulate their behaviours and moods, and work towards better everyday lives. The software should provide users with the opportunity to explore various possibilities in composition, whether these pertain to tonal music or sounds not strictly associated with a specific set of pitches. It should not exclusively constitute a simplified alternative of a composition curriculum for TD users, but more importantly serve as a mainspring for the carefree completion of everyday tasks in casual and classroom contexts. Ideas from influential personalities in the ASD music therapy domain (Berger 2002; Lim 2012, 2013; Hammel and Hourigan 2013; Ockelford 2013a, b; Scott 2017 etc.) are taken into close consideration when designing the software, so that the desired learning outcomes are achieved in a manner that reinforces learner interest in sustained occupation with creative music practices.

The biggest challenge that arises when setting the goals and aims of the endeavour in discussion, is the ambiguity between education and therapy within the same project. Empirically speaking, anything that would improve people's lives should be acquired by a special means of learning, whether this one refers to gaining experience, running into unforeseen situations and attempting to confront them successfully, or – most traditionally – acquiring new knowledge through books, texts and tutoring. The hypothesis to be initially supported, and then verified or contested through literature analysis and real-world research, is that people may be able to place the symptoms and consequences of an unfavourable health or life situation under control, through the personal work they commit to every day and their determination to seek for change within themselves. The above appears to be a convincing stance in helping qualify creative musical education as a prerequisite for the acceleration of autistic individuals' therapeutic processes.

Another idea discussed is the one that regards music therapy as a step towards the development of musical cognition skills and compositional aptitude, mainly considering that, to initiate certain music therapy programmes for diverse types of learners, no prior evidence of musical cognition is necessary (Jamabo and George 2014; Psychogios 2014). The combination of the above opinions should ideally enhance the argument that an interactive music software, similar to the one examined here, may assist in achieving a *reciprocal* relationship between educational and therapeutic influences of abstract sounds and tonal music with a definite pitch content. This principle should ideally advance the field of Information and Communication Technologies (ICT) for the alleviation of distressing disability symptoms through music (Charitaki 2015; Drigas and Theodorou 2016; Hardy et al. 2016: 37-8), and propose a unique creative composition approach as an addition to methods employed over the years in the construction of ASD-oriented music interfaces.

In short, the aims that the research intends to satisfy are the following:

- To assess the effectiveness of familiarising autistic individuals, irrespective of music skills, with an innovative music and sound composition platform.
- To determine how the software helps learners realise their creative potential and develop their preferences into a meaningful engagement with composition and music in general.
- To help learners exploit the acquisition of creative musical skills in an attempt to trigger their emotions, regulate their behaviours, increase their motivation and improve their wellbeing.
- To examine how the novel music and audio platform resolves the gaps present in similar music-oriented interfaces for ASD and special needs.

CHAPTER 1

MUSIC EDUCATION AND THERAPY FOR INDIVIDUALS WITH AUTISM SPECTRUM DISORDERS

1.1 Causes and general symptoms of Autism Spectrum Disorders (ASD)

The disability identified as Autism Spectrum Disorder (ASD) may be equally encountered in youngsters with various physical characteristics, and coming from different social and financial backgrounds around the world (Hart 1993: 41, Veague, Collins and Levitt 2010: 17-18). Autism is considered a 'pervasive developmental' disability, because it affects various aspects of the cognitive, social and emotional development of its respective learners (APA 2000; Eikeseth 2011: 320; Hammel and Hourigan 2013: 2; Kearney and Trull 2015: 402). It does not possess a unique cause and symptom profile but may manifest itself in a number of sub-conditions and variations (Watson and Marcus 1988: 272; Trevarthen et al. 1998: 28-39; Bogdashina 2006; Kluth 2009; Allen and Heaton 2010: 251). Although the disability was formerly considered rare, due to only a 0.025% of children being identified with it prior to the 1990s (Baron-Cohen, Leslie and Frith 1985), the respective figures have risen over the last few years, thus urging researchers and information services to regard autism as an 'epidemic' (Wing and Potter 2002; Jepson and Johnson 2007: 24-41; Veague, Collins and Levitt 2010: 11). In fact, findings of the last twenty-five years have demonstrated that autism diagnosis percentages could reach values as high as 1.6% in specific districts (Wing 1993; Baird et al. 2006; CDC 2014).

The causes behind the outset of autism, combined with the exact consequences it provokes in everyday human function and wellbeing, are not always similar, and may differ significantly among learners, while it also interferes with the individual's cerebral function and constrains interaction capabilities with one's surroundings (Ghaziuddin 2005: 93; Cassidy 2014). The origin of ASD appearance in humans cannot be precisely determined; certain research findings largely attribute autism to hereditary factors instead of influences from society or neurological factors (Cook Jr. 1998; Travis and Sigman 2000: 642), others mention the mild or larger influence of external surroundings in conjunction with 'heritability' (Constantino and Todd 2000; Hoekstra, Bartels and Verweij 2007).

In terms of ASD symptoms, Kanner (1943) identified such irregularities as: memorising sequences heard and instructed by peers, without being capable of critically evaluating them (Ibid.: 242), responding to questions by virtually reiterating their content rather than providing original answers, also expressed as 'echolalia' (Ibid.: 243, 248), and adhering to mechanically learned processes without a potential exploitation of creativity to reduce monotonous activity patterns (Ibid.: 245-6). Later on, the 'Camberwell' study (Wing and Gould 1979) proved that the existence of autism could possibly be due to an already existing brain malfunction or alternate disorder, and be associated with either conduct or communication and comprehension skills (Wing and Gould 1979; Wing 1981: 32), to include the process of valuing other individuals in their everyday environments (Wing 1998: 93-94). More recent studies have associated mental symptoms of ASD, especially communication deficits, with abnormalities in the human's genetic material (Bozdagi et al. 2010; Geschwind 2011) which is not exclusively the case as non-hereditary characteristics of the disability had already been identified (Lotspeich and Ciaranello 1993; Muhle, Trentacoste and Rapin 2004). Findings on autistic individuals of a broad age spectrum (Kobayashi and Murata 1998; Blacher and McIntyre 2006; Herring et al. 2006: 877-880) showed that certain interaction and behaviour problems may be attributed to the possible coexistence of autism with psychotic disorders (Simonoff et al. 2008: 921-2; Gray et al. 2012: 121; Del Pozzo, Roché and Silverstein 2018), although the two terms are not to be confused with each other (Bender 1959: 85) given that psychotic disorders are mainly characterised by people's inability to provide accurate and non-imaginary perceptions of the real world (Marshall Cavendish Corporation 2011: 350).

Autism presentation and diagnosis may be affected by the intelligence quotient (IQ) value of the human subject, leading to an increase in ASD presentation probability as the IQ magnitude decreases (Van Bakel et al. 2015). However, this relationship of 'mental retardation' (Wing and Gould 1979; Wing 1988; Wing 1994) to ASD has been broadly questioned. Kanner (1943) identified the high-IQ background of the children included in the examination sample (Ibid.: 248) and argued that the possibly superior gravity given by family members on subjects of academic or imaginative nature rather than on concrete human relationships, led children to exhibiting symptoms consistent with autism. Rutter (1983) also asserted that the relationship between low IQ and autism is not absolutely accurate but may vary between individuals. The characterisation of autistic individuals on the 'high-functioning' end may refer to individuals with an IQ as low as 60-70 on the Wechsler scale (Rutter and Schopler 1987; Gaffney et al. 1987), but subsequent researchers have set elevated IQ thresholds, at values above 100, in order for an ASD learner to be considered highly intelligent (Tsatsanis et al. 2003; Baron-Cohen et al. 2005). Recent research shows that the majority of the ASD population has a below average IQ (Howlin 2002; Charman et al. 2011), and that relevant intellectual gaps are attributed to autism, which can conversely be responsible for increased IQ in select subjects with comparison to TD individuals (Clarke et al. 2016: 419).

A common variation of ASD is *Asperger's syndrome (AS)* (Asperger 1944, Frith 1991), which primarily affects a learner's primarily emotional, psychological and communicative characteristics, more significantly than learning potential (Bauer 1996; Gillberg et al. 2001; Cohen 2008). A critical analysis of Kanner's (1943) and Asperger's (1944) texts describing 'classic' autism and AS respectively[1], demonstrates that autistic learners are more strongly affected in verbal and interaction-related aspects with comparison to AS-affected individuals (Aspy and Grossman 2011: 8), whereas the opposite is valid regarding the capability of forming complete lexical statements (Ibid.). People with AS may additionally exhibit pronounced difficulties in restoring previous experiences to mind (Bowler, Matthews and Gardiner 1997; Bowler, Gardiner and Grice 2000; Pierangelo and Giuliani 2008: 120). The corresponding symptomatology between AS and high-functioning autism, centred around the learner's conduct and his tendency to adopt actions observed by his external surroundings (Gillberg et al. 2001: 61-2), is the reason why various researchers attempted to correlate these two disorders (Baron-Cohen et al. 2001; Gillberg et al. 2001; Moyes 2002; Sansosti, Powell-Smith and Cowan 2010: 1-12).

To summarise, all conditions described above, in conjunction with autism-related patterns that do not comply with the standard profile of Kanner's or Asperger's disorder and are therefore described as *Pervasive Developmental Disorders Not Otherwise Specified* or PDD-NOS (DSM-IV / APA 2000; Delfos and Attwood 2005; Towbin 2005), are considered to normally belong in the autism spectrum (Wing 2011). Therefore, examples of people with ASD studied in the research literature, that will serve as subjects for the progression and completion of the *Terpsichore* interface case study (see Chapter 4), may exhibit one or more of the above disabilities and diagnoses. Consequently, conditions that have related symptoms and personality profiles to ASD or complement it within the same individual, including Attention-Deficit Hyperactivity

[1] A brief description of Kanner's work (1943), which was written in English as opposed to Asperger's (1944) German text, is available at the start of this Chapter.

Disorder (ADHD), dyslexia and Tourette syndrome (Wing 2011), are beyond the scope of the current analysis and will hence not be considered.

1.2 Music-assisted treatment in ASD: Main concepts and particularities

The familiarisation of autistic learners with musical concepts, with the prospect of applying these practically in everyday-life situations, is expected to be better facilitated when music is one of the subjects that apparently fascinates them. As a matter of fact, Emanuele et al. (2009) contend that learners interested in rhythm, melody and other music-related aspects, may exploit the power of music in order to improve such mental wellbeing areas as 'social interaction, communicative behaviour and emotional responsiveness' (Ibid.: 142), a point closely associated with autism since the era of Kanner (1943). Music often exhibits the ability to stimulate various feelings and provoke excitement (Sloboda and O'Neill 2001: 415-9; Menon and Levitin 2005; Lonsdale and North 2011; Cook, Roy and Welker 2017 etc.), as well as develop imaginative and interactive behaviours (Bunt 2012: 165; Beinhorn 2015: k2009-k2200; Foley 2017: 109-111).

Increased inclination of ASD subjects towards music, with comparison to neurotypical counterparts, has been attributed to a biological modification in the human's messenger RNA (Emanuele et al. 2009). This is possibly related to the fact that certain people diagnosed with autism express themselves in a more spontaneous manner through music than through conventional speech, accordingly affecting the extent to which they eventually achieve enhanced concentration, activity organisation and interaction skills (Thompson 2014: 1052), three of the desired *Terpsichore* interface long-term goals of non-musical nature. Moreover, the acquisition of musical aptitude prior to the emergence of linguistic communication skills has frequently been observed in autistic individuals (Hammel and Hourigan 2013: 66; Ockelford 2013b: 48; Hayes 2016: 178), thus encouraging therapists and researchers to highlight the musical aspect and incorporate it in potentially efficient learning strategies. Around 10% of people with ASD have been identified to possess particularly developed musical tastes and dexterity (Treffert and Wallace 2002). Such individuals are diagnosed with a 'savant syndrome' that subsequently allows them to take advantage of their outstanding cognitive and artistic skills as a means for accomplishing the previously cited non-musical goals (Ibid.: 81)[2], compensating for their

[2] Page numbers have been calculated according to the Scientific American paging (see top of PDF reference file) and not starting from 1, as the document shows at the top right-hand side of each page.

diminished overall IQ in case they are not considered gifted on an all-encompassing level (Treffert 2009).

The active engagement of autistic individuals with music has been suggested as a method capable of confronting the unfavourable functional and behavioural patterns induced by the disability itself[3], and highlighting the learners' qualities (Srinivasan and Bhat 2013). The authors present, in a diagram, the areas affected when bringing an ASD learner in contact with musical stimuli (Ibid.: 100), something that not only indicates the existence of changes in the cognitive abilities and welfare of the learner, but also implies that certain aspects associated with music education, such as 'perceptual' skills (Burnsed 1999: 8; Knieter 2013: 126), may be connected to other areas regarding mental health and everyday activities, thus implying a correlation between music therapy and the instruction of musical concepts.

Although the statements of Srinivasan and Bhat (2013: 100) indicate that feelings and logical reasoning are both affected by music, a debate has recently been raised regarding the capacity of music to stimulate emotions, based on the hypothesis that ASD learners are characterised by lower musical awareness than interpersonal communication skills (Allen and Heaton 2010: 251). The documented difficulties in certain individuals' ability to effectively absorb new knowledge and interact with peers (Hourigan R. and Hourigan A. 2009), and the emotional breakdowns resulting from an irregular brain function associated with ASD (Peretz 2006), explain the inefficiency of music to trigger feelings and meaningful human responses. In fact, certain sources (Allen and Heaton 2010; Allen, Davis and Hill 2013) have connected the above to a condition labelled as 'alexithymia', defined by negligent emotion processing in everyday situations (Fitzgerald and Bellgrove 2006) and affecting an increasing population of learners as the disability severity index becomes higher (Hill, Berthoz and Frith 2004: 232). Moreover, the investigation of how appropriate musical interventions may positively influence behavioural control, acquires particular debate value. This happens because adverse behaviours may not always derive from the learner's frustration and subsequent intentional necessity to get feelings noticed and comforted by others (Tilton 2004; Lipsky 2013: 135-160; NAS UK 2018), but may frequently indicate abnormalities in the learner's sensory processing system after having received an unmanageable amount of information (Berger 2002: 73; Dodd 2005: 70, 195; NAS UK 2018). These two different behaviours are respectively characterised as 'tantrums' and 'meltdowns' (Tilton 2004; NAS UK 2018 etc.).

Despite the above circumstances, the reliance on music as an educational and therapeutic tool for autistic individuals has been proposed in a number of situations. To begin with, various

[3] This explanation is to distinguish ASD-related behaviours from adverse conduct that, although detected in infants, not always suggests the existence of the disability (Kozlowski et al. 2011: 75).

findings have exhibited a contribution of ASD music interventions to improved linguistic integrity and communication (Gattino et al. 2011; Wan et al. 2011; Lim 2013; Gold et al. 2014 etc.), particularly when establishing a connection between verbal and musical stimuli (Siegel 2003: 219) and considering the congruence of various overlapping characteristics in these two aspects (Molnar-Szakacs and Overy 2006). A serious condition related to communication, for the treatment of which music has been found to play a significant impact, is 'echolalia' (Whipple 2004; Lim 2012: 183-7; Marom, Gilboa and Bodner 2018 etc.), termed as a mechanical repetition of speech patterns articulated by surrounding individuals It has also been demonstrated that disadvantaging ASD traits in communication and behaviour, even of increased gravity, can be efficiently countered through prolonged occupation with music (Boso et al. 2007).

Musical signals are understood and better processed through the firm function of the brain's right hemisphere (Joseph 1988; Zatorre, Belin and Penhune 2002; Addis 2004) as opposed to the left one, principally related to speech and linguistic functionality (Zatorre et al. 1996; Lim 2012: 39; Deutsch 2013: 152). However, the left hemisphere may also be responsible for developing the comprehension of time signatures, rhythm and any other notions associated with time in musical performances (Zatorre and Belin 2001). Therefore, an ideal programme of music instruction and therapy, tailored to the needs of autistic learners, should include elements able to harness the power of both hemispheres and concentrate on enhancing verbal communication skills as a result of music being heard and played (Lim 2012; Ockelford 2013b; Lim 2013: 208). This recommendation is also inspired by the fact that certain sounds, produced by either actual instruments or environmental sources, are characterised by pitches that belong to the ordinary speech frequency spectrum (Wilson 2002: 295)[4].

The musical procedures applied to learners with ASD are examined separately from the curricula that are favoured in neurotypical individuals' music instruction. However, Berger (2002: 112; 2016: 106) proposes that the ASD educational and therapeutic methods ideally concentrate on six components that universally characterise the music of today; these are the following:

> […] rhythm, melody, harmony, dynamics, timbre, and form. […] (Berger 2002: 112).

Various elements can also appear in combinations of two or more, influencing the connotation of a musical or lexical phrase and the manner in which this is expressed; these types of combinations are collectively defined as 'prosody' (Paul 2005: 813; Cleland 2010: 41), whose role in

[4] Although this finding is presented in a section related to 'hearing loss', it may serve as a commonly accepted fact that supports the need of jointly developing musical and verbal functions through the *Terpsichore* software.

understanding feelings of others has been found to positively correlate with musical literacy (Lima and Castro 2011: 1021).

However, recent treatment methods classified as 'music therapy' involve the broader use of sound stimuli that do not necessary fall into the category of music as defined through Berger's (2002: 112) proposed components (Shealy 1999: 230; Oldfield 2006a: 69; Bunt and Stige 2014: 60-61). On this basis, a meaningful and versatile curriculum aimed to satisfy the above purpose should not limit itself to elements that rely on Western European[5] music conventions, but should include sound to its highest possible extent, even if its pitch is indefinite and its rhythm or melodic structure abstract. This statement is connected to an alternative music education direction, which is not constrained to Western music conventions but is rather based on the 'organised sound' concept (Varèse and Wen-Chung 1966; Reitan 1992: 630; Hoffer 2009: 24-6), embedded in attempts to acquaint classroom learners with ideas of composition that extend beyond principles of common Western music theory and instrument execution (Paynter 2008; Martin 2012; Goodman 2017). Such sounds as falling rain, rainforest animals, town vehicles or the wind may be included in sequence playback, recording or composition routines, in an effort to increase auditory awareness through realistic representations of environment and compensate for any possible musical illiteracy or initial lack of interest in definitely pitched sounds.

A fundamental basis of various music therapy proposals is the *Nordoff-Robbins* method (Nordoff and Robbins 1971, 1977; Trevarthen et al. 1998: 188-9; Kim 2004; Carpente 2009; Aigen 2014). This method relies on a supposition related to the appreciation of music by the learner as an inherent characteristic (Kim 2004: 322; McDermott and Hauser 2005: 29), which subsequently strengthens the person's capacity to create music for purposes of wellbeing improvement and rehabilitation. Carpente (2009) elaborates on NRMT[6] as a procedure potentially allowing the learner to create original musical stimuli, subsequently leading to improvement in such areas as social interaction and cognitive integrity. This study is a representative example of attempts to develop abilities both associated and irrelevant to music, implying that the latter abilities could be palpably related to and influenced by the former (Ibid.). Moreover, Aigen (2014) regards active engagement with music as an inextricable component for efficient music therapy with a pronounced positive contribution to learner welfare, contrary to settings where music is employed indirectly and focus is instead given to emotion excitation or peer communication (Ibid.).

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[5] By 'Western music' we will henceforth refer to Western European music conventions governing classical music and subsequent relevant genres.

[6] NRMT stands for 'Nordoff-Robbins Music Therapy'.

A number of previous research endeavours also promote the ‘improvisational’ music performance and education as a suitable and effective technique in supporting the treatment process of ASD (Edgerton 1994; Wigram 2004; Kim, Wigram and Gold 2009; Geretsegger, Holck and Gold 2012). For instance, the primary school age learners recruited by Edgerton (1994) were subjected to a 10-week programme centred around the encouragement to perform original impromptu phrases, eventually resulting in developed ability to interact with peers. This statement implies that any future learning session series designed to favour composition over reproduction could be equivalently spread over the course of more than 10 weeks or distinct sections, with the prospect of expecting similar results relating to welfare improvement.

In another more recent example, Wigram (2004) attempts to connect the notions of ‘composition’ and ‘improvisation’ together (Ibid.: 19, 24-25) and distinguish impulsive music execution from the imitative repetition of a piece instructed by a peer tutor (Ibid.: 24-25). He also endorses improvisation as a method that gradually helps the learner memorise musical pieces without referring to recorded scores (Ibid.), and proposes, as a step-by-step learning strategy, the gradual transition from directly provided and instructed melodies to spontaneously arranged patterns with only specific structural constraints; this process is labelled as ‘extemporisation’ (Ibid.: 114). A similar alternative to the above technique would involve the instruction of a simple note succession, which would subsequently be repeated by alternating the positions of adjacent notes, once at a time. Furthermore, the inclusion of tasks specific to ‘improvisational’ therapy has recently been discovered in the ‘relational’ method encompassing multiple areas of mental condition intervention (Gallardo 2004, cited in Gattino et al. 2011: 144). Although the validity of associated results is doubtful (Gattino et al. 2011: 149-151), the principles of this method and its connection to spontaneous composition can be incorporated in the design of software interface to proactively enhance non-musical skills.

Finally, the succession of notes in a scrambled manner may possibly increase the learner’s creativity and subsequent interest in such activities, considering that Mannes and Kintsch (1987) had already proven that the cognitive abilities of autistic learners increased when people were brought in contact with verbal successions arranged in various orders (Ibid.: 113-4). Future statements associated with syntax and its relation to music (Miller 2007: 1) and the music instruction domain (Dalziel 2003: 594-5) may justify why a learner can benefit from rearranging musical components instead of passively reproducing their initial form. Mannes and Kintsch (1987) attributed the above result to increased effort to understand disorganised patterns, something that is not always the case for musical phrase recognition whatsoever. In fact, some learners demonstrate potential to increase their work rate to understand more complex concepts (Coucouvanis 2005: 15) whereas others are challenged by such a procedure and occasionally seek alternative pathways in returning to their comfort zones (Stahmer et al. 2011: 28). Such activities based on musical disorganisation may therefore counter potential unfavourable behaviours that indicate confusion.

1.3 Music Education vs. Music Therapy: Connecting notions, resolving ambiguities

As clarified from the start of the project description, the *Terpsichore* software interface is projected to educate individuals in a musical and artistic context, bringing them in closer contact with fundamental notions related to music performance and composition, while simultaneously employing music in order to treat everyday life aspects including, but not limited to, task organisation, peer communication, behaviour and motivation. The attempt to connect the two above objectives under the same practical task may be obstructed by the possible ambiguity created when examining them in conjunction with each other. A common question that arises concerns the possibility of fulfilling both goals in an equally satisfactory manner, without the risk of either retaining the learner in a state of inability to perform melodies and release his creativity, or aggravating his medical condition, health and behaviour. In addition, given that the user will be expected to respond directly to the structure of the interface and its dynamic components, such as a timeline or a moving panel, it is important to guarantee that the individual develops an understanding of the information and visual sequences vital to the engagement with expressive composition techniques, and allow this understanding to positively control behavioural and sentimental functionality. A major issue regarding the above statement is the possibility that the overlapping education and therapy objectives ultimately lead to the learner remaining absolutely passive, without demonstrating favourable changes associated with either of the aforementioned goals, in the short or longer run. For the above reasons, this Section will aspire to resolve the confusion between *music education*, or instructing a mentally impaired person to produce music, and *music therapy*, related to mental condition treatment and improvements using musical interventions.

Sharma (2008) presents a thorough analysis of the both educational and remedial aspects of music and their application to individuals. Through descriptive examples (Ibid.: 57-59), Sharma agrees that the instruction of such musical principles as rhythm and structure is crucial to the improvement of a young individual's emotional awareness, memory or 'cognitive' skills, and capacity of performing original actions and taking initiatives (Ibid.: 59-60). In addition, youngsters getting in close contact with music are more likely to develop a considerate code of behaviour towards other individuals (Ibid.: 60). It may be commonly assumed that music therapy's general aim is to ensure comprehensive mental treatment for learners in terms of conduct, communication skills and everyday functionality. The association of this statement with Sharma's (2008) assertions, provides a primary indication of the close connection between the two previously cited facets of music. More specifically, given Sharma's reported positive effect of musical teaching, such education may either serve as a prerequisite for the mental rehabilitation of individuals, or classify itself as an activity capable of enhancing the rhythmic and melodic knowledge of people, especially of a young age, to their everyday life advantage. This belief is also reinforced by Ockelford's (2000) emphasis on proposals on how practitioners should employ methods of therapeutic importance in educational settings of music, combined with the perception of compositional activities as a procedure where several components of a learner's personality play a predominant role (Bunt 2003: 191).

The above three analyses suggest an intimate connection of music education to music therapy, by means of a cause-and-effect relationship, defined by the accomplishment of therapeutic procedures as a result of education. However, Brunk (2004: 4) questions this opinion and instead argues that the two terms exhibit serious differences in their definitions. Specifically, her statements suggest that the application of music therapy is capable of influencing activities and behavioural patterns extending beyond the boundaries of music education, a field constrained to the plain instruction of music fundamentals, directed towards embracing music performance as a leisure activity and not as effectual in mental health than therapy (Ibid.). However, the author asserts that learning how to perform music may positively contribute to the development of interpersonal communication and confidence. Consequently, it can be deduced that music education is essentially a fractional component of a significantly higher amount of activities contributing to all the life-changing effects expected from the interaction with a music therapy system or practitioner. A therapist influenced by these judgments, might benefit from encouraging the disabled individual to absorb musical concepts through playful activities and still manage to satisfy the learner's 'physical, emotional, […] and spiritual needs' (Kennelly 2000: 57). This however implies that a certain degree of higher education should be achieved by a person undertaking therapeutic activities on a learner, something that does not necessarily apply to an exclusive instructor of music (Ibid.).

Wheeler (2015: 9) claims that the objectives achieved through these notions are distinctively different, but professionals in the two relevant sectors exploit similar procedures in harnessing the power of music. This statement reinforces Sharma's assertions, since it not only clarifies the distinction between the above terms, but also validates the cause-and-effect relationship under which these are bound. Her description also leads to an interesting observation concerning the reciprocal nature of the above cause-and-effect connection, defined not only by the favourable consequences the learning process can have to the learner's welfare, but also by the contribution of music therapy to increased understanding of rhythm, melody and other relevant principles:

> […] Those participating in music therapy very often also improve their music skills, and those participating in music education often improve aspects of their health… […] (Wheeler 2015: 9)

According to the above, music therapy is regarded as a sector of major importance for professionals involved in the instruction of music, regardless of their field of specialisation. Such an observation refutes Brunk's (2004) belief that the knowledge transferred by a conventional music teacher has trivial mental health benefits. Instead, it highlights the necessity for the inclusion of practical treatment aims in the learning process, without this one being restricted to the comprehension of notes, melody and rhythm. For instance, the hypothesis that the maintenance of a steady rhythm leads to the gradual coordination of the learner's actions in the time spectrum is confirmed in Wheeler's analysis (2015: 9), something that demonstrates music education's predominant place in therapeutic procedures. The case mentioned above, also assists in qualifying education as a crucial component in alleviating the symptoms of a mental disability. This statement appears to be closest to the objectives of the music composition interface about to be planned and applied to mental disability target groups, binding music education and therapy together, and is also in good agreement with what Sharma (2008) describes on the matter.

The remedial value of music education can also be justified by its documented role as a means of exploiting the need for 'sensory stimulation' (AMTA 2006a: 1; Hoemberg 2014: 7; Mac 2014: 229), interpreted as a series of signals, messages or actions serving as an impetus for additional motivation to perform tasks and openly express enthusiasm. For such individuals, the educational aspect of music is neither irrelevant to the therapeutic one, nor may serve as a plain substitute; instead, the author asserts that the benefits provided to the learner through the conventional learning process constitute only a fraction of what can be achieved by the practical interaction and engagement with unique means of education beyond the aforementioned restricted boundaries.

An agreement with the ideas of Mac (2014: 229) and Wheeler (2015: 9), regarding the contribution of conventional learning processes, also seems to be reached by the American Music Therapy Association (2006b), who instead are in favour of specialisation, with concern to not only practices that encourage learners to take initiatives, but also personalised learning systems. This is where the notion of an IEP ('Individualized Education Program' – AMTA 2006b) acquires special importance. An IEP allows the tutor responsible for the rehabilitation of the mentally disordered individual to adapt educational patterns to the learner's interests, conduct and eagerness to interact with the outside world (Ibid.). Therefore, a tutor willing to abide by IEP guidelines should initially acquire in-depth knowledge on the habits, strong and weak points of the learner, before proceeding to the design of an efficient therapy plan. In addition, the IEP clearly extends beyond ‘general’ learning conventions and concentrates on life values and global personality improvement, not constrained within a purely musical framework (Ibid: 1).

The above description indicates that music is a minor component of a much more elaborate procedure in improving a mentally disabled individual’s life. However, recent findings have shown that even this partial contribution of music education to the wellbeing of a person is important enough to be carefully considered during the design of a creative music therapy system, thanks to the objectives fulfilled through pure educational approaches. Renwick and Reeve (2012: 144-147) concentrate on a series of concepts closely related to the learner’s ‘motivation’, which can either be inherent (‘intrinsic’, Ibid.: 145) or ignited by the potential consequences of whether a specific task has successfully been completed (‘extrinsic’, Ibid.: 146). Ideally, the positive exploitation of instructing the individual how to perform and produce his own music should subsequently serve as an impetus for the emotional, social and behavioural rehabilitation of such a person; that said, the musical skills gained should be transferred into a broader non-musical context over time. The AMTA document (2006b: 2) proposes a bilateral collaboration between one entity or group serving as an ‘educator’, and another playing the role of a ‘therapist’. However, the interface will be designed mainly to enable the close interaction between a peer tutor and the learner, on the basis of individual learning. In other words, the endeavour to jointly take advantage of the interface structure and a human assistant should be sought and endorsed, in order to make the learning process more direct and prevent it from necessarily relying on more than one person per learner.

1.4 Technological advances in music for disabled people

The *Terpsichore* software interface, to which the majority of the current research will be devoted, is projected to adopt positive elements from previously constructed interfaces centred around music therapy or education for people with special needs, with a view of addressing targeted and compositional music education as a therapeutic strategy. As a theoretical framework serving as background for the eventual construction of *Terpsichore*, this Section will briefly present all representative interfaces that attempted to address such objectives in recent research, with an emphasis on their advantages and shortcomings, as well as their applicability to the ASD treatment field.

1.4.1 SoundBeam

Various research studies in the last two decades involve the exploitation of *SoundBeam*, a musical interface conceived by Edward Williams in 1984 (Williams 2007: 17) and becoming an object of interest for miscellaneous studies (Ellis 1994; Wigram and De Backer 1999: 258-260, Ellis and Van Leeuwen 2002; SoundBeam Website 2015). Williams' (2007: 17-19) initial aim was to simulate the execution of conventional orchestral timbres, by utilising the auditory effect caused by the movement of the body with relation to a steady object made of an electrically conductive material (Ibid.: 18). Moreover, the core instrument that accompanies the sensors is equipped, amongst others, with over 200 timbres to choose from, numerous pre-produced sequences for the instruction of musical segments, basic timbre modifiers, remote 'switch and beam' controls for sound generation from distance, and external connectivity options via MIDI and USB.

The combination of the SoundBeam's remote interaction component with the MIDI protocol for real instrument approximation has been a source of inspiration for accessibility in music therapy (Stensæth & Ruud 2014: 41), while the interface altogether was recently employed to regulate the motor skills of participants and acquaint them with diverse aspects of creative music performance (Martino and Bertolami 2014; Lee 2015). Moreover, a recent intervention by Lee and Ho (2018) concentrated on the 'holistic' deployment of the SoundBeam in preschool settings to foster joint development in music education and therapy through a syllabus-based approach, which is a principle on which the *Terpsichore* intends to base its construction. Figure 1.1 below presents a typical SoundBeam hardware configuration.

Figure 1.1 *Visual representation of the SoundBeam setup (Living Made Easy 2018).*

The example of SoundBeam can be adapted to the *Terpsichore* interface as it has to be a significantly useful musical tool for disabled children over time (Williams 2007: 18-9). Particular emphasis is given to the increasing creativity of SoundBeam users even when suffering from a highly incapacitating condition:

> […] All sorts of people who'd never, ever been able to do anything before… [ ] … suddenly found that by moving a little finger or an eyelash or the head they could control and make music, and ***compose*** music. […] you can suddenly hear that they (*i.e. the children*) are actually composing. They are actually saying, listening to it, yes, I like that, I'll do that again, now I'll do something else, which is after all ***basic composition***. […] (Williams 2007: 18)

On the contrary, through the same statement, the exclusive concentration of the author on young age target groups induces doubts over the efficiency of SoundBeam on disabled adults and particularly sensitive categories thereof.

- Lack of controls pertaining to rhythm and the organised sequence of notes and rests in predefined timeframes.
- Increased bias on tonal music and structuring, with classical influences, with only limited examples of acousmatic, atmospheric and environmental music applications of SoundBeam mentioned (SoundBeam Brochure 2015).
- Ability to only produce isolated note events directly; the construction of chords and other consonances can only be achieved through active intervention in the system by the user (B.P. and K. Challis 2008: 340). Having an on-screen utility that would allow such formation to be a more effortless task, eventually assists the learner in expressing feelings more clearly (Ockelford 2013b: 64) and aspires to facilitate musical form awareness, primarily when exploiting chords to accompany a song with lyrics (Brunk 2004: 41).

- Absence of an accompanying computer software potentially containing on-screen GUIs (Graphical User Interfaces) and assistive tools in the composition process, despite SoundBeam's external communication capabilities with computers (SoundBeam and Soundtree Websites 2015) given the increasing dependence on the latter in learning contexts. Elevated purchase price constitutes an additional issue (SoundBeam Project 2016).
- In addition to the above, Magee and Burland (2008: 140) identify that, despite the software's popularity in the special needs domain, carers and therapists are dissuaded from employing the SoundBeam to learners with ASD. This happens both because the software's fragile structure is possibly susceptible to behavioural adversities, and due to confusion issues raised by the interface's excessive reliance on auxiliary equipment (Ibid.).

1.4.2 MIDIGrid, MIDICreator and similar applications

As part of their research on music technology for therapeutic applications, Kirk et al. (1994) employed two systems whose functionality, similar to SoundBeam, is strongly governed by the MIDI protocol. The first of these, MIDIGrid, allows users to record voices of a definite pitch, or input building blocks representing notes onto a computer-based structure, responsible for converting signals into MIDI messages. In this system, a 'mapping' mechanism empowers audio generation through such a MIDI-enabled device as the keyboard (Ibid.). The second system, MIDICreator, complements the first one by exploiting the functionality of transducers to accomplish MIDI-driven sound production (Ibid.; Hunt, Kirk and Neighbour 2004 – see Figure 1.2), with electrical resistance shifts being the operative cause for MIDI message generation (MidiCreator Website, cited in Hunt, Howard and Worsdall 2000: 357).

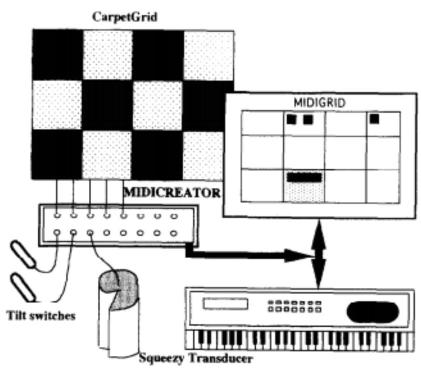

Figure 1.2 *Graphical representation of a system comprising MIDIGrid, a transducer and MIDICreator (Kirk et al. 1994).*

The MIDIGrid system has been revamped into a self-contained software version (Full Pitcher Music Resources 2014) operable through a fundamental mouse and keyboard setup, while the combination of sound generation tools and high-contrast imagery enhances the software's usability for disadvantaged individuals (Ibid.), while the MIDICreator was identified as a resourceful music performance aid for underage individuals with ASD (Biddulph, interviewed by Hildred 2006). These MIDI-driven systems, when compared with the SoundBeam, seem to possess similar functional principles especially due to their common reliance on gestural interaction (Martino and Bertolami 2014: 203), which is not always necessary in attempts to execute computer operations and undertake MIDI communication. Moreover, its applicability to underage learners with ASD A similar system employed in the disability domain is the *MIDIBox* (Lund, Henningsen and Nielsen 2009), which also supports sound generation via MIDI even if no direct mention to gestures exists.

In general terms, the MIDIGrid's format and compositional possibilities can be considered a premature or accessible format of modern-day sequencers, especially thanks to MIDI connectivity and the step recording process, which is similar to the piano roll concept. However, the manner in which the interface is structured, a number of content comprehension difficulties arise, especially in such areas as instrument selection and melody sequencing, which do not differ significantly from sequencing environments addressed to the TD population in terms of complexity (Full Pitcher Music Resources 2014). Another shortcoming is the absence of explicit elements of a rudimentary music curriculum, which would ideally increase the adeptness of participants at embedding theoretical knowledge in their compositions to enhance aesthetic quality.

1.4.3 Benemin and Octonic

The *Benemin* constitutes an attempt to implement contemporary technological advances in constructing a musical instrument that offers the capabilities available in modern synthesizers for non-disabled people (B.P. and K. Challis 2008a: 1221-7; 2008b: 338-340, see Figure 1.3 below). Named after Dr Ben Challis and the Theremin electronic gestural instrument, the *Benemin* employs a series of sensors which enable the remote interaction between a user's body and the instrument, thus rendering the process of creating melodies achievable regardless of musical literacy (B.P. and K. Challis 2008a: 1221).

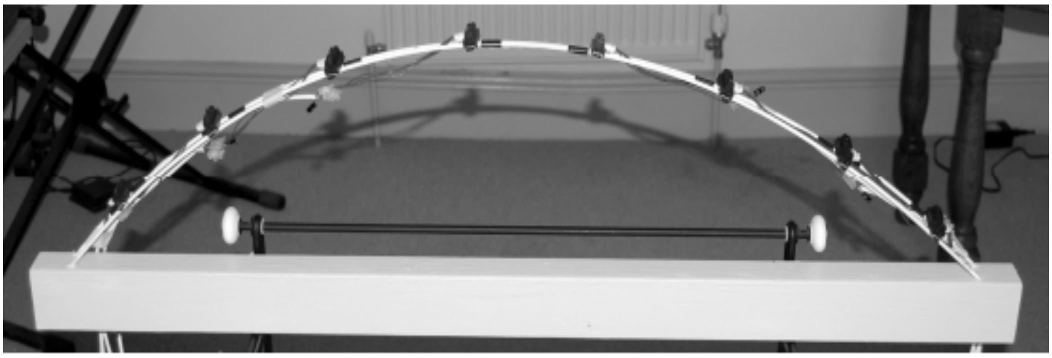

Figure 1.3 *Visual representation of the Benemin (B.P. and K. Challis 2008b: 342).*

The introduction of musical articulation and expressive phrasing in what would be considered, under other circumstances, a plain and sometimes uninteresting generation of tones or reproduction of environmental sounds or recordings, is of significant interest in enriching the learner's musical background and activate his emotional consciousness, which jointly constitutes one of the fundamental objectives of the *Terpsichore* project. The instrument is based on interpretative musical phraseology (B.P. and K. Challis 2008b), providing a clear distinction between the SoundBeam and the Benemin and qualifying the latter as an influential source for the current project, without diminishing the value of the SoundBeam whatsoever (Ibid.: 339). This concept is perceptible in a subsequent endeavour aimed at classroom contexts; the *Octonic*, as the instrument is called, is capable of acquainting learners with various fundamentals and offering advanced reproduction and composition capabilities (Challis 2011: 4-6) inspired by the principal elements of Western Music as outlined by Berger (2002: 112). The author's notable focus on simplicity is in high accordance with the need to ensure a carefree and unobstructed learning routine for disabled individuals, generally considering their decreased educational and cognitive potential with contrast to neurotypical entities. It is particularly necessary, as part of the Benemin learning process, to (B.P. and K. Challis 2008b: 339-341):

- enable the tutor to customise the structure and functionality of an interface in various ways, without constraints;
- expand the spectrum of interface users, in order to cater for all levels of kinetic and mental integrity;
- ensure the production of sound even when the human body is positioned at an elevated distance from the instrument;
- give prevalent emphasis on articulation, dynamics and sound colouration, rather than in the plain execution of notes.

Similar operational principles to the Benemin are distinguished in the *Octonic*, especially with regards to the sensor system included (Challis 2011: 5-8); however, the increased cost of purchase affected by the sensors, as well as the inability to directly alter parameters without external code-based assistance (Ibid.: 8), are considered crucial limitations in tutors' attempts to embed the Octonic in learning sessions. Furthermore, a more recent 'game'-based interface by Challis et al. (2017) encourages the creation and modification of visual environments by employing Western music principles in spontaneous composition. This project comprises, amongst others, the interesting arrangement of 'levels' (Ibid.: 5) to be applied, albeit differently, in the *Terpsichore* interface (see Section 3.2), but is constrained in both its freedom degrees in manipulating or selecting sound signals (Ibid.: 5) and its reliance on generalised notions implying the requirement for increased adaptability (Ibid.: 7).

1.4.4 Chrome Music Lab by Google and relevant adaptations

The *Chrome Music Lab* (CML) constitutes an attempt initiated by Google in combining the powers of music and computer technology, in order to provide youngsters with an interactive means of familiarising themselves with core musical concepts (Google 2017). As seen in Figure 1.4, the CML contains various sub-windows, each associated with a different aspect of fundamental music theory, harmony and awareness, including percussion layering on a timeline, creation of note melodies and consonances, and visual representation of sine waves.

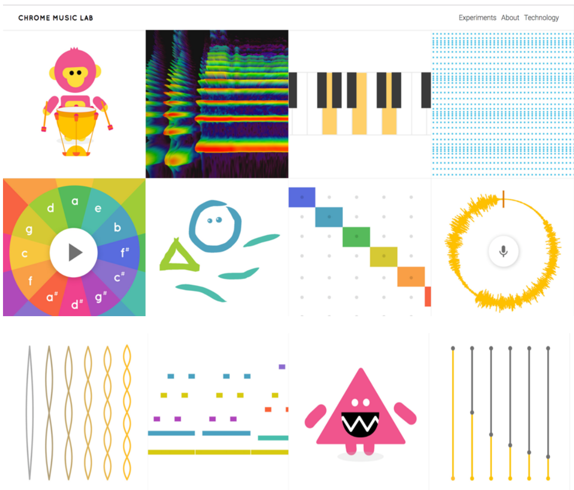

Figure 1.4 *Main Menu of the Chrome Music Lab (Google 2017).*

In contrast with previously described interfaces, the CML is characterised by an elevated degree of simplicity and user-friendliness, something potentially attributed to the joint exploitation of features offered by the Google Chrome browser and an accompanying working environment (Li 2016). Such an interface enables a user to manipulate, combine and modify different types of audio signals by exploiting relevant operational elements of an Internet browser (Gasston 2013: 174; Roberts, Wakefield and Wright 2013: 434). In addition, CML capabilities include the comprehension of scientific principles behind the formation of sounds, or the transformation of visual cues into music (Hachman 2016) without the requirement to use an external instrument.

Although the elements of CML are aimed at introducing learners to basic music notions, the interface does not provide step-by-step guidelines, in the form of levels, for the smooth transition from melody reproduction to original music composition, as employed in relevant ASD projects where learners are less capable of creating melodies from point zero (Pasiali 2004; Brownell and Arbor 2012: 123). Moreover, separate CML windows are arranged in an arbitrary manner and not according to clearly defined learning criteria, while spatial elements associated with perception of sound in the stereophonic field are not present. To solve this issue, Padmanaban and Monler (2016) conceived a 'virtual reality' adaptation of the CML that aims to represent stereo sound variability through a visual three-dimensional depiction of audio accordingly diffused around a 3D space. A simplified version of this approach can be implemented in interfaces for autistic individuals, considering their commonly limited learning aptitude especially in the low-functioning end; still, the step-by-step principle combining pure musical knowledge and compositional training prevents the CML from enabling an autistic individual to cultivate comprehensive music skills even at an elementary level.

1.4.5 The Skoog

The Skoog is a special education tactile music interface (Schögler / IdeaMensch 2011; Skoogmusic 2020) directed to youngsters with severe forms of physical and mental disabilities in their attempt to play and compose original music (McKeown and McGlashon 2015: 66). This interface, capable of operating with popular sequencers originally designed for neurotypical individuals (Skoogmusic 2020), contains a cubic object that can be manipulated in different manners and produced desired sounds in different forms of execution through relevant touch response technology (Hammel and Hourigan 2013: 46). The production of sound is made possible by means of signal transmission from the Skoog to an electronic device running on an Apple operating system (Smith 2016) with enhanced USB (Rothwell 2014) and MIDI support (Hammel and Hourigan 2013: 46). In addition, the versatility of the *Skoog* and its accompanying software is outlined in the ability to create, combine and modify sounds that are not necessarily tonal, but also form parts of environmental soundscapes and stimuli deriving from everyday life (Biddulph, interviewed by Schögler 2016).

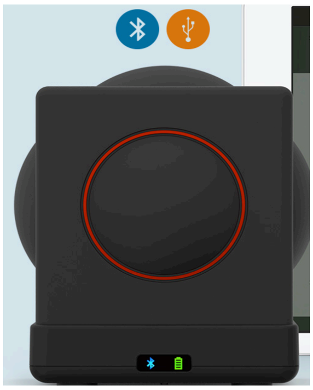

Figure 1.5 *Front view of the Skoog 2.0 (Skoogmusic 2020).*

The Skoog allows the composition of phrases in the form of free improvisation (Robertson 2017), which constitutes an important limitation of the interface in itself, as it does not provide any guidance that would direct the learner to improvise under specific regulations compliant with Western European music conventions, or other tonal relationships present in world music. This encourages the application, independently from the *Skoog*, of improvisation methods as gradually altering conventions and musical structures initially taken for granted (Gutstein 2000: 12; Treffert 2015: 243). Based on the Skoog is the foundation of other projects such as the *Actionplay*, intended to bridge the gap between improvisation and guideline conception (Feinstein 2016: 140-1). Skoog's availability in the form of a tangible object is considered an important advantage, mainly for reasons of a learner's increased comfort with activities and objects, including toys, commonly encountered in life (Siegel 2003: 52; Landa 2011: 222). However, its elevated price tag (Apple Store 2017) and constraint to five notes or samples at a time (Hammel 2017: 185-6) are considered obstacles for tutors planning to provide musical guidance to their autistic learners.

1.4.6 VESBALL

The *VESBALL* tangible interface was conceived by Nath and Young (2015) and is centred around therapeutic interventions in a collaborative context, where multiple participants engage in music performances to simulate an orchestra setup. This interface has an ellipsoid shape, as seen in Figure 1.6, while the use of 'soft foam' as its construction material, in similarity to the Skoog (Skoogmusic 2020), allows learners to produce audio signals through the deformation of its surface. Moreover, connectivity to a computer, which exists in the Skoog as means of remote interaction, is replaced by electric circuitry to transform instances of hand-interface touch into sound (Nath and Young 2015); the existence of MIDI audio generation and USB-driven battery recharge are indicative of the interface's independence from a computer to operate. The concept of working 'modes' is also a representative feature of the *VESBALL*, as users are presented with the option of alternating between drum and tonal instrument sound banks. The shape and material of the interface encourage its employment in various cooperative settings, without the risk of being damaged, while the lower mentioned purchase price compared to the Skoog (Ibid.) emerges as a potential advantage for use in music therapy.

Figure 1.6 *Physical representation of the VESBALL (Nath and Young 2015).*

An analysis of the *VESBALL*'s construction and functional principles implies that the development of fundamental musical literacy and miscellaneous educational elements is barely included, mainly in an attempt to lower interface cost and reduce the amount of required activities in order to accommodate non-musical goals. Considering that *Terpsichore* attempts to concentrate on music education and therapy as equally as possible, optimization of the above system would benefit from the inclusion of structures that provide guidance on how to compose melodies governed by not only an elementary degree of discipline, but also tonal variety extending beyond a limited five-note framework.

1.4.7 Window by Katharine Norman

Inspired by the fact that music education and therapy processes should not be exclusively realised through melodies and consonances produced by musical instruments with strictly defined pitches, *Window* constitutes an attempt to produce original auditory interventions relying on environmental soundscapes rather than conventional instruments (Norman 2012a). Norman's (2004) interest in electroacoustic music and means of producing expressive pieces from objects producing indefinitely pitched sounds, resulted in a platform aiming to narrate ordinary stories from people's lives through image, sounds and written captions (Norman 2012a, b). In *Window*, the user is enabled to seamlessly alter the on-screen visual and auditory content, so that it plausibly corresponds to everyday life environments associated with the year's twelve months (see Figure 1.7).

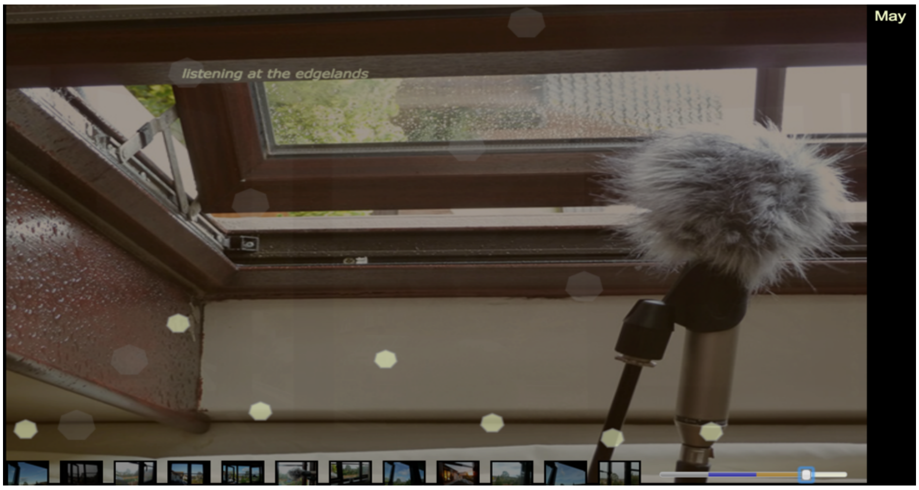

Figure 1.*7 Screenshot from 'Window', depicting a landscape in May (Norman 2012a).*

Norman was influenced by the work of 20th century music composer John Cage (Ibid.), whose musical occupation was centred around the reliance on sounds from the environment, especially when these are generated spontaneously, as means of energising a musical piece and increasing its appreciative value (Nyman 1999: 25; Kostelanetz 2003: 61-5). By observing the structure of *Window*'s online format (Norman 2012b), a high degree of relevance to two of Cage's landmark works is perceived. Specifically, in the *Imaginary Landscape* composition series, it is possible to distinguish either a series of recorded abstract sounds that gradually appear or vanish successively[7] (No. 5, LaBelle 2015: 8) or an aesthetically variable environment with mood and intensity parameters controlled by radio frequency changes (No. 4, Pritchett 1996: 89-90). Likewise, in *4'33''*, the idleness of the pianist (Ford 2011: 126) does not result in a purely quiet piece whatsoever, but rather in a distinct and variable soundscape formed by random environmental excitations of the pianist's or observer's surroundings (Pritchett 1996: 58; Brooks 2007: 124).

Window's notable difference from previously examined interfaces is that it constitutes an online or iOS-compliant audio installation, rather than an assistive software for the

[7] In *Window* (Norman 2012a), this role is played by a scrolling slider allowing navigation between four different modes, each represented with a unique colour.

comprehensive musical education and treatment of mentally disabled people, let alone ASD learners. However, the interface's features may be adapted to the learning routines of autistic individuals, or even serve as a departure point for subsequent use in computer-based tools for ASD, including *Terpsichore*. This is justified by the fact that the manipulation of image and sound characteristics over time not only represents the dynamic nature of a person's surroundings, but it also provides the learner with the opportunity to adapt the depicted audio-visual environment in order to suit personal preferences, in an aim to improve wellbeing aspects and accelerate the satisfaction of associated learning outcomes.

1.4.8 The SoundScape music project

SoundScape (Greher et al. 2010; Hillier et al. 2016) is a therapeutic project directed towards adolescents and adults with ASD, whose principal objective is to transform creative occupation with music into a meaningful social interaction initiative, intended to render participants more extrovert and regulate their emotional state (Hillier et al. 2011). The above studies directly are not considered music therapy interfaces per se, but instead exploit existing technology to persuade learners into releasing their creativity through a variety of improvisational routines. An example of the above is the deployment of percussion instruments to simulate, through composition by the ASD learner, the sounds emitted by a moving train (Greher et al. 2010: 12), and the combination of storytelling with supportive musical segments (Ibid.: 13-4). The former example designates that compositional activities are not exclusively associated with tonal music, but with any form of sound, including stimuli encountered in everyday life. In this way, this project provides inspiration for the introduction of indefinitely pitched sounds in the music composition process.

Research on means of musical mediation within the *SoundScape* programme, mentions GarageBand (Greher et al. 2010), a music sequencer common in production tasks for neurotypical individuals, and such remote interaction technologies as the iPad (Hillier et al. 2016), as playing a supportive role in nurturing social interaction through music composition. Although the latter study clearly demonstrates that over half of participants responded positively to the desired activities and managed to mitigate their anxiety levels (Ibid.: 8), the degree of complexity in the offered software may not be manageable for all associated parties especially when multiple participants are integrated in the project (Greher et al. 2010: 9, 12-14). Moreover, the scope of this project is confined to the achievement of therapeutic goals by means of learning to employ commercial packages for mainstream education (Hiller et al. 2016), thus implying that neither are the educational and notational aspects of music emphasised,[8] nor is it certain that ASD learners with reduced intellectual abilities will be equally adept at navigating in and around the proposed technologies.

1.4.9 The Musikus project and its relation to ASD

Most interfaces examined thus far have the common characteristic of being deficient in educational aspects of music, but instead encourage music reproduction and composition without delving sufficiently in its technical perspective. Although intrinsic appreciation of music is a rational explanation for the subject being widely appreciated by individuals with ASD (Nordoff and Robbins 1971; Hammel and Hourigan 2013; Ockelford 2013b: 68, 107, 151 etc.), this argument does not reflect that such individuals have a pre-existent awareness and knowledge of musical conventions. The endeavour of Psychogios (2014) is an attempt to make music education accessible to such individuals, as his *Musikus* project is designed to acquaint them with various conventions of tonal music in a comprehensible manner, while also retaining an acceptable degree of user-friendliness. The author's objective is to combine gestural interpretation through the Microsoft Kinect system with simplified versions of Digital Audio Workstations (DAW) to create entry-level compositions through a computer. This is performed through four discrete modes of software interfacing (Ibid.: 44-48) which pertain to the formulation and reproduction of melodic content and playback speed, the modulation of bass and synth instruments and the action of selectively activating constituent elements of a composition.

In his study, Psychogios (Ibid.: 68) mentions an anonymous user who asserted that the software's accessible features positively contribute to the applicability of *Musikus* to young ASD populations. However, this interface has been initially designed for the typically developing user and thus has to take into consideration the cognitive deficiencies that various individuals with ASD possess (see Section 1.1). The transformation of working modes into less complicated variants constitutes one possible solution to the accessibility issue, as for example Lipnyagov (2014, cited in Psychogios 2014: 25) has done with his 'Dubstep Launchpad' or Maguire et al. (2006: 135) recommend for the instruction of their systems to preschool children. Moreover, the educational nature of *Musikus* would be optimised, or successfully adapted to subsequent interfaces, by incorporating a learning procedure that would not be restrictive, but would rather

[8] This statement is particularly important in case a participant has not previously received adequate musical traning.

direct users to employ previously acquired knowledge in forging their own rudimentary musical identity through their compositions. Finally, the developer's self-evaluation of the *Musikus* (Psychogios 2014: 66) implies that the interface does not include sufficient capabilities to enable users to manipulate sound and its parameters, while the interface lacks a framework that would support gradual familiarization with musical concepts, regardless of the cognition and trainability levels of participants involved.

1.4.10 The Reactable and its applicability to ASD

The *Reactable* is an endeavour originating from a team of researchers in Barcelona, Spain (Jordà et al. 2007), who refer to this interface as being a 'tabletop' project inspired by their extensive occupation in computational applications of music. This interface is designed to offer original sound synthesis capabilities through fundamental controls including, but not limited to, synthesis capabilities through fundamental controls including, but not limited to, oscillators, filters and amplitude controllers, while non-tangible interaction abilities are also provided (Ibid.). As the creativity possibilities provided are not governed by theoretical discipline and thus do not contribute to this interface being ideal for music education purposes (Franceschini 2010), an innovative perspective in music learning was developed in which the *Reactable* eventually played a predominant role (Ibid.). As Figure 1.8 portrays, it is possible to draw letters of the English alphabet or combinations thereof to represent a conventional Western music chord, while it is possible to compose brief musical pieces by manually interacting with a virtual 'piano roll' structure (Ibid.). The above result in the *Reactable*'s optimised form offering multiple capabilities in facilitating acquaintance with music theory, while extensive reliance on the interface may set the foundations for meaningful communication and turn-taking strategies (Xambó et al. 2016). Using the *Reactable* as construction basis, extension to further music theory principles and modular synthesis is respectively provided through two recent adaptations named *ReactBlocks* (Parra-Damborenea 2014) and *Spyractable* (Potidis and Spyrou 2014).

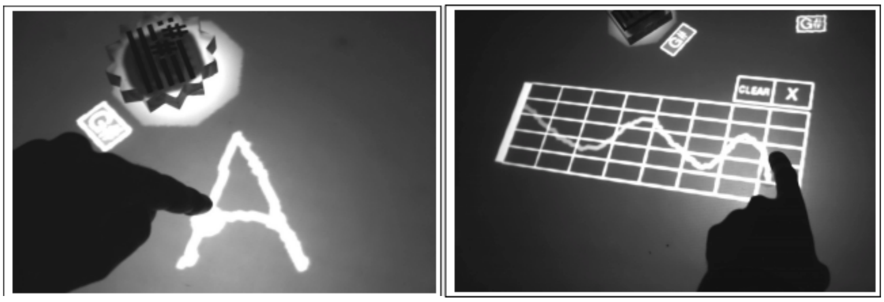

Figure 1.8 *Practical applications of the Reactable for music recognition and composition (Franceschini 2010). Left: Production of the A major chord by drawing the 'A' letter. Right: Interactive composition through a virtual 'piano roll' structure.*

In a pilot study by Villafuerte, Markova and Jordà (2012), four young learners with ASD and little to no verbal capacity temporarily increased their communication and social skills, as well as their ability to externalise emotions, whilst they operated the *Reactable*. Although the above is the only study to date where the *Reactable* is explicitly mentioned as an ASD therapeutic aid, similar advances have the potential of addressing this issue using corresponding means of interaction. Specifically, *CymaSense* (McGowan, Leplâtre and McGregor 2017) is directed towards the visualization of musical content generated from external sources to promote interactive behaviours, whilst *BendableSound* (Cibrian et al. 2017) exploits advanced haptic technology to facilitate control of music features nominally specified by Berger (2002: 112) in a game-based structure characterised by audio-visual interactivity and specifically directed to individuals with severe ASD symptoms. The common limitation of all systems mentioned in this paragraph, is the lack of indications that justify their possible suitability for autistic people with regards to music education. Moreover, the *Reactable*'s absolute emphasis on freeform creativity (Jordà et al. 2003) is inconsistent with the requirement to develop compositional skills even with small-scale constraints pertaining to Western or soundscape music conventions. Franceschini's (2010) adaptation seemingly bridges this gap to a respectable extent, but there is still no existence of a curriculum concept with a more definite objective associated with music education for ASD treatment purposes.

1.4.11 Interactive means for music education: MuSurface and ImproviSchool

The following two interfaces are not directly mentioned as being applicable to special education, but their operational principles provide a valuable source of inspiration, due to their attempt at making fundamental music theory, notation and composition accessible to youngsters. The first of these interventions is called *MuSurface* (Waranusast, Bang-Ngoen and Thipakorn 2013), in which a computer software coexists with an external tactile surface, as an environment enabling the formulation of musical phrases. A *MuSurface* user is invited to position compact objects, in the form of 'tokens', on a five-line stave initially designed on the tangible surface. A number of different note durations are available, while the vertical and horizontal positions of each note determine their pitch and location within the stave. This interface is innovative in its potential to promote real-time interaction with musical notes from a visual and entry-level didactic perspective, while it enlivens the composition process by bringing learners in direct contact with the versatility of note-based interaction. Reliance on images and symbols, as seen in Figure 1.9 below, might be a facilitator in the efforts of learners with ASD to absorb music notation knowledge despite their occasional emotional and cognitive challenges.

Figure 1.9 *Use of the MuSurface to create interactive music compositions (Waranusast, Bang-Ngoen and Thipakorn 2013: 404).*

The *MuSurface* is amongst the interfaces directly cited by Palaigeorgiou and Pouloulis (2018) as an impetus for the initiation of the *ImproviSchool* project, which concentrates on the immersion of students in a tabletop surface environment that would allow them to freely improvise and create large-scale musical segments that adhere to a story whose plot was communicated to learners in advance. No musical literacy is either required beforehand or expected to serve as a long-term objective; however, the storytelling incentive is compliant with the 'social stories' concept directed, amongst others, to ASD treatment (Gray and Garand 1993; Gray 1995; Taylor 2001; Pasiali 2004 etc. – see Section 2.4), and manifests itself as an idea that can be embedded in a composition-based interface that would strongly unify its user with the narrative represented through a series of sequential images.

1.4.12 Inclusive participation in musical activities via the RHYME project

In recent years, the university research sector of Norway (Holone and Herstad 2012; Andersson and Cappelen 2014; Stensæth and Ruud 2014; Stensæth 2014; Cappelen and Andersson 2018 etc.) has embarked upon an approach that favours engagement in musical activities, regardless of whether a disability can initially constitute an obstacle to achieving the above. The origin for such endeavours is the *RHYME* interface, whose purpose is described as 'musicking for all' (Holone and Herstad 2012), inspired by the verb form of 'music' emphasising on the collaborative nature of music performances rather than simply its content (Small 2006). The essence behind the above objective is to provide multiple participants in a musical context where each individual engages in musical activities in a self-paced manner (Holone and Herstad 2012: 267), aided by everyday objects as means of sound generation rather than a conventional computer setup (Ibid.: 263-4) to assist with mental health treatment. The project is based on two advanced tactile environments: the first one is called ORFI (Andersson and Cappelen 2014: 27-30) and consists of numerous malleable components that incorporate microphones and sensors responsible for the emission and manipulation of sound as a result of hand contact or vocal prompts on the user's part. The second one, named WAVE (Ibid.: 30-1), differs from the ORFI in its carpet format, and its ability to comprehensively undertake audio composition, sequencing and rhythm regulation, in similarity to mainstream music production technology.

The coexistence of the above two components is designed to make daily lives of seriously disabled individuals more comfortable, and this is no exception for the ASD field. Specifically, Stensæth (2014: 78, 83-6) refers to 'Dylan', a child with ASD whose reports of using the WAVE segment indicate that some degree of interactivity and independence was achieved, without any discrete music-activity being accomplished whatsoever. Various descriptions on the *RHYME*, combined with the above example and the *PollyWorld* installation (Cappelen and Andersson 2018: 638-641), infer that the music composition aspect almost exclusively serves therapeutic purposes and interprets the process of selecting a different timbre (Stensæth and Ruud 2014: 56-61) or source of pre-recorded music (Cappelen and Andersson 2018: 638-9) as some form of improvisational therapy. In short, this system does not follow a curriculum-based approach with a view of directing, as simply as possible, individuals to compose their own music instead of simply taking initiatives based on pre-set content at their disposal. However, one cannot underestimate the concerted effort to provide learners with an immersive music therapy setting as a mental health treatment aid.

1.4.13 *Music Spectrum*

The Music Spectrum (Lima and Castro 2012) is an interface for Apple's iOS technology that employs the 'virtual reality' specification also used in a recent variant of the *Chrome Music Lab* (Padmanaban and Molner 2016, Section 1.4.4), with an objective of allowing users with ASD to interact with various musical instruments on a fundamental level of reproduction and improvisation. A distinguishable element of this interface is its direction towards jointly satisfying the music education and therapy objectives, as the material designed for instruction ultimately aspires to alleviate the general symptoms of an autistic disorder and foster social inclusion. Particular emphasis is given to the development of initiative-taking with respect to a music environment and social skills in everyday situations, at the expense of passive forms of musical expression.

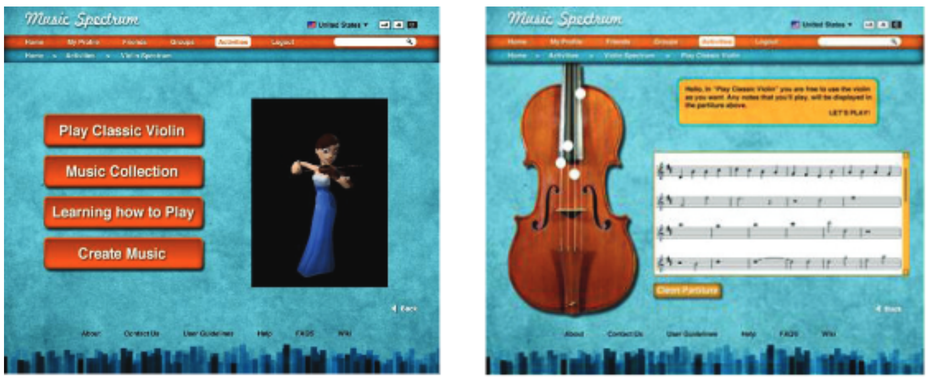

Figure 1.10 *Representative Music Spectrum screenshots (Lima and Castro 2012: 116).*

Figure 1.10 above presents an overview of the tasks available to the learner with regards to learning how to execute and create phrases, using the violin as lead instrument. Mostly elementary actions are available within this interface, but the possibility of the user becoming familiar with theoretical and instrument-specific principles before transitioning to composition sets the *Music Spectrum* apart from previously examined systems for music therapy. The rudimentary simulation of a musical curriculum, along with the software's tolerance of errors in directed tasks, move towards an appropriate direction in providing a carefree and comfortable environment for sustained musical occupation. However, this interface would largely benefit from the inclusion of extended environments that would gradually provide users with targeted indications not only on how to compose music, but also to develop their linguistic skills as a direct result. Another proposal for interface improvement would be the employment such mediation strategies as 'question-response' patterns (Ockelford 2013b: 204-6) in compositional activities, to enhance the learner's communication and social inclusion.

1.4.14 PLAIME: a curriculum-based approach

One of the challenges confronted during a disabled person's occupation with several of the music-oriented interfaces presented above, is that their reliance on manners to acquaint learners with music theory and miscellaneous educational concepts is limited. To resolve this issue, the conception of the *PLAIME*[9] (Cano et al. 2012; Cano and Sanchez-Iborra 2015) with a view of simplifying a mainstream music syllabus by presenting its fundamental concepts to learners with mental disabilities in a manageable manner that compensates for possible cognitive deficiencies and reduces the risk of adverse behaviours (Cano et al. 2012).

The *PLAIME* pays predominant attention to educational elements simulating Spain's framework for music teaching (Cano and Sanchez-Iborra 2015: 257), with the recorder being used as the sole instrument for which instruction is possible. Despite this limitation, the interface justifies its role in approximating a curriculum due to the existence of seven instruction windows (Ibid.: 259-260), along with a series of exercises in five ascending difficulty levels, enabling users to recall the instructed materials and habituate themselves with their application in music cognition and performance contexts (Ibid.: 260-262). As seen in Figure 1.10 below, interactive software elements are designed to convey the desired educational ideas in a playful manner, while the lack of prior education in the vast majority of participants was taken into consideration during the associated pilot study (Ibid.: 263). Learners may rely on the computer mouse or touch-screen technology to operate the project.

Figure 1.11 *Sample windows of the PLAIME interface in Spanish, associated with recorder execution practice (Cano and Sanchez-Iborra 2015: 259).*

[9] Authors (Cano and Sanchez-Iborra 2015: 254) state that *PLAIME* stands for 'Platform for the Integration of Handicapped Children in Music Education'.

The study in which *PLAIME* was tested involved fifteen participants in total, of which one was diagnosed with a 'pervasive developmental disorder' and several possessed learning difficulties (Ibid.: 264-6). The study demonstrated across-the-board improvements in various areas of mental health, including emotional state and communication skills (Ibid.: 267-8). The incorporated aspects of music education are purportedly responsible for increased enthusiasm and eagerness to progress through activities (Ibid.: 267-271), implying that an ostensible relationship between education and therapy in music is achieved. The positive remarks presented by the authors are potentially influenced by the existence of 'feedback' mechanisms designed to monitor accuracy of actions and assist in the learner's independent progress. However, the *PLAIME* system involves some limitations that need to be addressed in order to promote creativity release and active methods of encouraging wellbeing improvements:

- The concept of exercises in adjustable difficulty levels (Ibid.: 269-271) risks inserting the notion of discrimination between individuals with different levels of cognition. It is more advisable to reconsider this objective on a basis that would render music learning and occupation an inclusive process for everyone, so that difficult projects are tackled by even the most cognitively challenged learners. This may be achieved through the reduction of lexical content to the most necessary, and by tailoring the amount of evaluation prompts to the mental and perceptual characteristics of each participant.
- From the perspective of music education, the software would reach an expanded target group if instrument choice is introduced, in place of solely concentrating on the recorder.
- Considering that authors (Ibid.: 256) clearly outline the absence of compositional elements in their interface, the process of enabling learners to follow creative engagement routines would be ideally facilitated by the acquaintance with all twelve pitches of a chromatic scale and the identification of musical elements besides the identity of basic notes. Under the current format, favourable mental state changes in the *PLAIME* study result from a plain music instruction curriculum and do not guarantee that these will translate into an impetus to express oneself creatively through music.

1.4.15 ImmertableApp: sound synthesis in special education

The *ImmertableApp* (Baldassarri et al. 2016) concentrates on the acquaintance of typically developing and disabled learners with instruction elements associated with the creation of sounds through synthesis; the authors employ the term 'didactic' to highlight the educational value of the interface. Its principal feature is the reliance on voltage-controlled oscillators, filters and amplifiers, similar to basic fundamental music technology theory, by using physically constructed objects calibrated to operate the system, something made possible via their interaction with an electronic device. Following distribution of the *ImmertableApp* to experienced individuals in the music computing field, the authors (Ibid.: 374) propose its implementation in mental disability contexts as a component of further research. A drawback of this interface is that its functionality is only constrained to tasks based on synthesis and does not incorporate instrument-based music or comprehensive audio manipulation in its capabilities. In addition, the absence of structures that offer feedback on whether actions are performed appropriately, should be an object of scrutiny in the attempt to familiarise learners with a broader, and possibly more practical, spectrum of activities intended to cultivate compositional aptitude and mental health treatment.

1.4.16 Social robotics for music interventions: Xylotism and the robotic bear

An important step towards bringing individuals with ASD in contact with basic aspects of tonal music, is a collaborative effort by researchers from Tehran, Iran (Taheri et al. 2016) to introduce the concept of a 'social robot' in music education. This area of robotics was first developed by Billard and Dautenhahn (1997), who aimed to provide fundamental communication skills to each of the two robots employed, so that they successfully react to events in their environment and interact in virtual family settings (Ibid.: 5-7). Initially, Taheri et al. (2016) enabled one prototype of such a robot to engage in the execution of a drum and a xylophone in front of four learners with ASD, who were subsequently invited to play these instruments under the guidance of the robot. This intervention was coupled with a computer-based application simulating the structure of an actual xylophone, which could be operated through remote interaction via the Kinect device (Ibid.: 543). This study demonstrated an overall improvement in the mental condition of all four learners as a result of this intervention, although the low-functioning ASD participant exhibited less significant favourable changes than the other three and struggled to achieve independence in xylophone execution.

A subsequent endeavour related to xylophone execution is the *Xylotism* (Elahi et al. 2017), an interface for tablets where learners with ASD are invited to incorporate educational principles of music in their everyday lives, while attempting to increase their adeptness at playing the instrument in question. In similarity to the previous example, the real and virtual instruments were employed interchangeably, while important tasks included, but were not limited to, the emulation of instrument execution aided by a robot, the identification of notes and the formulation of sequences comprising up to four notes (Ibid.: 732-3). The accompanying pilot study, in which the *Xylotism* was applied to early-age pupils with average results, confirmed the authors' conjecture that computer-based technology motivates learners to integrate musical activities in their everyday schedules. It also provided a framework where the instruction of music principles is coupled with the development of communication skills through virtual contact with the software by means of cues of verbal salutation (Ibid.: 730, 733-6).

In the above two interfaces, portrayed in Figure 1.12 below, provided resources are limited to the identification and mostly imitative execution of patterns on an instrument. In other words, these interfaces do not appear to address the creative composition domain, meaning that they do not involve tools and facilitations that would assist learners in releasing their creative potential and possibly externalising their enthusiasm as a result, even though the latter was partially accomplished through software-based verbal reinforcement in the *Xylotism* study (Elahi 2017: 731). Even in the passive melody reproduction field, the distribution of the above interfaces to broader participant target groups as variations relevant to such instruments as the piano, the guitar or percussion instrument, would provide important contributions to accessibility and versatility.

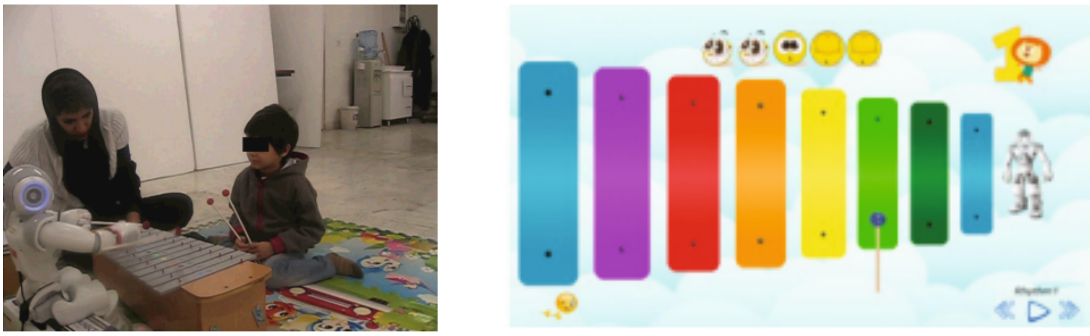

Figure 1.12 *Xylophone instruction tools for ASD learners. Left: Sample session with a social robot (Taheri et al. 2016). Right: 'Xylotism' tablet application (Elahi et al. 2017).*

1.4.17 Suoniamo: piano teaching for ASD

Suoniamo (Buzzi et al. 2019) is an application for the iPad tangible environment, through which learners specifically diagnosed with ASD are encouraged to acquaint themselves with fundamental aspects of piano execution. This endeavour incorporates ideas that clearly resemble a typical musical curriculum, as it comprises three working modes related to different areas of tonal music cognition. These are the acquaintance with a standard chromatic scale and different pitches on a piano, the execution of notes for a specified duration to assist with note value comprehension, and the familiarisation with the C major scale extendable to multiple octaves

(Ibid.: 282-3). The most recent edition of *Suoniamo* strongly relies on colour contrasts to facilitate task efficiency (Ibid.: 285), while the researchers assigned various activities to the learners in order to observe their performance and assess their reactions, as seen in the example of Figure 1.13 below. Results from the study indicated that participants completed tasks with minimal errors and generally welcomed the structure of *Suoniamo*, especially when offered activities were less complex (Ibid.: 289).

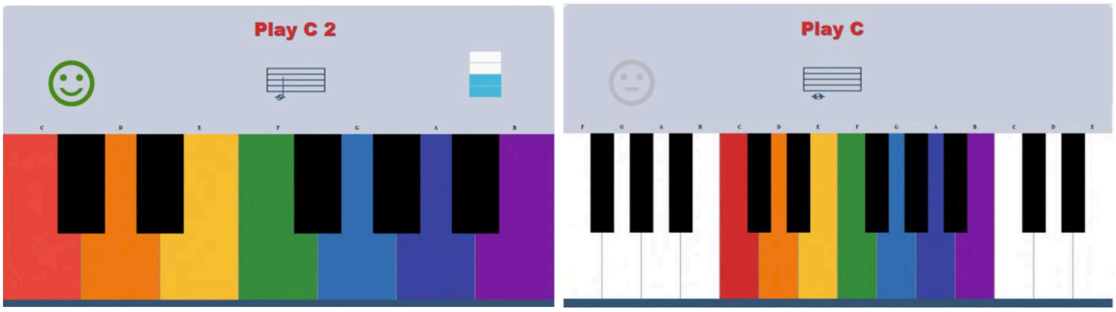

Figure 1.13 *Graphical user interfaces of the Suoniamo application (Buzzi et al. 2019: 285).*

Although research findings appear rather encouraging, the educational scope of the application is constrained to the passive reproduction of isolated notes and a fundamental scale. In fact, no direct reference to the execution of substantially long melodies is made, let alone the targeted composition of new content. In addition, future versions of the project should concentrate on how the programmed code accurately portrays whether an executed note or sequence correctly reflects the respective action performed by the user, so that instances of discomfort amongst learners are avoided (Ibid.: 290). This interface has a parallel architecture to recent advances with a largely curriculum-based design (see Sections 1.4.13-1.4.15), but lacks versatility in selected instruments, a component centred around soundscapes, and tools directly aimed at the development of compositional skills.

1.5 Rationale for the construction of *Terpsichore*

The interfaces presented in the previous Section clearly indicate the persistent evolution of research in the popularisation of music theory and creative practices for mentally handicapped individuals. However, none of these attempt to approximate a music curriculum that would allow learners, within the same interface, to gradually hone their compositional skills, and employ these acquired abilities to their advantage for wellbeing improvement purposes. The *Terpsichore* interface constitutes a comprehensive effort in addressing and filling the gaps of previous endeavours, with concern to the practical application and therapeutic value of music and soundscape composition in everyday life. This will be achieved via the joint satisfaction, as optimally as possible, of five key components that satisfy the above statement: tonal music elements, principles of audio recognition and processing beyond pitched stimuli, a curriculum-based approach, development of creativity in either case, and potential for mental health treatment. Interfaces examined in Section 1.4 base their functionality on one or multiple components, but never on all of them simultaneously. Moreover, no definite indications exist on whether any interface attempted to integrate itself in a context similar to *Terpsichore*'s projected ones.

In an effort to clearly explain the intended functionality of *Terpsichore* with comparison to the interfaces already studied, it is important to take a closer look at Table 1.1 below. This Table is adapted from the *PLAIME* study (Cano and Sanchez-Iborra 2015: 256) and utilises similar metrics to determine how the architecture of *Terpsichore* opts to expand upon previous endeavours and provide innovative experiences. Instruments are stated by the order these appear in Section 1.4, while their characteristics may be accessed through respective sources mentioned across the Section. Moreover, assessments on versatility and complexity not only refer to the execution process, but also the active operation of the GUI from an individual with ASD, while software architecture and areas addressed determine, from a personal and subjective perspective, the music computer knowledge that a tutor requires to calibrate it.

Interface ID	Tonal music elements	Soundscape awareness and/or formation	Existence of rudimentary music curricula	Therapeutic applications for mental health treatment
SoundBeam	No	Yes	No	Yes
MIDIGrid	Yes	No	No	No
Benemin	Yes	N/A	No	Yes
Chrome Music Lab	Yes	Basic	Good, but scattered (not step-by-step)	Yes
Skoog	Yes	Basic	No	Yes
Window (K. Norman)	No	Yes	No	No
SoundScape	Yes	No	No	No
Musikus	Yes	No	Good	No
Reactable	Yes	Yes	No	Yes

MuSurface	Yes	No	Adequate (notes, values, staves)	No
RHYME	Yes	Yes	No	Yes
Music Spectrum	Yes	No	Adequate	Yes
PLAIME	Yes	No	Good	Yes
ImmertableApp	Yes	No	Basic (synthesis)	No
Xylotism	Yes	No	Basic (xylophone)	Yes
Robotic bear	Yes	No	No	Yes
Suoniamo	Yes	No	Good	Yes
Terpsichore	**Yes**	**Yes**	**Extensive**	**Yes**

Interface ID	Elements of composition and/or creativity	Versatility of activities	Complexity of activities (estimate for ASD)	Required tutor knowledge
SoundBeam	Yes	Medium	Medium	Medium
MIDIGrid	Yes	Low	High (best for TD)	Medium
Benemin	Yes	N/A	Low	High
Chrome Music Lab	Yes	High	Variable	Low
Skoog	Basic	Low	Low	Medium
Window (K. Norman)	Yes	Medium	Low	Low
SoundScape	Yes	Medium	Medium (TD software use)	Low
Musikus	Yes	Medium	High (mostly suitable for TD)	Medium
Reactable	Yes	High	High	High
MuSurface	Yes	Low	Medium	Medium
RHYME	Basic (spontaneous improvisation)	Low	High	High
Music Spectrum	Yes	Medium	Medium	Medium
PLAIME	No	High	Variable, towards high (more applicable to TD)	Low
ImmertableApp	Basic	Low	Medium	Medium
Xylotism	No	Low	Low	Medium

Robotic bear	Basic (building blocks)	Medium	Low	Low
Suoniamo	No	Medium	Low	Low
Terpsichore	**Yes**	**High**	**Variable, towards low (suitable for ASD)**	**Low**

Table 1.1 *Intended functionality of* Terpsichore *in comparison to other interfaces.*

An analysis of the above Table indicates that *Terpsichore*'s projected functionality is closest to the *Chrome Music Lab*, the *Skoog and* the *PLAIME*, which lack the least areas that would allow learners to engage in multifaceted composition tasks as a resourceful mental health treatment aid. Since none of the interfaces address areas of musical cognition and creativity in a comprehensive and targeted manner, a potential suggestion for *Terpsichore*'s architecture is to integrate, within the same environment, the features of previous interfaces that best comply with the desired functionality, taking advantage of possible overlaps in structure. An example is the joint consideration of *MuSurface* and *Window*, which pertain to composition and creativity by respectively employing notation-oriented tonal music (Waranusast, Bang-Ngoen and Thipakorn 2013) and a selection of modifiable soundscapes (Norman 2012a, b). However, it is crucial to achieve an optimal degree of simplicity in the graphical user interface and available activities, in order to accommodate the needs of autistic learners with different particularities and preferences, and mitigate the risk for adverse behaviours due to interface complexity or disorganisation. This by no means indicates an 'one-type-fits-all' approach, detected for instance in the *PLAIME*'s exclusive focus on the recorder (Cano and Sanchez-Iborra 2015) or the *RHYME*'s generalised 'musicking for all' format (Holone and Herstad 2012 etc., Section 1.4.12), but rather a structure that each learner and tutor may adapt for increased efficiency.

The need to construct *Terpsichore* is based on the argument that an ASD diagnosis should by no means inhibit the acquaintance with disciplines and techniques with which a musically literate TD individual may be familiar. For this reason, the inclusion of a comprehensive but user-friendly curriculum is paramount, as is the implementation of a stepwise technique aimed at the gradual acquaintance with the composition of tonal melodies and the formation of soundscapes without a definite pitch. The reliance on music-oriented curricula as an adjunct to the educational process for learners with ASD, has been extensively studied in the literature. For example, Taylor (2011: 68-71) concentrates on the importance such an approach may have on an individual highly interested in music, to the point where multisubject programmes are less suitable. Hammel and Hourigan (2013: 122-3) assert that various special educators should highlight the value of targeted music instruction to other practitioners, while also employing a variety of techniques in which learner performance across a curriculum is optimised (Ibid.: 123-6).

Most importantly, Berger (2016: 242) promotes the implementation of versatile learning processes that explicitly emphasise on such music theory principles as notation and rhythm, as a recommended prerequisite for the engagement of disabled individuals in compositional tasks. Berger's statement exemplifies the need to explain techniques to learners that would allow them, through appropriate training, to compose their own musical segments and soundscapes, by simultaneously exploiting their personality strengths to facilitate this procedure (Ibid.). Therefore, the areas of composition and music-making, forming part of special education interfaces described in Section 1.4, make increased sense when resulting from a carefully organised strategy associated with the instruction of relevant concepts and the gradual adjustment to compositional techniques. That said, prospective *Terpsichore* users should be adequately enabled to freely exploit the musical capabilities on the interface, by means of improvisation as the driving force to improve wellbeing (Wigram 2004). However, they should also be made aware of fundamental principles that govern the relationships between notes and the position of sounds within time and space, with the ultimate aim of delivering aesthetically pleasing musical results, to the extent that their condition permits them. This applies to a lesser extent in the soundscape composition domain, due to the normally reduced role of pitch relationships, tonality, rhythm and relevant aspects by which tonal music is governed.[10]

Various observations from previous interfaces also suggest that the *Terpsichore* structure would ideally benefit from the inclusion of software-evaluated activities and automated processes, with an aim of providing informative feedback that allows participants to correct their errors and improve task efficiency over time (see *PLAIME*, Cano and Sanchez-Iborra 2015 and *Suoniamo*, Buzzi et al. 2019), by paying additional attention to the user's mental integrity; Sections 2.3 and 3.4.2 elaborate on the above. Furthermore, the simultaneous consideration of education and therapy within the same environment, means that the structures directed towards composition should be supplemented with content pertaining to the management of emotions and behaviours, and the realisation of everyday tasks. The music that accompanies visual representations should be inspired by 'prescriptive' (Pasiali 2004) or 'situation' (Kolar-Borsky and Holck 2014) melodies, over which users may subsequently have partial or full control, so that the gap between music therapy and composition is bridged; this also applies to music-based 'social stories' (Gray and Garand 1993; Gray 1995 etc., Section 2.4). In a nutshell, the

[10] This argument takes into consideration all known notation and tonality systems thus far, and not exclusively Western European principles and their application in compositions of e.g. the Classical and Romantic eras.

Terpsichore project is bound to provide learners with ASD with an accessible and versatile platform, characterised by the exploration of pitched music and non-pitched audio, in order to serve as the mainspring for compositional skill development and treatment of mental health areas that place burdens on daily life.

1.6 Disability politics and suggestions for satisfaction in *Terpsichore*

1.6.1 Definition and application to everyday social contexts

The area of *disability politics* acquires special importance with concern to the ethical integrity of the research and practical project application, taking into account the necessity to reduce the autistic learner's passive, unfavourable or volatile reactions to the minimum possible extent. It is particularly worth examining due to its valuable role in strengthening the relationship between the learner (or interface user) with its intermediary body tutor, and ensuring that the learning process is facilitated and not hindered by the subjective 'marginalisation' of the learners from the contemporary society (Priestley 1999; Ford 2012). Moreover, the debate on disability politics is induced by the constantly expanding phenomena regarding the political and jurisdictive exploitation of the dipole between neurotypical and disabled individuals (Barnes and Mercer 2010: 156).

Disability politics (DP) generally refers to the contexts and guidelines that should be followed, with regards to handling people diagnosed with a disability and assisting in their smooth inclusion in society (Oliver 1990; Campbell and Oliver 1996; Basnett 2001; Barnes and Mercer 2010 etc.). The process of attributing political relevance or financial integrity to disability matters has also been discussed, on the basis disability politics relates to legislative frameworks an individual should abide by (Oliver 1984; Shakespeare and Watson 2001: 546). However, contemporary findings have demonstrated that the relationship between the pure political sector and the treatment[11] of disabled people does not appear to be as strong as certain individuals imply (Barton 2013: 1), and that the investigation on the position of disabled people in everyday society should be undertaken in accordance with classical political conventions instead of taking the constant progress of social correlations into consideration (Davis 2013: 263).

At times, the combination of DP's legal dimension with a more civilisation-oriented perspective may be helpful in identifying the position of disabled people in everyday society, and

[11] By 'treatment' we cover both its social and medical definitions / extensions.

their contribution to its temporal evolution (Barton 2013: 32). An indication of the above is the manner in which the effort of impaired people's groups to establish themselves as equally respectable entities to neurotypical ones, has led to a 'social movement' (Oliver 1997) aimed at protecting and strengthening disabled people's lives. Likewise, the 'social model of disability' (Oliver 1990), is interpreted as a set of social behaviours towards individuals with an abnormal or idiosyncratic mental profile (Barnartt, Schriner and Scotch 2001: 431) or an opportunity to examine the existence and needs of mentally disabled individuals from a different social perspective (Swain et al. 2003: 24). Oliver (1997: 245) supports the distinction and separation of the DP field from various legislative bodies, a statement applicable to disability politics within the context of music as it indicates an increased focus on valuing each individual's personality.

Music professionals and enthusiasts diagnosed with a disability often face inappropriate behaviours by third parties, on grounds of remarkable differences from other individuals subjectively considered as normal; these behaviours are defined as *disability discrimination* (US EEOC 1998; Casserley and Gor 2001; Lubet 2010). Relevant to the above notion is *stigma*, a term describing a frequently prejudicial attitude against individual groups with a documented defect, impairment or differentiation (Byrne 2000; Corrigan and Watson 2002). These two analyses concentrate around 'stereotypes', an alternate explanation for the subjective opinions and actions demonstrated by humans with concern to the profile and competence of others. In fact, the UK Mental Health Foundation (2015: 5, 8 etc.) identifies such stereotypical behaviour as a predominant justification provided by employers, real estate brokers and individuals in general, for stigmatised people's lack of employment, accommodation and interpersonal communication opportunities. This often results in severe behaviour deterioration and aggravation of the mental condition such a person undergoes (Ibid.), something that adds to the belief that social interaction training is critical to avoiding such adverse consequences in the autistic human's mental profile (Chambers and Frye 2014: 711). It is therefore rational to deduce that carefully planned disability politics should be implemented in order to confront the unfavourable consequences induced by stigmatisation, and guarantee efficient results during and between each of the *Terpsichore* interface instruction sessions. An impartial endeavour to accomplish the above should consider both internal and external facets of stigmatisation, given the possible tendency of the disabled learner to exhibit a negative self-critical behaviour (Corrigan and Watson 2002: 16).

1.6.2 Recommended disability politics procedures for productive learning

As part of appropriate disability politics, a departing point necessary to inspiring the learner, elevating his confidence and optimising the learning process, is the fact regarding the large proportion of individuals who simultaneously had a disability and an imaginative charisma, combined with their constantly increasing contribution to contemporary art and civilisation (Barnes 2003: 2). The author later implies that the position and level of respect towards impaired entities have been negatively influenced by 'mainstream' conventions upon which the Western society and civilisation were shaped (Ibid.: 3-4). In various examples, the contemporary artistic world undervalues and marginalises disabled learners and professionals, by exhibiting an offensive attitude towards them (Barnes 2003; Shapiro 2014) unless they demonstrate a decent potential of performing similar actions to their non-disabled counterparts (Darke 2004). Judging from the above, an effective and DP compliant instruction system should concentrate on reversing the above hypotheses of marginalisation, and therefore consider disabled learners as equally respected parts of society and artistic creation.

Injecting confidence into the mind of the disabled person, in order to understand and fulfil imaginative potential, should be at the forefront of all endeavours to develop artistic awareness (Di Maria Nankervis 2013). This statement appears fully applicable to the challenging nature of the instructor-learner sessions involving the *Terpsichore* use, taking into consideration two important issues. Firstly, the interface is initially intended for familiarising its users with creative music composition, and not a precise reproduction of what is externally observed or heard. Although, as presented earlier, the purported 'imitation' of perceived tasks has been evaluated as a resourceful learning strategy in most autistic learners' educational environments (Ingersoll 2008; Rogers and Dawson 2010; Lowry 2011; Nauert 2018), musical excellence can better be accomplished when the learner is encouraged to perform different actions and construct different note segments or soundscape successions than the ones encountered.

Accomplishing something dissimilar to previous observations normally requires a positive attitude on behalf of the learner, thus stimulating the necessity to increase self-confidence during the interface instruction sessions (Gavidia-Payne and ARCN 2013). Secondly, the importance of associating educational with therapeutic goals through their previously described cause-and-effect relationship[12] requires that the DP procedures undertaken ensure that the learner's performance level increases over time, with subsequent influence on his reactions,

[12] As already mentioned, this constitutes the potential to positively influence aspects of wellbeing, human function and socialisation skills, as a result of implementing successful learning practices through *Terpsichore.*

communication with peers and ability to think critically and creatively. For instance, Trautman (2007: 104-5) refers to a five-step method, labelled as 'Developmental Therapy (DT)', primarily built to not only address and treat areas of cerebral, neurological and social functionality of ASD learners, but additionally enable them to perform original, non-imitative compositional patterns, upon completion of this method. Activities related to music are crucial in satisfying the desired DT goals (Wood et al. 1996: 221), while singing voices in real time or through reproduction (Gardstrom and Hiller 2010) and 'piano improvisation' (Goodman 2011: 185) are representative examples of the gradual musical engagement included in DT. Another intervention with similar principles is the 'Early Start Denver Model' (Rogers and Dawson 2010; Vivanti et al. 2016), which concentrates on the learner's collaborative participation in a variety of educational tasks, with potential improvements resulting from enhanced brain activity (Rogers and Dawson 2010). This intervention may include, amongst others, the reliance on emulating the actions of peers (Rogers, Dawson and Vismara 2012: 166-177). However, it can be adapted to the gradual acquisition of fundamental task independence both by introducing understandable instructions for the performance of activities towards completing an objective (Vivanti et al. 2013: 1722) and by subjecting learners to slightly different patterns and procedures from the ones replicated at the first instances of employing this method (Tordjman et al. 2015: 64).

Two additional methods may form an effective and welfare-friendly part of appropriate DP. The first one, as described correspondingly in the first Chapter, is the Nordoff-Robbins method. In fact, it intrinsically introduces the necessary confidence in the learners' minds and encourages them to engage themselves in original music-making processes, through the belief that music appreciation exists in their soul even prior to any music education being attempted (Kim 2004; Carpente 2009). Furthermore, the confidence injection principle mentioned above can be more effectively followed by complementing the Nordoff-Robbins method with a therapeutic approach that regards music as a direct goal in everyday life and not as a process indirectly described through texts and demonstrations of a purely clinical or medicinal nature (Aigen 2014).

The second of these techniques is the one defined by Greenspan and Wieder (2006) as the 'Floortime Approach'. Contrary to other methods mentioned above, Floortime concentrates on the age factor of the learners, and the assertion that the cerebral and cognitive abilities of the individuals are strongly dependent on this age factor (Greenspan and Wieder 2006: 37). It also encourages the learners, with the help of a peer tutor or parent, to develop a positive and appealing behaviour towards conventional learning routines by employing strategies for the enhancement of critical thinking, instead of passively conveying information, with a simultaneous special emphasis on the reduction and elimination of adverse behaviours. In music therapy and related rehabilitation contexts for ASD learners, the Floortime approach, particularly when combined with the DIR (‘**D**evelopmental – **I**ndividual Difference – **R**elationship-Based’ model, see ICDL n.d.; Anderson 2008), may deliver encouraging results. Hammel and Hourigan (2013: 90) prove that the decision of a therapist to employ attractive music patterns and songs to the senses of the learner eventually leads to the enhancement of the learner’s emotional awareness, concentration and ability to respond to sensory stimuli provided by the therapist. Given that the authors (Ibid.) refer to the ‘subtle[ty]’ of changes in the learner’s alertness and general condition, it can be observed that the joint Floortime/DIR approach, if employed cautiously, may serve as an effective alternative approach to Developmental Therapy where the learning process is realised on a gradual and sustained basis.

Extensive discussion has also been undertaken regarding the TEACCH[13] approach (Griggs-Drane and Wheeler 1997: 90; Mesibov et al. 2004; Cook, Roy and Welker 2017), which follows the previously recommended direction on disability politics as it relies on the elimination of discriminatory behaviours towards ASD learners and the enhancement of the therapist’s role as a learner-peer tutor intermediary (Mesibov et al. 2004: 11). This compliance of TEACCH with DP is also justified by the method’s emphasis on the respect and comprehension of ASD individuals’ particularities, and the eagerness of specialists to optimise their skills according to learners’ needs (Ibid.: 13-6) by following organised yet adaptable educational standards (Ibid.: 33-4; Lal and Shahane 2001: 172-8). One interesting study in the investigation of how TEACCH and music-assisted ASD treatment correlate, concerns the improvements in enthusiasm, music occupation consistency and interaction skills of a human subject when TEACCH is combined with ‘psychodynamic music therapy’ (Stewart 2002). The latter enables learners to determine their identity and characteristics and employ music for their externalisation (Edwards 2016: 423) possibly with the involvement of conversational speech (Metzner 2016: 455). Moreover, another study combining TEACCH and music therapy discovers multifaceted improvements in the majority of goals intended through a joint music education and treatment procedure (Algie 2012: 52-3), hence implying that such a combination practically elucidates any deficiencies in the education-therapy conflict described in Section 1.3.

Useful in ASD contexts is also ‘Auditory Integration Training (AIT)’, two variations of which were conceived by Bérard (1983; Bérard and Brockett 2011, English edn.) and Tomatis (1987, English edn. 2005). Even though it does not constitute a pedagogically governed method in itself, it can be incorporated in a broader DP-compliant learning schedule, during which full respect to areas of the learner’s spatial sensitivity should be paid. The Bérard method concentrates on the learners’ susceptibility or lack of awareness over parts of the audible frequency spectrum (Bérard

[13] TEACCH stands for ‘Treatment and Education of Autistic and Related Communication Handicapped Children’ (please refer to sources next to footnote superscript).

and Brockett 2011: k183)[14] in turn impacting cognition and behaviour (Ibid.: k2349). As an ASD intervention, it relies on subjecting learners to progressively increasing or decreasing frequencies at different sound pressure levels (SPL) (Bérard and Brockett 2011: k1067-1232). Judging from the results obtained from audio analysis and the learner's reactions, the tutor is subsequently encouraged to suppress unwanted frequencies using filters, in order to prevent upsetting and adverse reactions on the learner's part (Ibid.: k1343-1420). On the other hand, the Tomatis method has been designed to assist in improvements associated with linguistic integrity and interaction with peers (McCarton 2003: 121), and exploits modulated musical excerpts, to train the learner's ears in a way that would facilitate the above improvements (Tomatis 2005: 21-44; 55-76, 128 etc.). This method, initially designed for singing routines, may be adapted in the general ASD field by assessing learner responsiveness in a broad range of frequencies and SPLs, and complementing such a process with spatial awareness activities (Bogdashina 2016: 183-5). The Tomatis method is also expected to assist in creativity by employing techniques to enhance the ear's auditory dexterity (Tomatis 2005: 22-3) and to increase motivation, a primary non-musical goal in ASD computer interfaces (Woods 2003: k898-910).

The work of British disability specialist Phoebe Caldwell serves as another important consideration point, considering her dedicated occupation in the field of ASD, especially with learners demonstrating social misconduct as a result of a relevant diagnosis (Ibid.: Caldwell Website 2017). An integral part of Caldwell's specialisation in ASD is the notion of 'intensive interaction' (I.I.[15], Nind and Hewett 2012: 8 [1st edition 1994]). defined as the frequent, and often overwhelming, use of playful activities based on the active participation of a learner-peer tutor dipole in constant reciprocal communication. This method exploits the power of entertainment and intervention in a learner's daily routine in order to deliver more meaningful results regarding everyday behavioural conventions (such as 'taking turns'), demonstration of feelings and prompt response to cues provided by a peer tutor (Ibid.: 8-9). Educational processes based on I.I. may be enhanced by additionally employing visual and tactile stimuli to shift an autistic learner's awareness towards the desired tasks (Caldwell and Horwood 2008) and improve awareness of facts and surroundings (Moat 2013: 61-2). To describe the above, both researchers employ the term 'sensory integration', a frequently critical process enabling the brain to recognise the tonal, temporal and soundscape-based elements of music so that the intended educational and therapeutic goals are better satisfied (Wager 2000). Nevertheless, experimenting with music as a primary activity in a child's development has proven to eliminate, partially or completely, a

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[14] The prefix 'k' here indicates a location on a Kindle e-book where no page numbers are specified.

[15] The abbreviation I.I. was preferred in order to avoid confusion with the II Roman numeral (= 2).

child's sensory deficits, even in cases where an ASD diagnosis has not taken place (Albright and Grady 2013: 35; Berger 2016: 36-7).

To summarise, DP in learning sessions involving autistic individuals may be satisfied using a number of different approaches that potentially encourage a learner to become creative and progressively attain educational and therapeutic goals through personal initiatives, provided that the tutor respects the learner's particularities and points of attention throughout instruction sessions. Generally, the theoretical background concerning DP, the social model of disability and the disposition of society towards mentally deficient individuals, constitutes a helpful reference point for peer tutors and special school staff in their attempt to implement meaningful learning methods, especially when these are oriented to arts and music. The above described methods of the literature have been conceived and developed with DP principles in mind, whilst leading to the conclusion that inspiring an ASD human subject to learn and demonstrate artistic expressivity should not be based on standardised impersonal guidelines, but rather regard the personality, wellbeing and sensitivity of the individual as foremost characteristics for consideration when planning, amending or optimising an educational routine.

1.7 Connection of pedagogical procedures to ASD music education planning

The previous Section on disability politics referred, amongst others, to various methods, employed by researchers in classroom or one-to-one contexts, that respect the social, behavioural and cognitive particularities of learners and ensure that music education is smoothly and pleasingly undertaken. The mention of 'Individualized Educational Programs (IEP)' (United States Department of Education 2000)[16] within the context of resolving the music education-therapy ambiguity (see Section 1.3), instigates a discussion on whether an IEP can form an integral part in music-based pedagogy for autistic disorder treatment. The US Department of Education (Ibid.: 17-21) presents a formal version of an IEP for autistic learners where a caregiver should thoroughly mention, in writing, four key components related to the initial, progressive and expected final condition of the learner when being subjected to an academic process. Although this can be considered as a more rigid IEP format than the ones defined in Section 1.3, it is proposed as a strategy that allows a tutor to design sessions with the objective of developing the learner's musical aptitude and capacity of handling non-musical everyday situations (Sobol 2011: 249-250).

[16] It is possible for the word 'plan' (Wilkinson and Twist 2010: 9) to be used in place of 'program'.

In the United Kingdom, the purpose of linking IEPs to disability pedagogy is satisfied through the SENDA[18] framework, which ensures that all disabled learners in any educational stage are entitled to similar learning benefits to their neurotypical counterparts, and that their needs and educational preferences are sufficiently safeguarded. This manifests itself as a moral means of protection against stigma and unfair disrespect (Chilvers 2007: 89; Corbett, P. and Corbett, C. 2007: 16). The above information implies a strong connection between the SENDA and disability politics, but it also suggests that the design of pedagogical plans and IEPs, communicated to parents and tutors orally or in writing, should take into consideration the regulations outlined in the SENDA. Thus, a tutor involved in the autistic individual's pedagogy is encouraged to direct queries and support requests to an individual with extensive knowledge in the needs of mentally disabled individuals, usually referred to with the abbreviation SENCO[19] (Aarons and Gittens 1999: 77-8). The 'School Action' and 'School Action Plus' programmes (Hayes 2006: 31-2; Hayes 2009: 58-9) constitute an effort to establish a link between SENCOs and IEPs, given that such a coordinator gathers important information regarding a learner's relationship with ongoing learning routines, and uses it to design suitable plans considering the possible involvement of a classroom or extramural environment (Ibid.). Even without the involvement of an actual programme, the instructor-parent dipole may play a significant role in designing an official IEP and monitor how closely the written details are followed, something that acquires special importance in contexts involving music (Hammel and Hourigan 2011: 62-65).

An important framework applied in a variety of tasks involving music, is the 'SCERTS (Social Communication / Emotional Regulation / Transactional Support) model' (Prizant et al. 2003), employed as a step towards determining the behavioural and communicational requirements of autistic learners, which can later be used as a pedagogical planning guideline (Ibid.; Walworth 2007; Walworth 2012; Autism Speaks 2018). SCERTS can therefore be perceived as a learning framework assisting in comprehensive ASD diagnoses and addressing required objectives, and less as a method of disability politics similar to the ones described in Section 1.6. However, peer tutors may benefit from employing this approach as it strongly takes different particularities of the learner into account before constructing an IEP, in similarity with 'evidence-based' approaches (Møller, Odell-Miller and Wigram 2002; Reichow and Volkmar 2010 etc., see Section 3.4 for details). Moreover, the commonly accepted fact that communication issues and conduct problems are inhibiting factors in personal development and social inclusion, renders the reliance on the above as part of SCERTS an interesting consideration point, especially when music is involved (Walworth 2007). The adaptation of pedagogical plans to the SCERTS framework may

[18] SENDA stands for 'Special Educational Needs and Disability Act' (LSC 2002).

[19] SENCO is short for 'Special Educational Needs Coordinator' (Wall 2007: 102).

facilitate the connection of musical and non-musical goals within the same learning environment (Walworth 2007: 9), thus supporting attempts to bridge the gap between education and therapy in music, as analysed in Section 1.3.

In the music education domain, pedagogical planning can be regarded as either an integral part of the IEP itself (Colwell and Hewitt 2016: 81) or the desired goal towards which a music instructor should aim as a result of studying an IEP in detail (McCarthy et al. 2007: 20). In any case, pedagogy and IEPs should be governed by a profound relationship based on the etymological correspondence of pedagogy to education, meaning that the idea of personalised skill training should be in a prevalent position of an autistic individual's universal learning process considering individualities and unique characteristics that distinguish one human subject from another. An ordinary IEP, whether officially designed according to framework directives or as an unofficial open-format guideline document (Campbell and Scott-Kassner 2014: 410), should not only define the objectives to be fulfilled, but also outline the didactic interventions, to include social settings involving parents or classroom tutors, that best correspond to the learner's profile (Abraham and Flora 2008: 9; Campbell and Scott-Kassner 2014: 410). All-encompassing education appropriate for broader target groups can only be considered partially, since the particularities and strong points of affinity must not act as learning inhibitors (Webster, Cumming and Rowland 2017: 44-5). Parents and class instructors are therefore responsible for providing the necessary pedagogical background to optimise learning efficiency in line with the official IEP requirements and the particularities that distinguish autistic learners from neurotypical counterparts. Caregivers should understand that adherence to pedagogical rules should not translate into strict restraints in creativity and personal expression, as this can lead to adverse behaviours (Turkington and Anan 2007: 131; United States Department of Education 2018) detracting users from becoming creative in music-making processes.

1.8 Summary

The first Chapter concentrated on the literary background on autistic disorders and the associated role of music, setting an initial framework within which the construction of the *Terpsichore* interface will take place. To start with, the general causes and symptoms of ASD were discussed, as perceived from various research perspectives. Next, an analysis on musical interventions and methods for meaningful interaction with auditory stimuli was presented. Of prevalent importance was the debate on how the terms *music education* and *music therapy* may relate to one another, combined with suggested procedures for the exploitation of such a relationship to its optimum extent. The description of various music-oriented interfaces intended for use by people with mental disabilities served as an impetus of argumentation regarding the strong points and areas of potential deficiency that should be resolved through *Terpsichore*. The penultimate Section concentrated respectively on the development of ethical and learner-tutor interaction frameworks that should be followed, under the term *disability politics* (DP), to maximise efficiency and responsiveness and minimise the risk for learners' discouraging behaviour potentially putting mental health into jeopardy. Following the above argument, and given that the interface is to be subsequently tested in classroom contexts subject to defined pedagogical regulations, the final Section focussed on how an informal or official Individualised Educational Plan (IEP) can be employed in a pedagogical context in which *Terpsichore* is expected to play a comprehensive role, as part of assessing learners' reactions.

CHAPTER 2

LAYOUT AND FUNCTIONALITY OF A MUSIC ENGAGEMENT INTERFACE FOR AUTISTIC LEARNERS: A THEORETICAL INSIGHT

2.1 Sounds with discrete pitch and rhythm in therapeutic methods for ASD

In the previous Chapter, a discussion was initiated regarding the importance of various sound-compliant elements in the treatment and development of a learner with ASD. Some of these, including tonality and musical structure (Berger 2002: 112) are relevant to conventional classical and modern music, whereas others, such as soundscape, are mostly consistent with the more generalised perception of music as 'organised sound' (e.g. Varèse and Wen-Chung 1966). Considering that Berger's (2002: 112) six fundamental components of music are omnipresent in contexts where musical notes are employed to define a phrase or piece, together with Ockelford's (2013: 110-5) comparison between spoken discourse and music from a pitch-dependent perspective, it is useful to classify sounds with a definite tonal content under a uniform category, and examine, separately from abstract auditory patterns, their importance in music education and therapy for autistic individuals.

2.1.1 Pitch awareness, absolute and relative pitch

Pitch is one of the most critical elements to the treatment of autistic learners, since it is highly responsible for the establishment of a rule-based linguistic code of communication in the musical domain (Lerdahl and Jackendoff 1983; Patel 2003) whose integrity is dependent on neurological brain activity (Patel 2003). Radocy and Boyle (2012: 228-238, 244-5 etc.) agree that a number of pitch combinations can produce melodies and musical phrases, but assert that certain 'relationships' based on such criteria as periodic note presence and harmonic relevance form the basis for melodic patterns broadly used in contemporary musical contexts. In addition, Patel (2008: 13) builds on the previous argument by connecting the aesthetic beauty of music to the pitch correlations formed between notes; this is true especially when these pitch successions are associated with carefully planned time sequences and durations (Berger 2002: 95). A listener is also capable of classifying certain sounds heard into subcategories, including those that comprise harmonics of a certain scale (such as 'octaves', see Patel 2008: 13), and intuitively arranging them over the time domain to construct melodies (Lim 2012: 54). Consequently, an interface aiming to provide music education centred around tonal perception and distinction should take the prevalent notion of pitch correlations over time into account. These correlations can be strongly defined through the concept of 'tonality' (Radocy and Boyle 2012: 244-256), which appears more intensely as the relevance of a musical phrase and note succession to a specific Western music scale increases (Ibid.).

A characteristic relevant to tonality, identified across various individuals diagnosed with ASD, is 'absolute pitch' (AP) (Heaton, Hermelin and Pring 1998; Ockelford 2013b: 218-223; Stanutz, Wapnick and Burack 2014; Kupferstein and Walsh 2016 etc.), defined as the ability to recognise tonal identities and differences without referring to a tertiary stimulus (Ward and Burns 1982; Takeuchi and Hulse 1993). It has been discovered that no more than 5% amongst autistic individuals possess this trait (Rimland and Fein 1988; cited in Remington and Fairnie 2017: 464). Another study has demonstrated a stronger correlation of AP with an individual's profile than with a potential ASD diagnosis (Dohn et al. 2012). However, results from the study do not satisfy the significance threshold required to generalise the claim to further investigations[20], something verified in another investigation concerning preschool and primary school children with a higher AP likelihood when diagnosed with ASD (Matasaka 2017). Moreover, the correlation between ASD and AP has occasionally been connected to the coexistence of savant syndrome (Young and Nettelbeck 1995: 231; Mottron et al. 1999; Snyder 2009: 1399 etc.), something not always valid due to various non-savants possessing AP traits whatsoever (Heaton 2003: Samson et al. 2005: 69; Heaton, Hermelin and Pring 2008; Ockelford 2016a: 478, 483-4 etc.). It is important to clarify that AP does not always refer to a global awareness of the frequency and identity with which each tone is associated, but may be constrained to only a few notes and frequency profiles – harmonics produced by a specific instrument, thus justifying that AP and 'perfect pitch' cannot be employed interchangeably (Levitin and Rogers 2005: 28).

[20] This clarifies the explanation of 'statistically significant' research findings (Mitchell and Jolley 2010: 246).

The term 'relative pitch' (RP) is considered the opposite to absolute, considering that RP defines the ability to perceive how different pitches are related to each other, determined through awareness of 'intervals' or distance between pitches either within a defined tonal music system or based on frequency (Rakowski 1989: 4; Takeuchi and Hulse 1993; Cruz-Alcázar, Vidal-Ruiz and Pérez-Cortés 2003; Denham et al. 2016 etc.). Its importance in ASD studies is justified not only by the incidence of AP in several autistic individuals, as outlined in the previous paragraph, but also by universal brain activity required to develop a comprehensive awareness of pitch relationships (Ziv and Radin 2014). This is identified as a potential weakness in such people's brain integrity (Happé 1999; Mottron, Peretz and Ménard 2000; Foxton et al. 2003), and possibly explains why RP incapacity is generally a factor that obstructs the development of musical literacy (Heaton 2003) to the point where musical reproduction and composition are hindered. A recent study (Dooley and Deutsch 2011) identified the ability to recognise frequency relations between adjacent pitches as a direct consequence of advanced AP skills, thus implying the emergence of fundamental RP traits. Two following experiments associated with response to both RP and AP (Ziv and Radin 2014) demonstrated that increased delays in understanding tonal relationships possibly resulted from high prevalence of AP, which does not mean that such individuals are generally incapable of developing RP (Ibid.: 23) even after carefully planned training has occurred. This assertion encourages the incorporation of structured curricula pertaining to the gradual transition from AP to RP as an indispensable step towards achieving basic musical aptitude.

2.1.2 Perception and preference of various tonal music conventions in ASD

Patel (2008: 13) presents the notes 'C, D#, and G', basic elements of a C minor chord, as an example of a satisfactory pitch correlation that an ordinary listener would appreciate. This is consistent with the observation that several ASD learners are inclined towards harmonic patterns related to Western European music (Heaton et al. 2007). The reference on chords also instigates another discussion concerning the emotional impact of certain chord types, as also instructed in common music theory curricula. Major scales, as associated with feelings of joy and determination (Gregory, Worrall and Sarge 1996; Levitin 2011: 39, 273), are more favourably accepted in music-related routines than minor chords. (Lim 2012: 83; Ockelford 2013a: 132; Ockelford 2013b etc.). In addition, Levitin (2011: 272-3) examines the impact on the understanding of and disposition towards major and minor scales, something related to changes in the function of the brain; this justifies the relation between scale type, intensity and emotional responsiveness (Lindquist et al. 2012: 50) and its adaptation to the general ASD pattern[21].

In his research, Ockelford (2013b: 110-5) clarifies that tonal elements in music may conveniently substitute the lexical, syntactical and grammatical principles that define everyday spoken language and enable individuals to communicate or express emotions, in a changing manner as their life unfolds (Ibid.: 111-2). These structural principles have been documented to influence brain function and integrity, thanks to a number of different brain areas that enable listeners to distinguish notes and intervals and spot possible dissonances in musical phrases (Janata, Tillmann and Bharucha 2002). However, the existence of twelve different pitches as fundamental means of communication, in contrast with the vast amount of words constructed out of twice as many letters, justifies why a robust and integral brain function is not initially necessary for an autistic individual to express emotions and desires through pitch-dependent phrases (Ockelford 2006: 113-4).

Moreover, Headlam (2006: 109-110) claims that autistic people are mostly inclined, during their listening and performing routines, towards representations of tonal music that detract from what the classically trained individual discerns as ordinary (Ibid.: 118-9). This initiates a debate regarding the existence of an 'autistic' manner of responding to tonal stimuli, additionally determined by a preference in unconventional musical progressions (Straus 2011: 165-6) possibly attributed to the contrasting functionality of ASD human attention systems to the ones of neurotypical individuals (Sridharan et al. 2007). Such form of response was first assumed after Janata (1995: 153) performed a test where autistic learners were asked to appropriately complete a musical cadence, and a closing chord not corresponding to common Western music cadences emerged as one of the spontaneous outcomes. This response was later verified in male participants having a greater affinity for inharmonious musical progressions, characterising 20th century music to a higher extent than the Baroque and Classical eras (Matasaka 2017)[22], supporting that appreciation of Western music conventions (Heaton et al. 2007) are not a common rule in ASD learners' occupation with music.

It is reasonable to encourage learners to unfold their creativity in the most suitable and comfortable manner, especially in situations where certain musical styles are not appreciated (King 2012: 102; Powell 2016: 71). However, the requirement to achieve a necessary degree of discipline, crucial for the correct performance of everyday actions, should be reflected in certain interface structures where a learner is directed to understand and conceive tonal patterns subject to Western music conventions. Given that a personalised social skill instruction content is

[21] Previous statements in the paragraph can be carefully considered to justify this argument.

[22] High significance in the quantitative results ('$p < 0.001$', Matasaka 2017: 4) implies that the validity of the statement in the opposite gender can be safely assumed, for the purpose of our current research.

required to regulate the learner's activities including music (Hammel and Hourigan 2013: 71), the partial inclusion of regulation-based music instruction should assist in satisfying the above objective to a reasonable extent. The above decision while designing such an interface is reinforced by the potential of music governed by tonal discipline to enhance analytical skills, perception of the three-dimensional space, concentration and overall brain functionality, especially at a young age (Schlaug et al. 2005: 219).

2.1.3 *The role of rhythm in music therapy contexts*

Rhythm is another important aspect with regards to alleviating the symptoms of autism related to the learner's mental sanity. The application of rhythm and time-dependent musical patterns in ASD treatment programmes has broadly been regarded as an integral factor in motor movement regulation (Hummelsheim 1999; Thaut 2005; Hardy and LaGasse 2013; Berger 2016 etc.), a condition affecting a large proportion of the autistic human population to a higher extent than neurotypical counterparts (Dewey, Cantell and Crawford 2007; Fournier et al. 2010; McCormick et al. 2016). This term is related to the organisation and coordination of everyday actions and interpersonal interaction over time (Thaut et al. 2009a; Marsh et al. 2013; Fitzpatrick et al. 2013), especially if performed at recurring intervals (Hummelsheim 1999). The size of the individual's muscles used for the performance of various actions, in conjunction with visual awareness requirements, determines whether the associated skills are classified as 'gross' or 'fine' (Baxter et al. 2007: 22; Massey and Goodman 2014: 7-8), while the abilities consistent with communication integrity and educational potential with regards to spoken discourse, define the separate 'oral' category (Baxter et al. 2007: 22; Kurtz 2008: 28, 86; Belmonte et al. 2015: 200).

Thaut (1988) proposed a model that incorporates music to a significant extent in efforts to improve motor skills, on the scientific basis that internal functions of the brain are responsible for a learner's habituation with periodic rhythmic patterns, in turn improving 'reflexes' and the ability to expect, in the temporal domain, when a task is to be performed (Ibid.: 129). In addition, when organised rhythmic patterns within specific timeframes are paired with tonal stimuli, the cerebral functionality of the ASD learner is positively affected and leads to enhanced cognitive skills (Thaut et al. 2005). Recent research demonstrated that motor skills are positively affected when learners perform rhythm-oriented tasks (Thaut and Abiru 2010: 263), while learners strongly occupied with musical instruments tend to improve their fine motor skills over time (Schlaug et al. 2005: 219-221; Wan and Schlaug 2010: 567; Lee 2016: 133-4).

A challenging situation in treatment procedures is the possible coexistence of motor deficits affecting associated with different body parts, especially given the severe difficulty in confronting them simultaneously (Ayres and Robbins 2008: 87-92) and the strong correlation between motor abilities, corporal movement regulation and musical aptitude (Sutton 1984: 160; Michels 2003). A possible solution to the above is the careful planning of rhythmic patterns when employed to represent movements of the human body (Thaut et al. 2005: 244), something that would potentially encourage the process of employing the periodic movement of the hands in conjunction with the beats of a measure, similar to periodically recurring melodic stimuli as a means of developing coordination skills (Wan et al. 2010). Moreover, rhythm-based activities used to stimulate brain function can be combined with organised musical phrases characterised by commonly recognised transitions, in an effort to improve the universal 'sensorimotor' function of the individual with concern to intellectual and emotional awareness (Hardy and LaGasse 2013: 94). In ASD contexts, the appropriate reliance on rhythm in musical interventions does not only have a positive effect on the coordination of tasks and actions, but it may equally contribute to the regulation of behaviours (Ghetti 2002: 20, Yapko 2003: 132) and cultivation of communication skills (Orr, Myles and Carlson 1998; Wimpory and Nash 1999). It may also serve as a purposeful storytelling strategy designed to create a well-structured and artistically pleasant musical plot with a defined beginning, middle and end (Ockelford 2013b: 92-3). All the above may yield more promising results if rhythmic interventions, equivalently to any other associated with behavioural control and socialisation, are applied to learners for prolonged periods of time (Srinivasan et al. 2016).

2.2 Soundscapes and environmental sources in mental disability treatment; emphasis on creativity

While examining recently developed and tested music interfaces (see Section 1.4), particular focus was given to the aspect of tonal sound sources and auditory stimuli, combined with the performance of concrete melodies and rhythmic patterns. Despite the requirement of introducing a disabled person to the fundamental principles of music, instruments, structure and simple forms, in the effort to musically educate him and transform this knowledge into positive wellbeing results over time, this should not constitute the exclusive priority of the *Terpsichore* interface. In fact, it cannot be arbitrarily assumed that the disabled person is certainly in functional strength to grasp the key concepts of music theory and composition, without initially having at least a decent perception of the sounds that surround him, in other words, without developing his auditory sense centre adequately enough.

Christensen-Dalsgaard, Donnelly and Griffith (1999: 135) assert that a number of disabled individuals are virtually incapable of processing auditory and visual cues, and that the prevention of such an issue is a much more demanding task compared to the case of non-disabled people. It is therefore implied that the user's effortless response to any music software or interface, especially the current one, based on the choice of instruments through graphical cues and the subsequent reaction to the sounds produced, should not be taken for granted. Consequently, an external auditory incentive is required to assist the disabled learner in interpreting sound signals and become progressively involved in creating its own virtual auditory environment. The manipulation of existing soundscapes, combined with the creation of new ones, should ideally satisfy the following objectives:

- The ability to recognise different environments and to instinctively match an array of sounds into a distinctly defined situation (for instance, a rainforest, the seashore, a desert or a town centre).
- The establishment of a sufficiently strong auditory awareness, aiming to increase the user's capacity of dealing with any sound source he encounters.
- The relaxation of the mind and body, expected to accelerate the absorption of new knowledge and satisfaction of various non-musical goals including concentration and conduct improvement. In fact, the power of environmental excitations in soothing the disabled learner and normalising his overall situation has been extensively indicated in the relevant literature (Kashman and Mora 2005: 48, Larson-Kidd 2011: 20).
- The increase of vigilance in certain unresponsive individuals; according to Naftaly (2008: 265) this happens when these people get in contact with background sounds – of an especially intense nature – from their surroundings. These may include, but are not limited to, signals reproduced through loudspeakers, traffic sounds from adjacent vehicles, and noticeable screeches of animals.

Patel et al. (2008) have conducted an extensive investigation whose statistical results show a substantial percentage of learners not being competent in understanding the identity of the transition between pitches. Another example by Griffiths et al. (1997) concentrates on a third-age mental patient whose brain irregularities rendered him ineffectual in understanding distinct pitches and musical phrases, but did not damage his sound perception skills with regards to 'environmental' soundscapes. It can therefore be assumed, despite the above studies not being directly related to ASD, that the concentration on a detailed section within the *Terpsichore* interface dedicated to soundscapes is essential. This happens both because the learning process should originate from the aspect deemed most comfortable dealing with, and because the desired non-musical outcomes may be more easily met when the educational side of the interface is appropriately exploited.

In terms of the first justification which is comfort in the learning process, there are situations in which an environmental stimulus containing peaceful and gentle sounds can be introduced, by a parent or peer tutor, to the autistic male child, in an attempt to create a hospitable intramural ambience (Siri 2015), that would alleviate any concerns or behavioural outbursts, something equally applicable to females (Lyons and Stagliano 2015). Keeping in mind the inconsistency in symptoms exhibited as part of an autism diagnosis (Kanner 1943; Strnadova, Cumming and Rodriguez 2014), it may be assumed that some specific, if not all, learners, may be responsive to ambient sounds, on the basis that these do not irritate them or aggravate the mental situation confronted. In such an example, the preference of relaxing soundscapes or environmental materials to musical tone-based elements does not necessarily derive from difficulties in perceiving auditory signals, but may equally relate itself to the reduced potential of melodic and harmonic signals in improving facets of the learner's wellbeing. Thus, the problem identified when attempting to embed note and chord successions in learning schedules is its reminiscence to the congested environments that the learner detests or attempts to avoid in daily routines.

Dairianathan (2014: 1050) refers to soundscapes as a way that 'connect[s] details within [any given] sound to an ecosystem of interrelated areas'. However, it is afterwards explained (Ibid.: 1052) that the encouragement of learners to engage with various people and activities are mostly stimulated via more energetic sounds and patterns. If the study is to predominantly involve soundscapes, these must include drums and percussion. The fact that the enthusiasm is not comprehensively achieved with timbres possessing an abstract tonal profile does not mean that younger disabled people should be obliged to interact with such sounds. It is therefore recommended to combine abstract environmental textures with concrete sonic patterns, and include structures that will allow the attenuation of sharp auditory stimuli in case they elicit a sense of discomfort.

Finally, of significant research and implementation interest is *Soundscapes* (Lewis-Brooks 2011), a project focussing on the exploitation of ambient environments and relevant sound sets as a means of endorsing and developing original skills in composition and 'gesture'-based performance, in an entertaining manner (Ibid.: iv-v). Two important tasks that enhance the attention and interest of the learner, are the constant alteration of the overall sound constituents and characteristics, and the challenge to create something original (Ibid.: 37). Positive effects in psychological rehabilitation may also be induced through embedded music learning processes (Ibid.: 39), thus implying a direction towards bridging the music education-therapy gap. As a departure point towards embedding soundscape-compliant music activities, the above statements may serve as an impetus for the organisation of sounds into clusters, to be actively reproduced by a computer software and creatively blended together, in learners' efforts to organise their own sonic settings and fulfil the desired relaxation, concentration and motivation objectives.

2.3 Applications of feedback in ASD treatment

The core format of the *Terpsichore* interface, including all levels, fundamental learning activities and User Manual, have been designed in an effort to best address the educational and therapeutic needs of autistic learners in several categories, including the ones with similar characteristics to the learners of the thesis' respective case studies. However, if the software is chosen to undergo commercial distribution in its current, unchanged format, it will lack the capability of monitoring the actions taken by the learner at any specific instant, something that will prevent the correction of flaws in activity completion and the maximisation of the learner's educational potential.

The above issues serve as an impetus for commencing a discussion related to *feedback* in learning processes associated with disabilities on the autism spectrum. In general terms, and for purposes of *Terpsichore* optimisation, feedback refers to the ability of acquainting the learner with the tasks performed within a short notice, in an effort to improve areas of incompetency over time, a method successfully put into practice in various contexts (Seltzer and Bentley 1999; Greve 2003; Askew and Lodge 2004). For instance, Hall (2007) demonstrated an increased ability to complete activities accurately amongst learners informed of their mistakes and the pathways towards their correction, something that complies with the everyday life value of learning from one's mistakes. Furthermore, when autistic learners are brought in contact with music performance and composition tasks, they are expected to utilise peer advice to their advantage, so that the rhythmic, melodic and motor characteristics of the produced music are of an elevated standard (Zatorre, Chen and Penhune 2007), while simultaneously exploiting the versatile sensory influence of musical excitations (Srinivasan and Bhat 2013: 101). The discussion on motor characteristics and evaluative tutor-learner interaction becomes important as the ability to guide learners with regards to their degree of accuracy may be beneficial both for organisational and for communicative purposes (Hammel and Hourigan 2013: 97).

The purpose of building a feedback mechanism, for use within the *Terpsichore* interface, is the ability of learners and tutors to monitor the tasks performed on-screen in the short-term past, so that the constructive correction of flaws and the optimisation of the learning process can be realised. Ideally, such a mechanism should be capable of storing visual actions and auditory patterns in a buffer, allowing any user to call its existing content for evaluation and improvement. This mechanism simulates a rudimentary 'closed loop' Automatic Control

System, where output signal modifications actively influence the action performed by the system itself (Bakshi U.A. and Bakshi V.U. 2009: 1.10[23]; Ghosh 2009: 3, 11) but calibrated in such a way that the output signal is equal to the input. For instance, the ideal format of a feedback routine or automatic control arrangement should allow the change in colours of a level's buttons to occur in exactly the same succession as the one resulting from the learner clicking buttons with the mouse. A source of inspiration for the application of such feedback is Ockelford's (2013b: 115) account on a youngster capable of hearing, in a replicated format, the percussive sound he had produced slightly earlier, mainly thanks to the constrained space in which he is placed.

The discussion on visual representation of feedback does not undermine the influence of its auditory form, even if not accompanied by video. Volkmar and Wiesner (2009: 138) indicate that everyday functions related to speech and volume control of the individual are influenced by the audio component of interactive support mechanisms. The hypothesis concerning the positive effect of such mechanisms remains under question, considering recent research demonstrating mixed speaking skills and overall responsiveness amongst autistic individuals brought in contact with an audio signal they had already produced through a microphone (Russo, Larsson and Kraus 2008)[24]. Particular attention can however be drawn to the potential of feedback, in the form of auditory stimuli, to enhance the functionality of the right hemisphere (Lauter 2008: 99), associated with musical awareness and aptitude (see Section 1.2), or shift the learner's attention to the desired auditory source (Miller and Chrétien 2007: 76). These two methods should yield favourable results provided that the signal employed for feedback is not such a complex sonic continuum that it would cause concentration deficits and distraction (King 2012: 135).

The reliance on feedback within a music interface for ASD learners should not be limited to providing guidance for the correction of errors or overall progression throughout instruction sections, but is strongly recommended to account for the individual's need to tangibly understand when an action is performed according to a given guideline, potentially inducing a reaction of joy and enthusiasm positively impacting progress. In fact, the efficiency of feedback may be optimised when some form of congratulatory 'reward' towards the learner is included (Rogers and Dawson 2010: 12; Barton and Harin 2012: 222), even for actions considered encouraging yet trivial compared to a more comprehensively defined accomplishment (Smith J., Donlan and Smith B. 2012: 41). Such a strategy can be extended to a computer-based interface through the use of colour structures indicating whether a task has been completed

[23] The page is referred to as '1-10', or page 10 of the first chapter; the symbolism 1.10 was used to avoid confusion with the possibility of interpreting '1-10' as 'pages 1 through 10'.

[24] In this context, the assessment process (Russo, Larsson and Kraus 2008) involves 'feedback' in its scientific rather than in its social definition.

successfully or not, inspired by the physical way of presenting approval or dissatisfaction through colours (Devine 2014: 96-8). This approach may be compared to the tutor's leniency on the basis that the ASD individual does not learn to confront difficult situations and overcome everyday obstacles, and instead becomes sentimentally vulnerable whenever tasks differ from the learner's norm (Nason 2014: 75). During learning routines, tutors are faced with the choice of either being overly supportive or realistic in their feedback, in parallel with the case concerning family environments (Garland 2014: 156; Gould and Redmond 2014: 177). In order for the most appropriate decision to be made and possibly implemented in a music interface, the reaction of the ASD learner to each type of feedback should be assessed, considering that it is firstly important to render confidence levels manageable for sustained learning sessions so that adverse behaviour shifts are less intense when facing the realism of new musical tasks requiring additional effort.

The process of achieving feedback for the educational and mental benefit of autistic individuals, may be classified, for the purposes of the current study, into the categories of interpersonal and virtual feedback. By definition, the first term refers to the establishment of lexical or tactile relationships between two or more individuals, thus establishing a necessary communication loop through which the learner can improve points of deficiency over time. The second term, on the contrary, refers to the relationship initiated between the learner and the objects and devices with which a contact is formed; on certain occasions, the realisation of playful or leisure activities may also be regarded as a means of receiving feedback from oneself (Williams 1996: 253) consequently classifying such occasions as *virtual* feedback instances.

Interpersonal feedback is necessary especially in cases where the inability to effectively communicating with one's surroundings, as one of the perceived symptoms of autistic disorders (Bayliss and Etchells 2016: 62; APA 2017), is intense and should be at the forefront of treatment routines. This can be justified considering that communicative deficiencies are not a choice by which various learners elect to abide, but rather a developmental obstacle that they need to overcome (Hammel and Hourigan 2013: 41). Verbal interaction is preferred over its nonverbal counterpart in situations where a constant contact between learner-caregiver is to be established (Stone and La Greca 1986: 54), where sign language is not sufficient to enhance a learner's attention (Emmons and Anderson 2005: 121-2), and where the clear expression of opinions, emotions or the desire to acquire something becomes necessary (King 2012: 189; Hammel and Hourigan 2013: 41). Conversely, communication routines detached from speech are preferred in cases where the alternatives to perform an activity under various imaginary circumstances must be understood (Sargent et al. 2012: 198, 213-4).

The tendency towards nonverbal expression can be reversed through appropriate musical occupation with emphasis on educational rather than completely therapeutic elements, eventually resulting in increased language observation and activity due to brain functionality alterations (Moreno et al. 2009). Thus, in cases where reliance on gestures and body movements independent from speech function are interpreted as an ASD learner's comfort zone, the process of acquainting learners with fundamental concepts of music, such as the ones outlined in Section 1.2, is crucial in improving linguistic integrity to the point where speech can be regarded as a meaningful alternative communication form.

Virtual feedback has been already defined in a manner that detaches the involvement of third-party individuals from such a procedure, as the electronic device is responsible for returning useful information to the learner on whether an action has been accurately performed. For example, when a learner is asked to perform a musical phrase according to specific conventions, the compliance with the directed task is understood by the interface after having been appropriately calibrated, leading the virtual environment to assess task completion accuracy on the learner's part. The absence of direct human involvement classifies virtual feedback as a manner of nurturing interactivity and alertness with decreased risk of adverse effects of nearby peer presence. It can also be established as a meaningful manner of confronting motor skill deficiencies, with the help of so-called 'brain-computer interfaces' addressing various neurological conditions and disabilities extending beyond ASD (Birbaumer and Cohen 2007; Pfurtscheller et al. 2011 etc.).

2.4 'Social Stories' in ASD music-assisted treatment

Emphasis on society-based interventions to enhance treatment efficiency in autistic individuals derives from the social extension of autism spectrum disorders as a disability category altogether. Siegel (1996) elaborates on diverse instances where social deficits caused by ASD are of a nature that causes children to immerse themselves in virtual environments irrelevant to reality (Ibid.: 26), or become isolated from peer surroundings especially when under emotional pressure (Ibid.: 36). This behaviour extends itself to adults who might additionally be incompetent in recognizing emotions and actions of other individuals (Ibid.: 28-30). The components of 'communication', 'recognition' and 'imagination' employed to assess social competence (Wing 1988: 91-3), shape the general social profile of an autistic individual and may be employed for the determination of suitable treatment procedures, although it is not absolute that all areas in question are equally affected (Baron-Cohen 1988: 382).

The importance of 'social stories' (SS) (Gray and Garand 1993; Gray 1995 etc.) in the *Terpsichore* analysis derives from the assumption that peer communication is not something an individual can simply learn by passively attempting to network with others, but rather results from active acquaintance with a skill through participation in actual situations where a key role is expected from the learner (Taylor 2001). Generally, SS consist of activity representations for the satisfaction of social objectives (O'Hara 2010: 2) and are mainly directed towards four objectives through various statements of an informative, instructive or observational nature (Gray and Garand 1993; Gray 1995: 222, 237). These objectives are the acquaintance of ASD learners with various new courses of action in everyday life, the enhancement of overall cognitive and social awareness, the assistance in understanding regulations to be followed, and the process of addressing social issues that may be cause for misinterpretation or adverse behaviour patterns.

It has been proven that behavioural outbursts and communicative interruption decrease with the increasing use of SS in ASD learning contexts, whereas they increase when SS are excluded from learning routines (Kuttler, Myles and Carlson, 1998: 176; Lorimer et al. 2002). SS were also found to yield less positive results in behaviour improvement when paired with other means of social interaction control (Delano and Snell 2006), whereas their efficiency may be favoured by their inclusion in a broader visual environment that the learner is to interactively exploit (Schneider and Goldstein 2010). Furthermore, the use of animated designs is favoured as a principal SS implementation tool (Gray 1998), invalidating previous assertions (Gray and Garand 1993) based on the definition of 'comic strip conversations' as the inclusion of plain images to complement everyday two-way communication (Gray 2000: 1). Moreover, the use of pictures as an adjunct to written discourse should preferably constitute a compromise between visual simplicity (Turner and Spears 2011: 60) and illustrative detail to outline potential differences in an intended everyday setting (Chung and Chen 2017: 501). In the current context, there are two SS characteristics that can be instrumental in making the procedure highly interactive and dependent on the learner's personality: designing all SS without following a generalised profile, but by placing predominant emphasis on the learner's strong points (Timmins 2017: 19), and making use of computer facilities to receive feedback and inform the peer tutor of one's feelings at any moment (Gray 1995: 237).

The application of SS in settings where active occupation with music is required, may serve as a step towards increasing an ASD learner's responsiveness towards the environment and classroom or family demands, in terms of actions performed, conduct and peer communication (Harms 2007: 228). Although general information on SS is regarded as equally applicable to music as to any other discipline (Hammel and Hourigan 2013: 48-50), the enrichment of a commonplace musical setting with a SS should make learners increasingly aware of the scenario they are about to face, and provide them with the necessary space and time to successfully confront it (Ibid.). In addition, the use of musical segments playing in the background, especially in favour of similar methods not involving music, may prove vital in young ASD learners' attempts to interpret feelings of peers and exhibit an accordingly satisfactory social understanding (Katagiri 2009: 15). This, in itself, constitutes an important advantage in deciding to make computer-based environments for ASD treatment strongly dependent on music, although the use of 'background music' cues (Ibid.) could be substituted, in the future, by active and spontaneous choice of sounds, to be organised into a coherent result that best reflects the provided non-musical content of the SS.

In an effort to confront lack of interactivity using comprehensive participation strategies capable of making the learner an integral part of the music-based SS interpretation process, three notable endeavours are of special importance. Firstly, Brownell (2002) adapted ordinary text-based SS into songs, whose music composition was the researcher's responsibility, in order to increase situational awareness and responsiveness whenever the learner was invited to articulate the SS both in spoken discourse and by singing it. Secondly, in the method proposed by Pasiali (2004), the songs employed to support verbal SS are characterised as 'prescriptive' because they are carefully targeted to alleviate negative facets in the learner's mental condition, taking into close consideration personal music preferences and the need to develop straightforward reciprocal communication based on a relevant 'A-B-A-B' pattern, where A refers to a 'baseline' state of instructional idleness and B to a time schedule fully governed by SS (Ibid.). Thirdly, Jones (2006) examines the variability of the effectiveness a musical SS may have on ASD learners of various ages, based on whether a pattern is original or closer to something popular. This study demonstrates that the use of already popular songs may be better suited to the educational and therapeutic processes of the learners' majority (Ibid.: 99-107), with the opposite observation being consistent with a therapist's ability to musically depict a SS through an original composition (Ibid.: 107).

The above three initiatives distinguish themselves from other documented applications of SS, because they employ music as a predominant reinforcing element, considering the power of music in strengthening peer communication and externalisation of emotions (Kalyva 2011: 96). However, such attempts are associated with the conception of musical segments by the tutor or therapist, without any direct reference to a transitional or training procedure that would allow learners to provide their response to a SS by creating their own musical phrases. This matter becomes more concerning in situations where a therapist does not possess special qualities needed to optimise the content of an appropriate song (Jones 2006). Key to the resolution of such an issue and the incorporation of compositional tasks in SS, are the proposals made by Ockelford (2000; 2013b: 193-212) based on the utilisation of appropriate music-lyrics pairs in order to direct learners' attention towards completing desired tasks and understanding vital concepts of everyday life, including motor skill development through periodic activities (Ockelford 2013b: 195-201) and question-response interaction (Ibid.: 204-6).

Given that SS design in *Terpsichore*, as described in detail from Chapter 3 onwards, exploits the combination of image with sound, it is essential to base the visual component of a story on the 'Picture Exchange Communication System (PECS)' (Bondy and Frost 1994; Hammel and

Hourigan 2013: 46-7). This system assists learners in effectively interacting with peers (Ibid.), while it concentrates more on imitation or other mechanical reactions, and more on phrase development under a variety of communication circumstances (Bondy and Frost 1998: 373). Although its initial aim was to facilitate ASD learners' achievement in targeted quotidian activities to include nutrition and play (Dodd 2005: 26), such an approach was deemed to yield improved results when employed universally, as an inextricable element of learners' lives (Siegel 2003: 198).

Finally, in the context of an ASD-oriented software interface construction, it is sufficient to select appropriate pictures or successions thereof, based on relevant assertions regarding the ideal structure of a SS (Deiner 2010: 330; Hammel and Hourigan 2013: 55). These pictures should then be arranged in such an order that the learner is capable of not only understanding them, but also exploiting them as an inspiration for the composition of original phrases and pieces. This may be achieved as a result of constant learner-tutor collaboration, where the latter executes musical segments from within the interface in order to lead the learner towards increased adaptability to different everyday situations (McLaughlin and Adler 2015: 287) and informed decision-making (Harms 2007: 228).

2.5 Summary

This Chapter provides a theoretical background on the principles to be incorporated in the *Terpsichore* software interface, as part of satisfying educational and therapeutic objectives for ASD learners. Emphasis was initially given on how wellbeing, motor skills and various life aspects can be positively influenced by tonal music stimuli and rhythmic interventions, and how the possible use of soundscapes in contrast to tonal music can be engaging and elicit remedial effects for certain learner categories. Information is also given regarding the importance of feedback in learning and recommendations on how its interpersonal and virtual formats can be employed in autistic individuals. Finally, the notion of 'Social Stories' is introduced, combined with examples on how a music-based interface, accompanied by pictures to create an engaging audio-visual environment, can employ them to the fullest, in order to ensure a productive occupation with the *Terpsichore* elements pertaining to this notion.

CHAPTER 3

RESEARCH METHODOLOGY AND DEVELOPMENT

3.1 Methodology overview: a two-component approach

Satisfying, as comprehensively as possible, the research aims outlined at the start of the *Terpsichore* analysis, requires a concisely planned methodological approach directed towards an objective assessment of the software's overall efficiency and practicality. Specifically, such a strategy should not only ensure, in principle, that the software has been designed according to the general educational and therapeutic needs of learners with ASD, but also verify this assumption through a series of real-life tests intended to evaluate the existence of additional value to existing instruments and projects that have attempted to contribute to an autistic person's mental and cognitive development.

Considering the above, an appropriate method that takes these two requirements into account should focus on an approach characterised by two components: a *theoretical*, *case study-based* analysis and a *practical, real-life* research based entirely on the interaction with actual human subjects in which the *Terpsichore* interface is to be examined thoroughly. These elements are to be presented in detail and assessed in conjunction with one another, in an eventual aim to deduce whether the *in vivo* results deriving from an extensive application of *Terpsichore* to individuals with ASD verify or contradict the preliminary findings extracted from the available bibliography on mental health, autistic disorders and music for special needs education and treatment. Considering the recent innovations pertaining to the introduction of music in classroom and casual settings to which ASD learners belong (see Section 1.4), along with relevant methods directed towards rendering music a prominent everyday life occupation for such individuals (e.g. Siegel 2009; Lin and Li 2012; Wechsler 2012), the implementation of this bilateral analysis is crucial in determining the potential of *Terpsichore* having a substantial social and quality of life impact.

3.1.1 Theoretical component: case study analysis

The importance of compiling a detailed case study is justified by the necessity to gain an initial insight on the responsiveness of the learner to a series of planned activities eventually leading to the personal enjoyment and improvement of everyday life aspects via the authentic, and ideally independent, composition of music. In brief, the case study currently employed constitutes a procedure where human subjects extracted from the existing bibliography are hypothetically brought in contact with *Terpsichore*, so that an overview, by means of an educated prediction, is compiled regarding the expected effect of software use in a learner's educational progress and mental condition treatment. Findings extracted from this case study will serve as a basis for cross-examination against the actual results accumulated after the software has been substantially employed.

ASD may not be uniformly defined as a unique condition, as not all learners present similar or identical symptoms, behavioural patterns and reactions (see Section 1.1). Therefore, the inclusion of selected cases with different characteristics in educational potential, behaviour and communication skills aspires to provide a comprehensive image of *Terpsichore*'s beneficial attributes and the areas from which it would benefit in the future. A thorough statistical analysis of the results exhibited in people's academic potential, wellbeing and correlation between these two factors would ideally include the accumulation of relevant data from numerous different environments, whether scholar, casual or purely therapeutic. However, each of the autistic cases examined possesses its own particularities, despite any common characteristics it may share with others (O'Neill 2005: 2), something that would naturally require multiple samples to be examined in parallel with *Terpsichore*'s representative traits.

Under normal circumstances, lengthy research initiatives would have to be taken in order to eventually be in position to accumulate, compare and comment on results covering a broad spectrum of autistic learners on a universal basis, with regards to the efficiency and strong points related to the interface. As part of a research procedure constrained to a specific period of time, an approach similar to the above would not be suitable because of two crucial factors. Firstly, the need to include a voluminous sample size would in turn create the requirement of contacting bodies and institutions from multiple parts of one or more countries. Although positive effects in ASD condition assessment have been identified through this procedure (Volkmar, Koenig and McCarthy 2003: 5-6; Fombonne 2005: 17), it is usually time-consuming and further complicated by the fact that not all institutions can guarantee direct access to learners (Geretsegger, Holck and Gold 2012). Secondly, the process of employing large human samples might cause an enhanced risk of confusion while prioritising research tasks and organising results. Moreover, as practical research progresses over time, so are various technological advances and inventions that are centred around the optimisation of ASD learner rehabilitation (Lovaas et al. 1989: 286). For this reason, a gradual acquisition of separate data on a 'step-by-step' basis (Ibid.) is deemed more suitable, in order to account for the different educational and wellbeing aspects in which each separate person or individual group demonstrates change or improvement. Actually, researchers have increasingly adopted similar learning methods with respect to such actions as the motivation of a child to pursue recreational activities through specific linguistic stimuli (Greenspan and Wieder 1998; Gabriels 2002) and increase productivity in tasks essential to the mental development of a youngster (Hilsen 2011). It should not be forgotten that such a 'step-by-step' approach can occasionally be compared to the Developmental Therapy (DT) concept forming part of beneficial disability politics for music-assisted treatment in autism (see Section 1.6).

Considering that the bibliography-based case study will primarily serve as a supportive basis for the practical research and analysis centred around real-life *Terpsichore* occupation, the option of expanding this case study, with regards to either sample size or minute details, detracts from the emphasis that should be given on the actual findings extracted by a series of carefully planned software-led sessions, in individuals whose condition can be closely monitored. Although the accounts by Robson (2002: 89-90, 178), Thomas (2011) and Barrett (2014) suggest that thorough evidence-oriented practices significantly define and increase the value of a case study, it is still not sufficient on the occasion regarding *Terpsichore*, as the method employed altogether should ultimately strive to demonstrate how comprehensively the response of real-life ASD learners contributes to the satisfaction of research aims determined directly from the Introduction. The above may also constitute a third reason why the inclusion of numerous human samples from previous accounts would detract from the principal objective that the case study should serve, which is to build this supportive framework that should allow, over time, to draw more thorough conclusions regarding the efficiency and sustainability of the *Terpsichore* project.

Certainly, the above comments do not indicate, by any means, that a bibliographical case study is either redundant or inapplicable to the overall *Terpsichore*-based research. However, what is anticipated from an approach that involves isolated human samples as opposed to a multitude of available case studies, is to determine the ways in which the software and its constituent levels is expected to assist learners in developing their creative potential and treat areas of behaviour, concentration, motivation, emotional control and cognitive integrity that are possibly affected by their underlying ASD condition. Incidentally, the assertions of Bakan

(2014, 2015, 2018) acquire special importance in relation to the above, as the author exploits the observations extracted from a broad-spectrum bibliographical research, interestingly on music and ASD studies, to strengthen his position en route to acquiring the facilitations that would enable the development of his own music occupation projects.

The extent to which positive consequences on the above are attained, will be determined by the practical research that will follow the case study analysis, but the points in which attention is required, combined with the courses of action taken to optimize the overall structure of the *Terpsichore* software especially in the shorter term, may be extracted from the literature provided that its analysis is constructed as precisely as possible and with clearly supported arguments. This is where a combinatorial approach comes into effect, where the principal course of action is the parallel examination of case study human subjects and the influence of certain components, present in instances of *Terpsichore*, on the factors related to both the learners' occupation with music and their everyday lives in general. Section 3.2 will elaborate on this in more detail, including the steps followed for the extraction of the most comprehensive observations possible.

3.1.2 Practical component: analysis based on actual human subjects

The reliance on young individuals with an official ASD diagnosis from a relevant organisation, is a crucial component in validating literature-based findings and significantly heightening research reliability. This statement is supported by the belief that the *in vivo* observation of actions and practices associated with specific individuals as the research progresses, is a direct indication of whether a research project, subject to use and evaluation for development purposes, moves towards an appropriate direction, or whether specific actions and optimisations should be proposed to resolve issues that a purely bibliographical research may not detect (Robson & McCartan 2016: 3-12). Inspired by the example of Burnard (2012: 219-225), who elaborates on the essential nature of 'real-world research' in determining and analysing the diverse aspects and future directions of musical innovation in our contemporary society, the decision to make practical research on *Terpsichore* a predominant component of the overall analysis, is justified by the fact that individuals who have actually used *Terpsichore* in real-life conditions may provide a more trustworthy and less biased indication of the strengths and weaknesses of the software. The ultimate aim of the above is to determine whether the software is competent enough to not only bring ASD learners in contact with the music composition field, but also assist them in positively nurturing their personality skills as a result. This objective is in line with the increased requirement in directly perceiving the responses of learners whilst music-oriented sessions are taking place, so that more reliable results are obtained than the ones extracted within a distanced academic framework (Kellett 2000: 150).

The inclusion of case study samples from the literature with highly varying characteristics may compensate for the possible bias in the general post-research observations regarding *Terpsichore*, considering that these have been verified through findings and statements expressed by professional music therapists and relevant practitioners. However, there is no guarantee that bibliographically supported results will translate into similar ones as far as the occupation with the software itself is concerned. An example to clarify the above is the widely supported statement that learners with ASD have demonstrated substantial increase in attention span and concentration after music-related activities, whether traditional or innovative, have been included in their daily routines (Mahlberg 1973; Brown 1994; Gifford et al. 2011; Lim and Draper 2011; Peng et al. 2014 etc.).

In the above instances, researchers themselves have included evidence from actual autistic individuals to reinforce the validity of their statements. That said, they have done so on occasions associated with components and techniques that are totally different with the principles around which *Terpsichore* has been constructed. For instance, the assertion that robotic visual aids may serve as complementary assets in the effort to increase concentration during music performance activities (Peng et al. 2014) does not automatically signify that dynamic visual aids in *Terpsichore*, built in a manner that simulates this previous initiative in a compact, computer-based environment, are expected to yield the same favourable outcome and to a similar or greater extent. Likewise, the reported beneficial effects of music-based training sessions to improve vocal integrity and reduce mimetic speech patterns of pre-school children (Lim and Draper 2011) by no means suggest that real-life individuals, especially of a more advanced age such as pupils and adolescents, can present similar improvements when one or more *Terpsichore* components are designed according to case studies demonstrating a positive correlation between echolalia reduction and musical training. Of course, the purpose of the previously mentioned combinatorial analysis, where critical literature evaluation, is the extraction of observations on the expected response of learners to the software; the keyword 'expected' indicates that this bibliographical study should be referred to as a comparison point for the tangible findings to be obtained from planned sessions associated not with variants of *Terpsichore* described in previous studies, but with the exact same environment as constructed to serve specific educational and therapeutic purposes.

The significance and benefits of real-life human condition observation and monitoring has been highlighted by various researchers specialising in autism spectrum disorders. First of all, Kim (2017) conducted a study where disadvantaged pupils, influenced by the unpromising social and financial background in their country of residence, were subject in music therapy sessions that included greeting songs, turn-taking approaches and plain instrument execution.

The study's characterisation by the author (Ibid.) as 'real-world' indicates that the literature review initially conducted, from which general assumptions on the behavioural impact of music therapy derived, served as a supportive foundation for further investigation and evaluation using a sizeable sample of existing pupils, with which the researcher developed a direct research-based contact. The reported promising effects of music therapy on behavioural control carry a statistical significance magnitude of less than 0.05 (Ibid.) required to safely theorise that conduct improvements in broad spectra of learners are indeed a direct consequence of music therapy application rather than coincidence or chance (Asmus and Radocy 1992; Rosenthal 2012: 202), and thus can be assumed to be valid for the majority of human subjects recruited elsewhere and subject to the same procedures (Rosner 2011: 211-222). However, since music therapy sessions employed in Kim's (2017) research involve conventional practices without the direct inclusion of a software with a clearly defined scope of attempting to bridge the gap between music education and therapy for autistic learners, the belief that treating behavioural deficits is facilitated by music therapy can only be used as a preliminary hypothesis to be subsequently verified or refuted after the learners within the sample have occupied themselves with *Terpsichore*.

Douglas (2019) has compiled a study where the main subject of developing techniques to alleviate the disadvantaging symptoms of an existent or evolving ASD condition, is being investigated through an approach involving the examination of large-scale human samples and sources to propose manners in which severe complications, arising from the escalation of ASD-compliant symptoms, can be prevented. Although the description 'real-world' (Ibid.) indicates that general observations result from a joint analysis of divergent information, based on contacted human participants, to produce congruent conclusions and working hypotheses, the fact that the researcher herself has not yet developed an investigation team that would assess these prevention tactics to actual learners, detracts from the progress of this specific research field as its sustainability would rely on whether a specific system, directly applied to such learners, would yield the desired benefits in treating what Douglas (2019) arguably expresses as 'an emergent public health problem'.

The approach of Kossyvaki (2018) concerning the inclusion of actual human participants combined with appropriate supervising practitioners seems to better clarify the requirements that would best provide solutions towards judging the efficiency of *Terpsichore* and its sustainability in future projects and special education settings. The researcher (Ibid.) uses the term 'naturalistic' to highlight the benefits of including of non-disabled individuals, whether therapists or parents, as an integral part of ASD condition assessment and treatment, while she also recommends that small-scale research initiatives be also taken by these intermediary entities to assist with the extraction of useful results. Kossyvaki's book (Ibid.), predominantly focussed on the methodological aspect of ASD studies, seems to resolve the issues that the previous two examples (Kim 2017; Douglas 2019) are deficient in. In short, real-life practices, as the term suggests, should be characterised by directness in contact with individuals and supervision of events, especially as far as *Terpsichore* and its desired objectives are concerned, and not by a plain compilation and meta-analysis of previously conducted studies which, after recent real-life research has taken place, may ultimately prove outdated. Although Kossyvaki's (2018) target group mainly consists of adults, whereas children and adolescents occupy the greatest part of samples in the current *Terpsichore* study, her overall insights constitute a resourceful departure point in planning the methodology centred around the software, having in mind both the varying profiles of young individuals with ASD, combined with the role such an intermediary body as a tutor or therapist can play in ensuring that the positive outcomes of occupation with a completely new interface are maximised and sustained in the long term.

The two methodology components will be discussed in more detail in Sections 3.3 and 3.4. To facilitate their comprehension and the ways in which *Terpsichore* will be embedded in the methodology, it is initially essential to thoroughly present the principal parts of the interface, while providing additional emphasis on the constituent working modes and levels, specific points of particular interest, and the overall objectives that should ideally be satisfied during the learner's engagement with the software, either independently or under the support of a qualified music practitioner. The analysis of *Terpsichore* primarily aims to clarify the manners in which the tasks related to the overall methodology are set for completion, with regards to both bibliographical analysis and human participant-centred research, taking into consideration that progress monitoring and condition assessment strongly depend on the learner's engagement with the software, in conjunction with various external circumstances.[25] The analysis of *Terpsichore* can also be interpreted as a detailed design brief, directed towards assisting tutors, therapists and miscellaneous readers in better understanding the interface's qualities and special attention points, so that they can apply the software to peers with ASD, in a manner that potentially yields positive changes in the creativity and mental state of such learners.

[25] These circumstances include, but are not limited to: educational environment (home, classroom etc.), the learner's relationship with parents, tutors and other acquaintances of significant influence, and general computer literacy.

3.2 The *Terpsichore* interface in detail: important components, software levels, intended purpose in education and therapy

3.2.1 Main working modes and graphical user interfaces

The decision to construct *Terpsichore* has mainly been made according to the requirement for simplicity in learning processes, as also outlined in the Introduction. Considering the principal characteristics and limitations of the software and hardware interfaces examined in Section 1.4, it is important to create a multifaceted but integral and user-friendly software that will draw positive and valuable concepts from the functionality of previous interfaces, and combine them with innovative ideas in order to satisfy educational and therapeutic goals. Construction principles of such an interface are centred around the following factors:

- Inclusion of two distinct working modes, labelled as *Tonal* (Definite Pitch) and *SIP* (Sound and Indefinite Pitch), so that learning routines are not always biased towards pitch-defined auditory sequences.
- Ability to automatically provide on-screen feedback to learners on various actions performed within the interface.
- Enhancements employed to address specialised areas related to the learner's mental condition and sensitivity, such as frequency filtering and controls for time limiting in interface use, to prevent addiction to computer systems, with any unfavourable consequences this may induce.
- Capacity of operating the interface either directly through a personal computer, or with the aid of external tangible environments including a piano keyboard or a smart mobile phone.

The *Terpsichore* software interface, named after the Muse for dance and musical theatre in Ancient Greek mythology, was built in the SuperCollider (version 3.9.3) programming language, through a document that contains approximately 50,000 lines of textual code. This language is mainly characterised by the ability to convert appropriate code to sound clips and sequences, either synthesised or sampled, windowed visual structures and button stacks designed to performed a broad spectrum of actions (Wilson, Cottle and Collins, eds. 2011; Koutsomichalis 2013; Valle 2016). In addition, it is possible to view the unveiling structure of *Terpsichore* and correct any script flaws in real-time (Wang 2007: 66; D'Escrivan Rincón 2012: 160). The above advantages of the language were exploited to the highest extent, in an effort to satisfy the desired simplicity and practicality objectives of the interface.

Figure 3.1 depicts the main menu of *Terpsichore*, including four navigation buttons for the Tonal and SIP modes, for miscellaneous options and for quitting the software. A structure for the control of explosive behaviours or oversensitivity (S) is also accessible through this menu, alongside two buttons for the recording and playback of sound emitted via the SuperCollider sound engine. The main window does not appear directly after running the interface, but is preceded by another window using the visual cue 'Hello!!!' to virtually greet the learner. A similar window displaying the word 'Goodbye!!!' appears after the user decides to quit *Terpsichore*. These windows are inspired by various research findings, especially in private and classroom education contexts, that strongly proposed the inclusion of an appropriate tune intending to salute learners, in the form of 'hello' (Rogers and Dawson 2010: 114-5; Hammel and Hourigan 2013: xi; Ockelford 2013b: 205-7 etc.) or 'goodbye' (Warwick 2001: 200, 204; Brunk 2004: 43; Ockelford 2013b: 191-2 etc.). Similar to examples where peer tutors directly addressed participants by their names prior to task outset (Kamps 1997: 83; Lima and Castro 2012: 116), the user has the option of entering a name that accompanies the 'Hello' window when launching *Terpsichore*, in the attempt to draw the learner's attention to software occupation. Although default sound patterns are initially specified to accompany greeting windows, peer tutors may load their own WAV or AIF files for personalisation purposes (see Figure 3.2).

***Figure 3.1** The main menu of* Terpsichore.

Figure 3.2 *Initial sound selection window for learner greeting.*

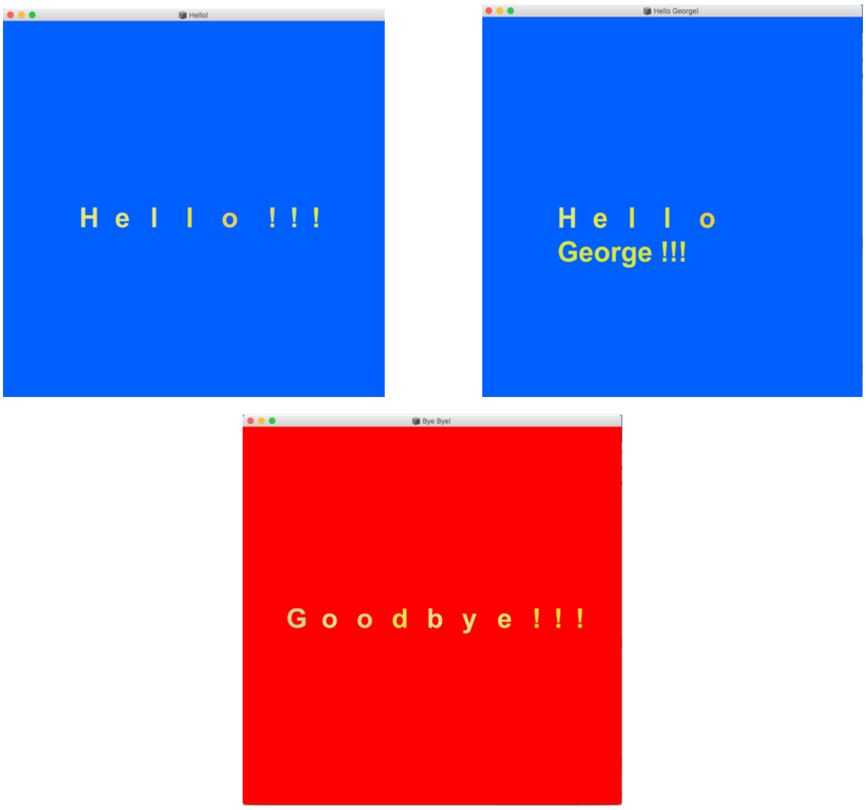

Figure 3.3 *'Hello' window with or without name input, and 'Goodbye' shutdown environment.*

The Options menu offers a number of capabilities that can facilitate the progression through the *Terpsichore* structures and ensure that educational and therapeutic potential are achieved to the fullest, depending on particular ASD characteristics or deficiencies. Firstly, it is possible to annihilate any frequencies in which a learner is highly sensitive, or to address specific cognitive

/ emotional areas activated by emphasis on predetermined frequency ranges (Nwora and Gee 2009). Secondly, in an effort to either prevent addiction to computers (Grüsser, Thalemann and Griffiths 2007; Romano et al. 2014; Lonie 2015: 57) or enable learners to successfully confront time scheduling issues and adapt learning timetables to unforeseen circumstances (Roberts 2010: 161-2), a Timer Mode can be enabled, with a user-configurable countdown duration, specifying the amount of time the interface will be running before automatic shutdown. The window accessed via an 'S' button visible in the bottom left corner of Figure 3.1 is inspired by a case study where the learner is oversensitive to loud sounds (Brownell 2002, Section 4.4). This window utilises a colour code to monitor the intensity of voices arriving to a microphone or other connected recording sources. On occasions when learners emit loud sounds, they are textually advised to 'calm down' before proceeding to further tasks, something complemented by a percussive timbre on occasions of excessive vocal intensity. This structure is based on Cresswell's (2009: 60) observation on children's purported inability to learn under uninviting circumstances, being therefore an important factor in ensuring an overall carefree learning environment.

The Tonal and SIP modes each have their own main menus serving as starting points for their operation, prior to accessing the instruction level structure that accompanies each mode. These main menus, as demonstrated in Figures 3.4 and 3.5 respectively, comprise various fundamental but important elements associated with everyday musical activities, designed for use especially after the level structure has been covered in its majority.

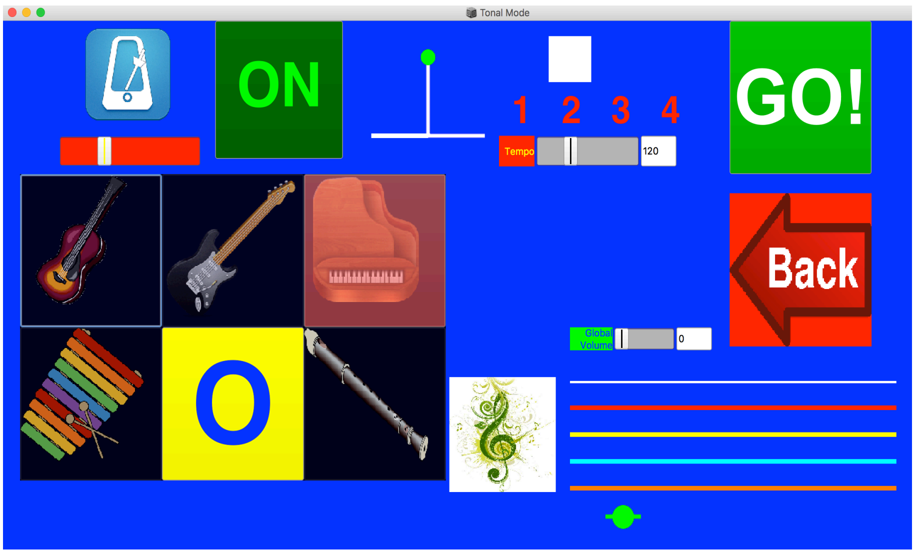

Figure 3.4 *Main Menu of* Terpsichore*'s tonal (definite pitch) mode.*

***Figure 3.5** Main Menu of* Terpsichore*'s soundscape and indefinite pitch mode.*

In the Tonal Mode (TM), the main window components play a corresponding role to musical instrument study books employed to maintain and sharpen dexterity skills. To begin with, the TM main menu contains a metronome used to dictate tempo, in case the learner needs to perform actions and execute melodies under a specific temporal timeframe. The user may adjust the volume and tempo value (40-300) associated with the metronome. In addition, the tempo and beat in a default 4/4-time signature are visible on screen at every instance, in order to provide an audio-visual indication of rhythm while operating *Terpsichore*. It is worth reiterating that a high correlation between rhythm and motor ability development in ASD human subjects has been proven in Section 2.1 by examining relevant sources. Secondly, the Main Menu has been programmed in such a manner that various notes represented in Western European music conventions, with or without accidentals, can be shown on screen as a result of pressing computer keys, similar to the 'musical keyboard' feature of Apple's Logic Pro sequencers (Cousins and Hepworth-Sawyer 2014: 200). A note map, employed to match notes to keys pressed on a computer, can be accessed by pressing the 'X' button; its contents are visible in Figure 3.6. The letters in the note map must not be confused with the letter representation of pitches in conventional Western European music.

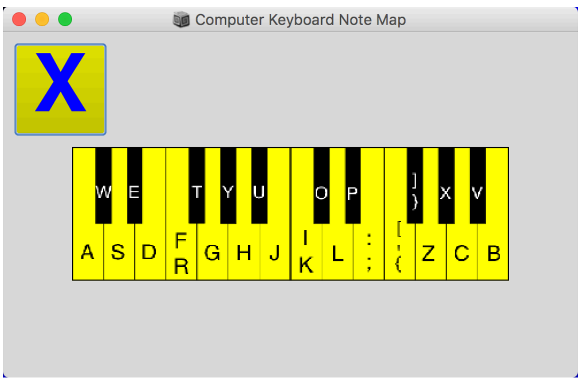

***Figure 3.6** Computer Keyboard Note Map, matching computer keys to pitches played. The 'X' button in the top-left corner closes the window.*

3.2.2 Tonal Mode (TM): brief description of levels

As part of the interface construction's ongoing process, and assuming that the 'virtual' case study subjects are to be brought in contact with *Terpsichore*'s levels, ideally starting from the first and proceeding to the subsequent ones, 18 levels were completed in the Tonal Mode.

Level 1 introduces the user to the first five distinct pitches of tonal music. Western music conventions accept that C is the fundamental musical piece, deriving from the middle C in a piano (MIDI Note 60). However, the pitches chosen to appear in this level eventually correspond to the first five letters of the English alphabet. Various research findings incidentally focus on the power of music to facilitate the instruction of the alphabet for autistic learners (Brownell and Arbor 2012: 118), the connection of musical stimuli to speech and lexical representations through the International Phonetic Alphabet / IPA (Howland 2015: 311), and, most importantly, the association of music notes with alphabet letters by considering the 'fixed Do' / C note principle consistent with Western music (Berger 2016: 176).

The same Level some of the most common musical instruments and encourages the user to select an instrument and a pitch of his choice at the same time. No two different instruments or notes can be chosen concurrently; this has been programmed in SuperCollider for reasons of avoiding unnecessary confusion and learning complications, based on the relevant analysis of Section 1.6 on disability politics. This level is complemented with three buttons: the green Play button executes only the selected instruments and note, while the blue Loop button executes all five notes, at fixed intervals, both forwards and backwards, only by using the instrument (or timbre) selected by the user. The dark red Loop button performs the same function as the other Loop button, but with all five available instruments in turn, in the form of an extended phrasal sound-set.

Level 2 extends beyond Level 1 in terms of pitch identification and understanding, while the connection between pitches and letters is also retained. The note A, corresponding to the second space (from bottom to top) in a G-clef-based stave, was selected as the base pitch. B, C, D and E above the second space A follow. The five letters, A to E, are grouped in a series of square views, to the right of which a green *Play* button and a red *Stop* button are visible (see Figure 3.7 below). Upon clicking on the *Play* button, a fixed routine is activated, where the notes A to E are heard in turn twice, the first time with a 2-second interval between adjacent notes and the second time with a 1-second interval. When each different pitch is heard, the foreground and background colours of each square (corresponding to the pitch) are inverted. It is possible to stop and reset the routine to its initial state by clicking on the Stop button. The instrument used to produce the pitches is the one that the user has selected from the Tonal Mode main menu. Moreover, as shown in the Figure below, the user is capable of activating a built-in user manual providing guidelines for the operation of the Level in plain English, a reward mode representing a task that has to be completed by the learner in order for *Terpsichore* to continue functioning, and a feedback structure repeating, after a short time interval, an action induced by the push of on-screen buttons; further information about the three above features is provided in Section 3.5.

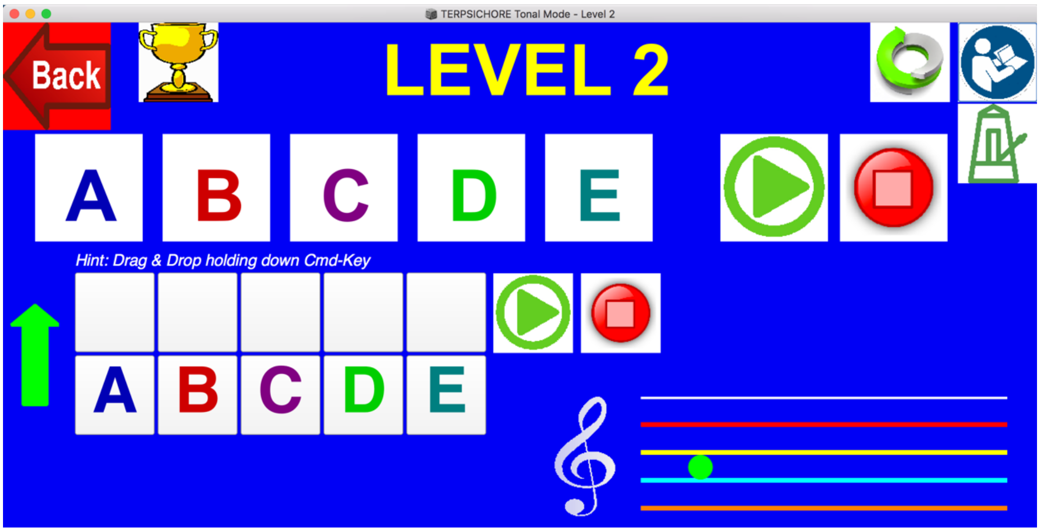

Figure 3.7 *On-screen view of TM Level 2.*

The two groups of five buttons each, constitute another cluster that allows notes from the bottom row to be transported, through a drag-and-drop technique, to any of the top row's buttons. This cluster exploits the use of the keyboard, so that when the Command button is pressed, any letter/pitch can be dragged and dropped to any button in the top row. Using an action assignment function, two tasks can take place after the completion of the drag-and-drop procedure. The first one is the ability to produce pitches corresponding to the letter that matches the button value (e.g. A for the second space A, B for the third line B etc.). The second one, triggered through another Play button situated next to the cluster, is the ability to translate all five button values into a note routine and – consequently – simple musical phrase. This is the most important operation of the two, provided that it allows the user to produce numerous different types of phrases with only five different pitches. The total number of available permutations, taking into account that no constraints on note repetition have been imposed, is the factorial of 5 (5!), or 120.

Level 3 familiarises the user with the concept of an octave or a musical scale, inspired by other previous examples of music therapy where instruction took place by gradually increasing the level of difficulty[26] (Berger 2016: 161; Bate 2013: 194). Once the window opens, the boxes corresponding to letters and notes A through E appear, while three more boxes with the letters

[26] 'Increasing difficulty' is a general course of action followed, not necessarily relevant to scales and octaves.

E, F and G follow after a few seconds. Ultimately this cluster arrangement will help the learner comprehend that the possible pitches and letters in a conventional Western music scale, range from A to G. The playback function of the entire scale is again available and characterised by the same principles as the ones described in Level 1, while an additional drag-and-drop function enables the creation of authentic musical patterns. Phrases with five notes each can be built through this level, meaning that the number of available permutations will now equal 2,520.[27]

In **Level 4**, the notion of rhythm and the organisation of notes into bars, as a form of a conventional timeline, are introduced. Organisation of music into bars has been proposed as a plain and potentially effective learning strategy for autistic children (Humpal and Kern 2012: 168). In order for the concepts of note group separation and measures to be better understood, the learner is fundamentally familiarised with the three basic note duration values, which are the semibreve (whole note), the minim (half note) and the crotchet (quarter note)[28], communicated visually for reasons of facilitation. Once the Play button is pressed, and a routine starts to play, during which the note 'A' is heard each time the arrow reaches a different note on screen. This movement of the arrow, combined with the execution of the same note, is intended to demonstrate the duration of the note that is executed. The 'Go' button opens another structure labelled as the 'Practice Window', which familiarises the learner with how different note durations are reflected in a timeline, with each measure comprising four crotchets or beats, as defined by a typical 4/4-time signature. Each pattern is executed once the respective 'Play' button has been pressed, and an arrow moves from one numbered position (indicated by 1, 2, 3 and 4) to another before disappearing from the screen once the pattern has been finalised.

Level 5 is a practical adaptation of the method that Shore (2003: 7174) proposes as part of a case study in a third-party learner named 'Sam'. Specifically, Shore's (2003) case study is centred around the representation of simple English words in the form of musical note successions, given that each of the letters A through G is associated with a pitch that can also be shown on a conventional 5-line musical stave. The code for this level has been constructed in a manner that the sound from the matching note is activated when any of the computer keys A through G is pressed. Furthermore, an 'Examples' section depicts four different simple words in the English language, which are 'BAG', 'DAD', 'ACE' and 'FACE', the first three also being suggested by Shore (2003). A series of play/stop buttons is observable next to each word. Whenever the appropriate Play button is pressed, a sequence is executed involving each of the word letters in their regular order, while a circle covers the matching position on the 5-line stave, to visually explain which note is being played at any given instance.

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[27] Source: http://stattrek.com/online-calculator/combinations-permutations.aspx.

[28] Both representative names (e.g. minim – half note) can be used interchangeably in learning routines.

Level 6 aims to link the concept of listening to music with a young human's everyday activities. Specifically, this level regards music as a form of 'language' through which various orders or requests towards a learner are interpreted. It has been influenced by various examples where musical interventions were used to encourage learners to perform specific activities (Kern, Wakeford and Aldridge 2007; Presley et al. 2011: 74 etc.), including the concept of 'situation songs' (Kolar-Borsky and Holck 2014). This level relies on six different phrases, with their mood tailored to each of the actions for which these are intended: *'wake up'*, *'go to school'*, *'have lunch*', *'study'*, *'play'* and *'go to bed'*. In the event that the tutor utilises verbal cues, the insertion of such an element as *'let's'* before each of the above phrases, ensures that the on-screen pictures are meant to encourage the learner to perform an action and *not* to serve as an authoritative order, with potentially unwanted wellbeing consequences (Hufft 2014: k2422). For the playback of these phrases, a structure resembling a flower has been constructed, including six differently coloured petals. Next to each petal, a Clipart image demonstrates each of the actions for which a musical phrase is intended, while a rectangular button triggers the pre-programmed phrase. Such a structure may be beneficial for the parent or peer tutor, as the instruction of the relevant musical phrases will gradually assist the supervised learner in recognising the exact action to be performed when a specific musical excerpt is conveyed.

Level 7 functions as a natural continuation to the previous level, as it presents, in a more detailed format, small passages of the phrases that are triggered by the petal buttons of Level 6. This is where the role of music in enabling the learner's everyday awareness is complemented with the importance of music modification and recreation in making an individual less passive and more enthusiastic. Level 7 is split into six sub-windows, whose numeration and button colours are based on the Level 6 petal colour that pertains to a specific phrase and activity. Each of the phrases represented in a window may not only be executed by pressing the on-screen play button, but it can also be modified to a very high extent, thus setting the foundations for authentic music composition. More specifically, about 70%-80% of the buttons in each sequence can acquire up to three different note values, which have been chosen by the programmer in order to maintain a regular note flow in the C major scale of Western music. The remaining buttons have a fixed note value which cannot be changed; this initiative was taken in order to help tutors and learners understand that changes to a model phrase cannot be unlimited, but are subject to small constraints that guarantee minimal modifications to each phrase's mood and character.

Level 8 extends beyond the compositional area covered in Level 7, as the user is now capable of modifying the structure of a default phrase by relying on a larger number of possible pitches for each note or sound. This level consists of two different windows accessed by clicking on the respective navigation buttons at the top of the screen. Each window consists of a series comprising seven different pitches, the first five of which can have their identity modified by clicking on the button that represents the respective musical note as shown on a 5-line stave.

The values in the buttons match the letter representation of different notes, whose durations are also predetermined and cannot be changed, in an effort to retain the rhythmic structure of the demonstrated musical phrase. Moreover, note selection constraints in the final two pitches of the sequence are employed to familiarise the user, in a more playful and empirical manner than conventional strategies for neurotypical people, with the concept of a simple musical cadence, or transition between a dominant and a tonic gradient (i.e. 'V-I') that is normally used to conclude a phrase. Incidentally, the importance of bringing an autistic individual in contact with cadences has been documented by various relevant experts (Boxill 1985; Lim 2012a: 126 etc.) especially when attempting to utilise the formulated musical phraseology to improve a learner's speech capacity (Edgerton 1994; Lim 2012a: 66-68; Lim 2013 etc.), thus providing inspiration for imposing these constraints.

Level 9 is similar to Level 8 but is characterised by a predominant difference; although the structure of Level 8 permits the existence of two or more identical pitches at any position on the stave, the code in Level 9 has been reconstructed in order to ensure that no two notes within a three-measure phrase are exactly the same. To make this possible, a series of conditional clauses ('if') and repetitive loops ('do') has been employed, in order to create a complex feedback loop that will ensure that all notes within the stave are different from each other; moreover, the same constraints regarding the two final notes of the phrase are in function.[29] The principle upon which Level 9 is constructed is the twelve-tone technique employed by Arnold Schoenberg (1874-1951), based upon the execution of all notes in a chromatic scale without drawing particular attention to a specific pitch of the scale over others (Ehrenzweig 1953: 109-112; Perle 1991; Boss 2014). The interesting fact about the aforementioned Schoenberg technique, which makes its adaptation applicable for the purposes of *Terpsichore*, is that it has been frequently regarded as a musical manner that explains the condition and living routines of an autistic individual, thus creating an otherworldly environment that cannot be easily understood in neurotypical people's terms (Straus 2016: 700-1). This argument adds to the references made with regards to the 'autistic' manner of listening and responding to sounds (Section 2.1), and justifies why the use of a concept, considered unconventional by the average musician, could be better suited to the ASD learner's effort in composing authentic music.

Level 10 is intended to practically bring the learner in contact with the notions of tempo and rhythm variability. Pressing 'Play' activates a routine where a circle in the accompanying 5-line stave moves in accordance with the pitch alterations between C to G, something that is also reflected in the five buttons that illuminate once each of the notes is executed. With the help of the two buttons that are located above the letter representations of the notes, it is possible for the user to change how fast the default pattern will be played, and whether the relation between

[29] See description of Level 8 above.

the note durations implies a straight or swung rhythm. It is possible to adjust the tempo through three different buttons (> for slow, >> for mid-tempo, >>> for fast). Likewise, the right button allows either a straight (--) or a swung (~) rhythm to be played. Besides the documented effect that integration of rhythm in music education has on the 'motor' abilities of autistic individuals (Pavone and Ruggieri 2005: 191-2; Hardy and LaGasse 2013; Berger 2016: 106-7), the existence of two different styles within Level 10 is helpful in making rhythmic music occupation interesting and less monotonous, as also recommended in the research of Schmidt-Peters (2000).

In **Level 11**, the learner is introduced with all twelve discrete pitches of a chromatic scale, as the virtual black piano keys, representing notes with accidentals, complement the white neutral-pitched keys. This addition acquires particular importance in certain ASD-based circumstances, whether these are interpreted as an applied form of music interval awareness investigated in learners by Heaton, Pring and Hermelin (2001: 443) or as a challenge aiming for comfort and inner fulfilment as a result of covering the entire range of scales (Ockelford 2013b: 249). Apart from the above however, this Level provides a strong indication of how audio-visual feedback can be implemented in *Terpsichore* where necessary. The objective of feedback in this Level is to monitor the keys pressed via the computer mouse at any given instant, as well as the order in which a spontaneous phrase is created. The default repetition interval of three seconds, adjustable through the 'Options' window, allows the ASD learner to recollect actions performed over the 12 keys of the octave and subsequently improve auditory integrity to better recognise pitches (Berger 2002: 96; Berger 2016: 103; Ostiz-Blanco et al. 2016: 328-9).

In **Level 12**, the learner is expected to exploit the absorbed material from the previous Level in order to extend the phrase creation process to the construction of a rudimentary electronic instrument through fundamental sound synthesis of sines, sawtooths, triangles and squares. It can be understood, from common music technology knowledge, that a sine wave constitutes a unique tone with a strictly defined frequency for each corresponding pitch, and that all types of instruments and sounds may be disassembled into sine tones. Therefore, this Level is a first-rate opportunity to exploit previous ASD research endeavours with sine wave interventions to treat neurological (Seri et al. 1999: 1825-7) or socio-communicative abnormalities (Kuhl et al. 2005) resulting from the general disability profile altogether. Sounds can be formed through the combination of any four oscillators, whether same or different, while feedback implementation through automatic key striking remains, exactly as in the previous Level. It is additionally possible to control the envelope characteristics of the composite sound, in order to configure sharpness, warmth, intensity or any other parameters through four ADSR knobs. However, the evident difference in Level 12 is that notes automatically produced, as a result of feedback implementation, are characterised not by the envelope values of original notes, but by the ones configured through knobs at the time of replicated execution. This characteristic is not mandatorily negative, as it should enable the learner to perceive, through ear activity, the alterations that respective sounds have undergone, so that they can be reconfigured according to the learner's actual preferences and aversions.

Levels 13 and **14** are inspired from two case studies respectively analysed in Sections 4.2 (Mottron et al. 1999) and 4.6 (Pasiali 2014), and a research account by Bruscia (1982), all addressing the issue of 'echolali[a]' or non-critical repetition of speech articulated by peers without a conversational purpose. As suggested in Chapter 4 relevant to case studies, these levels present the learner with a default, pseudo-ideal[30] manner of completing five-note phrases with two missing pitches or formulating an independent five-note sequence, as an adjunct to another phrase of identical length serving as a question stimulus that requires a response. A series of play and evaluation buttons are available for each different sequence, where the former demonstrate the expected notes for successful phrase completion, and the latter evaluates whether the actions ultimately performed comply with this recommendation. In the two-note completion it is mandatory to select specific two notes for each position, whereas in the question-response format a greater degree of flexibility exists, as the sole constraints are limited to initial and final pitch choice or repetition of the same pitch within the sequence.

Level 15 introduces the concept of pitch layering, allowing the simultaneous execution of three different audio layers in the form of counterpoint. As an introductory activity, the temporal relations between notes in each of the three staves have been predetermined, mainly towards the aim of time perception improvement and the distinction of one melodic line over another. The compositional functionality of this Level expands from the one presented in Levels 8 and 9 as it allows full natural pitch control in two octaves for increased creativity options. In **Level 16**, accidentals re-appear this time as an integral part of the 5-line structure, parallel to ascending difficulty theoretical and harmonic activities for neurotypical learners. A default C major scale is initially observed on the stave, but the position of notes and the accompanying accidentals may alter according to the action of pressing buttons that change the tonic gradient and the scale type, between major, harmonic minor and melodic minor.

Level 17 exploits the area of 'social stories' (SS) discussed in Section 2.4, and attempts to encourage a learner, having already mastered the compositional principles outlined through previous levels, to create a totally authentic musical phrase that reflects the order of pictures represented in a social story (SS). This level has been designed to offer the increased flexibility of loading images directly for the computer to support the SS, rather than having to rename images to match a specific filename, as was the original intent in earlier prototypes of *Terpsichore*.

[30] The term 'pseudo-ideal' is employed to denote that the perception of ideal music conversation strategies is subjective and unique to specific human or researcher groups.

Finally, **Level 18** serves as a recapitulation environment summarising all notions and techniques instructed in previous TM levels, where the learner is given full creative freedom to experiment with different notes and durations in the default 4/4 signature followed throughout the interface, something that marks the ultimate transition from passive reproduction to totally authentic composition, governed by the ideas on improvisation and 'extemporisation' (Wigram 2004: 114; Wigram 2012: 438-9) explained in Section 1.2. On selected occasions, it may be useful for the tutor to provide the learner with subconsciously sung lyrics to assist learners, not fully familiarised with the process, in creating phrases of six bars maximum that reflect the inner themes of both the reference song altogether (Ockelford 2013b: 192-3) and its word constituents (Ibid.: 56-8). However, such a choice should be carefully made or discarded, considering either the preference of learning session convenors to concentrate on music prior to complementing it with lyrics (Gutstein and Sheely 2002: 272; McManmon 2016: 495), or the possible threat to the learner's wellbeing through being overwhelmed by such verbal stimuli (Riggs 2013: 60).

3.2.3 Soundscape and Indefinite Pitch (SIP) mode: brief description of levels

The SIP mode principally includes temporally abstract, soundscape-compliant sounds; however, it was deemed beneficial, judging by the documented ability of percussive timbres to improve motor function (see Section 2.1.3), to bridge soundscapes with drums within the same environment, exploiting their common characteristic of indefinite tonal and frequency identity.

The first levels of the SIP mode emphasise on increasing the learner's awareness towards typical sounds encountered in everyday life, or when spending certain periods of time in the external environment. To begin with, **Level 1** entirely focuses on specific sounds that are highly likely to be heard in an everyday environment: flowing water, wind and leaves' movement as influenced by the wind. Each of these sounds is represented with a button, whose background image is a specific icon referring to these three environmental components. By clicking on any of the buttons of the Level, the respective environmental sound is activated. Once another button is clicked, the new sound stimulus replaces the existing one through gradual crossfading. The crossfading time has been set to three seconds, as immediate transitions between sounds are not recommended in ASD treatment. Specifically, unfavourable and aversive behaviours have been documented when a learner arrived in contact with quickly alternating sounds (Senator 2005), and decreased when a less immediate sound transition approach was preferred (Schneider 1999: 68).

Under each of the large buttons representing the three available sounds for Level 1, the letters W, B and L appear respectively, aiming to acquaint the learner with what each picture represents (water, breeze and leaves). These letters are coloured according to three respective colours whose initials are W, B and L (white, blue, lime). In addition, a 'test' sub-window is accessible through this level, where the user is encouraged to select the picture that corresponds to each of the letters, as a method in increasing awareness and concentration. When the correct button is pressed, the respective sound is heard. However, when the incorrect button is pressed, the playback of any sound stops immediately, a red X letter appears over the selected button and a processed human voice pronouncing the exclamatory sound *'uh-oh'* is heard. This sound, extracted from the 1996 computer game *Gazillionaire*,[31] represents negation and is therefore employed to inform the learner of any wrong decision, albeit in a vivacious way that can positively influence emotions and wellbeing. The sub-window is inspired by the recent 'GOLIAH' software developed by Bono (2017), where a system employed to identify a musical instrument is included in the broader prototype (Ibid.: 58); the fact that the learner has unlimited attempts of identifying a correct environmental stimulus in *Terpsichore* renders this musical occupation less stress-free than its 'GOLIAH' counterpart.

In **Level 2**, which is constructed upon the characteristics of Level 1, the user has the possibility of selecting between four different environmental sounds instead of three. The concept of introducing an increasing number of auditory and sensory stimuli has also been applied on various ASD treatment occasions (Higbee and Sellers 2011: 370; Blumstein 2015: 302), which serves as a source for inspiration in applying a similar construction process. Secondly, numerous soundscapes deriving from the actual environment consist of more than one components, such as the combined sounds from the sea waves and the birds flying above the sea and ground. For this reason, the ability to choose more than one soundscapes at the same time has been enabled. The additional feature of Level 2 is the panning slider, capable of shifting the entire soundscape to various different positions towards the left or the right of the stereophonic space. Timmermans et al. (2004) refer to 'panning' as a process used to constrain the directions from which sounds arrive and isolate the auditory and sensory stimuli that the learner should concentrate on. Although the slider is not accompanied by numerical values, it can be mentioned that the panning values may range between -0.5 and +0.5, with zero being the centre panning position and -1, 1 the hard left and right panning extremes respectively. In this manner, a decent degree of balance between sounds arriving in both ears is maintained. However, it is possible to extend the panning range between -1 and 1, since the ears of several ASD learners may process a specific sound stimulus differently, and risk encountering painful auditory experiences in one of their two ears (Ockelford 2013b: 215).

Level 3's structure is based on Byrne's (2012) suggestion on the 'anthropomorphi[sation]' of sounds, defined, as also shown in Chapter 4, as providing an imaginary human identity to

[31] Link to the software: www.gazillionaire.com.

everyday environmental sounds, so that these are associated with emotions or other activity indicators especially for ASD learners demonstrating mood detection incapacities (Hobson, Ouston and Lee 1989: 237). This endeavour resembles a recent visual emotion recognition project by Conallen and Reed (2016) but extended to the sonic domain. To do this at the fundamental level, a number of new sound stimuli were introduced, which include, but are not limited to, children playing, everyday activity of humans in a dense town, thunderstorms, fights and the calm night atmosphere, as depicted in Figure 3.8 below:

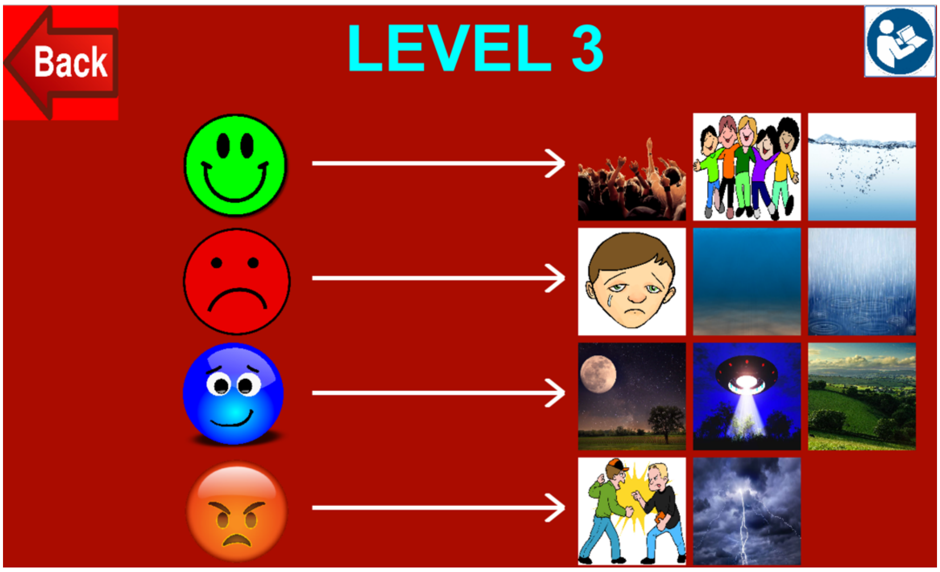

Figure 3.8 *Matching soundscapes to emotions: window associated with comprehension and expression of feelings through sound.*

Amongst the feelings that the level intends to convey, always in accordance with images with a carefully selected amplitude and frequency content, are happiness, calm and neutral expression. An issue that arises concerns the two negative feelings of sadness and anger, whose visual representations have been employed to assist in the assessment of personal feelings at any given time (Gutstein and Sheely 2002: 179), while also serving as identification objects by ASD human subjects in relevant computer programs and principally '*Let's Face It!*' (Wolf et al. 2008; Tanaka et al. 2010, 2012). One should not neglect the likelihood that learners are adversely affected by unfavourable audio-visual signals to an ethically unacceptable extent, especially when faced with the menacing feeling of anger (Matsuda, Minagawa and Yamamoto 2015; Lindell 2017: 145), rapidly identified as part of the 'anger superiority effect' (Hansen C.H. and Hansen R.D. 1988, Rosset et al. 2011 etc.). However, on various occasions, response to negative feelings and faces was either controlled or reversed into a more positive disposition thanks to playful or storytelling interventions (Bernad-Ripoll 2007; Chedd and Levine 2007: 80-82; Fitzgibbon 2008: 19-20; Faber and King 2017: 23). Irrespective of the case, it is possible to conceal the views associated with negative feelings, replacing them by buttons where any sound and image can be loaded from the computer. As in Level 1, any user may select one stimulus at a time and immerse into an experience designed for more meaningful emotional understanding.

Level 4 aims to enhance awareness of time in autistic learners and assist them in understanding that, in the everyday environment, the overall sound that is heard changes regularly over time, inspired by research endeavours related to the subject matter of 'time perception' (Maister and Plaisted-Grant 2011; Gerland 2013: 178; Williams et al. 2004: 74-80). An on-screen arrow assists the learner in understanding that sounds in the auditory spectrum are presented in the order in which they will be emitted from the computer's sound source over time. To select the sounds that will form the timeline soundscape, ten square buttons appear under the timeline view. The colour of each square depends on the amount of times the matching button is pressed, and the sound stimulus that corresponds to each colour is visually presented at the bottom of the screen, based on the correspondence between colour and stimulus as shown in an accompanying reference window (see Figure 3.9 below).

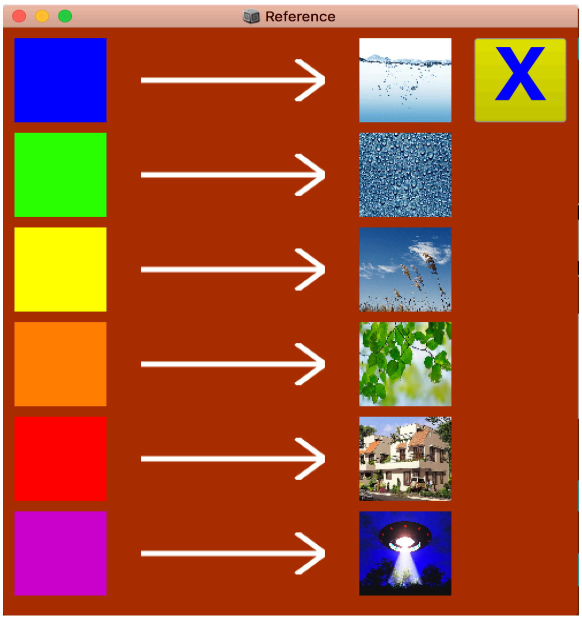

Figure 3.9 *Reference window used to connect colour views to their respective stimuli.*

By default, the duration of the entire 'timeline' soundscape has been set to 60 seconds which means that a transition between two adjacent timbres will occur every six seconds. To facilitate the understanding of sound transition at the aforementioned intervals, and even though the primary focus should be given to auditory and not visual excitation, a small arrow will appear after clicking the 'Play' button, and will gradually move across the timeline in order to provide an idea of the sound that is actually playing, combined with the time during which this execution takes place.

Level 5 introduces the idea of a sound map or a self-called 'acousmatic circle'[32], which differs from a conventional circle – or ellipse given the unstable radius – in the fact that it reflects the difference in amplitude and panning position of sounds situated at any position around the centre of the circle. In the circle's centre, a reference sound source is placed, with a predetermined amplitude value and a panning factor of zero. The timbre heard once the 'OFF' button is switched to 'ON', is controlled through the button that triggers the same background colours as the ones of the timeline in Level 4. However, the Level 5 main view does not include the square views that demonstrate which auditory stimulus corresponds to which colour; this function is performed by the question mark button (?), opening a reference window where the desired information is presented. Four more buttons with the same functionality are located in distances almost equal to the mean radius of the circle. The amplitudes of the four peripheral sources are scaled down to reflect the distance they have from the centre, while the panning factor may reach values as low as -0.75 for the leftmost source and +0.75 for the rightmost source. In order for sound to arrive to both listeners' ears, even without full balance taking place, the two panning extremes have not been set to -1 and +1. The objective of such a structure is to help the learner perceive the differences in volume and derivation of sounds within a specific distance, something that is projected to gradually increase observation skills.

Level 6 is similar to Level 5 in terms of the sound map existence and the inclusion of five sound sources, one in the centre and four in the same peripheral positions as in the previous level. However, an important addition, which represents the everyday world situation where sound sources are not always stable, is the ability to make peripheral sound sources rotate clockwise or anticlockwise, around the circle, with an equivalent effect in the dynamic change of their panning positions. The sound will start playing at the time when the 'ON' switch is activated, but pressing the 'Play' button initiates rotation either clockwise or anticlockwise, depending on which respective button is selected. As the buttons move around the circle's perimeter, the panning factor changes, again between the extremes of -0.75 and +0.75, according to how left or right the sound source is situated with respect to the vertical axis that passes through the central sound source, which, at all instances, remains stationary. It is worth mentioning that button movement and rotation whilst sounds are playing can be perceived as a type of 'eye-gaze' discovered to increase awareness of sound amplitude and origin to a fundamental extent (Borjon et al. 2011).

Level 7 continues to rely, as did Level 4, on the need to make the learner more aware of temporal evolution, and endorse rhythmic activities as a method to attain this objective (Huss et

[32] Term inspired by the definition of 'acousmatic' as a continuum of indefinite pitch stimuli and sounds extending beyond the sphere of conventionally determinable timbres (Schaeffer 1966, cited in Schaeffer 2017-comment by Cox and Warner 2017: 95; Hamilton 2009: 151-2).

al. 2011; Amos 2015: 141). Since the SIP mode should not attempt to acquaint the learner with tonal aspects of music, but rather with the integration of sound in everyday life, the new timbres introduced are simple percussive sounds[33] that form the basis for fundamental rhythmic patterns in contemporary music. The user or peer tutor may click on any of the four buttons presented in the series numerically labelled as '1', '2', '3' and '4', thus creating a four-beat sequence that can be activated by pressing the 'Play' button located at the top-right corner of the screen. The rhythmic pattern can be stopped at any time, and it can also be layered with one of the sustained sounds found in previous levels, serving as a background stimulus and helping with the learner's transition from more prolonged auditory excitations to sharper and more momentary sounds.

Level 8 has the rather plain functionality of altering the frequency content of sound stimuli once active by mouse selection. Three knobs are visible on screen, controlling, from left to right, low-pass and high-pass filter cut-off frequencies, and master volume of the Level. The purpose of such a level is to address the issue of excessive or deficient sensitivity to specific frequency content and enable the learner to either distinguish a set of desired frequencies (Frith and Hill 2004: 199), favour specific sound pitches over others on grounds of possible adverse emotion expression (O'Malley 2015: 98) or cancel the frequencies that potentially hinder the learner's capability of engaging in auditory training or generally shifting attention towards specific sounds (Norman 2003: 43).

The layout of **Level 9** has been designed in order to allow a user to alter the amplitude and panning position of all six default soundscapes, by simply clicking anywhere on screen once each of the soundscapes has been activated. To do so, it is necessary to click on the button corresponding on each of the images, as it has been done in previous levels. Multiple sounds can be simultaneously activated, while the variable parameters, amplitude and panning, can be altered independently for each of the different components, thus allowing for the creation of a more complex sound imagery based on a notion labelled as 'auditory localisation', which refers to the ability of identifying the estimated position from which a sound originates (Oconnell 2015: 54; Weiten 2016: 131). Such an ability is deficient in various youngsters diagnosed with autism and relevant handicaps, who often fail to recognise a component stimulus or its relative stereo position within a complex sound set (Teder-Sälejärvi et al. 1999; Chermak 2002; Skewes and Gebauer 2016). The visual representations of sound position assist in the development of AL skills, based on a similar proposal of sound-image hybridisation (Leo et al. 2008; Stamm and Altinsoy 2013: 467-8). The addition of filtering and volume faders to the Level structure is aimed at learners sensitive to certain frequencies while simultaneously assisting with the overall continuity of the SIP mode structure, since is it ensured that the ideas of co-existent stimulus

[33] These sounds are the following: kick drum, snare drum, drumsticks and timbales.

selection (Level 2), identification of sound source positions (Levels 6, 7) and frequency suppression (Level 8) are merged into a structure encompassing all the above.

Level 10 matches the thirteenth and fourteenth Levels of the Tonal Mode in terms of functionality, as the strategy of completing 5-stimulus phrases with missing two sounds – represented in coloured format through buttons – is directed towards the treatment of imitative motor patterns and 'echolalia', albeit with more abstract sonic excitations. In any situation and where initial pitch perception and general musical awareness are impaired, thus dissuading a tutor from initiating *Terpsichore*-led sessions from the Tonal mode and taking advantage of the broader definition of music as any form of sound with amplitude and pitch, not necessarily concrete.

Levels 11 and **12** proceed further into the field of manipulating abstract soundscapes, inspired by the use of 'electroacoustic music' interventions in increasing attention span when about to interact with a sound installation (Kontogeorgakopoulos, Wechsler and Keay-Bright 2014). Moreover, a more general transition from simple sound perception, combination and manipulation takes place, considering the already communicated concepts of panning, consistent with 'auditory localisation' previously described, and filtering. The above foundations are vital in releasing the learner's creativity to produce real-time electroacoustic soundscapes, by means of granular synthesis and default soundscape modulation. Incidentally, Timmermans (2015: 16-18) asserts in his work that granular synthesis tasks are performed using a numerical model based on a script transformation function, similar to the MEDIATE interface (Timmermans et al. 2004) for ASD learners, thus implying an indirect connection between ASD treatment and granulated sounds. In addition, the potential of granular synthesis in reconstructing the temporal and spatial content of an audio stimulus (Roads 2004: 26; Hugill 2012: 153; Houix et al. 2013: 22; Lazzarini et al. 2016: 337) can create a sense of abstraction capable of shifting the autistic listener's focus from the sound manipulation mechanism to the final auditory result, something in turn beneficial for the learner's devotion to an interface (Westerkamp 1993, cited in McCartney 1997: 62), being *Terpsichore* in the current research. The above assumption is justified through the description of the 'autistic' manner of hearing as analysed in Section 2.1.

Level 11 employs sine waves with grain durations that can be adjusted through the movement of the computer mouse longitudinally, along the X-axis. The Y-axis movement aims to control the range between the two frequency extremes around which the individual grains' pitches are to be defined. The profile of individual grains can be altered by exploiting any one of the available four on-screen buttons, and selecting amongst a *pink noise*, a *white noise*, a *sine wave* or a special SuperCollider *vibrato* profile. Afterwards, Level 12 employs a white noise function to control modulation intensity of any chosen default soundscape, while the X- and Y-axes fulfil the exact same functionality of grain duration and frequency range specification. The strength of the modulator is determined through a horizontal slider movement, something that also applies to volume and panning, each associated with its own independent slider.

Level 13, as observed on the computer screen, is a compact format of a Laptop Orchestra (LOrk) setup, which should ideally be distributed to more than one computers for optimum results, as each user, whether autistic learner or caregiver, should ideally engage in only one of the four subsections for the LOrk system in total. Of these four constituent parts, one is dedicated to volume and panning control of default soundscapes, another undertakes buffer granulation in accordance with Levels 11 and 12, while the third is based on an oscillator selector whose pitch values can be altered in various ways, so that an abstract continuum is created through a virtually concrete sound source.

Level 14 is a plain level designed to increase the possible sounds and timbres that can be reproduced. Given that soundscapes in everyday life can be formed by a virtually infinite number of different components, the ability to actively record any sound significantly increases the possibilities of discovering and perceiving new auditory stimuli. In the level's window, the leftmost of the three large buttons, when pressed, allows the recording of the desired sound provided that a microphone is enabled either through the computer or externally. The peer tutor subsequently has the ability to perform any given recording for a user-configurable period of time specified through a number box. The middle button reproduces the sound already recorded, while the rightmost button toggles the reverb effect on or off, aiming to add depth to the recorded sound. Three parameters can be modified: the reverb time, the damping factor, and the proportion of processed sound being mixed with the original recorded signal.

Finally, **Level 15** serves a similar purpose to TM Level 17, as rudimentary social stories can be formed through loaded images and subsequently employed for the creation of environmental or recorded sound successions aimed at the auditory interpretation of each story. The right-hand side of the window consists of buttons responsible for the activation of pre-recorded sound samples, which the user can load from the computer's storage space. In such a manner, a library of sounds is created, allowing both the learner to switch between different stimuli of personal preference, and the tutor to acquire creative freedom in selecting appropriate sounds for the regulation of the ASD human subject's emotional profile, concentration and behavioural control. The ability to select different patterns for the creation of a composite soundscape can be perceived as a compositional routine for the auditory representation of a visual story, justifying why the term 'composition' is currently not limited to definite pitches as constituents of a longer phrase.

It is here important to mention that, contrary to the TM, it was not deemed necessary to include an internal feedback option intended for visual and auditory segment repetition after a specific time period. The reason for this is the mode's dependence on sustained sound stimuli, with the exception of finite duration percussive timbres included as part of periodic structures and not as isolated instances that would justify the necessity for these to be repeated after some seconds to increase awareness. In other words, when a sustained sample is chosen or manipulated in *Terpsichore*'s SIP mode, subconscious auditory feedback is provided at any instance, allowing learners and tutors to adjust content and parameters as they go along.

3.2.4 Proposed feedback implementation methods

Judging from SuperCollider's features, presented both in the available literature and the Help Browser integrated in the language (SuperCollider 2018), there appears to be no mention of a direct technique that allows visual changes in the interface to automatically occur at a specific point after the user's proactive interaction with the software. This means that SuperCollider does not possess the capability of capturing visual information into a video buffer, although the respective procedure is fully feasible with regards to audio (Peres et al. 2008: 159; Koutsomichalis 2013). Perhaps in an effort to address the above issue, systems have been developed allowing the acquisition of video through a live SuperCollider session that involves real-time audio generation (Collins 2003b; Collins and Olofsson 2006). However, in the current context, such a method entails the disadvantage of requiring external third-party programmes and coding facilities to export a session into video, in the form of an external file dissociated from SuperCollider and not serving as a replicated version of tasks performed from within the main interface window.

Despite the absence of direct feedback means for application within SuperCollider, the existent capabilities of the software may still be utilised meaningfully in order to achieve the desired objective, aspiring to replicate the feedback diagram of Bhattacharya (2009: 5) as closely as possible. As a result of experimentation and meticulous investigation of SuperCollider's particular capabilities regarding feedback implementation, two potential methods for the accomplishment of the desired objective were discovered, each with its beneficial characteristics and practical defects. The ultimate method choice for any given peer tutor depends on the character and intensity of feedback to be given to the learner. The above takes into consideration either the requirement to guide the learner through most learning process steps regardless of their simplicity (Coyne, Vandenburg and Nyberg 2011: 4; Barton and Harin 2012: 269), or the possibility of the user becoming irritated or mentally unstable due to feedback being subconsciously interpreted as excess pressure to perform. In the latter case, it may be beneficial for the user to express his positive disposition towards informative feedback so that the above subconscious feeling is no longer an issue for the tutor to handle (Rigler, Rutherford and Quinn 2016: 180).

Method 1: Plain audio feedback

The first method is based on the fundamental audio buffer theory of SuperCollider and is proven, through real-time testing, to only accomplish feedback in the audio domain under any circumstances. Two buttons associated with audio recording and playback are embedded in a window that first appears on-screen when *Terpsichore* is launched. Through the 'Record' button, any sound produced from within the SuperCollider engine may be recorded until the process is stopped by the user. At that point, the sound is saved in a buffer that can be triggered by pressing 'Play', thus providing auditory feedback on the sequences played and produced by the learner throughout the entire interface. This method has the advantage of not requiring a microphone input to capture audio signals, since the SuperCollider engine is solely responsible for any sound saved within a buffer.

Although, as stated above, no visual cues are included to achieve the required guidance, the sole reliance on audio can still deliver positive effects to certain learners, especially with regards to meaningful action control and remote provision of advices or constructive criticism, without the compulsory need of the peer tutor being in close proximity with the learner in the longer term (Volkmar and Wiesner 2009: 138; Solomon 2012: 255). An alternative form of such feedback, also requiring a microphone input to capture external sounds, is provided through Level 14 of the SIP mode. Through this Level, users can record patterns stored within a buffer independent from the structure described in the previous paragraph, and manipulate their parameters for immediate playback using an appropriate 'Play' button.

Method 2: Joint audio and video feedback through recurring routine repetition

As mentioned earlier, the most notable disadvantage characterising the pure audio feedback method is, obviously, the inability to monitor the actions taking place in the visual domain so that an activity is correctly completed through pressing the correct buttons or keys in the appropriate order. To resolve this issue, having a visual feedback component aspires to make the process of self-assessment, personal improvement and motivational gain more interactive.

With the tools at the programmer's disposal when constructing the *Terpsichore* code in SuperCollider, it is important to construct a series of routines associated with the automatic repetition of an action on-screen shortly after the user has performed it. All routines associated with the touch of a button or the realisation of an interactive command will include the duplicated execution of the intended action at a predetermined interval (such as five to ten seconds between two iterations), which can be adjusted by the user through a compact control panel within the finished interface. In such a manner, the main feedback design of the Bhattacharya (2009: 5) diagram is satisfied, providing a zero 'error detect[ion]' function (Ibid.);

in other words, the conception cited above manifests itself as a representation of a feedback loop with equal input and output signals.

The routine duplication process, which satisfies, the desired feedback purpose, is only necessary in situations where a task is expected for completion by the learner or a level's manner of operating depends on decisions and/or modifications performed by the learner. To clarify matters, such environments as the TM Level 3 window, where different note values are communicated to the learner, do not require the addition of feedback loops, since the objective of such a level is not practical but purely informative.

3.2.5 Transformation of the SuperCollider code into a Macintosh executable

The principal target group of *Terpsichore* involves ASD learners and peer tutors with the identity of music therapist, special education instructor or domestic caregiver. Understanding the infrequent probability that tutors are technologically skilled, not least experienced in programming, the requirement to manually run a lengthy script constitutes an overwhelming and possibly confusing task, entailing the risk of discomfort and wellbeing deterioration spreading to the learner. For this reason, an important step towards designing *Terpsichore* for public use, is the conversion of an environment fully dependent on SuperCollider to a bundled executable application, functioning more explicitly as a 'software music interface'.[35] Various sources have described procedures for SuperCollider code compilation into an executable (Valle 2016: 9; Vogrig 2016; Athinaios 2017; SuperCollider 2018a), combined with personal experimentation, two methods were deemed suitable for the construction of an application allowing the software to be accessed on computers running Apple Macintosh computer systems.

The first method utilises SuperCollider version 3.10.4, the latest available as of April 2020. According to instructions (SuperCollider 2020), it was possible to modify an existing template's start-up and interface codes in a hassle-free manner not relying on third-party environments besides the programming language and file indexing service. However, this method has the principal shortcoming of visual dependency on SuperCollider; specifically, it still appears on screen as if the code was loaded and manually compiled. When the user attempts to close *Terpsichore*, the programming language does not quit whatsoever, signifying a possible redundancy in the essence of this process.

[35] See title of the Thesis.

The second method exploits code written and edited in version 3.9.3 as well, but is based on a bundling template designed modified by Athinaios (2017)[36] in version 3.6.6 and adapted to 3.7.0 by Vogrig (2016). This method outclasses the first in the fact that SuperCollider structures are neither visible nor directly editable by the average user. It is evident that the SuperCollider code is embedded in the *Terpsichore* application content package and can be modified at the user's discretion. However, the procedure of running *Terpsichore* leads to the sole appearance of windows directly relevant to the menu and working modes with which learners and tutors are intended to occupy themselves. On both occasions, the template conversion process to a bundle was performed using *Platypus* (Vogrig 2016, Athinaios 2017), a versatile textual code wrapper offering substantial possibilities relevant to the creation of Macintosh standalone applications (Thordarson 2018).

It is important to mention, as a remarkable advantage of the second method compared to the first, that the *Terpsichore* user can successfully close both bundled application and SuperCollider's 'Interpreter' responsible for script compilation (De Campo et al. 2007: 367-8; Valle 2016: 121) upon quitting the interface. This was not made possible in the first method, where an in-script UNIX command asking Terpsichore to quit only affected the 'Interpreter', ceasing all compilation capabilities without terminating SuperCollider altogether. Both described methods are available for use and modification, and the decision over which version is more appropriate should rely on the process of carefully balancing advantages and drawbacks for each isolated learner case.

3.3 First methodology component: case study analysis

As previously analysed, various case studies and elements of proof are accessible in the literature concerning music-oriented procedures and programmes that have aspired to improve the educational potential and mental condition of children and young adults (Kern, Wakeford and Aldridge 2007; Fang 2009; Pelayo & Sanchez 2009; Forrester 2010; Caltabiano 2011; Kim 2013 etc.). All these documents are based on previously undertaken music-oriented activities involving actual human participants, brought in direct contact with the respective researchers in the endeavour to extract the required data and deliver comprehensive results on the rehabilitation potential of music therapy methods.

[36] Athinaios (2017) first conceived the template modules in 2015 and undertook modifications as of 2017 for practicality purposes.

Taking into consideration the above, the research methodology with which the investigation of the educational and therapeutic efficiency of *Terpsichore* can be thoroughly made possible, should be centred around actual evidence from previously documented case studies and music therapy sessions involving individuals, with an emphasis on youngsters[37], who had potentially been brought in contact with musical procedures and software for treatment purposes. Apart from the various issues, regarding research ethics and integrity, that are likely to emerge at any stage of the interface testing procedure with relation to learners directly employed as case study samples (Sue et al. 2013: 109), the proposed methodology constitutes an approach that does not necessarily rely on external cooperation to produce results, but is equally beneficial in identifying the degree and rate of development, from a both musical and mental perspective, that a prospective user of the interface may experience over time.

The methodology mentioned above annihilates the need for procedures involving a high mental condition aggravation risk, as any changes in behaviour and learning potential are to be investigated and discovered through a bibliography-based combinational analysis. This should principally rely on examining, in parallel, the characteristics of the ASD learner subjects in previous case studies, and the components of the *Terpsichore* interface likely to maximise the learner’s educational potential and response to specific everyday tasks. By electing to employ this working approach, the learners whose information is extracted from the literature would hypothetically be subject to specific exercises and activities relevant to the current interface, and observations would be drawn from scholarly source assertions on the attitude and mental rehabilitation of ASD learners when faced with diverse musical stimuli.

On certain occasions, it is convenient to extract ‘virtual’ human participants from analyses pertaining to music therapy, but this should not always be a rule of thumb. Since the underlying ASD symptoms of learners constitute the only focus of source studies, it is only necessary to highlight the characteristics that demonstrate learning and mental deficiencies and apply a carefully planned working procedure based on the interface. Findings that illustrate the positive and negative effects of musical and visual clues on the mental integrity of an ASD learner will be examined in parallel with the initial condition of the learner, and this correlation will lead to initial assumptions on the overall influence of *Terpsichore*. However, the decision to emphasise on human subjects with a pronounced interest in music or experience in music therapy treatment, can be justified by the uncertainty over an autistic person’s interest in music, given that certain youngsters are unwilling to follow disciplined schedules centred around music cognition and composition skill development (Bernstorf 2016: 275), or by the possible tendency to find music a repulsive activity, at least before undergoing music-assisted treatment (Siri and Lyons 2010). Throughout the case study, it is interesting to determine whether the layout and learning format

[37] General term covering infants, children, adolescents and adults around the age of 20.

of *Terpsichore* may be applicable to the musical tastes of the learners, and whether possibly negative inclinations towards music may be avoided through interface-related strategies.

According to the information provided in various bibliographical accounts, with concern to the beneficial influences and particularities of each separate software component, the overall condition of each learner will be monitored at regular intervals. Highest focus should be given to the changes in auditory and musical awareness, cognitive abilities, concentration, behaviour, motivation and control of routine movements and actions, as frequently stressed from the beginning of our analysis. Any deficiencies or unfavourable incidents appearing whilst the *Terpsichore* instruction procedure is underway, should be employed as guidelines for the reconfiguration of certain interface structures, with an unequivocal purpose of maximising performance and accomplishment of improved welfare through educational means. Finally, special attention should be drawn to the information and techniques that best reflect and treat the exact condition of the individuals involved in the case study. This can be most appropriately achieved by paying attention even to the most minute details on the learner's condition[40], and avoiding generalised facts that are likely to backfire or cause unnecessary confusion.

The case study sample will comprise nine human subjects in total. The example presently mentioned is a male youngster named 'Mike', whose response to piano playing and inclusive classroom teaching techniques is assessed by Fang (2009: 54-55, 64-122). Below are some distinctive facts related to his condition and daily routine (as extracted from the above source), which will serve as starting points in constructing a *Terpsichore* personalised training plan. It is obvious that various auxiliary information, regarding such aspects as geographical habitat and monetary income (Ibid.: 54-55), is beyond the scope of the current analysis.

- Mike is an adolescent learner who belongs to a family where the mother serves as peer tutor and the father's occupation is highly relevant to mentally disabled individual treatment (Ibid.: 55). He maintains a strong relationship with his mother, to the point of even being 'obedient', whereas he appears to lack experience in communicating with individuals outside his familiar environment (Ibid.: 65).
- He has a pronounced interest in music and piano, where he demonstrates the highest aptitude (Ibid.: 66-68). However, he is particularly vulnerable to sharp sounds, including 'balloon pop[ping]' (Ibid.: 66) and loud piano pieces (Ibid.: 68).
- Sonic and visual stimuli entirely absorb Mike's focus, making him particularly introvert and preventing him from making any contact with his external surroundings (Ibid.: 74). The actual study demonstrated that the learner's performance increases when being treated as equal to neurotypical individuals instead of a special case (Ibid.: 76-78).

[40] Ostensibly small details may generate large differences in the exact mental and learning diagnoses of the learners, even if the autism sub-condition with which they are diagnosed is similar or identical.

- Mike's childhood was characterised by learning and phrase articulation delays (Ibid.: 72-74), making him incapable of continuously acquiring new knowledge without being externally encouraged to do so (Ibid.: 74-5). His linguistic deficiencies significantly disable him to translate images into words and prevents him from making appropriate word choices in communication, which in turn negatively impacts his motivation (Ibid.: 83-86).
- Although music appears to be the cognitive area in which Mike finds the greatest comfort, he struggles when facing challenges with an increased level of difficulty (Ibid.: 89-92) or irrelevant to his strong point of playing the piano (Ibid.: 95). This implies that various existing music interfaces (see Section 1.4) would cause discomfort to the learner if applied in real time, creating the necessity of introducing plain structures in *Terpsichore* combined with visual hints and simplified alternatives to techniques and study modes deemed to be especially complicated.

Whilst findings from Fang's (2009) study were being listed, increased emphasis was given to the mentally related areas that needed improvement and that the authentic musical procedure endorsed through *Terpsichore* would satisfy: peer communication, motivation, verbal aptitude and controlled behaviour when faced with adversities or initially distracting stimuli. Therefore, the overall design of the current software interface, designed to enable the transition from reproductive music execution to authentic and creative occupation with the field, should be employed in a manner that the talent and pianistic dexterity of 'Mike' are carefully harnessed. The above traits should ideally evolve into a definite ability to generate new meaningful melodies rather than actually imitating the exact same musical melodies and patterns that he hears from his surroundings (Fang 2009: 72).

In the example of Mike, as in all other case studies analysed at present, the objective of treating the unfavourable areas of the autistic individual – as part of *music therapy* – through clearly defined *educational* means, should not be neglected at all. Consequently, the content of the virtual sessions should include the educational elements that, according to the preliminary findings of Fang's (2009) study, assist the learner in drawing his attention to the task at hand, stimulating his interest, and bring feelings of appreciation and optimism to the foreground. Such elements, tailored to the exact particularities of the individual, may be thoroughly identified in the existing bibliography on music therapy, as well as classroom and inclusive developmental learning techniques. Moreover, in order for the instructional process to be made possible, it would be beneficial to transfer the investigation of Fang (2009) to the present time, whereby the *Terpsichore* interface, obviously based on computing and music therapy developments and configurations completed as of 2020, would begin forming part of Mike's actuality. This method can henceforth be referred to as the 'human subject clone' method.[41] For the case of Mike, implementation of such a method means that if the software application were to consider his overall condition at twelve years of age, it would be hypothesised that the above would be his actual age at the present time.

Facts from existing research, investigated in conjunction with the importance of certain *Terpsichore* software structures, as well as Mike's strengths and weaknesses, should lead to preliminary observations on the efficiency of *Terpsichore* in positively impacting the musical and overall daily routine of the learner. Particular attention should be given to the detail of the observations, supported as thoroughly as possible by the bibliography on both the music-autism relationship and the case study individuals themselves. Obviously, the performance of actual learners and the evolution of their characteristics after sustained occupation with *Terpsichore*, matters considerably in determining the software's compatibility with autistic individuals. That said, the detailed presentation of case study findings is still particularly important in the overall investigation, as it should ideally provide points for comparison and contrast with the findings that ultimately derive from the learners' direct contact with *Terpsichore* under realistic classroom or special education conditions.

3.4 Second methodology component: real-life human participant research

Reiterating, in simpler terms, the principal arguments favouring the enhanced emphasis on actual rather than virtual participants, it is vital to assess how actual individuals perform when employing *Terpsichore*, either independently or with the assistance of a certified tutor, to ensure that the construction principles of the software pave the way for its increased application in attempts to treat and comfort the disadvantageous characteristics of people diagnosed with ASD. *Terpsichore* is designed to be subsequently embedded in daily routines and curricula of institutions associated with the involvement of music in special education and therapy. Therefore, assistance from actual schools and special needs foundations constitutes the most representative source of evidence that shall not only evaluate the software and its applicability in the broader field of treating disabilities through artistic interventions, but also determine whether observations resulting from the combinatorial case study analysis can safely be assumed

[41] This term has been personally conceived for the purposes of the research, despite only two instances of the exact term present in search engines, both highly irrelevant to the scope of *Terpsichore* and only one officially published in the late 19th century (Encyclopaedia Britannica 1893).

for *Terpsichore* and applied in full-scale learning environments, with multiple human participants seeking to improve their quality of life through music.

Various institutions and special schools in the Attica region of Greece expressed their eagerness in engaging themselves with the *Terpsichore* project, after the overview and principal points were directly supplied to them for their perusal. These institutions agreed to either provide official diagnoses consistent with each learner's ASD-related condition, or encourage learners to follow the software's structure and directions for use, in an effort to monitor the educational and mental development of these individuals after a substantial period of time, presenting relevant information either in writing or through completed questionnaires to support research.

3.4.1 The research questionnaire: purpose and layout

An important step towards optimising research rigour, is to determine an appropriate method that not only reflects how actual learners respond to *Terpsichore* after sustained occupation, but also provides the amount and breadth of data necessary for drawing reliable conclusions regarding the software's efficiency and the congruence of the observations deriving from the bibliographical case study with the ones ultimately obtained following practical research. Such a method additionally needs to consider that sufficient data is provided for all learners within the sample, on a wide range of aspects regarding *Terpsichore* overall, its levels and its constituent points considered strong or weak on different occasions. Where possible, personal information pertaining to each learner separately should complement standardised data, while a suitable balance between the two is essential in ensuring optimum research detail and objectivity.

The above arguments justify the assessment of software efficiency mainly through a questionnaire, in which specific structural requirements need to be followed, to ensure sufficient reliability in the accumulated data. Responses should not only form the basis for future applications of the software, but also provide a comprehensive background for comparison with miscellaneous initiatives taken within the research, such as the literature-based case study approach described in Section 3.1. The research of Allen, Hill and Heaton (2009) provides such an example, given that the decision to embed a detailed questionnaire assists the authors in determining the extent of congruence between their study and previously conducted ones, with regards to the music preferences of young ASD learners and the emotional shifts they encounter during the listening process. An important consideration point is the nature of the questionnaire, as briefly portrayed by the authors:

> […] by using a *semi-structured* questionnaire with an open-ended interview approach. […] (Allen, Hill and Heaton 2009: 22)

The term 'semi-structured' (Ibid.) reflects a major construction principle of the *Terpsichore* questionnaire, given that various questions, as described in following paragraphs, include the option of flexible text responses to be recorded. The objective of this approach is to further justify the choices provided to associated multiple-choice responses, and to capture the caregiver's perspective on the situation and overall response of the human participants recruited for the project. Such an approach cannot be interpreted as a pure interview format characterised by commonly used extended question-response patterns, but the fact that respondents can freely provide details where necessary, clearly demonstrates the questionnaire's flexibility but not at the expense of concision.

The survey format is additionally inspired by Hillier et al. (2011), whose questionnaire, serving as a data extraction method on a music-related initiative for young autistic individuals, features a series of questions designed to be answered before and after occupation with the project, mainly to determine its influence on social and emotional aspects of such people's lives. Considering that *Terpsichore* has been designed to advance creative musical knowledge of ASD and treat mental characteristics not necessarily associated with music, a format focussing on the software's overall influence is deemed indispensable. Learners potentially subjected to substantial software occupation will be characterised by particular general and musical awareness traits *before* they get in contact with the program, will exhibit specific responses and emotional shifts *during* its use, and may or may not demonstrate changes in their mental condition and creativity *after* a number of sessions has been completed.

Included questions are all inspired by the theoretical analysis of the first two chapters, where an extended analysis was performed on how music composition could affect ASD learners' concentration, motivation, behaviour, emotional state and cognitive potential, coupled with an attempt to establish a defined relationship between music education and therapy in ASD contexts. Section 3.2 demonstrates, amongst others, how previous research endeavours have influenced the level structure and content of *Terpsichore* in various different aspects. Considering this, the amount of questions enables a comprehensive image of the learner's response to be recorded, and ensures, to the highest possible extent, that shifts in various different characteristics and abilities are thoroughly monitored. Since emotional state, behaviour, concentration, musical cognition, compositional skill and ability to consistently use the software are all crucial factors in assessing the software altogether, it is important to dedicate some questions in each of the constituent elements that *Terpsichore* has been designed to address. It is also worth mentioning that the research aims outlined in the Introduction were carefully borne in mind when developing the survey and the phraseology of its questions. To further facilitate the completion process, the questionnaire, initially designed in a paper-based format presented in Appendix III, was adapted to an online alternative[44] that helped researchers reduce the workload needed to deliver results for analysis purposes.

The Introduction section of the questionnaire invites the learner's supervisor to specify details regarding the learner's overall personality, relationship to music, relevant theoretical or instrument knowledge, and ASD diagnosis. Selected questions enable the supervisor to provide input on the learner's condition severity, trainability and reactions when faced with specific music genres or environmental sounds. Moreover, the ability to specify the type of diagnosis can both lead to the exclusion of human participants whose condition is not consistent with the autism spectrum (e.g. Tourette syndrome, ADHD), and aid in determining whether a variation in diagnosis to typical autism affect *Terpsichore* performance altogether.

The next section, dedicated to what has been termed as 'initial user condition', assesses the learner's principal characteristics before primary contact with *Terpsichore* has been made. The supervisor is asked to reveal key aspects of the learner's emotional integrity, behaviour towards others, control of actions and tendency to inflict self-harm, attention span and ability to focus on miscellaneous tasks, gross and fine motor coordination, and overall learning potential in organised educational environments. Most multiple-choice questions in this section include options that range from 'positive' to 'negative' or 'very often' to 'rarely / never', while a few others allow multiple answers as they are associated with communication and behaviour routines possibly characterised by several different elements.[45] Various questions are paired with a short text field where supervisors may provide further explanatory information, if required for clarification purposes. The section's overall objective is to facilitate supervisors in determining the most favourable setting, training schedule and points of emphasis when attempting to encourage the learner in developing sustained occupation with *Terpsichore*.

The questionnaire's third section exclusively relates to the *Terpsichore* software itself and the different stages of active use by the learner, in close cooperation with the supervisor given the first time that all learners are faced with the interface. At the section's start, some general questions aim to outline the supervisor's perspective of *Terpsichore*'s ease to follow, user-friendliness and compatibility with the learner's needs and interests. The supervisor is then invited to specify the purposes for which application of the software is intended, such as to improve behaviour in everyday contexts, enhance task concentration, improvise or learn a musical instrument. Before actively engaging with the software, the supervisor is finally asked to present the learner's reaction to the upcoming learning sessions, as well as the amount and

[44] This was implemented through the SurveyMonkey website (www.surveymonkey.com).

[45] An example is, as presented in Appendix III, 'articulation incapacity' and 'echolalia' for Question 6.2 regarding communication.

length of sessions required to discover noticeable changes in the human subject's condition, directly resulting from *Terpsichore*.

The same section subsequently includes questions associated with the Tonal Mode, with concern to the learner's responsiveness to the content of the tasks, especially given the ascending difficulty of levels, the quality of melodies produced and their congruence with typical Western European music norms. Information provided initially pertains to the mode as a whole, before elevated emphasis is given to particular levels and associated exercises that both test the learner's skills in a variety of situations, and determine the influence of attempting to compose new music or modify existing phrases on various mental and cognitive facets of the learner's personality. For instance, a question related to Level 5 aims to assess the learner's comfort in typing specific words and phrases on the computer keyboard, either with the help of textual prompts or independently, to create new melodies. Likewise, questions regarding Levels 13 and 14 are directed towards the learner's ability in completing partial musical phrases according to given instructions, such as the notes D-E as a natural succession to A-B-C, while simultaneously attempting to reduce tendencies of mechanically copying notes visible on-screen. Questions are also included regarding the final two levels, respectively referring to the *social story* approach described in Section 2.4, and the independent and unconstrained construction of melodies from point zero.

Within the third section, the questions that follow refer to the Soundscape and Indefinite Pitch (SIP) Mode, and are phrased similarly to the ones of the Tonal Mode. These questions primarily emphasise on the overall reactions of the learner when facing not only the working environment altogether, but also its different levels and distinctive content. For instance, one important question associated with the mode aims to evaluate whether the metronome structure was frequently required when navigating through environmental sounds, considering its objective in enhancing rhythm awareness and concentration as mentioned in Section 3.2. Regarding separate level, questions included invite the respondent to provide input on how programmed panning changes in such Levels as 5 and 6 affect the learner's recognition of sound direction, on the effects of Level 8's filtering structure on reducing susceptibility on initially worrying frequencies within the audible spectrum, and on the modification of synthesised (Levels 11, 12) or externally recorded (Level 14) sounds, with regards to sample repetition, modulation and panning. By comparing responses between the subsections pertaining to the Tonal and SIP Modes, an important observation to be made is whether specific learners are more comfortable in composing and manipulating soundscapes than devising musical phrases using pitch-defined notes, or vice versa. This will subsequently lead to conclusions regarding the overall compositional value of *Terpsichore*, evaluated through its applicability to accommodate the learning needs of individuals with ASD inclined towards different forms of music or sound, and with varying music cognition levels.

The fourth and penultimate questionnaire section relates to 'final user condition', defined as the mental, behavioural, cognitive and compositional profile of the learner following all sessions led by the supervising practitioner. The tutor is asked to describe how the learner's occupation with *Terpsichore* affects emotional integrity, ability to behave rationally and avoid self-harm, communication skills and comfort in approaching surrounding people, musical creativity and expressivity, compositional independence and development of auditory awareness. Changes in sensitivity to potentially irritating sounds is also examined, as is the possibility of *Terpsichore* momentarily inducing adverse behaviours on the learner's part; the objective of this is to propose solutions in which the software can become, in its future editions, more accessible to individuals with lower levels of trainability, so that the power and influence of sound is comprehensively harnessed under the majority of circumstances.

The final section takes all information provided throughout the questionnaire into account, enabling the respondent to provide a collective image on whether *Terpsichore* has benefitted the learner educationally and therapeutically, and to what extent. Although the relationship between music education and therapy is to be determined through the analysis and juxtaposition of relevant data deriving from the questionnaire, the supervisor is also invited to present, even from a subjective perspective, whether this relationship has been satisfied as adaptation to *Terpsichore* progressed. As a final step towards questionnaire completion, the respondent is asked for a personal opinion on whether *Terpsichore* can be recommended to other practitioners concentrating on special education, and whether the characteristics, layout and value of *Terpsichore* on the learning and treatment fronts may enhance the focus on music composition as an important means of improving the daily lives of individuals with ASD.

It is worth mentioning that, from the second session onwards, the majority of questions are phrased in such a manner that answers represented in a numerical scale, from 0 to 10, are expected. In this case, the number zero refers to a highly negative view of the software, deterioration in condition or adverse consequence of use, according to how each question has been formulated. Conversely, the number 10 indicates that a significant positive response, condition improvement or expression of enthusiasm has been reported as a result of exploiting specific features of the interface. Other questions allow for responses in qualitative scales ranging from excellent to poor, or from strong agreement with an opinion to complete disapproval, while certain questions are also coupled with option to openly provide detailed clarification, if this is required to make understanding of condition and learning potential evolution more explicit.

On all occasions, the formulation of questions and alternative choices within the questionnaire has been achieved to ensure that the data analysis process in Excel, IBM SPSS and NVivo, as described in Appendix V, is as smooth as possible and produces results that clearly outline *Terpsichore*'s strong points and areas where attention is required. A careful interpretation of questionnaire findings should also assist in determining whether the reported effects of general or special interface aspects on ASD individuals' musical skills and wellbeing, as demonstrated through literature review and case study analysis, are verified, thus setting the foundations for evaluating *Terpsichore*'s performance and applicability to ASD education contexts extending beyond the settings and samples examined.

3.4.2 Contact with institutions and sample selection

The process of getting in contact with establishments and schools that would best fulfil the requirements imposed by the research, was aided by three intermediaries that were directly involved, in their daily schedule, with classrooms and isolated learners with ASD who spent considerable time in activities relevant to art and music. These are Mrs. Chrysoula Papakirykou, Music Tutor at the 3rd Public Middle School of Piraeus, additionally responsible for private on- and off-site teaching of children and adolescents with pervasive developmental disorders[46], Mrs. Panagiota Kyriakidou, Music Tutor at a special state-funded school in Piraeus[47], and Ms. Persefoni-Alexia Sergi, Special Education Teacher with a focus in music applications for mental disabilities including ASD[48].

The three practitioners received the software on Macintosh computers and distributed it to learners in collaborative classroom settings, whether music-oriented or extracurricular. All tutors had a period of four months at their disposal to instruct the software structure and levels, and were present throughout all the sessions, which amounted, on average, to sixteen – one a day – lasting a total of twelve hours per individual. The total hours dedicated to the software resulted from the joint consideration of the tutors' daily commitments that potentially reduced free time to work on the project, and the advice given to them concerning the need for sustained, but without exaggerations, activity with *Terpsichore* to ensure tangible results. On some occasions, accounting for only a small percentage of the entire research, less sessions were dedicated to specific learners, especially on grounds of borderline trainability or strict timeframes in educational schedules. Researcher supervision was provided at regular intervals, to ensure that sessions progressed according to plan, that areas of ambiguity in operation and instruction were resolved, and that a personal perspective on learner responses to *Terpsichore*

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[46] Contact: http://3gym-peiraia.att.sch.gr/autosch/joomla15/index.php/prosopiko/18-xrysoyla-papakirykou

[47] Additional information: http://2eeeek-peiraia.att.sch.gr/; tutor belongs to the teaching staff of 2018-19: http://2eeeek-peiraia.att.sch.gr/?page_id=2259

[48] Curriculum Vitae: https://www.linkedin.com/in/persa-sergi-b9ba1699, E-mail: persergi@hotmail.com

was obtained. A total of twenty-eight learners (*n* = *28*), diagnosed with an ASD-compliant condition, participated in the pilot study.

Part of the investigation that would lead to the extraction of useful observations regarding *Terpsichore*, should take the personality characteristics and particularities of learners into predominant account. This is inspired both by the proposal of adjusting music education principles to the distinctive traits of each individual (Ockelford and Welch 2012; Ockelford 2013a), and by a vital construction principle of *Terpsichore*, which is the close consideration of the areas to which foremost attention should be paid when treating learners with ASD, as assumed through detailed literature and case study analysis. Therefore, the sample size chosen aims to achieve a balance between the two extremes of a *Terpsichore*-based investigation either being excessively unreliable due to a minute sample size, or relatively impersonal due to higher emphasis being given on the congruence and statistical significance of the results than on the effects of *Terpsichore* on the personality, cognitive integrity and emotional characteristics of the learner. Reflecting on the information on the questionnaires submitted to practitioners, as demonstrated in Subsection 3.4.2, the results to be extracted should derive from a careful data analysis based on the responses collected from the questionnaires pertaining to each of the learners, with an emphasis on qualitative text-based accounts on how the learners act in their everyday lives and respond to *Terpsichore*. This should ideally set the foundations for determining whether future editions of the software, optimised in cooperation with large-scale music software and therapy institutions, can enhance the quality of life in more sizeable learner groups around the world, which justifies why working with a sample of this size is a practicable strategy on which the overall methodology should be established.

3.5 Investigation and planning of learning routines

To determine the main points that should characterise the structure of educational and therapeutic sessions to accompany the *Terpsichore* interface, it is firstly important to mention a frequently voiced opinion regarding this objective:

> If there is one golden rule in working with children[50] with autism, it is that there are no golden rules! […] (Ockelford 2013b: 245-6; 2016: 166).

[50] For the purpose of this analysis, this statement may be extended to individuals of more advanced age.

Through this statement, Ockelford (2013; 2016) assumes the nonexistence of strictly defined regulations to which a therapist or peer tutor must conform when attempting to instruct a musical interface, and encourages the insertion of freedom degrees in the proposed learning routine structure. Nevertheless, various researchers have chosen to create rudimentary rules for learners to abide by, in order to better identify the problems that have to be dealt with, facilitate aspects of music-oriented activities according to each different sub-condition treated (Prizant 1983; Wigram 1999: 70; Valerio et al. 2011: 276; Hammel and Hourigan 2013: 12, 71, 82). This approach is additionally based on the perception of music as a composite system of concrete regulations (Sloboda 2005: 140-142; Molnar-Szakacs and Overy 2006). Incidentally, even Ockelford himself (2013: 246-7) relies on sub-typical 'rules' that should be followed when teaching music to autistic individuals, even though there is no reference as to whether these 'rules' are followed in most instances.

Judging from the above, the process of planning *Terpsichore*-based sessions for each of the learners should involve some exact steps dictating the actions of the tutor-learner dipole when interacting with the software. However, the learning process should not be constrained to strict boundaries, but rather be adjustable according to the learners' needs, which are expected to significantly vary due to the pervasive nature of ASD. The gap between undisputable rule following and complete learning freedom is the introduction of 'guidelines' used to support the tutor in his attempt to direct the learner towards performing the desired actions (Anderson and Lawrence 2014; 14, Scott 2017: 47-50, 141-143).

A suggested approach towards defining guidelines is the one that derives from documented indications of each learner's particularities or areas unfavourably affected by the diagnosed ASD condition. This approach is often defined as 'evidence-based' (Møller et al. 2002; Simpson 2005; Reichow and Volkmar 2010; Wong et al. 2014) and utilises the response of a human subject to a specific musical activity or non-musical quotidian task as a basis for the design of specific steps and guidelines aiming to alleviate the negative consequences of the ASD-compliant condition separately or altogether, with Møller et al. (2002: 16-7) presenting an example of the above. Such a course of action does not involve strict 'golden rules' by the definition of Ockelford (2013b: 245-6) but relies on the personalisation of certain features found in *Terpsichore* and the order in which learning modes and levels are taught, in full dependency on the cognitive, emotional and social profile of the nine human subjects examined in the case study. If any type of subsistent rule is to be included, inspiration may be drawn by the 'CARD (Centre for Autism and Related Disorders)' approach (Najdowski 2014). Despite the fact that its applicability has been documented for children up to primary school level (Ibid.: 193-4), its characterisation as 'evidence-based' is justified by the requirement to accumulate as much diagnostic and progress monitoring information as possible to design an instructional plan effective for each different ASD circumstance (Ibid.), thus invalidating the solution of generalised and default learning patterns as arbitrary.

Furthermore, the notion of 'evidence-based' analysis signifies the obvious statement that an accompanying therapist or tutor will be required to monitor the attention, performance and behavioural changes of each learner, both at the start of *Terpsichore*-led sessions and during their progress. This will assist the tutor in identifying which elements of the interface should be exploited as a matter of priority, in order to achieve the desired results for the learner's wellbeing and musical literacy. The initial learner characteristics, as extracted from the nine bibliographical sources referring to the relevant case studies, will also serve as 'evidence' needed to shape the content and level order of *Terpsichore* best applicable to the learner's requirements.

In an effort to clarify specific aspects of the interface, especially to the tutor whilst interacting with the ASD learner, a text-based user manual, in plain but comprehensible English, accompanies the levels of *Terpsichore*. In addition, the extraction of sample images from the interface as screenshots, so that they are subsequently added to the manual, may satisfy informative purposes but increases the manual's overall complexity. Finally, the entire learning process is made even more cumbersome by the tutor's need to recurrently switch his focus between the manual and the software. The attenuation or elimination of such issues is made possible by embedding the manual to the software, in a more interactive and simplified format. By default, when accessing any level of *Terpsichore*, a number of hints associated with guidelines on how to operate a level are presented. In various instances, the hints are numbered to indicate that respective tasks should be followed in a specific recommended order. The majority of hints are enclosed in a yellow background, although certain points of emphasis are highlighted in other colours. The tutor may disable the manual at any given time, so that the learner concentrates on each task without being distracted by the existence and complexity of complete sentences, especially when issues of limited literacy are observed.

Moreover, in cases where the peer tutor is concerned about the learner becoming excessively obsessed with electronic devices, to the point where such an addiction may be beyond control, it is sensible for the tutor to take advantage of the software's *reward mode* and *timer*. The Reward Mode, when activated, leads to the appearance of a task associated with the respective learner, which the learner is encouraged to complete successfully. If the outcome of such an activity is not successful, the *Terpsichore* interface completely shuts down, in accordance with the corresponding "Game Over" environments in video gaming. In addition, the enablement of the Timer Mode initiates a countdown stopwatch present on screen, which forces the shutdown of *Terpsichore* once it reaches zero. The default timer length has been set to 500 seconds but can be user-definable according to the needs of each particular human subject.

3.6 Summary

The third Chapter concentrates on the methodology proposed for the investigation of the *Terpsichore*-based learning procedures employed, and potential musical and mental areas affected. Research on the interface is based on two components. In the first one, nine case study learners, extracted from the literature on ASD and musical interventions, are hypothetically subjected to a detailed *Terpsichore* educational routine, while observations on interface efficiency result from a thorough literature analysis on how the software's elements may positively affect learning and therapeutic potential. The second component relates to the distribution of the software to twenty-eight adolescent and adult participants with ASD, actively supervised by three secondary and special education tutors in the Attica region of Greece. The accumulation of data is made possible by the completion, on the instructors' part, of a detailed questionnaire that encompasses a broad spectrum of areas related to music education and composition, cognitive development and wellbeing, so that a comprehensive image is provided on the software's efficiency and applicability. The Chapter involves, amongst others, a thorough description of the interface's two working modes, Tonal and SIP (Soundscape and Indefinite Pitch), including their predominant case study-compliant traits and inspirations from relevant findings. Moreover, various methods of internal and external feedback implementation are proposed, combined with a framework for the design of educational plans, in the form of IEPs or loosely defined educational routines.

CHAPTER 4

CASE STUDY ANALYSIS: ASSESSMENT OF EXPECTED *TERPSICHORE* RESPONSE IN NINE LEARNERS WITH AUTISTIC DISORDERS

In this Chapter, a detailed evaluative endeavour will be made in assessing the effect the structure and functionality of *Terpsichore* is expected to have on nine learners from the bibliography on autism spectrum disorders. As part of the methodological approach described in Chapter 3, the learners are chosen with such criteria as previous occupation with music, particular responses towards sounds, or key mental and activity deficits, to be addressed through the focus on diverse compositional tasks. Analysis pertaining to each concentrates on the main points to be considered when being brought in contact with *Terpsichore*, meaning that it is not necessary to elaborate on all levels when conducting each of the studies; ideally, engagement with the software should be subject to learning sessions encompassing all levels of the mode recommended for each particular case.

4.1 Case Study 1: Mike (Fang 2009)

The first example to consider is a Chinese American named 'Mike' (Fang 2009) whose personality characteristics were covered in Section 3.1, to assist with clearer explanation of the proposed methodology. Mike appears to be deficient in understanding musical notation but exhibits a capacity to respond to note letters (Fang 2009: 81). This confirms that the first three levels of the Tonal Mode (TM) have been constructed in accordance with the needs of Mike, and the student may better rely on letters of the alphabet than notation to perform in a productive manner. This also justifies the use of A through E to be paired with pitches, rather than C through G, as in Western European music. Judging from relevant findings (Loveland et al. 1997; Vivanti and Hamilton 2014), the occupation of a young learner with letters may be considered a pleasant activity directly from the initial stages of development, additionally stimulating the learner's emotional awareness (Loveland et al. 1997). From the above, it can be expected that after a number of Level 1, 2 and 3 iterations, combining the playback of the seven Western music fundamental pitches with their corresponding letters, Mike's ability to match pitches with notes will be enhanced, as is his capacity of expressing his feelings overtly and recognising external emotional excitations. Moreover, the inclusion of letters as a manner of interpreting musical notes may partially compensate for the linguistic deficiencies of Mike and his lack of concentration (Fang 2009: 85). The way auditory sequences have been constructed throughout the TM force sounds to be played at a rather elevated volume, given that loud sounds arriving to an autistic learner's ear may assist with their ability to focus on assigned tasks (Lawrence 2010: 22), implying a positive contribution to Mike's effort in drawing attention to non-musical tasks, judging by the above relationship between emotional awareness and concentration.

The tutor notices that Mike's linguistic skills improve gradually when the learner is introduced to relevant activities in which music forms a prevalent part (Fang 2009: 86). For this reason, it is not absolutely necessary that the *Terpsichore* sessions for Mike be organised in the same order that the Tonal Mode levels are; specifically, emphasis should be given to Level 5 exactly after Level 3 has been incorporated in learning sessions. Level 5 has been constructed in full compliance with the needs of not only Mike, but also a number of autistic learners who are found to exhibit an elevated lexical awareness when brought in contact with music. In the current context, music is linked to language through Level 5 thanks to a structure inspired by the relevant research of Shore (2003: 69-74), focusing on another case study involving a third-party learner. Since it is possible to connect letters of the English alphabet to positions in a 5-line stave (Ibid.)[60], simple words formed of any of the first seven letters from A to G, may be associated with plain musical phrases that can be executed on an instrument. This is why, it is necessary for the learner-tutor group to labour together in an attempt to enhance Mike's understanding of everyday people and objects, represented by such plain words as 'BAG', 'DAD', 'ACE' and 'FACE'.

Hammel and Hourigan (2013: 42) also cite the utterance of simple words such as 'dada' as an important step towards achieving larger-scale communication with peers through the reciprocal enthusiasm induced by this iterative process. Therefore, to satisfy Mike's

[60] Although it is obvious in this context, it should be mentioned that notation in the 5-line stave is governed by the G clef, with the exception of TM Level 15 where one of the staves is governed by the 4th-line F clef.

communication requirements, it is necessary to extend connection between notes and musical phrases to the entire span of English alphabet letters, which will render such supplementary words as 'mama' (Ibid.) part of the collective effort of composing fundamental note successions. For this reason, the additional window labelled as 'Reference' within Level 5 will allow Mike to press keys on a computer keyboard to simulate typing, something that will translate into melody composition. Experimentation with such everyday usage words as 'work' and 'play' confirms this, while the ending letters of certain words (such as A for 'dad**a**', C for 'tal**c**' or E for 'tal**e**') may be musically represented as phrases completed through Western music cadences, as shown in Figure 4.1. Mike's initial musical background (Fang 2009) may also induce more positive results than normal in brain activity and linguistic competence when connecting pitches to letters (Wong and Perrachione 2006; Musacchia et al. 2007).

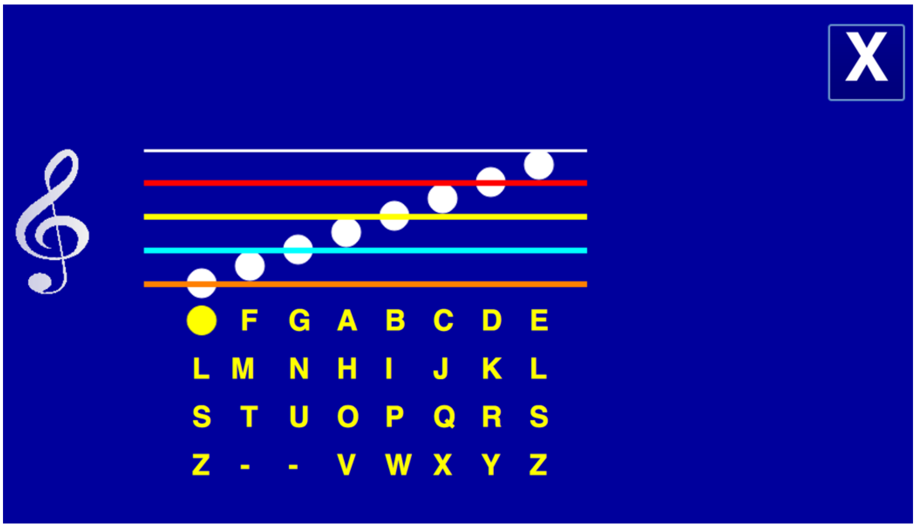

Figure 4.1 *Letter-pitch matching map for note execution via the keyboard in Level 5. The 'E' key was pressed to conceal the respective letter with a circle.*

Furthermore, Shore (2003: 73-5) proposes that plainly structured songs form part of a learner's routine, as a follow-up step to the musical representation of simple words. In conjunction with Mike's pronounced interest in musical routines, to the point where facets of his everyday life are positively affected (Fang 2009), Shore's proposal should be employed through the active occupation of Level 6, where the musical phrases triggered by the buttons serve as the external stimulating factor to assist Mike with the performance of the desired actions. Such an initiative is closely related with both the combined positive influence of a suitable pitch sequence and temporal content in music (Jusczyk and Krumhansl 1993), and the reliance on external musical sources to ignite the learner's eagerness to take initiatives and refrain from being passive (Kamitsubo 2013). Moreover, the adjacent placement of Levels 6 and 7, the latter of which allows full or partial musical phrases reproduced in Level 6 to be altered by the learner, is designed to contribute to the transition from passivity to activity in a playful and resourceful manner. The internal motivation required on Mike's part (Fang 2014: 74-5) can be incited by the capacity in visually and audibly monitoring the playback of Level 7 musical excerpts, and to experiment with the buttons via which selected note changes are made possible. Driven by the belief that initiative-based musical tasks facilitate cerebral function and perceptual awareness, motivation and enthusiasm are expected to increase and contribute faster to possible wellbeing changes (Wan and Schlaug 2013: 575). This argument can be reinforced by the Nordoff-Robbins principle of inherent music appreciation (Kim 2004: 322; McDermott and Hauser 2005: 29) serving as an impetus for meaningful responsiveness to fundamental phrase recreation in Level 7.

The ability of *Terpsichore* to provide auditory or audio-visual feedback is necessary in Mike's attempt to occupy himself independently with the software as the sessions progress. For this reason, the reliance of Levels 11 and 12 on feedback is of invaluable importance to the initially submissive Mike. Specifically, progression through these levels should consider the hypothesis that internal and unforced motivation can be cultivated when an indicator of activity performance and auditory accuracy[61] is communicated virtually by the interface itself. Not only does the software's automatic pattern repetition feedback mechanisms contribute to achieving such a goal, but also the Reward Mode's corrective and congratulatory character should help Mike acquaint himself with procedures deemed necessary in ultimately developing compositional skills and motivation to perform such a task.

Levels 11 and 12 may possess a transitional functionality, in which the representation of notes, letters and accidentals on a piano, serves as an impetus for easier task comprehension and achievement. For Mike, the decision of not extending the virtual piano principle to additional levels is not arbitrary, but rather assists in reducing his passivity or overreliance to 'comfort zones' inspired by similar ASD strategies to improve communication and socialisation (Brunk 2004: 57; Stillman 2010; Gosine, Hawksley and Quinn 2017: 7). Besides, overwhelming musical activities making Mike unresponsive to the outside world (Fang 2009: 74) are replaced by structures where musical tasks do not serve an exclusively educational functionality. For example, Levels 13 and 14 rely on a question-response model common not only to music, but also to everyday interaction. The aforementioned model has been designed to extend musical aptitude to communicational competence, especially when a tutor, initially familiar to Mike at first, incorporates pitch-dependent cues of these levels to his everyday speech so that Mike can respond effectively to questions and requests.

[61] In this context, and as a recommendation for learners similar to Mike, accuracy can be interpreted and symbolically measured through compliance with Western Music conventions or pleasure to the ear.

Successful completion of learning and therapy outcomes up to Level 14 is expected to help Mike cultivate his abilities and manage his behaviours when tasks of increased complexity are instructed, which was not the case prior to hypothetical occupation with *Terpsichore* (Fang 2009: 89-92, 95). Tasks requiring full-scale note modification (Levels 15, 17) or pattern creation from a blank document (Level 18) are obviously deemed more complex to the learner, but certain reports possibly connecting ascending complexity to improved communicational and emotional integrity (Mendelson et al. 2016; Ostiz-Blanco et al. 2016) may justify why the cultivation of such characteristics may be facilitated via the inclusion of these final levels, combined with their adequate compliance to tasks directed towards neurotypical people with which Mike is comfortable on occasions (Fang 2009: 76-8). Finally, Level 17 may prove additionally helpful as it exploits social stories in music-making, hence encouraging Mike to not employ music as a one-dimensional activity but rather as a medium to interpret a set of images and social situations, potentially shifting his attention towards the everyday tasks depicted and peer communication as a facilitator to achieve them, as seen in Section 2.4.

4.2 Case Study 2: QC (Mottron et al. 1999)

The female adolescent labelled by Mottron et al. (1999) as 'QC' is a person who, at the time of the study, was close to turning 18 years old, thus on the verge of adulthood. Considering that the virtual personalised *Terpsichore* sessions are bound to begin at the aforementioned point of QC's life, this case study creates the initiative to assess how a representative young adult responds to the stimuli initiated by a targeted occupation with *Terpsichore*. The following traits were isolated with regards to her condition and music appreciation potential:

- The learner's physical development and potential as an adult are unaffected by autism, but her linguistic skills were negatively influenced, partially because of an early streptococcus infection (Ibid.: 487).
- Several of QC's family members were diagnosed with at least an abnormal physical or mental condition, including speech incapacity of the father and a cousin's brain-affecting ASD (Ibid.: 487).
- As a child, QC exhibited a notable delay in cognitive development, paired with such commonly observed symptoms of autism as isolation from her human surroundings, tendency to focus on objects and activities of illegitimate interest, and imitative use of language in the form of 'echolalia' (Ibid.: 487-8). Moreover, her attention is negatively affected by complex activities not fully corresponding to typical learning sessions (Mottron et al. 1999: 492).

- QC is easily irritated by sharp and loud recurring sounds and is sensitive to auditory excitations that may be as soft as 15 dB lower than a non-disabled person's absolute threshold of hearing (Ibid.: 488).
- Her occupation with music began at the age of 2. At the time of the study, she is only capable of performing musical passages of an intermediate difficulty and requires supplementary effort in expressively articulating music rather than simply executing it; moreover, her ability to trigger feelings is rather limited (Ibid.: 488-9).
- At the time of the study, her ability to recognise pitches at least by identifying them through spoken expression, is relatively high; thus, her 'absolute pitch' skills are elevated, but her capacity to link successive pitches to one another is rather constrained (Ibid.: 488).

It can initially be observed that QC presents a series of symptoms compliant with the typical form of autism as discussed in Chapter 1, some of which seriously obstruct her comfort in occupying herself with such an educational platform as *Terpsichore*. To start with, the presence of 'echolalia', which is the imitative reproduction of external oral stimuli (Prizant 1983; Prizant and Rydell 1984), suggests that QC would tend to replicate the vocal advices or orders given by the peer tutor rather than execute them. Despite the above, her exposure to musical activities and early development of musical and vocal skills (Mottron et al. 1999: 487) could make the theme of interactive music education more familiar to the learner, considering her advanced development level in contrast to the one of her childhood. Moreover, QC's susceptibility to distracting stimuli suggests that she should primarily be encouraged to employ the User Manual while advancing from one level to another, without being diverted by elements irrelevant to each level she confronts. In this context, the correlation between autism and tendency to cause attention breakdowns should also be considered (Moyes 2002: 82; Autism Speaks 2012), especially when studied alongside her genetic profile and abnormalities (Sinzig, Walter and Doepfner 2009; Rao and Landa 2014).

As part of the relevant information on disability politics, the *'Floortime'* method, which predominantly relies on the learner's actual age (Greenspan and Wieder 2006) may be a representative point of departure for QC's occupation with *Terpsichore*. The above technique assumes that QC's autism diagnosis and proximity to adulthood justifies her impairments and underdeveloped characteristics. Although the research of Mottron et al. (1999) places the outset of certain deficits at earlier stages of QC's life, the *'Floortime'* method principles and explanations (Greenspan and Wieder 2006) should serve as an impetus for the gradual familiarisation of the learner with procedures aim to steadily replace echolalic behaviours with the tendency to become more independent and creative in composing musical patterns (Ibid.). The proposed strategy is based on instructing parts of the levels repetitively until understanding of procedures has been improved, without the concern that such a procedure would acquire elevated time dedication (Hammel and Hourigan 2013: 90). Therefore, the above features correspond to the learner's cognitive deficiencies and the need to concentrate on required musical activities and minimise irrelevant distractions.

In the case of QC, it is sensible to separate levels, especially more complex ones, into simpler constituents, each of which will occupy one separate session. Absolute pitch traits and their influence on QC's corresponding routines are a factor that would make *Terpsichore*'s Tonal Mode (TM) more appropriate for musical occupation and non-musical treatment. In Level 1, an interesting activity tailored to QC's needs, is the execution of the A, B, C, D and E pitches at distanced intervals, starting from as much as one minute, before reducing the intervals at a gradual pace. Level 2 may then be separated into two different components, pertaining to pitch recognition and phrase construction out of the five pitches from A to E. The tutor should initially conceal the bottom half of a screen and assist the user in connecting the five letters of the alphabet to their respective pitches, given the joint situation of QC determined by good pitch recognition and deficient cognitive profile. This constitutes a smooth learning method that shall assist the learner in developing long-term relative pitch recognition skills, along with the ability to match the first five alphabet letters to their adjacent notes. Instruments such as the flute and the oscillator combinations are most appropriate for the level instruction, as they have a smooth timbre and are characterised by the existence of only one frequency in the audio spectrum as opposed to other instruments.[62] Such sounds are employed in studies pertaining to autism, sensory processing and vocal integrity, in the form of either isolated pure tones or plain combinations thereof (Gage et al. 2003; Zhang et al. 2005: 712).

By taking into account QC's underdeveloped capacity to perceive relative pitch changes and her deficient verbal skill profile, the learner may optimally profit from *Terpsichore* through the implementation of tutor-led strategies intended to address the above imperfections, using as a starting point areas in which QC is most comfortable. Ockelford's (2013b: 156-160) case study on third-party learners reveals a proposed method on how to assist QC, through *Terpsichore*-oriented sessions, to develop relative pitch aptitude. In all levels where a routine of five successive pitches is executed[63], the routine in discussion is absolutely fixed in terms of pitch identity and progression. This is consistent with a method proposed by Ockelford (Ibid.), which, translated in *Terpsichore* terms, considers the 'A' note as a reference pitch for the four B, C, D, E notes that follow, while 'B', 'C' and 'D' serve as similar reference stimuli for respectively *three*, *two* and *one* notes that have a higher frequency. By instructing QC to listen for the

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[62] This assumption was made through iterative testing of all timbres and comparison to an open 'a' or 'o' vowel sound (the 'a' sound was employed in the experiment by Yau et al. (2015).

[63] Example of these are Levels 1, 2 and 4 in the Tonal Mode.

upcoming notes each time the same sequence is repeated, she should gradually be capable of identifying the sounds that follow and precede a specific pitch, especially when the same sequence is reproduced several times in an effort to enhance the memorisation of all notes that exist therein.

The above method extends to Level 5, where the connection of externally selected words by the tutor can be applied to *Terpsichore* by matching computer keyboard buttons to their respective notes, assuming that relative pitch is developed due to QC learning to expect what notes to play in order to complete a word's musical representation. This strategy, assisted by the audio-visual content of *Terpsichore*, is compliant with the 'zygonic theory' of transition from absolute to relative pitch conceived by Ockelford (2006; 2013a, b). This theory relies on the gradual or sporadic replacement of elements within a musical phrase or piece, including tempo, melody and form, so that reworked alternatives of the same initial phrase are created (Ockelford 2006: 142-152) based on a profound relationship amongst separate parameters including pitch (Shibazaki, Ockelford and Marshall 2013: 433-4). The 'zygonic' approach proves itself highly appropriate for *'Floortime'*-based strategies (see Greenspan and Wieder 1998; 2006), especially when *Terpsichore* is involved, because it will allow QC to employ the functional part of her brain in order to understand, especially in the longer run, the order of notes in a musical scale or a part thereof[64], something that translates into enhanced relative pitch capacity.

As part of favouring original composition to the passive reproduction of unaltered patterns, the strategies proposed for the *Terpsichore*-led sessions of QC attempt to counter the irregularities or obstacles possibly created by the attempt to grasp musical knowledge of information through the memorisation of separate 'absolute' pitches (Kupferstein and Rancer 2016). Through common musical knowledge, compositions have diachronically relied on the relationship between adjacent notes on a stave or a timeline, thus making both 'echolalia' and total dependence on absolute pitch unfavourable factors in injecting composition skills into the learner. Thus, the described strategies are designed to increase the independence of QC in composing plain and coherent musical phrases rather than resorting to meaningless key striking. The efficiency of such a method may be enhanced by a communication routine involving a 'leader'-follower relationship between tutor and learner respectively, where the prospective success in completing a task – which is relative pitch recognition in this context – is bound to increase the enthusiasm of QC to the point where the roles of the above relationship can be reversed in her favour (Hutchinson 2013: 11).

In Level 7, the 'zygonic' method (Ockelford 2013a) is employed practically because QC is encouraged to alter parts of initially programmed phrases, by leaving selected notes intact whatsoever. Understanding QC's incapacity in providing autonomous responses to a peer when

[64] A simple example is the five-note A minor scale, where B, C, D and E naturally follow the tonal 'A'.

asked to perform an activity (Mottron et al. 1999: 487-8), it is vital not to omit Level 6 prior to 7, expecting that this will provide an introductory framework for the gradual modification of default melodies. In Levels 13, 14 initially designed to prevent and counter stereotypical responses, it is assumed that relative pitch has been sufficiently developed through sustained concentration on previous levels. For QC's learning schedule, the increased degree of freedom in Level 14 as opposed to 13, is regarded as an important step towards independence in phrase composition, based on the 'zygonic theory' principles, meaning that the learner's performance in compositional tasks should be ideally based on how successfully and effortlessly the activities of the first 14 levels have been performed, which can be objectively measured by a therapist or evaluated within *Terpsichore* while the Reward Mode is active.

4.3 Case Study 3: Nathan (Brownell 2002)

The research of Brownell (2002) focuses on four young pupils in early educational levels with special underlying conditions related to autism, one of which, named 'Nathan', attracts special attention because of several distinctive attributes that prove critical to the prospect of meaningfully operating a computer-oriented music interface. The learner, aged between 6 and 9 years (Ibid.: 126), exhibits the following characteristics relevant to the current analysis (Ibid.: 134-5):

- He finds the presence of other people in his close surroundings irritating, which is also the case for direct corporal contact with individuals.
- His communication skills are very limited; he appears more comfortable when in isolation.
- He exhibits serious problems in transitioning from one learning component or everyday setting to another; however, his everyday activities are not always characterised by imitative patterns.
- The issue of highest gravity is that the intensity of his voice may only take two fixed values, which may probably be quantified in terms of sound pressure level in decibels (dB)[66]. The soft one is considered normal but there is a much more potent voice variation capable of disturbing and frightening other people in a casual or classroom context.

The research of Brownell (2002) attempted to primarily address the issue of control deficit in speech volume by instructing the peer tutor to familiarise the learner with the concept of employing low-decibel vocal routines, labelled with such challenge phrases as 'quiet voice'

[66] The statement on decibels is a hypothesis based on the findings of Brownell (2002).

(Ibid.: 135). In the current *Terpsichore*-based analysis a personalised educational routine should be employed to mitigate the risk of Nathan expressing intense reactions with his voice. This task may often prove itself to be more demanding than expected, because, apart from the possibility of responding abruptly to irritating music or miscellaneous stimuli (Kaweski 2011: 52-55; Frantz and Zellis 2016: 311-2), it is always probable that the learner randomly produces loud or disturbing voices, without being provoked by an excitation that would justify his emotional outburst (Gus 2000: 467; Talay-Ongan and Wood 2010: 206; Ibañez, Stone and Coonrod 2014: 596).

Although there is no direct mention as to what causes Nathan's loud voice variant, two possible causes may be assumed. In the first instance, the documented susceptibility to direct contact with surrounding individuals (Brownell 2002: 134-5) is a distressing issue, potentially hindering Nathan's productivity and responsiveness to *Terpsichore*-led tasks especially when based in an adjacent spatial setting (Williams 2011: 81). Such an occurrence could also result from exposure to intense sounds as an indicator of elevated sensitivity (Andersson et al. 2002; Khalfa et al. 2004: 50-52) or irritation (Jones, Quigney and Huws 2009: 115; Lucker 2013: 184). Hence, the sounds with which Nathan should initially be familiarised should primarily be as subtle as possible, in accordance with similar sound-based endeavours to improve a learner's behavioural profile (Singh et al. 2011; Seo and Aravindan 2015), meaning that such a technique should involve the *SIP Mode*. The peer tutor should initially activate each of the three timbres in Level 1 in turn, and allow them to be executed as looped patterns for a few minutes each, at a volume regulated by the relevant volume controls on the computer keyboard. Transition between sounds should not be performed at highly frequent intervals, nor should a session, constructed upon any separate level, last for only a limited period of time. This is due to Nathan's difficulties interacting with others and grasping knowledge from different instruction areas (Brownell 2002), something connected to sensory perplexities caused by the misperception of dynamic or alternating soundscapes (Turkington and Anan 2007: 14).

Because of the above, at least in the first instruction sessions, the tutor should disable any already active sound in Level 2 prior to enabling any other auditory excitation, despite the level's construction that permits the simultaneous execution of multiple sounds. Provided that the tutor carefully follows this principle, Nathan should gradually immerse himself in each of the soundscapes and benefit from their subtle and sustained character to become less susceptible to abrupt reactions. In case, after a number of iterations, Nathan's tendency to scream or generally produce loud sounds persists, the described strategy may be combined, similarly to the soft speech strategy proposed by Brownell (2002) himself, with a warning timbre audible when Nathan's voice becomes excessively loud. Furthermore, an 'amplitude follower' within SuperCollider (Valle 2016: 339-341) assists in capturing the audio signals arriving to the internal or external microphone of the computer, causing the above sound pattern to activate itself when the SPL detected exceeds a specified threshold, represented in SuperCollider as a 0 dB reference value above which clipping occurs.

Level 3, as described in Section 3.2.3, allows Nathan to reproduce sound samples whose content and mood correspond to a specific emotion. Considering Nathan's communicative deficits despite no sensory deficiencies reported (Brownell 2002), occupation with this level may still be useful on the hypothesis that the externalisation of emotions is an expressive manner of communicating at least nonverbally. Wigram (2000: 15) maintains that learners who improvise are capable of jointly developing the above two aspects, and although improvisation is not present as such in Level 3, experimentation with different samples exemplifies the 'free' character of improvising (Ibid.). Moreover, expected results may be enhanced by the representation of human face pictures as a simulation of an interlocutor's actual facial expression, inspired by Hernandez et al. (2009). Through this level onwards, Nathan's nonverbal learning needs may be satisfied thanks to the auditory feedback provided from within *Terpsichore* whenever the Play button is pressed.

However, it is vital for Nathan to gradually become more fluid in accepting the presence of other individuals in his surroundings and learn how to interact with these. A method proposed by Bull (2008: 71-2) focuses on the peer tutor's initiative of creating percussive sounds to match, in the time domain, the execution of a melodic instrument by the learner. The peer tutor should begin the relevant procedure by coordinating the gentle impact of Nathan's hand on a solid surface with the on-screen movement of the arrow, preferably with the sound on, albeit at a low volume to avoid distraction and intense vocalisation occurrences. Furthermore, the possibility that Nathan's potential relaxation and improved volume control results primarily from the application of the Brownell (2002) method, justifies the necessity of including a sub-window accessed from *Terpsichore*'s main menu and aimed at detecting potentially intense incoming signals and subsequently prompting Nathan, or any other learner, to 'calm down', often with the assistance of a warning bell at excessively high volumes.

The difficulties of Nathan to fluidly transition between two different learning components can partly be overcome by encouraging the peer tutor to repeat procedures associated with *Terpsichore* levels multiple times. Levels 5 and 6 can be used interchangeably since they respectively pertain to the static and dynamic character of certain sounds in terms of amplitude and spatial origin. Likewise, Levels 11 and 12 concentrate on the similar functionality of manipulating indefinite pitch timbres, respectively through granular synthesis and wave timbre modulation. Despite slightly divergent functionalities, buttons and faders are arranged in a similar manner aiding with the transition process and the exchangeable use of levels multiple times in Nathan's learning routine. Repetitive procedures can also be combined with enabling the built-in metronome aimed at habituating Nathan to the notion of stable rhythm, something included as a clearly defined music education component in Level 7, in which periodic percussive patterns may be devised. Such notion not only shares common fundamentals with similar approaches based on gradual learning component inclusion (Ockelford et al. 2011: 185-6, 199[67]; Ault and Griffen 2013), but also constitutes a useful tool for the development of necessary motor skills (Pavone and Ruggieri 2005: 191-2; Hardy and LaGasse 2013; Berger 2016: 106-7).

Levels 5 and 6 are additionally useful in Nathan's learning routine on the basis that unfavourable behaviours towards peers and feelings of irritation derive from certain ASD learners' problems in adequately detecting sounds in a spatial setting, especially in an environment of coexisting stimuli affecting various senses (Boddaert et al. 2003; Rizzolatti and Craighero 2004; Bahrick and Todd 2012). The use of the sound map or 'acousmatic circle'[68] works towards such a direction, as Nathan, for whom no visual impairments have been reported (Brownell 2002), is trained to better localise sounds within the three-dimensional space having visual cues as an assistance; outcomes are expected to be more intense via dynamically mobile sources in Level 6, in similarity to real-life sound source changes perceived even by a stationary observer. Although Level 9 is the next to incorporate 'auditory localisation' (Weiten 2016: 131, Section 3.2.3), the two previous ones are not redundant in Nathan's learning schedule. The previous paragraph outlined motor benefits in the operational principles of Level 7, while the reliance of Level 8 on filtering and amplitude configuration of isolated default or loaded samples could compensate for problems in determining stimuli and frequencies possibly causing irritation, similar to ASD individuals' issues in localising sound components within a broader acoustic setting (Čeponiene et al. 2003; Tomchek and Dunn 2007).

SIP Level 10, initially designed to counter imitative responses to given musical stimuli, can be exploited as a means of virtual communication attainment, initially detached from surrounding individuals to which Nathan is susceptible. Inspiration for their inclusion in his learning plan can be drawn from a study employing musical intervention as an alternative to diversion-oriented 'toy[s]' in order to accommodate learners' wishes, improve communication and relieve symptoms resembling echolalia (Thompson and McFerran 2015: 4, 7-9). In Nathan's case, it can be affirmed that these *Terpsichore* levels efficiently satisfy Nathan's requirements, thanks to the feedback provided by the interface regarding the ideal sequence that completes unfinished phrases. Nathan's occupation with these levels should be meticulously monitored, to ensure verbal interaction objectives through musical phrasing are achieved without undesirable implications (Whipple et al. 2015: 79-80). Finally, further cultivation of communication skills can be achieved through the social stories principle upon which Level 15 is constructed, since

[67] Such names as 'Carter' and 'Chang' refer to tutors participating in the programme devised by Ockelford et al. (2011, see above), and not to researchers with specific works cited by the former.

[68] It is clarified here that the term 'acousmatic circle' has been conceived personally for research purposes.

this computer environment combines visual cue successions as verbal communication facilitators, similarly to PECS (Section 2.4) but with a creative approach of displacing notes on a stave for storytelling purposes, as expected from a social story structure. This statement indicates that the Tonal Mode, especially Level 17 on Social Stories, could also be employed by Nathan as an adjunct to SIP Mode activities.[69]

4.4 Case Study 4: GM (Yau et al. 2015)

The investigation concerning the primary school girl named 'GM' acquires special importance taking into consideration that, similarly to 'QC' (Mottron et al. 1999), GM's development is heavily retarded mainly due to impaired integrity of her brain, exhibited through the coexistence of cerebral palsy (CP) and autism diagnoses (Yau et al 2015: 2). The main characteristics pertaining to her overall disability are the following (Ibid.):

- She is generally incapable of articulating complete words, but rather attempts to express herself by producing fundamental sounds, whilst her interaction skills are only enabled through external motivation.
- In preschool years, signs of slow progress were evident, and her general condition appeared to deteriorate after 18 months' time.
- The existence of autism was discovered at around five years of age, as a result of diagnostic tests that delivered magnitudes relevant to autism or were suspended due to GM's emotional breakdowns. The above diagnosis also demonstrated that GM simply resorted to producing meaningless phonetic patterns without attempting to behave in an extrovert manner.
- Her alienation from other people in her surroundings and her pronounced difficulties in completing certain activities, makes her incapable, even in more advanced stages of her childhood, of performing satisfactorily in standardised tests. In addition, her concentration is often weakened by her exposure in crowded settings with loud voices around her.
- Finally, more positive than normal reactions were detected when the learner was brought with auditory contact with sinusoidal 'pure tones' at various frequencies (Ibid.: 1, 5, 9).

The GM example addresses a large number of symptoms common to various autistic disorders, including, as analysed in previous Chapters, problems in concentration, motivation,

[69] These actions are beyond the scope of this analysis, as emphasis was given to the SIP mode in the learner's attempt to regulate his voice and externalise emotions through tasks of minimal complexity.

communication with peers, behavioural integrity and cognitive development. The general disability profile of GM is jointly shaped by autism and CP, but the near total – rather than partial – verbal incapacity could result from CP solely on the occasion that GM was found 'tetraplegic' (Edebol-Tysk, Hagberg B. and Hagberg G. 1989: 46), of which there is no direct mention (Yau et al. 2015). Moreover, it has recently been discovered that early-age children with ASD-CP comorbidity[70] exhibit stronger mental and communication deficits or more unorthodox responses than individuals without ASD (Hattier, Matson and Kozlowski 2012: 90; Smile et al. 2013: 397; Smile and Kawamura 2016: 361-374), an argument consistent with GM's actual condition. It can therefore be safely assumed that autism played a significant role in shaping the mental profile of GM over time, thus making her an appropriate subject for experimentation with *Terpsichore*.

The tendency of GM to only articulate dispersed sounds is a primary reason why the instruction of *Terpsichore* should commence through the Tonal Mode. Amongst the sounds available for use by default, the closest possible timbre to a typical vowel sound, is a sine oscillator, a combination of oscillator timbres containing at least one sine wave, or a flute[71]. A proposed strategy involving the use of vowels and their subsequent combination with consonants, is occasionally directed towards the development of speech capacity (Dunn and Harris 2017: 77-91). However, its applicability to learners who are of a developed age and high-functioning, neither of which is the case for GM, requires the peer tutor to perform simpler actions towards connecting a musical timbre to an appropriate vowel or vocalisation. Increased attention should be paid to the exact instrument or oscillator combination used at any given instance, as each programmed timbre in *Terpsichore* sounds similarly to a different vowel or syllable each time, depending on the part of the body employed for articulation (Paul 2008a: 81-2; Rogers and Dawson 2010: 169-173; Dunn and Harris 2017: 77-88). It is however encouraging that consecutive notes sounding similar to vowels are processed in a manner similar to the one consistent with neurotypical individuals (Kemner et al. 1995; Alcántara et al. 2004), although this can be regarded as a session-facilitating tool only when a peaceful and noise-free environment is guaranteed to avoid becoming distracted (Čeponienė et al. 2003).

The lowest degree of complexity should be sought when employing the User Manual along with the software. Given GM's cognitive abnormalities, along with the possibility that GM's integration into a classroom or family setting may elicit overwhelming sensitivity when

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[70] This term refers to the simultaneous existence of incongruent disabilities but must certainly be concealed from disabled learners in order to prevent mental condition deterioration (Kaplan et al. 2001).

[71] Information regarding the beneficial nature of oscillators is presented as part of Case Study 2 (Section 4.2).

attempting to interact with multiple peers (Education and Skills Committee UK 2006: 669; Quinn and Malone 2011: 128), a sole peer tutor responsible for the instruction of simpler *Terpsichore* parts is required, for reasons of sensory confusion avoidance (see Section 1.2). The structure of the first three levels has been constructed in accordance with GM's requirements for increased structural simplicity, something that especially applies to Level 1 and its corresponding isolated note execution features. The importance of this level lies in GM's tendency to produce phonetic vocalisation routines without the involvement of previous musical training, which justifies why he should be treated similarly to individuals with tone-deafness[72].

A subsequent way to steadily insert music in GM's daily schedule as a virtual means of engaging in rudimentary communication, is the movement to Level 6[73]. This level contains an iconic representation of individuals, in the form of Clipart images depicting young pupils aged close to GM, inspired by the role of 'virtual people' in learning programmes for ASD subjects (Kerr, Neale and Cobb 2002; Milne et al. 2011: 25; Parsons 2014: 126-7). This strategy sets the foundations for the smooth and uninterrupted inclusion of the individual in society, as a primary step towards the formulation of concrete human relationships. It should be noted that overreliance on the 'virtual people' method may produce the opposite results to the ones intended (Milne et al. 2011). However, the presentation of human faces on-screen potentially diminishes the likelihood of GM becoming upset or angered at the neighbouring presence of the tutor. One sole peer should first demonstrate how the learner should press the buttons and how these match the respective on-screen images. Then, GM should be encouraged to experiment with the buttons himself, while assigned Level 6 actions should be prefaced by the tutor, preparing the learner about his expected duty, such as go to school, have lunch or go to sleep.

In terms of Level 7, the reconstruction of default phrases using the predefined freedom degrees in *Terpsichore* may be easier to undertake when a vowel is communicated by the tutor and chosen by GM, judging from the timbres and strategies employed that approximate a vowel sound. As part of nurturing verbal aptitude, it is recommended that the comprehension and eventual selection of consonants results from a method approximating Hammel and Hourigan's (2013: 20) 'speech therap[y]' proposal, hypothesising that the understanding of language fundamentals favourably affects conversational skills in the ASD domain (McDaniel, Slaboch and Yoder 2018: 208-211) and that some interconnection is present among motor coordination, consonant production enablement and communication (Iverson 2010). Adding reference buttons

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[72] An insight into 'amusia' or tone-deafness, and its potential connection with autism is found in such sources as Peretz and Hyde (2003), Hyde et al. (2010).

[73] It should be repeated here that the level structure for both moves only serves as a *general* guideline that should best accommodate the needs of a large number of autistic individuals, but not necessarily all of them, considering the pervasive and multifaceted character of ASD.

that, when pressed, emit sounds approximating how letters A through G sound, at pitches corresponding to the note frequencies (such as power-of-2 multiples of 110Hz for A), are expected to assist in the development of more intelligible vocalisations through the playful activity of recreating default musical patterns.

Understanding that, at the supposed start of the GM case study, the learner exhibits no apparent capacity of responding to peers' signals even by mechanically duplicating them[74], forms of virtual feedback should be favoured to help GM progress through subsequent levels. Clicking the on-screen keyboard buttons in Levels 11 and 12, after selecting or synthesising appropriate timbres, with feedback mode activated, ensures that an indication of a previously performed action is conveyed to GM, so that she is encouraged to engage in an interactive loop potentially benefitting communication aptitude on the therapeutic domain (inspired by Pfurtscheller et al. 2011: 12), motivation to progress through levels (based on Ploog et al. 2013: 314-9) and ability to articulate plain phrases within the framework of music education. Incidentally, Level 12's reliance on oscillator tones to produce synthesised timbres could be regarded as a facilitation due to one of the component options being a sine wave, which Yau et al. (2015) discovered to benefit GM's daily routines. Extension to other oscillator timbres should follow the pure tone synthesis with which the learner is comfortable.

As *Terpsichore*'s design favours the progression through levels more as recommended guideline and less as a compulsory requirement, priority should be given to less complex and more practical levels in order to attain desired communication and motivation goals. It may be possible for tutors to omit Level 9 and its accompanying Schoenberg note rearrangement functionality, or from GM's learning schedule, on grounds of excessive complexity. However, the documented high engagement of GM with both nonverbal and sinusoidal stimuli (Yau et al. 2015: 1) possibly infers his tendency to develop 'autistic' hearing (see Section 2.1) and related performing routines, something that would render his response to unconventional melodic sequences more encouraging. Moreover, as Levels 11 and 12 enable GM to experiment with all twelve notes of an octave, the principles conveyed in Level 9 through the standardised rearrangement of pitches can serve as transferable skills for the gradual improvement of musical phrasing. The expected outcomes from such an approach may be optimised by including the above proposals into the private or classroom tutor's official IEP, as this has already been applied to mathematical ASD education (Su, Lai and Rivera 2010)[75]. Consequently, the above argument should encourage tutors to weigh their options considering whether Level 9 should be introduced in learning schedules as a precursor to *Terpsichore* environments that use all

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[74] See brief mentions on 'echolalia' in Sections 1.1 and 3.2.

[75] At this point, the commonly accepted relation between mathematics and music can be considered as an impetus for connecting this research finding to our present case.

different pitches of an octave. Such examples are Levels 16 and 18 where GM is introduced to the visual-auditory relationship of accidentals in Western music.

4.5 Case Study 5: Melanie (Orr, Myles and Carlson 1998)

As part of the case study approach, it is important to isolate certain cases whose characteristics relevant to autism can be better treated by employing the SIP Mode of *Terpsichore*, where the acquaintance with diverse auditory stimuli, not necessarily associated with concrete tonalities, may be defined as 'music'. One of these examples is a 11-year-old girl (Orr, Myles and Carlson 1998), whose salient traits for the purposes of *Terpsichore* application are presented below:

- Melanie's linguistic development is not one that would make the comprehension of her utterances completely possible in an external environment (Ibid.: 163).
- She tends to behave in an irrational and explosive manner every time her requests are not granted, or she is not perceived as the centre of attention in a communal context (Ibid.: 163). Two frequent examples of such behaviour, without adhering to a temporal pattern of emergence, included rapid head fluctuations and the need to shout at a neighbouring individual to request or demand something (Ibid.: 163-164).

A recommended basis for the design of *Terpsichore*-led educational curricula is the identification of manners through which rhythmic interventions favour the development of motor abilities and communicative integrity, as presented in Section 2.1. The proposed method in Orr, Myles and Carlson's research (1998) regarding the notion of 'rhythmic entrainment' should not be followed exactly as desired, but may be utilised as a guideline to take the highest advantage of the soundscape-oriented levels, as the majority of previous case study approaches employed the Tonal Mode as primary means of action. The above concept is also applicable to Goldman's (2002) research with regards to activities intended for relaxation and elimination of explosive reactions, by exploiting the contribution of alpha waves in mental comfort and normalisation. Appropriate to the behaviours of Melanie is also the arrangement of learning sessions based on the TEACCH and 'psychodynamic music therapy' combination (Stewart 2002; Mesibov et al. 2004, see Section 1.6), on the basis that the meaningful completion of music activities can be better achieved when Melanie regulates her emotions and concentrates on tasks without always being addressed by a peer tutor.

The manner in which the *Terpsichore* SIP Mode is structured encourages users to take advantage of its abilities to invoke relaxation and enhance concentration. This presupposes that the required changes are made to the content and succession of level windows so that Melanie's needs are comprehensively met. In *Terpsichore*, the default level arrangement and content ensure relaxation under certain circumstances, considering the softness of sustained audio loops compared to sharper and unmasked ones (Quill 1995: 40), or the ability of musical interventions to facilitate the completion of associated actions by the learner (Scott 2017: 111-120). However, the inclusion of more explicitly time-dependent elements is required not only to make *Terpsichore* better suited to 'rhythmic entrainment' as described in corresponding research (Orr, Myles and Carlson 1998; Strong 1998; Strong 2014), but also to assist Melanie and other similar profile learners in improving motor skills and absorption of knowledge (Thaut et al. 1999; Thaut et al. 2009b; Hardy and LaGasse 2013).

Level 7 of the SIP Mode is a recommended starting point for Melanie's musical training sessions, as it allows the creation of simple percussive patterns at a steady beat and with a periodic repetition of the pattern every four seconds; moreover, the 60 BPM[76] tempo in which the Level 7 code was programmed by default is within the 50-65 BPM range that Orr, Myles and Carlson (1998) suggest for 'entrainment' purposes. The above, however, lead to the misbelief that Levels 1 through 6 should be skipped, as no rhythmic elements are actively included. To avoid this being the case, and to exploit general interface capabilities to the fullest, two modifications, described in the following paragraphs, should take place in the first six levels of the interface in order to better confront Melanie's weak points while simultaneously exploiting these levels' operational value (see Section 3.2.3).

Firstly, adding a tempo and metronome structure for levels not directly associated with rhythmic tasks, ensures that sustained audio soundscapes playing in the background are complemented with a periodic timbre, with the option of either a kick drum or a bell-like sound (see Figure 4.2 below). To accommodate the proposed 'rhythmic entrainment' method (Orr, Myles and Carlson 1998) without however having to fully abide by such suggestions, the repetition rate of the percussive note should be equal to around 60 BPM or multiples thereof. Furthermore, the metronome window, accessible from most SIP Mode levels, ensures that the rhythmic complement can be adjusted to any different tempo, provided that it is consistent, to mitigate the risk for adverse behaviours or arbitrary head vibration (Ibid.: 165).

[76] BPM stands for 'beats per minute'.

Figure 4.2 *Screenshot of a SIP Level 1 part, with the 'Change Tempo & Activate Metronome' structure visible on screen. Box '1' activates kick drum when pressed, while '2' is related to a percussive bell-like sound, synthesised in SuperCollider.*

Secondly, the peer tutor should control the activation of sound stimuli and the interchangeable transition between different sounds (such as *water*, *wind* and *leaves*), so that these occur at steady intervals, necessary for the development of concentration and motor skills, as described above. The addition of the percussive or indefinite pitch timbre – especially in the lower frequency domain – as an adjunct to the soundscape succession, is expected to deliver desirable results, as such sounds excite the nerves associated with awareness of sounds (Large and Palmer 2002; Hove and Keller 2015). The audio layer involving percussion and soundscapes constitutes an approximate means of confronting Melanie's two main ASD-induced irregularities, given that multifaceted auditory stimuli are considered means of shifting a learner's attention towards improved task accomplishment and 'exploratory' enthusiasm (Bergmann 2016: 200).

The potential of SIP Level 9 can be maximised through a procedure that matches the tutor's position with respect to the learner, to the placement of on-screen sound sources using the mouse. This procedure aims to direct Melanie towards clicking, with the mouse, on an appropriate horizontally defined region to indicate whether the sound of, or touch from, her neighbouring person, arrives from the learner's left, right, or centre. The existence of the six default soundscapes, which correspond to everyday environmental phenomena and auditory excitations – such as the town sounds, the sea waves and the robotic drones – are designed to form a soothing environment for Melanie so that the function of her 'nervous system' (Rogers et al. 2012: 39) is improved to the point where explosive behavioural reactions are reduced to a minimum (Ibid.; Conn 2016: 110). Taking into account that Melanie's head fluctuations are probably an indication of attention deficits increasing with outburst intensity, the panning-dependent structure of this Level may favour the implementation of attention-enhancing procedures based on changes in conduct, especially with the assistance of a peer tutor (Whalen and Schreibman 2003: 160, Berger 2017: 133)[77].

In addition, Level 13 is particularly important in Melanie's attempt to communicate with her surroundings and relieve herself from egocentric behaviours (Orr, Myles and Carlson 1998). This is due to the level being inspired by laptop orchestra (LOrk) activities, ideal for simultaneous completion across more than one computers, allowing some form of interaction to be achieved. Although research on LOrk activities and autism is limited, the former may be crucial in shifting Melanie's attention from herself to her tutor (Nason 2014: 170) or establishing equivalent emphasis between the two in communication routines (Snelling 2013: 13). Furthermore, the 'turn-taking' approach (Vismara and Rogers 2008; Finnigan and Starr 2010) may be applicable to the current LOrk context, especially if Melanie is accompanied by another autistic individual in the learner's position possible causing issues of biased or unfair competition (Riley-Hall 2012: 94). The 'Concordia' project developed by Tsabary (2014) is an additional impetus for the use of *Terpsichore*'s LOrk level, as multiple individuals are encouraged to participate alongside Melanie and follow role alternation (Vismara and Rogers 2008; Riley-Hall 2012: 94), with the purpose of simultaneously increasing motivation, initiative-taking and educational awareness (Tsabary 2014: 659, 662).

4.6 Case Study 6: JPH (Pasiali 2004)

In her research, Pasiali (2004) refers to three different youngsters whose conditions, albeit dissimilar, are all relevant to behavioural abnormalities consistent with autism, in learners generally fond of music. Given that each of the three cases refer to only a specific part of cognitive and mental development, it is worth constructing a combinational study based on a hypothetical youngster exhibiting all autism-related traits present in 'Johnny', 'Peter' and 'Helen', the names of Pasiali's (2004) study participants. In this manner, a greater part of *Terpsichore*'s content and capabilities is exploited, and more areas of individual improvement are addressed in facets of both the educational and the therapeutic domains. The resulting imaginary subject named 'JPH' is eight years of age (mean value of 7,8 and 9, see Pasiali 2004: 14-16) and is characterised by the following:

[77] In the relationship between attention and behavior, the technique of Whalen and Schreibman (2003: 160) presents attention as the effect whereas Berger (2017: 133) identifies it as the cause for potentially improved attention.

- Positive reaction to music listening, to the point where appropriate sounds may evoke relaxation (see Peter, p. 15).
- Response to external speech stimuli in the form of 'echolali[a]' (see Johnny, p. 14), which, as described in the first Chapter, refers to imitative repetition of words and phrases without specific intent.
- Tendency to produce unintelligible sounds when instructed to perform an activity considered undesirable at the time (see Johnny, p. 14).
- Tendency to perform tasks that either result in workspace untidiness (see Helen, pp. 16-17) or equipment damage (see Peter, p. 15), which increases when personal conduct is adverse or not appropriately controlled (see Helen, pp. 16-17).

Starting from the aspect of untidiness mentioned above, it is important for the visual arrangement of components in *Terpsichore* to conform to a specific organization pattern, an example of which would be the symmetry of a button stack to either the centre of the computer screen or a specific axis (horizontal, vertical, diagonal). An instance of this is found in Figure 4.3 below, where all asymmetric inconsistencies were corrected by placing components in symmetrically appropriate positions. This modification is inspired by a classroom intervention by Oldfield (2006b: 34-6) for the musical treatment of Tourette syndrome, where particular attention was paid to the meticulous arrangement of objects within the classroom boundaries. This implies that extending such an initiative to *Terpsichore*'s structure is a first step in confronting the neatness issues faced by JPH in his[78] everyday life.

Figure 4.3 *Changing visual aspects of SIP Mode Level 2 for symmetry and neatness.*

The supposition that JPH's reaction to music is positive and soothing (Pasiali 2004) is consistent with the principles upon which the Nordoff-Robbins method is based, the foremost being inherent music appreciation (Nordoff and Robbins 1971; Kim 2004; McDermott and Hauser 2005: 29) and capacity in performing tasks whether associated with music or not. To

[78] The gender of JPH was chosen to be male, as it derives from a combinational study of three pupils of which the majority (two) are male.

exploit the joint educational and therapeutic potential of *Terpsichore*, it is important to instruct the interface's components in the appropriate order. This consists of initially addressing therapeutic aspects of the SIP Mode, aiming first and foremost to decrease the probability of JPH exhibiting explosive behaviour, through calming timbres and a uniform set of music intervention sessions, changing infrequently and steadily. The similarity between Levels 1-2 and 5-6 complies with the above; in the first pair, only one new sound stimulus is introduced in the second level compared to the first, while it is possible to adjust the number of sounds simultaneously activated, to make level difference as minimal as possible. In the second pair, the only apparent difference is the ability to rotate peripheral sound sources in the sixth level as opposed to the fifth, which can be considered a key prerequisite for the perception of dynamic nature in an everyday environment.

JPH's condition can be examined alongside with the proposed conversational model of Bruscia (1982) according to which the transition from complete echolalia to a dialogical strategy that allows the learner to provide a response that does not replicate the respective question, or to complete a phrase when given a part thereof. Given its reportedly positive effects in reducing echolalia in an actual testing environment (Ibid.), this strategy may be employed in the design of certain levels in both *Terpsichore* modes. Inspired by Bruscia's analysis (1982), it is possible (a) to include question structures that require an answer on the learner's part, or (b) to specify series of musical sequences following a conventional question-response pattern; both concepts are commonly encountered in music morphology and often associated with everyday speech (Besson & Schön 2001).

Case (a) is largely applicable to the SIP Mode as it may assist the learner in recognising a timbre or an auditory stimulus when asked by the tutor to select it, or when faced with the lexical or image cue associated with the environmental sound in question. Case (b) may be better suited to Tonal Mode levels, as its music-oriented application is feasible in two different manners. The first one is the completion of a predetermined sequence with the missing notes, such as the specification of the notes F, G in a diatonic sequence when C, D and E are given. The second one involves two different short musical phrases at any given time, following the bipolar *a-b* model of musical communication (Bruscia 1982); such a method gradually trains the learner to create a musical pattern that is not absolutely identical to the one produced by the tutor, but can contain the appropriate pitches in an order that may make the overall result of two consecutive phrases similar to normal conversation. A plain example of this is the execution of all notes from C to G in a sequence that is inverse to the one played by the tutor (i.e.: C-D-E-F-G as question, G-F-E-D-C as a response).

Case (b) may be beneficial to JPH since specific principles about fundamental composition are instructed, while the learner gradually develops a routine that allows him to actively communicate with his surroundings rather than mimic the actions performed by an accompanying individual. It should not be neglected that timbres and sound loops selected in both modes should be designed to minimise the possibility of such communication hindrances as incomprehensible speech or temper tantrums, which may also occur whenever JPH brings a previous unpleasant experience into memory as a result of overstimulating or amplified sounds (Rickard, Wong and Velik 2012). Still, there are components within the SIP Mode, from which *Terpsichore* instruction was chosen to start, that can encourage JPH to gradually abandon his echolalic patterns. For instance, a full timeline structure, corresponding to a complete soundscape in Level 4, should consist of 10 different sound samples activated by buttons, while the learner can choose out of 6 different stimuli, meaning that at least four should be present more than once to complete the phrase. Another example is Level 10, specially designed to counter imitative response symptoms, where two empty slots are to be matched to an auditory stimulus to complete a soundscape initially comprising three components instead of two.

Occupation with Levels 4 and 10 may be influenced by an echolalia treatment method aiming to gradually render a learner adept in plain communication by means of peer interactive aids and verbal cue introduction as an interference with imitative responses on the learner’s part (Sterponi and Shankey 2014). After the five-component phrase completion strategy of Level 10, experimentation with different stimuli through the timeline structure of Level 4 should rely on these shorter phrases to construct longer, non-imitative ones. In the latter level, mechanically assembled phrases can be intersected through the arbitrary introduction of audio samples, visually represented through a colour code, between existing components – similar to examples from the above investigation (Ibid.: 283-296).

Another method applicable to JPH and similar ASD learners, in an effort to contextualise soundscape formation and composition in mental treatment especially with concern to imitation avoidance, is ‘fictive interaction’ (Dornelas and Pascual 2016). This concept is related to the recollection of phrases employed in foregoing communication settings as a means of responding to peer questions with no straightforward repetition involved (Ibid.: 343, 346-357). The role of this concept can be undertaken by Level 15 associated with ‘Social Stories’ (see Section 2.4) also employed by Pasiali (2004), considering the hypothesis that imagery may stimulate JPH’s reminiscence of sounds and other vocal cues that would progressively enable their selection[79], with the tutor’s aid, to audibly support the social story (Bánréti 2010: 913). Furthermore, the level’s design is inspired by instances of learners with language and comprehension deficits attributed to reduced memory (Whitehouse, Maybery and Durkin 2006: 858-862, see Section 2.3.2). This implies that a social story could compensate for difficulties in remembering and subsequently articulating phrases in an order that would suggest a premature conversational

[79] It is reminded that SIP Level 15 associated with ‘Social Stories’ allows users to load preferred waveform clips, in order for these to be reproduced from a buffer source.

character under typical circumstances. Remaining in Level 15, the fact that learners are encouraged to select from a pool of sounds available through a computer window, differentiates the *Terpsichore* approach from Pasiali's (2004) work, where social story-ready pieces were composed beforehand and served as sole constituents of an ASD treatment plan. Even at a fundamental level, it is possible for JPH himself to take important initiatives and motivate himself in choosing the sounds that externalise his mindset and organise his workspace in a more willing and less volatile manner.

Hypothesising that melodies first appearing in Level 6 can exhibit a 'prescriptive' nature (Pasiali 2004), as being associated with plain task performance directives, procedures depicted in this Level can be conveyed to JPH repeatedly as reminders (see Ibid.: 16). These should not only pertain to the visualised tasks, including waking up, having lunch or going to bed, but also direct him towards rearranging the patterns of Level 7 as an engaging activity jointly satisfying his needs for calmness or outburst prevention, and non-imitative communication as a previously identified step in 'Developmental Therapy' processes (Wood et al. 1996: 223, Trautman 2007 – Section 1.6). Vital to the development of communication skills and original composition as an activity less likely to incite tantrums or incomprehensible vocalisations, are the final TM levels, including 13 and 14 aimed at conversational phrase completion, as well as 17 consistent with social stories from a tonal music perspective, potentially more rewarding in terms of 'turn-taking' and performance autonomy than non-musical instruction equivalents (Finnigan and Starr 2010).

4.7 Case Study 7: John (Nwora and Gee 2009)

Given that *Terpsichore* has been designed to optimise the music-related learning and treatment routines for individuals on the entire autism spectrum, it is interesting to determine how the *Terpsichore* structure and tasks are applicable to an ASD variant that differs from typical autism. Such an example is 'John'[80] (Nwora and Gee 2009), a 5-year-old male with Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS), whose main characteristics are the following (Ibid.: 30):

- He lives in a conventional familial environment, meaning that any of his parents may serve as a peer tutor in educational processes. He also appears to have a high level of cognitive and lateral intelligence.[81]

[80] The researchers (Nwora and Gee 2009) gave a 'pseudo-name' of John to the human subject.

[81] De Bono (1990) implies that unleashing one's creativity is largely dependent on 'lateral thinking'.

- Although his post-birth linguistic development was reasonable, it took him three to four years after birth to transition from isolated words to basic conversational speech.
- He exhibits frequent behavioural breakdowns towards his surroundings and is largely irritated by exposure to sensory and mainly auditory stimuli. In other words, any sound arriving to his ears may be cause for adverse conduct and lapsed concentration.
- Recreational and collaborative activities are restricted and not preferred in John's schedule, as they involve objects producing sounds to which he is extremely sensitive.

This study refers to a person whose principal symptom is the aggravation of his mental condition when brought in contact with sound. Although no further information is provided on the above, it may probably imply that he may initially exhibit difficulties in coping with any form of audio arriving to his ears, whether produced in the tonal or the SIP Mode. This confirms various studies reporting aural hypersensitivity issues in ASD, resulting in distressing experiences (Gaines et al. 2016: 73), abnormal behaviour and speech patterns (Tilton 2004: 72), or the preference of certain stimuli over others (Jacobs and Betts 2012: 52).

Although Nwora and Gee (2009) do not clarify the auditory elements that induce behavioural abnormalities in 'John', the researchers' reference to a treatment routine called 'The Listening Program (TLP)', originally conceived by Advanced Brain Technologies USA (2016), may be helpful in determining necessary configurations in *Terpsichore* that would allow the learner to better advance through the levels of both modes. By analysing John's symptoms and areas addressed in TLP, it can be assumed that the nature of John's abnormalities is neurophysiological and possibly dependent on asymmetric structures in the brain's opposite hemispheres (Tsai et al. 1982; De Fossé et al. 2004), even though alternative research suggests that asymmetric structures are less intense in autistic than in neurotypical individuals (Kinsbourne 1987: 116). Therefore, some appropriate elements of the updated TLP may be implemented into *Terpsichore* in order to ensure that John is progressively acquainted with different frequency spectra and exhibits positive changes in the tactile, social and motor domains (see Nwora and Gee 2009).

Level 8 of the SIP Mode is dedicated to the equalisation of sound stimuli, through the attenuation of certain frequencies at the low and high ends of the auditory spectrum. As this level includes the above feature in accordance with the TLP routine (Nwora and Gee 2009: 29; Advanced Brain Technologies 2016), it is considered sufficiently appropriate as specific frequencies may be isolated by employing the included filters. However, considering the requirement to proceed through all levels without stimulating John's sensitivity, with any accompanying consequences, the ability to isolate and filter frequencies should be extended to all levels, in order to more comprehensively address the learning and mental rehabilitation elements associated with separate frequency sub-spectra (Nwora and Gee 2009). To achieve this, a pair of low-pass and high-pass filters were added to the interface and applied directly to the SuperCollider server that controls any sound emitted from the programming software, as shown in Figure 4.5 below. In an attempt to train separate aspects of John's development, all levels in both tonal and SIP Modes will have their sound content adjusted in order to only contain low, mid-range or high frequencies, applicable to the range between 20Hz and 20kHz. A separate window in the start-up menu of *Terpsichore* fulfils this objective; the window shall be controlled by the peer tutor, thus annihilating any concerns about confusion or adverse behaviour when having to deal with sliders and alphanumeric characters to configure filtering.

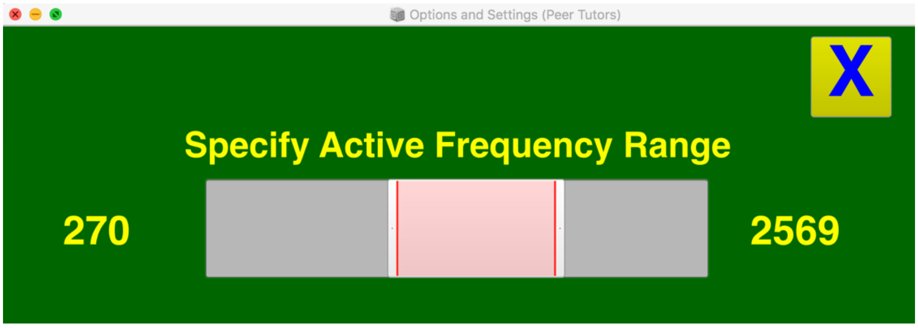

Figure 4.4 *Screenshot of an Options Window part associated with the specification of frequencies (in Hz) that will be active in interface menus and levels.*

The educational process that John should ideally follow focuses on the isolation and enhancement of audible spectrum frequencies in an ascending order, given that his cognitive and cerebral functions are affected by lower frequencies, whereas more creative aspects are influenced by higher ones (Nwora and Gee 2009). The ability to understand and think, associated with left brain functionality, may be a prerequisite for imaginative potential development (Dietrich and Riam 2010; Flaherty 2011). However, certain learners may require a sustained creative impetus to bring motor skills to an acceptable level (Bluestone 2005: 91). The SIP Mode is recommended for such a process not as much because of the included Level 7, which provides equalisation facilities, but principally given the variety of sounds that can be employed, both as defaults or thanks to sound library features allowing miscellaneous files to be loaded in certain levels. Emphasis on the SIP Mode can also be justified by the working hypothesis that environmental and acousmatic soundscapes are mostly perceived as signals inducing therapeutic effects rather than recreational activity sources, towards which John is initially indifferent.

The first two SIP Mode levels feature four of the interface's six default sound samples, whose frequency content largely varies; this in itself constitutes a supplementary facilitator in the development of frequency awareness to gradually decrease oversensitivity. The recommended process for *Terpsichore* is in line with Bérard's (1993) 'Auditory Integration Training (AIT)' method (Section 1.6) as being based on fluctuating levels of susceptibility to different pitches and designed for behavioural control treatment and the development of concentration and motor skills (Bérard and Brockett 2011: k170-k230, k3052 etc.). In addition, it bypasses the need for frequency adjustment through the interface's Main Menu settings, allowing John to anticipate and isolate sound stimuli from one another, thanks to his manifested intelligence (Nwora and Gee 2009). In Level 2, for instance, the order in which the tutor is to activate sound stimuli may follow an ascending frequency pattern, such as: 'water, wind, leaves, droplets'. The same applies to Level 3 where the default sound pool is broader, but attention should be given on John's susceptibility to tantrums, to the point where representation of a sad or an angry face may be hidden to restrict on-screen access.

In the best-case scenario, any default sound connected to the Level's angry face picture may be employed as an impersonal form of feedback, not directly involving the peer tutor, that would help John demonstrate a better understanding of the consequences associated with excessive anger and substitute such behaviour and mood with a more positive alternative (Chedd and Levine 2007: 80-82; Fitzgibbon 2008: 19-20). The structure of Level 3 may serve as an introduction to the broader social story principle of Level 15, which constitutes a practical manner of applying all *Terpsichore* tasks associated with previous levels in real time settings and circumstances that John may have initially been less comfortable in confronting. In addition, most levels between 4 and 14 inclusive, concentrate on building John's awareness of varying frequency content, to the point where AIT-compliant methods relieve his tendency to become nervous prior to the introduction of full-length stories in Level 15.

Discussion on the potential effects of Level 4 in John's condition arises from the level's focus in assembling definite-time soundscapes out of ten isochronous components. The recommended order of the default sounds within a timeline should not be absolutely fixed but adhere to adjacent sound samples having similar or overlapping frequency contents. For example, such a condition may be satisfied by placing the water and wind samples next to each other, or the environmental town soundscape component next to the stimulus associated with leaves. However, due to the learner's initial lack of responsiveness to broad-spectrum tasks and reduced concentration, it is unnecessary to attempt motivation and focus development via the extension beyond the six default environmental samples of *Terpsichore*, which are nonetheless compliant with sounds with which most individuals are brought in contact during their daily routines.[82] The combination of a sustained environmental sound with percussive timbres

[82] Of the six defaults, the drone may not be as commonly encountered in everyday settings, but still encompasses a large part of the audio frequency spectrum – while its common perception by neurotypical individuals as a relaxing stimulus may potentially justify its use in ASD learners as well.

employed to create rhythmic sequences, an initiative offered by Level 7, endeavours to gradually extend the frequency content that John is capable of processing at once. This process is aimed at treating John's concentration problems according to the AIT features described earlier in this Section, although such sounds as the drumsticks, given their high frequency content and fast attack, could be avoided to lessen the possibility of behavioural outbursts occurring (Willey 2015: 28; Landon, Shepherd and Lodhia 2016: 46).

John's reported concentration issues (Nwora and Gee 2009) indicate that 'auditory localisation' can be an efficient method, alongside AIT, to increase his competence in determining the origin of a sound, for reasons explained in Section 3.2.3. As SIP Levels 5, 6 and 9 offer the possibility of combining sound samples, whose amplitude and panning value are influenced by their position in the stereo field, the compound soundscape task creation and its repetition over time may help John develop such an understanding. Moreover, the existence of a visual GUI to support the above is expected to contribute positively to such an objective (Leo et al. 2008: Stamm and Altinsoy 2013: 467-8). It is advisable that occasional changes in active frequency range can continue while sound sources are combined and dynamically moved on screen. The purpose of such a strategy is the improvement in awareness of different sounds within a complex environment according to their amplitudes and timeframes in which each sound is first perceived, based on angle between observer and sound source (Carlile, Leong and Hyams 1997; Hofman and Van Opstal 1998; Curry 2017) or on the common physics principle of frequency being inversely proportional to wavelength. The above strategy can also be extended to Level 11, characterised by the ability of creating complex soundscapes through synthesis of sine grains and modification of their parameters with the mouse. Throughout the entire SIP Mode, gradual increases in amplitude when sounds are played may provide an additional positive contribution to John's concentration (Dunn 2008: 332). It should also not be neglected that information justifying the neurological impact of sine waves (Seri et al. 1999: 1825-7), combined with certain young learners' inclination towards complex sounds described as 'sine-wave analog' (Dawson, Webb and McPartland 2005: 416), a term possibly applicable, amongst others, to soundscapes formed out of numerous pure tones with different frequencies.

Some of the tasks addressed in Levels 12, 13 and 14 allow sounds to be loaded from a computer, something that is bound to assist John in performing desired activities without the risk of auditory stimuli being perceived as excessively sharp. However, the ability to alter the temporal and frequency content of created soundscapes is also a useful *Terpsichore* tool for John's needs, as being in line with the procedures followed in the Tomatis AIT method (Tomatis 2005), reported in Section 1.6 to elicit positive effects in peer communication, an aspect on which Nwora and Gee's (2009) attention was drawn prior to their engagement in therapy sessions with John. Finally, the principles of Level 14 can elicit advantageous effects in John's condition and music occupation independence, as the recording structure through a microphone allows John to take control over the sounds performed either through the objects that do not irritate him or through a regulated voice he produces. In general, the manipulation and real-time composition of soundscapes throughout the entire mode, when employed according to the above suggestions, may help John and his peer tutor make *Terpsichore* an integral part of his attempts to develop necessary non-musical skills associated with his prospective life as a pupil.

4.8 Case Study 8: MN (Carrington and Graham 2001)

Carrington and Graham (2001) refer to two equal-age boys officially diagnosed with Asperger's syndrome, an ASD that differs from typical autism as presented in Section 1.1. The boys' primary traits pertinent to *Terpsichore*'s desired functionality will be combined into a new hybrid imaginary learner named 'MN'. The learners revealed certain of their characteristics and weaknesses as part of parent-adolescent interaction sessions. Although their statements could be under scrutiny on grounds of subjectivity, this information may be employed for *Terpsichore* assessment because principal emphasis is given to learning procedures and desirable interface modifications according to the characteristics described. MN's condition is synopsised in the following:

- Constrained nutritional preferences and routines, which must be very precisely followed and prepared; this constitutes an example describing the learner's reluctance to alter his manner of acting in different situations (Ibid.: 43, Mark).
- High fondness of electronic appliances including computers, to the point where this interest may be interpreted as exaggeration (Ibid.: 43, Noel).
- Fear of social interaction with peers on grounds of mockery possibility (Ibid.: 44, Noel), or distancing from any form of human contact or communication (Ibid.: 44, Mark). No issues of linguistic deficiency are demonstrated, rather than difficulties in social inclusion (Ibid.: 42-45).
- Difficulties in confronting the demands of organised teaching, in classroom contexts; this potentially results in the expression of adverse and sometimes self-convicting feelings (Ibid.: 44, Noel).
- Difficulties in handling pressure and maintaining one's calm under difficult circumstances, something further reinforced by the boys' tendency to either hide their feelings or exhibit outbursts for no apparent reason (Ibid.: 45-6, both Mark and Noel).

To begin with, the particularities of MN are mostly of a social and emotional and much less of a cognitive nature, something that correlates well with the general profile of most individuals diagnosed with Asperger's syndrome (AS) contrary to typical autism (Burgoine and Wing 1983; Szatmari et al. 1990; Szatmari et al. 1995 etc.) and partly justifies that AS influences a human's social function more than the 'cognitive' side of it (Weiss and Westphal 2015: 73). Secondly, by comparing MN's profile to the one of 'John' in the previous case study, and overlooking the differences between their two pervasive developmental disorders, it is possible to notice that the effect of appropriate music of MN can be positive and calming (Ibid.), whereas any sound coming to John's ears could cause annoyance prior to the start of any *Terpsichore*-led session (Nwora and Gee 2009)[83]. Thus, the interest of MN in music is a positive first step in inspiring him to use *Terpsichore* for the desired music treatment needs. Carrington and Graham's (2001) research does not include any mention of musical literacy in MN, hence the application of *Terpsichore* may commence from the SIP Mode, which only contains abstract sound successions and, under certain circumstances, percussive instruments. Moreover, since the daily tendency to excessively employ computers can equally be interpreted as addiction, having the tutor activate the Timer at the start of occupation with *Terpsichore* is vital in countering potential tantrums.

The element of the SIP Mode's Level 1 that acquires particular relevance is the association of images and sound generation buttons to initials representing both a sound stimulus (***W****ater,* ***B****reeze,* ***L****eaves*) and a colour *(**W**hite, **B**lue, **L**ime*[84]). This can be examined in conjunction with Byrne's (2012) suggestion on the representation of emotions through 'anthropomorphise[d]' sounds, which – by etymological definition[85] – are auditory stimuli to which an imaginary human condition is given. In Level 1, the letter representation facilitates the peer tutor in achieving the desired goal, as he will ideally produce matching vocalisations of W, B and L, or even of the sound loops associated with each button, in order to encourage MN to select the matching sound stimulus when operating the Level. This method, applicable to Level 2 as well, represents a primitive form of communication despite no evidence of speech fluency deficits in MN (Carrington and Graham 2001: e.g. 42-6), as it is consistent with Paul's (2008b) proposal of enhancing interaction skills in AS learners by regarding communication as a composite procedure where isolated sounds or syllables act as components.

The third SIP Mode level of *Terpsichore* can be reshaped in order to satisfy the 'anthropomorphise[d]' sound description of Byrne (2012) with concern to the comprehension of how people feel in their everyday routine, for which Attwood (1998: 59-60) has also recommended alternative solutions involving creative arts and music. A method proposed here

[83] Refer to the analysis of Case Study 8 ('John') above.

[84] A tint of yellow/green sharing the same initial with 'Leaves'. 'Lemon' would be another colour choice but 'lime' was chosen as being a more popular colour in everyday speech and writing.

[85] 'Anthropomorphise' (< άνθρωπος = human being + < μορφή = form, both in Greek)

may consist of environmental sound sets with varied frequency and amplitude contents, and clipart images invoking emotions, in the attempt to treat awareness issues often detected in Asperger's syndrome (Njiokiktjien 2001: 79). Inspired by a study where directly employed verbal cues were better understood by autistic individuals than the respective emotions represented (Grossman and Tager-Flusberg 2008), auditory cues with a defined frequency content are directed towards the enhancement of emotion awareness. The ability to conceal views relevant to negative feelings (see Section 3.2.3) allows tutors to load any preferred sound clips, with optimum results achieved when clips are sustained and prolonged. In addition, selection of high-frequency sounds especially when associated with positive feelings, might positively contribute to MN's emotional profile. In fact, an encouraging finding on how brain activity is affected after exposure to high-frequency content (Zheng et al. 2010: 1190)[86] may be incorporated to alter MN's behavioural patterns, as part of a plain audio-visual structure based on similar theoretical and practical suggestions to treat impaired 'theory of mind' (Doyle and Arnedillo-Sánchez 2011; Fox 2012: 8). Level 8, consistent with audio stimulus filtering, may also be exploited in activities of progressive low- or high-end frequency suppression to alter energy levels and regulate MN's emotional profile as a result.

Subsequent levels, for instance the ones between 4 and 8, have the advantage of being suited to self-paced learning routines without supplementary classroom requirements, especially since the User Manual can be activated at will for guidance purposes. Although it is generally possible for individuals with AS to demonstrate linguistic or speech deficits, the existence of data from spoken interviews of Mark and Noel imply that language is not a major issue to dissuade MN from employing the manual to progress through levels. The use of vocalisations on the tutor's part, as outlined in the Level 3 example, can continue at this point, as the recognition of sound stimulus imitations can encourage MN to select the appropriate sounds that would best fit a timeline (Level 4), a two-dimensional soundscape (Levels 5, 6 and 9) or a pattern of percussive sounds with a defined rhythmic content (Level 7).

Possible difficulties in MN's learning schedule, originating from the contrasting subject matter of Levels 4 to 9, may be justified by MN's documented preference in very specific activities (Carrington and Graham 2001: 43) and his susceptibility to difficult situations (Ibid.: 45-6), characteristic of a 'meltdown' rather than a 'tantrum' (see Section 1.2), due to pressure being cause for such behaviours. Common curricula suggest sustained and repetitive occupation as a strategy to confront such difficulties, a particularly important statement for Asperger's syndrome cases as Grandin and Barron (2005: 85) assert for similar behaviour-oriented

[86] The finding is aassociated with depression, whose general connection with Asperger's (Attwood 2016: 9-12) or application given 'theory of mind' particularities (Baron-Cohen, Leslie and Frith 1985; Bogdashina 2006 etc.) is of particular interest.

treatment situations. Incidentally, Attwood (2007: 161) employs this principle in a method labelled 'CBT (Cognitive Behaviour Therapy)', aimed at improving an individual's emotional profile by attempting to modify the manner with which different situations are perceived, resulting in the emergence of more positive emotions (Donoghue, Stallard and Kucia 2010; Attwood and Garnett 2016: 9-15). As the inability to perform desired tasks is not a result of cognitive abnormalities but rather of emotional particularities, embedding CBT in the musical routines of *Terpsichore* levels, subject to careful planning (Sofronoff, Attwood and Hinton 2005: 1155), is expected to relieve the learner's social anxiety and outbursts (Attwood 2006; Chalfant, Rapee and Carroll 2007), ultimately rendering MN more motivated and enthusiastic to compose his own soundscapes.

The situation of MN demonstrates how the interface can be exploited to develop a learner's inclination towards targeted musical tasks, as a result of treating behavioural and emotional deficiencies by means of music education interventions. Various interface levels possess learning value capable of facilitating therapeutic objectives, such as Levels 4 (timeline audio arrangement) and 7 (percussive pattern construction). However, this is more evident at later stages, assuming that CBT-compliant interventions have been fulfilled with the aid of initial *Terpsichore* activities. For instance, Levels 11 and 12, consistent with granular synthesis and multifaceted audio manipulation, may positively affect concentration and motivation through a focus shift to soundscapes ultimately created during experimentation with the on-screen GUI (Westerkamp et al. 1993, cited in McCartney 1997: 62, also see Section 3.2.3). The collaborative value of Level 13 associated with laptop orchestras has been documented in Section 4.5, although a number of sessions with simple format levels is required to avoid 'meltdowns' reoccurring as a result of excessive complexity. Furthermore, in Level 15, the creative freedom in choosing sampled or recorded sounds to support a Social Story while engaging in a compositional task, is a predominant factor in further alleviating negative symptoms induced by Asperger's syndrome, judging from opinions regarding the joint application of CBT and Social Stories (Attwood 2004: 15-6, Landy and Bradley 2014: 329).

Apart from the Levels separately examined, the process of enabling *Terpsichore*'s Reward Mode shall be of significant benefit to ameliorating MN's condition, something that will subsequently reduce the risk of self-convicting behaviours and instead favour the development of positivity and motivation through congratulatory reinforcement. Given that failure to comply with such tasks leads to automatic *Terpsichore* shutdown, this mode also has the potential to control computer addiction, justifying its applicability to MN. To avoid benefits of levels being neutralized by the learner's possibility to exhibit feelings of inferiority when a task is not successfully completed, initial *Terpsichore* sessions should involve a peer tutor and concentrate on repetitive occupation with each level or thematic group thereof. In this way, the benefits of

CBT are paired with interface-related tasks, in the hope of enhancing positive behaviours and developing independent composition as a purposeful means of self-expression.

4.9 Case Study 9: Ted (Wager 2000)

In an effort to render the interface accessible to the highest possible age groups with regards to ASD cases, the current investigation includes an exception study, compared to the previous ones where the highest reported age was 18 years. Wager's (2000) study pertains to 'Ted', a 36-year-old male reported as having an additional mental impairment to autism. His main characteristics are the following (Ibid.: 132-133, 136):

- At the start of his life, he exhibited abnormalities in emotion expression, body function control and speech.
- His autistic condition was aggravated by additional disorders while still a pupil, including 'schizophrenia', and he spent all his adolescence under hospital care.
- In adulthood, despite his fondness of music and absolute pitch skills, he employs an unorthodox manner of piano playing, by executing single-finger passages at high volumes.
- He is easily distracted when facing everyday tasks, and is susceptible to serious emotional outbursts.
- Instrument execution is performed at a generally awkward manner, while tempo perception and maintenance are often a challenging task for him.
- Peer communication is perceived as another form of distraction and constrained to very short responses.
- The therapist occupied with his condition recommended him to play well-known pieces, composed in major keys, using different instruments and objects.
- The concept of ascending difficulty in music learning processes motivates Ted to improve his overall performance, provided that different musical elements are taught in an appropriate order.

An interesting departure point is Ted's ability to only communicate through brief word sequences instead of complete sentences consistent with communication in non-disabled individuals. Such an interaction routine, based on the comprehension and / or creation of short phrases, is generally common amongst ASD learners, either younger (Lansing 1989: 156; Trevarthen et al. 1998: 198-9; Smith 2012: 133-4) or older (Crane, Goddard and Pring 2009; Markowitz 2016: 301). In addition, Ockelford (2013b: 120-1) refers to the same brief communication routine being employed in musical terms by a female human subject.

The above routine may be applicable for Ted and the attempt to gradually shift from shorter to longer phrases, something extendable to all levels. In order for this to be effective, a peer tutor should initially encourage Ted to proceed through Tonal Mode levels[87] in small segments, without having to create full phrases or exploit all the elements of each level in one section, as the achievement of a fundamental level of learner-tutor interaction is a matter of higher priority. For instance, TM Level 1 could form a definite starting point for Ted to gradually achieve more advanced communication skills with his peer tutor, something that realised by having the tutor manually select and execute all pitches from A to E at regular intervals, and subsequently proceed to the playback of note combinations, following the A-B, A-B-C format discussed above, as a means of gradually developing relative pitch competence. Likewise, as far as Level 2 is concerned, the tutor of *Terpsichore* should stop the basic A-B-C-D-E note sequence after C has been first heard. In such a manner, Ted enables himself to form the entry-level phrase A-B-C and reproduce it, so that this can later be done with another three-note sequence and, eventually, with all five notes. Moreover, considering Ted's absolute pitch skills and lack of reference to relative pitch by Wager (2000), the note recognition patterns of Level 1 should commence by isolated executions of only one pitch, for example 'A' in default patterns, and then gradually move on to A-B, A-B-C and so on. The importance of the peer tutor's personality and communicative intent in guiding Ted through this level, something also applicable to the entire mode, is a reason why the TEACCH and 'Developmental Therapy' approach principles (see Section 1.6) can be jointly implemented in the construction of *Terpsichore* learning sessions.

Furthermore, the choice of isolated notes and sharp timbres[88], as in all TM levels of *Terpsichore*, is in full compliance with both the applied music therapy routine of Wager (2000) on Ted, and the suggestion of Toigo (1992, cited in Wager 2000) in employing such timbres to treat Dr Grandin's established ASD condition. However, the joint examination with the study of Menon et al. (2002) relating higher attack times to more efficient cerebral functionality, leads to the assumption that level instruction should commence by selecting the flute as the primary instrument thanks to high attack and low times of the respective pre-recorded sample. As for other timbres including the piano and the acoustic guitar, decreasing the peak amplitude value from within the SuperCollider code would even more enhance Ted's ability to process information in his brain.

[87] Obviously, the musical interest activities observed by Wager (2000) should ideally guide a tutor to initially instruct *Terpsichore*'s Tonal Mode (TM) to Ted.

[88] All six timbres included in the interface's Tonal Mode are considered 'sharp' with relation to their fast attenuation after reaching peak amplitudes.

Wager's (2000) mention on Ted's inability to play songs on the piano with more than one finger, combined with her proposal to gradually acquaint Ted with the process of multi-fingered piano execution, encourage the inclusion of a reference window in *Terpsichore*'s TM main menu, useful for purposes similar to Ted's. This window assigns the numbers 1-5 to each finger of both hands, progressively encouraging the learner to match each finger to the desired note, provided that the root for each task is communicated to the learner. For instance, in Levels 1, 2 and 4 where the root note is A, the aforementioned window will assist Ted in striking the piano's A note with his thumb, C with his middle finger and E with his little finger, when employing the right hand.[89]

The ability of triggering major key melodies associated with different everyday actions in Level 6 of the TM, perfectly satisfies the preference of both Ted and his peer therapist in melodies written in major scales (Wager 2000). The impact of major scales in the expression of favourable feelings (Gabrielsson and Lindström 2010: 388; Lim 2012: 83; Ockelford 2013a: 132; Ockelford 2013b etc.) as also presented in Chapter 2, should be carefully considered in this context. Thus, the use of Level 6 in learning sessions constitutes a representative example of a process intended to enhance a learner's enthusiasm, positivity and tendency towards more creative and less reproductive patterns.[90] Furthermore, Level 7 allows the user to recreate the melodic lines of Level 6's phrases, which constitutes a more proactive but simultaneously demanding task than the one outlined in Level 6. Thus, having Ted listen to melodies in major keys is expected to further ignite his interest in modifying the melodic content of Level 6 phrases, consequently marking a significant contribution to his motivation and creativity.

Wager (2000) reports that Ted's therapist employed various methods to train Ted's rhythmic and temporal awareness, including percussive timbres, thus favouring the choice of the percussive format of the SIP Mode's built-in metronome to accompany tasks. Besides the proven impact of rhythmic interventions in motor integrity (see Section 2.1), it is important to consider that such percussive iterations are at the forefront of attempts to enhance communicational strategies (Wan et al. 2011), in which Ted experiences problems at the start of the study. Even though the above does not directly apply to adults, the fact that Ted had been occupied with music since his youth (Wager 2000), in conjunction with an analysis proving increased rhythmic awareness amongst musically 'early-trained' individuals (Watanabe, Savion-Lemieux and Penhune 2007: 337), is an encouraging sign for the inclusion of percussion in the otherwise purely tonal environment of *Terpsichore*, expectedly resulting in the ability to articulate more complete sentences and draw increased attention towards Ted's interlocutor.

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[89] A similar procedure may be used when attempting to execute melodies with the left hand, adapted to the absolute position of the fingers (thumb to the right, little finger to the left).

[90] In this Level, images may be substituted to better reflect Ted's advanced age and not seem infantile.

Various levels that visually include any form of a musical stave or a set of piano keys are constructed in high compliance with the content of the tasks proposed by Wager (2000) for Ted's music treatment, as the note representation on an actual keyboard can conditionally form part of Ted's learning routine (Ibid.: 133). The fifth level allows the user to press computer keys corresponding to word letters, creating simple phrases pertaining to any word as already described in detail. In such levels as 9, 10 and 15, notes are already present on a 5-line stave and can be manipulated to form original phrases, executable through the 'Play' button of each level; these phrases may serve as a reference point that Ted may subsequently recall, in the visual and auditory domains, to articulate corresponding melodies on the piano. The expected result of the proposed procedure is the attainment of compositional skills, especially considering that the ability of manipulating phrases starting from a default pattern is in line with the 'extemporisation' strategy presented in the first chapter (Wigram 2004: 114; Wigram 2012: 438-9).

By jointly examining Wigram's description on 'extemporisation' and the pre-treatment traits of Ted, it can be understood that emphasising on such TM levels as 9, 10 and 15 satisfies the targeted improvisation requirements potentially helping Ted express his feelings in a more meaningful manner. The ascending complexity in 'extemporisation' strategies (Wigram 2004: 114; Wigram 2012: 438-9) is expected to increase Ted's motivation as well (Wager 2000). Having examined 'extemporisation' within the general context of composition skill building strategies (see Section 1.2), it can be assumed that the gradual increase in compositional freedom degrees, as TM levels progress, has indeed been undertaken not arbitrarily, but with conventional Western music norms in mind. Moreover, functionality of the Reward Mode, causing *Terpsichore* to shut down when relevant level tasks are not fulfilled, simulates the real-time evaluation of music theory accuracy in relevant ASD groups (Monteith, Martinez and Ventura 2012: 87-9) thus enhancing the importance of the above argument.

Levels 11 and 12, which allow any user to produce all 12 notes in a chromatic scale by clicking on an on-screen virtual piano, can be utilised appropriately to enhance Ted's concentration and decrease the possibility of him being distracted. In similarity to the *Suoniamo* interface (Buzzi et al. 2019), each virtual key is highlighted once clicked upon, indicating visually that an auditory excitation has been activated. This combination of audible timbres and targeted colour changes is thus expected to assist with motor coordination skill development in both the acoustic and the visual domain, with equivalent consequences in Ted's concentration. Moreover, the colour changing patterns activated upon the reproduction of a note encourage Ted to draw attention to the musical content itself, especially as it is conveyed for a second time through the automatic feedback mechanism that characterises these two levels. This feature satisfies the requirements set by Scott (2017) with regards to the avoidance of external stimuli, irrelevant to the music task per se, as a means of improving concentration.

Levels 13 and 14, characterised by the question-response patterns based on suitable phrase completion, may be exploited as a means of rendering communication through longer segments more possible. For a person like Ted, initially incapable of articulating lengthy phrases, a recommended strategy is explained in certain researchers' attempts to shift a learner-tutor communication routine from short and sporadic articulations to more concise word successions, with potential 'reward' actions by the tutor serving as necessary reinforcement (Jordan 1990: 69; Cipani 2011: 41; Stahmer et al. 2011: 83). In musical terms, achieving increased communication requires the use of *Terpsichore* to satisfy the content of Nordoff-Robbins musical interventions, considering their potential to assist a user in understanding and interacting with peer music-making routines (Guerrero and Turry 2012: 132-3). The question-response structure of the two aforementioned levels perfectly fits the intended goals for Ted's communication requirements, supposing that he will benefit from the fact that Level 14 constitutes a slightly more complex representation of Level 13. Critical to this argument is the account of Ockelford (2013b: 64-7) on tonal 'motifs' and their applicability to ASD music studies, as the potential iteration of small segments can form the basis for the patterns of greater length, which is where the *Terpsichore* structure is bound to serve as a powerful assistive tool.

As *Terpsichore* instruction nears towards its end, Ted's familiarisation with all different pitches within the Western notation model satisfies a dual objective. Firstly, Level 16 encourages the enhancement of pitch perception and its subsequent adaptation to the unrestricted compositional environment of Level 18, instigated by the hypothesis that chromatically defined music manifests itself as a reliable spoken language substitute, even in ASD contexts (Reynolds and Hayes 2017: 414, 417) and that learners may have an improved grasp of pitch identity when twelve-tone note distribution is preferred (Andreopoulou and Farbood 2010). Secondly, as the major-minor distinction of a musical scale is largely based on adjacent pitch intervals, the acquisition of advanced pitch awareness shall assist in the independent composition goal on two occasions. On the one hand, Ted's previous exposure to major scales, combined with the pitch associations whereby they are defined (Lamme 2012: 8), is an important and motivating step towards composing original phrases, based on the recent instruction of relevant *Terpsichore* (e.g. TM Level 6, 7) and miscellaneous pieces. On the other hand, the already existent motivation of Ted to push knowledge boundaries (Wager 2000: 132-6) may subsequently assist him in using Level 18 to expand his compositional scope to such positively influencing genres for ASD as jazz (Wigram and Elefant 2009; Greenberg, Rentfrow and Baron-Cohen 2015), taking advantage of notational examples as the ones of Smith (2017: 18) pertinent to entry-level jazz and blues phrasing.

4.10 Summary

This Chapter is devoted to the extraction of nine case study learners with a primary ASD diagnosis, and their hypothetical introduction to *Terpsichore* over a sustained period of time. Detailed investigation of the case study analysis is based on a method devised for the current purposes under the name 'human subject clone', by assuming the existence of identical learners to the ones presented and transfer them to the present time while maintaining the age and associated mental profile suited for the presentation of each case.

Thorough investigation pertaining to each human subject commenced from the identification of ASD-compliant deficits and symptoms. This provided an introductory explanation on how *Terpsichore* should be employed, to which areas research attention should be shifted, and how these reported conditions can translate to software element addition or amendment compared to early-stage versions – thus signifying an evidence-based approach in software design. The most suitable mode for intervention and analysis was subsequently identified, ultimately achieving a uniform focus on both the Tonal and SIP Modes with five learners being occupied with each. Concentration on characteristic *Terpsichore* elements attempted to follow the exact order of levels from beginning to end, although select cases favoured a small-scale exchange of Levels – for instance Level 10 preceding rather than following Level 4 in the SIP Mode (JPH – Pasiali 2004, Section 4.6) – on grounds of optimised educational coherence and efficiency in attainment of musical and non-musical goals.

Table 4.1 presents the proposed procedures for *Terpsichore* use and implementation in daily schedules, depending on points requiring attention for each different learner, briefly described at the start of each Section of Chapter 4. These procedures may on occasions be interpreted as informal Individualised Educational Plans (IEP) for tutor and caregiver perusal (see Sections 1.4 and 1.5) and encompass the key levels in each mode, to form part of a large-scale set of learning sessions based on all *Terpsichore* levels.

ID	Age	Working mode	Proposed method of inspiration	Main areas of *Terpsichore* involvement in learning sessions
1. Mike	12	TM	Develop-mental Therapy (DT)	• Levels 1-3 (notes/letters) • Level 5 (musical phrases matching words) • Levels 6-7 (adaptation of reproduced phrases into original ones) • Levels 11-14 (transition from virtual piano to fully computerised structures, question/response patterns) • Level 15-18 (progress towards composition from a blank document)
2. QC	≈ 18	TM	DIR-Floortime	• Levels 1-5 with an emphasis on transition from isolated pitches to integral phrases • Levels 6-7 (pattern modification inspired by 'zygonic' theory (Ockelford 2006; 2013a, b) • Levels 13-14 (question-response patterns, same inspiration as above)
3. Nathan	6-9	SIP	Intensive Interaction	• Levels 1-2 (simple sound identification and crossfading) • Level 3 (emotion recognition through sound samples) • Levels 5-6 (combination of samples in a static and dynamic space) • Level 7 (percussive pattern creation) • Levels 8-9 (sound localisation) • Levels 10, 15 (phrase completion for communicative purposes)
4. GM	9-11	TM	DT	• Use of flute/recorder or oscillator-made timbres • Levels 1-3 with an emphasis of increased simplicity • Level 6 *before* 4-5 for the same reasons and for communication development • Level 10 (rhythm-based motor skill development) • Levels 11-12 with feedback enabled • Levels 16-18 (full-scale composition) with a possibility of employing Level 9 (Schoenberg-inspired pattern modification) beforehand

5. Melanie	11	SIP	TEACCH, 'Rhythmic entrainment' (Orr, Myles & Carlson 1998)	• Level 7 as starting point, since it incorporates rhythmic activities • Levels 1-8 onwards, with reliance on Metronome structure • Level 9 (drag and drop sound sources) • Level 13 (Laptop Orchestra tasks) with an emphasis on interpersonal communication
6. JPH	8	SIP / TM (sec.)	Nordoff-Robbins & DT	• **SIP:** Pairing Levels on grounds of similar subject matter: 1-2, 5-6 • Afterwards: Levels 4 and 10 for the same purpose • Level 15 (Social Stories and auditory sample selection to aurally represent them) • **TM:** Emphasis on Levels 6, 7, 13-17
7. John	5	SIP	Sensory Integration, Auditory Integration Training (AIT)	• Suppression of undesirable frequencies from Options Menu • Level 8 (auditory filtering with sound loading capabilities) • *Next:* Level 4 (sound organisation in timeline) • Level 7, with an emphasis on combining percussive patterns with a sustained soundscape • *Afterwards*: Levels 5, 6 and 9 (sound combination with panning) • Levels 11, 12, 14 (loaded and recorded pattern modification and modulation in real time)
8. MN	13	SIP	Nordoff-Robbins, Cognitive Behaviour Therapy (CBT)	• Enablement of Timer and Reward Mode to avoid addiction phenomena • Levels 1-3 with an emphasis on shifting attention to task performance • Levels 4-9 with an emphasis on peer tutor-learner collaboration and repetition to avoid behavioural breakdowns • Levels 11-12 (granular synthesis, sound sample modulation) for concentration and motivation • Level 15 (Social Stories)

9. Ted	36	TM	DT, TEACCH	• Low attack and high sharpness of sounds • Levels 1-4 with an emphasis on simple phrase completion starting from isolated pitches • Levels 6-7 (see above) • Levels 9-10 (existing pattern manipulation) • Levels 11-12 to improve motor skill development and concentration • Levels 13-14 for reciprocal communication • Levels 15-16, similar to 9-10 • Level 18 as a final step resulting from previously acquired skills

Table 4.1 *Proposed procedures for* Terpsichore *use in case study learners.*

CHAPTER 5

HUMAN PARTICIPANT RESEARCH: PRESENTATION AND ANALYSIS OF RESULTS

5.1 Background

The examples analysed as part of the previous Chapter, provided a preliminary insight on the procedures enabling learners affected with various disorders on the autism spectrum to occupy themselves with *Terpsichore* in the most efficient manner possible. All conditions of the case study virtual participants have been carefully considered when designing virtual educational plans aimed towards fruitful music learning and sound familiarisation experiences, simultaneously assisting in mental, behaviour and cognitive treatment. Despite the challenges faced in proposing optimum *Terpsichore*-based solutions to even the most overwhelming problems, the case study approach in Chapter 4 demonstrated that the application of carefully planned strategies, as a supplement to simply employing the software without specific directions, allows tutors and learners to comprehensively harness the strengths of the interface.

However, it should not be neglected that the above statements result from a plain exploitation of bibliographical information principally focussing on the beneficial or disadvantageous impact that certain elements compliant with music or soundscapes may have on various life aspects associated with ASD. The literature-based analysis and virtual subjection to *Terpsichore* routines alone, does not guarantee that various actual human participants will exhibit responses associated with statements connecting music to autism. For instance, the statements of Wigram (2004), Gallardo (2004) and Gattino et al. (2011) essentially attempting to establish a relationship between improvisation-based techniques and the cultivation of non-musical skills, as mentioned in Section 1.2, cannot be perceived as a reassurance that all levels in *Terpsichore* associated with the spontaneous creation of new musical segments are certainly bound to affect learners in similar, if not identical, positive manners. This statement is associated with both the pervasive nature of ASD and the fact that most statements purportedly connecting certain aspects of music and sound to improved wellbeing as far as ASD management is concerned, cannot be verified in terms of statistical significance, allowing valid assumptions to be made for a wide variety of human subjects diagnosed with a compliant disorder.[91] For example, the reported improvement of communication skills in elementary school pupils occupied with a specific music-related activity (Sharda et al. 2018; Jones 2018) does not necessarily indicate that different interfaces, such as *Terpsichore*, will yield similar results, even if the constructional principles exhibit minimal differences to the ones characterising the above system. Even in cases where the thresholds for statistical significance are satisfied, as in the example of task-oriented melodies aiming to positively affect social interaction (Roberts 2019: 15), the researcher's mention of preschool children as the study's human participants (Ibid.: 14) casts doubts over the congruence of the aforementioned results as far as other age groups, educational backgrounds or song-based interventions are concerned; in other words, it is unsafe to assume the general validity of such observations without conducting a thorough examination of the *Terpsichore* interface to the human participant group already specified in Chapter 3.

Taking the above into account, the main purpose of this Chapter is to evaluate the responses and trends recorded through the Questionnaire provided to the three tutors responsible for monitoring the 28 human participants forming part of the research sample. This can be achieved via the combination of quantitative and qualitative analysis methods, where the former are favoured in multiple-choice questions and the latter in open-ended ones. The goal is to not only discuss survey responses, but also attempt to establish relations between factors that will reinforce the general discussion on *Terpsichore*'s applicability to ASD learners and sustainability in future projects. Apart from the general investigation regarding all 28 participants, examples will also be provided on how specific learners responded to *Terpsichore* throughout sessions administered by supervisory tutors. Answers to all multiple-choice questions can be accessed in Appendix IV for reference and explanation of the argument developed in the current context, while all individual responses may be accessed through the attached Microsoft Excel file for the reader's perusal.

[91] This statement is justified by the exact definition provided on 'statistically significant' results (Mitchell and Jolley 2010: 246).

5.1.1 General information on tutors and learners

When first distributing the questionnaire to interested parties, it was mentioned that practitioners not directly related to music would be advised to seek supplementary assistance from professionals explicitly occupied in this field. Eventually, this was not deemed necessary as all three individuals responsible for providing input on the ASD learners are tutors specialised in music. Ms. Sergi's (Tutor 1) concentration is in autistic disorders and relevant disabilities, as is Mrs. Kyriakidou's (Tutor 2). Moreover, Mrs. Papakirykou (Tutor 3) has reported to frequently get in contact with adolescents with a clearly diagnosed ASD condition, within the secondary school she is employed. The three tutors instructed the software to 12, 4 and 12 learners respectively, while Tutor 1 undertook her *Terpsichore*-based responsibilities in two schools, working with 8 learners in the first and 4 in the second. Table 5.1 presents fundamental information with regards to respondents, who will hereafter be referred by their code name, in the form of RXX, where R stands for 'Respondent' and XX is a number between 01 and 28.[92]

Name / ID	Supervisor ID	Age	Gender	Type of ASD diagnosis	Severity of condition
R01	Tutor 3	14	Male	Typical autism	Moderate
R02	Tutor 3	13	Male	Typical autism	Moderate
R03	Tutor 3	14	Female	Typical autism	Moderate
R04	Tutor 3	13	Male	Typical autism	Mild
R05	Tutor 3	13	Female	Typical autism	Mild
R06	Tutor 3	14	Male	Typical autism	Mild
R07	Tutor 2	20	Female	Typical autism	Moderate
R08	Tutor 2	16	Male	Typical autism	Severe
R09	Tutor 2	21	Female	Typical autism	Severe
R10	Tutor 2	21	Male	Typical autism	Moderate
R11	Tutor 1	16	Male	Typical autism	Moderate
R12	Tutor 1	12	Male	Typical autism	Mild
R13	Tutor 1	14	Male	Typical autism	Moderate
R14	Tutor 1	13	Male	Typical autism	Mild
R15	Tutor 1	18	Female	Typical autism	Mild
R16	Tutor 1	17	Female	Typical autism	Mild
R17	Tutor 1	17	Female	High-functioning autism	Mild
R18	Tutor 1	17	Female	Typical autism	Mild
R19	Tutor 1	13	Male	Typical autism	Mild
R20	Tutor 1	17	Male	Typical autism	Moderate
R21	Tutor 3	12	Male	Typical autism	Mild

[92] Numbering between 01 and 28 is based on the time order of questionnaires completed, within the SurveyMonkey online platform.

R22	Tutor 3	13	Male	Asperger's syndrome	Mild
R23	Tutor 3	13	Female	Typical autism	Moderate
R24	Tutor 3	13	Female	Typical autism	Mild
R25	Tutor 3	14	Male	Typical autism	Severe
R26	Tutor 3	17	Male	Typical autism	Moderate
R27	Tutor 1	15	Female	Typical autism	Moderate
R28	Tutor 1	29	Female	Typical autism	Moderate

Table 5.1 *General profile of the twenty-eight human participants in the study.*

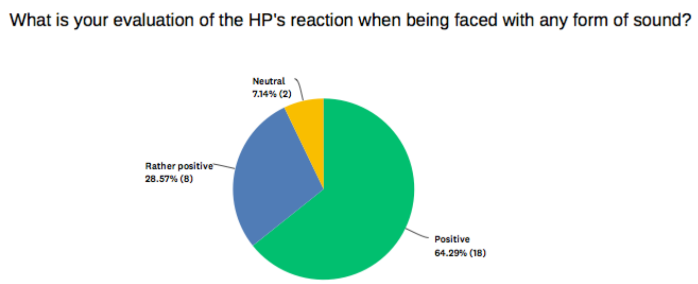
In terms of age distribution, the vast majority of human participants (HP) are adolescents, with prevailing ages being 13, 14 and 17 years old; no participant is younger than 12, while four adults also exist, one of whom being 29 years of age. Distribution between the two genders is also fairly even, with 16 out of 28 HP being males and the rest females. Most learners have been diagnosed, by leading disability-specific institutions in Piraeus and the broader Attica region, with typical autism; only one participant has Asperger's syndrome while another has high-functioning autism. It might be interesting to determine whether differences in the underlying ASD condition influence user interaction with *Terpsichore* combined with mental state and cognitive potential, especially considering that at least one case study per atypical autism has been examined in the previous Chapter.

An important factor to consider when distributing *Terpsichore* to learners, within both classroom and isolated settings, is how their level of trainability is judged by the supervising tutors. Had a tutor not considered a specific HP trainable, then relevant advice against instructing the interface would be provided. This was not the case with any of the learners, although Tutor 2 warned that the HP under her control are borderline trainable, which translates into a greater chance of exhibiting unsatisfactory progress or unfavourable behaviours throughout the learning process. In all situations, tutors took into close consideration the particularities of learners and the advice provided in the on-screen manual and walkthrough video, and thus did not elect to pressure them beyond their limits to force results, interrupting the learning procedure where necessary to assist participants in recovering their focus. The official research consent documents from the institutions with which the three tutors are affiliated, constitute irrefutable proof that all necessary precautions were taken in an effort to ensure, in no uncertain terms, the smooth completion of required activities associated with the *Terpsichore* testing procedure.

Over 80 percent of the sample's HP, apart from being diagnosed with a condition within the autism spectrum, additionally possess characteristics that comply with some form of mental retardation or learning difficulties. Although it is not absolute that ASD and intellectual disabilities are bound by a defined cause-and-effect relationship (see Section 1.1), the existence of such cognitive impairments in the majority of ASD learner cases (Fombonne 1999: 769, 775;

Ghaziuddin 2005: 78) is also confirmed in this sample. Moreover, relatively above half of the samples have one or more diagnoses supplementary to ASD, which can be classified either as a discrete disability, such as ADHD or phobic anxiety disorder, or a disadvantageous personality condition, including, but not limited to, learning difficulties, poor motor coordination and impaired cognition. NVivo node coding and analysis has demonstrated that developmental (5 instances), attention (4), intellectual (4) and communication disorders (2) are amongst the most common within the sample. It is also worth mentioning that one person has been diagnosed with ADHD in addition to typical autism, presenting symptoms of decreased attention span and hyperactivity that explicitly satisfy the definition of ADHD; nevertheless, this sample has not been excluded from consideration as it was officially diagnosed with ASD in a certified institution.[93]

In all instances that learners were brought in contact with sound and music throughout their lives, tutors have reported generally positive reactions; 54% of the HP did not exhibit any issues, while the remaining 36% presented minor irritation or more substantially worrying reactions when sounds encountered were not compatible with their tastes or areas of comfort. Inconveniences may arise in a wide variety of circumstances; for instance, R2 becomes increasingly agitated when he listens to songs whose genre is different to his preferences, R4 interprets loud or bizarre sounds as ominous and potentially causing threat to his wellbeing, while R5 exhibits difficulties in understanding the origin of sounds within the three-dimensional space. Figure 5.1 portrays the above in the pie-chart format employed by the SurveyMonkey platform to visualise results; all subsequent graphical representations may be accessed through Appendix IV.



ANSWER CHOICES	RESPONSES	
Positive	64.29%	18
Rather positive	28.57%	8
Neutral	7.14%	2
Rather negative	0.00%	0
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

Figure 5.1 *Distribution of learner reactions to sound in their everyday lives.*

[93] It is here reiterated that tutors were advised to only include participants diagnosed with a condition consistent with ASD.

A highly encouraging sign while the research progresses, is that all human subjects are fond of listening to music, although their appreciation may often depend on genre, orchestration and the characteristics of separate sounds and groups thereof. Nine individuals either prefer listening to multiple genres or are not particularly inclined to a specific one. The 29-year old adult has been reported, by Tutor T3, to principally enjoy children's music, something that may be due to the developmental disorder that she possesses as an adjunct to ASD.

The most preferred genre amongst participants is pop music, whether in Greek (3) or other languages (8), while another two HP find classical music particularly appealing. This statement acquires particular importance since Heffernan (2016: 98-9), after conducting a series of interviews, highlighted the musical and rhythmic content of mainstream pop and classical songs as a factor influencing ASD learners of advanced age to increasingly listen to songs of this genre. In addition, pop music has been identified to assist adolescents and adults in overcoming negative mood shifts (Rentfrow and Gosling 2003; George et al. 2007), although such aspects of pop music as the negative connotation of its accompanied lyrics, on frequent occasions, may induce unfavourable consequences (North and Hargreaves 2005). The above is consistent with the broader classification of music genres into 'classical' and 'pop' depending on the former's increased focus on musical content rather than expression of feelings (Allen, Hill and Heaton 2009). In addition, the argument on how pop music structure and increased preference in ASD are correlated (Heffernan 2016: 98-9) is consistent with the amount of HP, within the current study, that appreciate this genre and its variants, such as hip-hop.

It is rather common, within the sample, that loud sound stimuli and the sharp attack of certain objects and instruments, elicit extensive feelings of disturbance and displeasure, with at least eight of the participants satisfying this statement. Suddenly emerging sounds, combined with high-pitched audio or progressively intensifying stimuli, are considered minor causes for concern. High sensitivity to elevated volume sounds has been presented in two of the bibliographical case studies ('Mike', Section 4.1 and 'Nathan', Section 4.4) as a potentially discomforting issue, while the sensitivity window in *Terpsichore*'s main menu, combined with certain levels concentrating on 'Auditory Integration Training (AIT)' (see Section 1.6.2), are designed to predominantly address and alleviate such disturbances. Moreover, another eight of the learners are not generally bothered by any form of sound, as assessed by the tutors prior to *Terpsichore* use.

Although all learners express their enjoyment in listening to music, only three could be considered as being actively occupied with this subject. Specifically, R18 had been enrolled in a choir for three years prior to research, while R22 had been playing the guitar over the same period. R24's contact with music is only within the classroom framework, but her particularly strong performance in this subject at school influences her characterisation as an active music enthusiast. According to Tutor 3, R22's musical literacy is also reinforced by fundamental music theory he had been instructed as part of his guitar lessons; he is the only HP adept in music theory. Although this information indicates that only a few learners normally embed music in their daily schedules, the fact that none is disapproving of music even as a passive occupation allows the Nordoff-Robbins principle to serve as a useful foundation for organising educational sessions, assuming that the urge to compose music and soundscapes is linked to a favourable disposition towards appropriate and engaging sounds (Kim 2004; McDermott and Hauser 2005 – see Sections 1.2, 1.6.2).

5.1.2 Emotional state profile

In general terms, the human sample consists of learners demonstrating respectable comfort in communicating their emotions to peers. Specifically, as shown in Question 4.1 of Appendix IV, a rough 71% of respondents has a certainly or fairly positive disposition towards other individuals, while neutral or fairly negative responses are each encountered in four learners. An analysis of comments provided by the tutors indicates that learners highly capable of conveying feelings may range from calm and joyful to emotionally distressed and susceptible to outbursts. This statement aims to clarify that a positive evaluation of emotional awareness is irrelevant to feelings of happiness, but rather an indicator of capacity in showing others how the specific learner feels. For example, the 'rather negative' evaluation of learner R7 merely constitutes an ability to only externalise fundamental emotions, while a representatively 'neutral' attitude is the condition of R10, who peacefully integrates himself in entry-level communication, but is also affected by his underlying echolalia.

Similar statements apply with regards to learners' capacity in understanding how other individuals feel, something that can commonly be deciphered through facial expression, movements and diction in spoken discourse. With comparison to the previous case, positive evaluations are significantly lower, at around 57%, while neutral and negative evaluations respectively comprise approximately 39% and 4% of the sample. The reduced number of learners naturally cognisant of emotions in their surroundings is not surprising, as this trend is frequently encountered amongst individuals with ASD (Carter et al. 2005) and termed as deficient 'theory of mind' (Baron-Cohen 1985; Happé and Frith 1995; Bogdashina 2006). A nonpositive assessment of external emotional recognition may manifest itself either as an unwillingness to participate in tasks involving classmates or peers,[94] as in the case of R7, or as a reduced capacity in determining how others feel in everyday lives, a characteristic which R10 possesses.

Survey question 4.3 referring to the assessment of a learner's emotional state from the tutor's perspective, takes favourable or adverse feelings into close consideration. This means that a negative emotional state is more likely to be associated with consistently low morale, meltdowns and temper tantrums[95], while calmness (R1, R4 etc.) and enthusiasm to engage in collective activities (R22, R24 etc.) are examples of the exact opposite state. An approximate 61% of respondents is deemed to generally exhibit more favourable emotions, although the remaining 39% implies that the attempt to mitigate instances of negativity through *Terpsichore*, even in the short term, may prove challenging. This statement acquires special importance considering the characterisation of two HP's conditions, specifically R8 and R9, as intensely variable. This is defined as a series of unpredictable fluctuations between strongly expressed happiness and unmanageable anger outbursts.

In the optional question where tutors were asked to describe learners' reactions when getting in closer contact with sounds, a number of different attitudes towards music and sound were observed, ranging from pronounced enjoyment of certain musical content and activities to intense emotional breakdowns under displeasing or menacing stimuli. By interpreting the accounts provided by the tutors and grouping responses in NVivo depending on their content, the trends presented regarding attitude towards sound and music are outlined in Table 5.2 below. As the Table suggests, music is expected to positively benefit learners especially when its content is appealing to the ear, with the opposite happening when a sound is intense or does not stimulate relaxation. The fact that four of the learners exhibit a neutral, or even indifferent, disposition towards music, can be attributed either to reduced inclination towards this discipline and associated lack of interest (Ockelford 2013a: 147) or to the cognitive deficiency issues that accompany ASD throughout some of these learners' lifespan (Heaton et al. 2010).

Reaction to sound	**Number of learners**
Aggressive towards disturbing sounds	2
Avoids sounds because of familial issues	1
Becomes isolated under inappropriate sounds	3
Calmed down by appropriate music	3
Enjoys sound and music	8
Irritated by strong, loud, sharp sounds	2

[94] Such a behaviour is consistent with the etymological origin of 'autism' (< anc. Greek – αὐτός = oneself).

[95] Section 1.2 provides explanations on the last two terms.

Mild irritation universally	1
Negative emotional shifts by inappropriate sounds	2
No particular disturbance (neutral attitude)	4

Table 5.2 *Response to sound amongst the sixteen learners for which answers was given to Question 4.4 (see Appendix III). Multiple statements may be true for certain learners.*

Given that answering the question referred above is optional, the subsequent multiple-choice Question 4.5 associated with sounds potentially causing disturbance provides a resourceful insight on how the tutor, in all instances, is supposed to approach the interface altogether. With responses provided for all 28 HP and shown in Table 5.3 below, it is observed that over half of the learners demonstrate aversion to sounds suggestive of fear or threat, such as human cries, unexpected stimuli and, most importantly, sounds played at elevated volumes.

Sounds potentially causing irritation	Number of learners
High volume sounds	21
High duration sounds	7
Abrupt sounds	17
Sounds from sharp objects	6
Combination of sounds	5
Intermittent or periodic sounds	2
Human speech	1
Human cries or shouts	15
Don’t know / Prefer not to say	2

Table 5.3 *Breakdown of sounds potentially causing irritation amongst all 28 learners in the sample.*

5.1.3 Behaviour profile

The determination of learners’ behaviours in everyday situations are critical in the tutor’s attempts to adapt *Terpsichore* to their needs, as the optimisation of the learning process is naturally facilitated when the participant’s outbursts and actions of discomfort are kept to a minimum. A promising sign for the tutors, in the attempt to embed *Terpsichore* in music education and composition routines, is that the vast majority of learners, at roughly 85%, exhibit controlled and socially acceptable behaviours during their interaction with familiar surroundings, such as parents, relatives or teachers in classroom settings. Only four learners’ conduct towards close acquaintances can be evaluated as nonpositive; however, two of these four learners have been under the supervision of the same practitioner. Tutor 2's occupation in a special needs education and rehabilitation setting for profoundly disabled learners means that the issues confronted on a daily basis are more likely to elicit undesirable effects on wellbeing and behavioural integrity, regardless of the person with which a learner endeavours to interact. In fact, R7 frequently views her peers as inhibitors in her attempt to remain calm and consequently confronts them aggressively, while R8's behaviour towards acquaintances cannot be foreshadowed. However, in most other situations, learners are enabled to behave themselves less impulsively and more reasonably thanks to constant visual, tactile or verbal communication with familiar individuals. For instance, the interaction skills of R2 and R23 may be positively affected by his relationship with peers, a factor also significantly contributing to the efficiency of R10 and R22 in intramural activities.

Considering that learners within the sample have been reported, by their respective tutors, to devote extended periods of time to interacting with acquaintances and fulfilling daily requirements under their supervision, it should be expected that behaviours of HP towards unfamiliar individuals tend to vary negatively. Findings from answers to Question 5.2 of the survey (see Appendix IV) that only half of the learners express themselves towards strangers in a manner considered as 'rather positive' or 'positive'; the opposite applies to 13 learners while one person has never encountered individuals other than intimate peers. Considering that responses provided in this question have been classified within a Likert scale of five elements, with 5 being 'positive' and 1 'negative', Table 5.4 shows that fifteen HP behave better towards peers than strangers, no significant differences are observed for eleven people, and one person (R14) controls his interactions more effectively in unfamiliar environments. This statement generally satisfies not only the hypothesis set at the start of the paragraph, but also various remarks concerning the perception of individuals other than peers as 'strangers' or threateningly behaving entities (Thomas 1993: 25; Serhan 2011), or even the disrespect of certain ASD human subjects for such people (Richman 2006: 157). The latter's reference (Ibid.) to a young learner with Asperger's syndrome on the unsuitable vocabulary used to describe strangers is similar to the situation of R22, who confronts unfamiliar people apprehensively, even if his behaviours do not extend to circumstances potentially uncontrollable.

Name / ID	Behaviour towards peers (A)	Behaviour towards unfamiliar individuals (B)	Difference (A) – (B)
R01	5	5	0
R02	4	2	2
R03	2	2	0
R04	5	3	2
R05	5	3	2
R06	5	4	1
R07	2	2	0
R08	3	2	1
R09	2	1	1
R10	5	3	2
R11	5	5	0
R12	4	4	0
R13	4	4	0
R14	4	5	-1
R15	5	4	1
R16	5	5	0
R17	5	5	0
R18	5	5	0
R19	5	5	0
R20	5	4	1
R21	5	3	2
R22	5	3	2
R23	4	3	1
R24	5	3	2
R25	5	3	2
R26	4	4	0
R27	5	N/A	N/A
R28	5	4	1
		Mean value (out of 28)	**0.7857**

Table 5.4 *Comparison between responses of learners to peers and unfamiliar individuals.*

Responses from Question 5.3 in the survey, regarding potential causes for aggressive behaviours, indicate that approximately half of the learners are negatively influenced by the prospect of being warned or reprimanded, while a 32% of the sample is likely to face deterioration in conduct when attempting to engage in activities beyond their interest, or when circulating in unhabitual environments. This evidence indicates that task efficiency in *Terpsichore* could be positively influenced by ensuring constant communication between tutor and learner, based on the latter's encouragement, throughout the instruction process.[96] Moreover, at the stage prior to active occupation with the interface, it can be hypothesised, based on answers to Question 5.3, that the on-screen structure involving appealing pictures, colour diversity and comprehensible visual cues ensures that potentially deleterious effects on behaviour are avoided. Judging from responses to Question 5.4, the danger of the learner inflicting damage to objects or self-harm is rather reduced, with only three HP, all under the guidance of Tutor 2, exhibiting such misconduct.

All tutors responded that appropriate music and sounds are capable of countering unfavourable or unmanageable behaviours. Where necessary, explanations were provided as to which sounds would contribute to an improvement in conduct. In general terms, sounds regarded as calm and gentle are expected to satisfy this objective, as outlined for instance in responses concerning participants R6 to R9. Furthermore, the selection of music consistent with the learners' preferences, in conjunction with the willingness of tutors to oversee and support them, may set the foundations for positive emotional state shifts likely to translate in more acceptable behaviours, especially taking the sensitive life period of puberty and young adulthood into account (Tervo 2001: 86-7; White 2019: 139).

5.1.4 Miscellaneous background information

The profile of participants with regards to their abilities in communicating with their surroundings is rather mixed, although 68% of learners' condition can be described as positive or rather positive, meaning that they can generally articulate phrases and engage in meaningful discourse even with occasional breakdowns. Furthermore, one-quarter of HP resort to constructing plain or vaguely formulated sentences, while two individuals possess a borderline sense of communication. Interaction difficulties observed include reduced speech intelligibility, sporadic sound production and echolalia, with the latter being encountered in eight HP, four of which being supervised by Tutor 2 similar to previous instances. Having explained the aspects of echolalia in Chapters 1 and 3, what is to be determined through these HP's occupation with *Terpsichore* is whether their underlying condition affects their aptitude in independently composing music and soundscapes, without having to mechanically repeat either directions

[96] As the interface has been designed to ideally motivate learners to independently compose pieces and soundscapes, the tutor may occasionally act as a silent supervisor only having to intervene when breakdowns or control losses occur on the learner's part.

provided or cues present on screen.[97] For all learners, the tutors have indicated music to positively impact their communication skills, something consistent with the remarks in Section 1.2 regarding the relationship between music and interpersonal interaction.

Concentration in specific tasks appears to be a slightly worrying issue for various HP, as 32% of them are evaluated as having a neither positive nor negative ability to maintain their focus on tasks for extended time periods, whilst 39% of respondents exhibit a rather positive relevant ability and 18% confront serious attention span problems. Zager and Wehmeyer (2020) acknowledge the prevalence of such issues in adolescent ASD learners and propose continuous encouragement by tutors as a means for alleviating these problems, while opinions on the potential of music to improve concentration in youth (Schlaug et al. 2005: 219; Hammel and Hourigan 2013: 90) may serve as educated hypotheses in attempts to meaningfully utilise *Terpsichore* as a stimulator for increased focus, given that the sample consists uniquely of adolescents and adults. Participant R6 is reported, by his supervising tutor, to possess eye-gaze deficits, meaning that such attempts to alleviate this issue through music as the one of LaGasse (2014) could be closely considered in order to discover whether relevant effects are promising when *Terpsichore* is employed.

A number of participants, namely 12 out of 28, have been discovered to present at least one form of motor deficiency, whether gross, fine or oral in four cases each. Examples of gross motor deficiencies include spasmodic movements of entire body parts (R23) or combinations of reduced eye-gaze and movement capacity (R5); fine motor skills manifest themselves as disorientation in hand and feet movement (R3) or awkward instrument execution (R7), while difficulties in articulating plain words (R14) or engaging in intelligible discourse (R21) constitute examples of underdeveloped oral motor skills. The substantial existence of such difficulties justifies why it was deemed necessary, throughout the *Terpsichore* construction process, to rely on rhythmic and motor-enhancing structures, as well as elements combining music and letters in efforts to improve vocalisation capacity, in parallel to the GM case study in Section 4.4.

According to information regarding Question 7.4 (see Appendices III and IV), a total of 19 HP within the sample are at least fairly comfortable in confronting the demands of daily learning schedules, whether these refer to a special education institution or a mainstream secondary school, as in the case of Tutor 3, most students of whose coexist with neurotypical adolescents. The remaining 9 respondents, whose condition in this sector is considered 'neutral', seem to

[97] Levels 13 and 14 of the Tonal Mode, along with Level 10 of the SIP Mode, are critical in measuring learners' aptitude in avoiding mechanical repetition and achieving compositional autonomy (see Section 3.2).

present more pronounced difficulties in successfully meeting educational requirements. Transition between different components of a learning discipline is primarily a minor issue for an approximate 64% of respondents, while another 29% exhibit occasional struggles with this issue and therefore would benefit from a gradual succession between learning components within *Terpsichore*, enabling them to seamlessly complete the software and treat aspects of their wellbeing. Concerning Question 7.5, the ascending difficulty of activities involves some challenges for fifteen of the participants, while remaining HP do not regard this as a major issue impeding their progression. This particularity has already been encountered in Sections 4.1 and 4.10 respectively regarding 'Mike' and 'Ted', where strategies centred around specific groups of *Terpsichore* levels were proposed to ensure that some positive contribution to mental state, cognitive development and musical skills is achieved despite an increase in difficulty as each mode unfolds. Finally, the fact that over 80% of learners demonstrate a cooperative and amicable spirit towards their tutors is generally expected to facilitate the *Terpsichore* instruction process and help learners achieve a positive disposition while also releasing their creativity.

The background information described throughout its Section pertains to clearly defined aspects regarding the condition of learners as affected by ASD. After *Terpsichore* has been instructed for a substantial period of time within planned learning sessions, the tutors reassessed, among others, the situation and performance of learners on the exact same aspects, in order to determine whether the software induced short-term improvements, produced little to no changes, or provoked deterioration that needed to be countered using other methods not associated with the interface itself. Before elaborating on these post-testing results, it is vital to concentrate on how tutors perceive the participants' active occupation with *Terpsichore*, as interpreted through questionnaire responses directly related to software use during learning sessions taking place within the learner-tutor collaboration environment of a classroom. This analysis is designed to provide an indication on the overall response of participants to the content of software levels, the manners in which challenges during instruction may impact progress and objective satisfaction, and the compatibility of the interface with the learners' personality and areas of interest.

5.2 Software use and analysis of findings

After assessing the learners' initial condition, tutors were asked to inform participants of their upcoming involvement in a software they have never encountered before, with a focus on music. As the software is designed for computers running on Apple Macintosh operating systems, accessibility to tutors was made possible by distributing the software in three different machines, one assigned to each tutor, who would then be responsible for instructing the software to associated learners, within a classroom or an independent setting. Prior to the onset of *Terpsichore* application, it was clarified by all tutors that learners had not deployed any other software or technological system associated with music and sound.

To facilitate the learning process and ensure that all tutors work towards maximising the participants' educational potential, creativity and instances of favourable emotional state and behaviour, a walkthrough video of the software was provided, used to further clarify the on-screen guidelines provided while the user manual was enabled. The purpose of relying on these visual aids is to facilitate progress monitoring and enhance objectivity in result acquisition. In general terms, tutors have indicated that the software can be applied to the autistic learners of their supervision successfully, as stated in the official consent documents in Appendix II.[98] In fact, the survey results provided present a software completion rate of 100% for all participants but three, who were supervised of Tutor 2 and were capable of progressing through at least an estimated 70% of the instruction content.

The pervasive nature of ASD, as reiterated at various points throughout the analysis, suggests that different responses to certain parts of the interface are probable to be recorded amongst various learners, that certain participants may be susceptible to some components and increasingly responsive to others, and that various factors congruent with mental condition or personal development affect progress and potential incidents associated with *Terpsichore* use. For instance, participants unable to complete *Terpsichore* requirements in their entirety are supervised by Tutor 2, who has discovered these learners to have reduced educational awareness even if specified as trainable. Moreover, most magnitudes associated with questions presented in Section 5.1, are lower in participants R7 to R10 all cooperating with Tutor 2, than in the rest of the human sample. These statements lead to the establishment of a pre-research hypothesis that higher trainability levels, or more generally a decrease in condition severity, is associated with a learner tendency to display superior interest in *Terpsichore*, enthusiasm in creating new musical and sound content, and improved traits related to ASD condition even in the short term.

Having emphasised on composition and connection of lexical and musical content (Ockelford 2000; 2013a; 2013b) as approaches endorsing the development of the education-therapy relationship, another hypothesis for validation is that *Terpsichore*'s structure and succession of levels is capable of fostering learner treatment through compositional skill development, and contrariwise motivating participants to express themselves creatively through

[98] These documents have been signed by tutors themselves, stamped by the authorities of the Greek Ministry of Education and Religious Affairs and affiliated institutions, and translated into English.

sound and music as a result of improved wellbeing aspects. Furthermore, a number of observations extracted from the bibliographical case study research of Chapter 4 may be interpreted as supplementary hypotheses, whose validity and strength will be subject to scrutiny while evaluating *Terpsichore* through a number of aspects, as outlined in the respective questionnaire responses. All divergences between case study research and actual participant circumstances will not necessarily lead to the rejection of such hypotheses, but rather constitute an additional issue for discussion as factors possibly causing such discrepancies will be sought, as an intermediary step towards broadening the scope of *Terpsichore* research and further optimising software efficiency in future instances.

This section will firstly focus on the general perception of the software's layout, intelligibility and usability from the tutor's perspective, combined with the learner's reactions when being informed of the prospect of engaging in *Terpsichore* and while generally participating in interface-related activities. Afterwards, separate emphasis will be given on the software's two working environments, the Tonal Mode (TM) and the Soundscape and Indefinite Pitch Mode (SIP), and on how learners not only perform but also conduct themselves when participating in the specialised activities provided. Separate ratings for each of the levels will measure compatibility with their musical and quotidian requirements, while distinctive questions pertaining to a number of levels will embark upon how their characteristics affect learner response in a particularly encouraging or concerning manner. The formulation of most questions associated with the *Software Use* part of the Questionnaire (see Appendix III), allows for multiple-choice responses to be recorded within an equal difference scale ranging from 0 to 10. Depending on the phraseology of each question, a zero response may be defined as 'not at all', 'abysmal' or 'strongly disappointed', whereas a magnitude of 10 may be associated with 'absolutely', 'perfect' or 'strongly delighted'. In questions aiming to identify improvements originating from engagement in specific *Terpsichore* tasks, a rating of zero designates significant deterioration, with 5 representing unchanged condition and 10 strong amelioration, unless indicated otherwise.

5.2.1 General information and software assessment

To begin with, tutors were prompted to evaluate *Terpsichore* with regards to its layout, reasoning in the succession of levels and overall comfort in use and progression through its constituent elements. Even though three tutors provided the responses, noticeable differences in answers are justified by the fact that tutors were directed to centre their answers around the individual personality of each learner. This means, for example, that ratings of 5 and 8 with respect to the difficulty level of the software structure, both specified by the same tutor while completing the survey for participants A and B respectively, indicate the tutor's opinion that learner A is expected to become less comfortable with *Terpsichore* than learner B. To clarify this issue more comprehensively, it is beneficial to draw attention to Table 5.5, displaying, via keywords, all responses to Questions 8.1 through 8.5 as presented in Appendix IV. This information will be analysed in conjunction with the respective pie charts displaying number of HP matching each specific rating classification.

ID	Condition severity	First impression of HP [Q 8.1]	Overall layout [Q 8.2]	Ease of use (tutor's perspective) [Q 8.3]	Compatibility with HP's needs [Q 8.4]	Intelligibility of Manual & Reward Mode [Q 8.5]
R1	Moderate	7	7	7	8	6
R2	Moderate	7	9	8	9	7
R3	Moderate	5	8	9	8	6
R4	Mild	9	9	9	8	9
R5	Mild	8	9	9	9	7
R6	Mild	9	10	8	8	7
R7	Moderate	1	9	8	4	2
R8	Severe	5	10	10	3	2
R9	Severe	5	9	9	5	5
R10	Moderate	5	5	5	5	5
R11	Moderate	10	10	9	7	5
R12	Mild	10	10	9	9	8
R13	Moderate	10	10	9	8	7
R14	Mild	10	10	9	9	9
R15	Mild	10	10	9	9	8
R16	Mild	10	10	9	8	8
R17	Mild	10	10	9	8	8
R18	Mild	10	10	9	8	7
R19	Mild	10	10	9	8	9
R20	Moderate	10	10	9	8	7
R21	Mild	9	9	9	8	7
R22	Mild	8	10	9	8	9
R23	Moderate	9	8	9	8	7
R24	Mild	9	9	9	9	8
R25	Severe	9	8	8	8	6
R26	Moderate	10	9	9	8	6
R27	Moderate	10	10	9	9	7
R28	Moderate	9	9	9	9	8

Table 5.5 *Breakdown of responses associated with Questions 8.1 through 8.5 of the survey presented in Appendix IV, for all 28 human participants of the study.*

Findings from Question 8.1 evaluate the primary reaction of participants when *Terpsichore* is first presented to them whilst conventional teaching takes place. It is apparent that the majority of learners present a rather appreciative attitude towards the software, with 43% of HP displaying such reactions of strong approval and enthusiasm to justify the rating of 10, while a rating of at least 8 complies with three-quarters of the sample. On the contrary, one participant is strongly disapproving of the environment and its features (rating of 1), while attitude for another four learners is average (rating of 5); only one learner not enrolled in the institution of Tutor 2 satisfies a rating of 5 or less. At the early stages of practical research, some dependency of ratings on the environment in which learners circulate is gradually established, considering that the special school in which Tutor 2 based, accommodates learners with profound disabilities requiring special long-term guidance. However, the plethora of convincingly approving ratings, combined with the average of 8.36 concerning first impression, indicates that the graphical user interface is overall in a highly satisfying standard and close to ideal for ASD learners enthusiastic about engaging in computer-based interactive routines. The same applies to responses associated with Question 8.4 regarding software compatibility. The average rating of 7.78 is suggestive of a fairly strong, if not absolute, agreement with the assertion that *Terpsichore* is bound to satisfy treatment requirements towards an improved quality of life, while relatively lower compatibility ratings pertain to participants under the guidance of Tutor 2. In fact, interface compatibility ratings of 8 are consistent with nearly over half of the participants, while for one-quarter of HP a rating of 9 better reflects how *Terpsichore* is matched to learner profile and corresponding interests. Lower ratings imply that associated tutors consider selected aspects of the software to diverge from the actual needs of learners, similarly to the example of a young adult with atypical music interests and an aversion to theoretical knowledge (McCord 2017: 39-41).

According to evaluations on software and level structure, with concern to the areas covered and the difficulty of concepts mentioned, tutors feel that the software is expected to comprehensively address the requirements of learners and ensure an environment of seamless progression, as outlined in the respective responses to Questions 8.2 and 8.3 of the survey. Answers were recorded following the tutors' personal engagement with the interface, according to the on-screen guidelines provided after the User Manual and Reward Mode were activated. Overall responses, with ratings averaging 9.21 and 8.68 respectively, indicate that *Terpsichore* contains tasks not particularly complicated in their progression and completion, at least from the tutors' subjective view by taking however each learner's particularities and areas of potential discomfort into account. Interestingly, in each of the questions, the single response rated 5 pertains to R10, under the supervision of Tutor 2, and the one rated 7 refers to R1, one of Tutor 1's learners. The above statement suggests that learners monitored by Tutor 2 are generally projected, from the practitioner's perspective, to perform in a satisfactory manner while attempting to progress throughout the interface, apart from learner R10 who the tutor asserts to be more susceptible to *Terpsichore*'s layout and tasks. Therefore, ratings listed with respect to Questions 8.2 and 8.3 can principally be viewed as predictions for the overall responsiveness of learners to the structure and requirements of the software, and not as direct indicators of how participants actually perform.

The current research project constitutes the first instance in which all 28 learners have ever experienced *Terpsichore* in their lives. This statement may justify why ratings associated with learners' overall understanding of the lexical content of the User Manual and Reward Modes, as measured through responses to Question 8.5, are relatively reduced – with an average score of 6.79. Difficulties in comprehending on-screen directions may be attributed to shortfalls in intellectual integrity affecting efficiency in entirely novel tasks (Jayson 2007) or fulfilment of various daily life objectives (McManmon 2016: 89); both authors describe these characteristics as 'executive function' deficits. By plainly observing ratings across participants, it can be deduced that learners associated with Tutor 2 are generally less adept at independently understanding the lexical content of on-screen directions, compared to the remaining learners for whom the minimum observed rating is a 6. Moreover, one-way ANOVA demonstrates that differences in ratings on interactive word content intelligibility are statistically significant, for the three different alternatives in which a condition could be specified in the questionnaire, $[F(2, 25) = 12.37,\ p\ \approx .00]$. A relevant Tukey HSD test, assuming a significance threshold of 0.05, presents significant differences between mild ASD severity and either moderate or severe; comparisons between moderate and severe condition do not provide statistically significant differences. Relevant information is displayed below, in Figure 5.2:[99]

[99] All advanced statistical tests (ANOVA, post-hoc etc.) used in this research can be accessed through the attached SPSS output files.

Oneway

ANOVA

8.5 Intelligibility of Terpsichore content

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	43.131	2	21.565	12.370	.000
Within Groups	43.583	25	1.743		
Total	86.714	27			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: 8.5 Intelligibility of Terpsichore content
Tukey HSD

(I) Severity of condition	(J) Severity of condition	Mean Difference (I–J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Mild	Moderate	1.917*	.529	.004	.60	3.23
	Severe	3.667*	.846	.001	1.56	5.77
Moderate	Mild	−1.917*	.529	.004	−3.23	−.60
	Severe	1.750	.852	.120	−.37	3.87
Severe	Mild	−3.667*	.846	.001	−5.77	−1.56
	Moderate	−1.750	.852	.120	−3.87	.37

*. The mean difference is significant at the 0.05 level.

Figure 5.2 *One-way ANOVA and post-hoc test results, produced in SPSS, to measure effect of condition severity in lexical content intelligibility of Terpsichore.*

Question 8.6 relates to the manners in which the tutors intend to employ the software while instructing it to learners. NVivo qualitative analysis has demonstrated that emotional state, task concentration and music improvisation comprise the principal objectives to be fulfilled, at 86%, 75% and 79% respectively, while tutors are bound to concentrate on music composition skill development in 64% of participants. Communication improvement is also an issue whose treatment through *Terpsichore* will be endeavoured in around half of the learners, while behaviour and motor skills has been deemed a minor activity to concentrate in. Interestingly, 15 out of 18 participants expected to engage in broad-spectrum music composition tasks, and 19 out of 22 concentrating on music improvisation, also focussed on interventions potentially benefitting emotional state regulation. Furthermore, all participants aiming to obtain creative music education knowledge employed *Terpsichore* in the attempt to achieve meaningful mental health treatment and rehabilitation in one or more non-musical aspects. This finding highlights the eagerness of tutors to nurture the mutual education-therapy relationship in interface-based sessions. Finally, five of the HP engaged with the software without prioritising the acquisition of imaginative music skills. Of these learners, four are under the supervision of Tutor 2, something justified, as in previous cases, with the particular condition of such learners affecting classroom curriculum and development areas in which more thorough emphasis is given by practitioners within Tutor 2's educational environment.

Learning schedules centred around *Terpsichore* were planned so that, in general terms, all supervised participants completed a substantial part of the software within a collaborative setting. Tutors 1 and 3 committed a minimum of ten sessions, lasting nearly 50 minutes each, to the instruction of the software's Tonal Mode, while SIP Mode familiarisation and application was realised in at least seven 35-minute sessions, and most commonly in eight distinct 45-minute slots amounting to six hours in total. In instances where it was necessary for specific learners to further practice a level or for tutors to assist in the clarification of ambiguities, the tutors elected to devote more sessions to *Terpsichore* than the ordinary instruction length. For instance, further individual training of participant R23 in both modes resulted in a total of 20 relevant sessions, with a cumulative duration of 16 hours. This statement demonstrates that some divergence from a standardised classroom-based schedule was deemed beneficial in selected cases. Tutor 2, in contrast to 1 and 3, administered only three hour-long sessions of *Terpsichore* to her four associated participants, something that is not only attributed to the extensive difficulties arising from their ASD-compliant condition, but also engenders the hypothesis that less substantial favourable effects are expected from limited integration of *Terpsichore* in conventional special education curricula.[100] On average, as calculated in Appendix IV, Tonal Mode instruction was completed in approximately 9 ½ learning sessions lasting 49.33 minutes each, while respective figures for the SIP Mode are slightly over 8 sessions of 47.59 minutes.

5.2.2 Tonal Mode: General use

To ensure that all components related to music composition, soundscape construction and environmental sound modification form integral parts of *Terpsichore*-oriented schedules, all learners were invited, by their respective tutors, to commence occupation with the software from the Tonal Mode (TM). Tutors unanimously agreed that levels within the mode were structured in a reasonable manner, progressively advancing from fundamental music theory and instrument cognition elements to the concept of authentic music composition, thus providing an encouraging indication on the forthcoming reaction of learners to the requirements imposed by the software.

Responses consistent with the TM's overall efficiency were recorded following a thorough supervision of all learners' actions as sessions advanced. Participants were directed by both their tutors and the on-screen guidelines, which were frequently explained to ensure seamless progression between levels. As opposed to the bibliographical case studies of Chapter 4, and in the attempt to ensure increased homogeneity in the extracted observations, instruction started at all instances from the Main Menu and proceeded linearly from Level 1 to 18. Considering the different aspects addressed within the TM, along with the groups of adjacent levels with corresponding content (such as 6-7, 8-9, 11-12) and the gradual progression from reproduction to unconstrained composition, results concerning learner comfort in progressing through the mode are fairly positive. This can be deduced from responses to Question 9.2 being rated 7 or above for nearly 80% of respondents, and 8 or above for 57% of the entire sample. A weighted

[100] Comparison and analysis of findings in the following paragraphs will be employed to confirm or counter this hypothesis.

average of 7.36 is a representative indicator of the generally slight or moderate difficulties in transitioning between knowledge fields, which may be more serious amongst learners instructed by Tutor 2 as on previous occasions. Different condition severity indexes, as specified in the Likert scale of ‘mild, moderate, severe’, lead to significantly different ratings in transition between learning components, with relevant ANOVA results being $[F(2,25) = 16.339,\ p = .00]$[101] and the same Tukey post-hoc test as in Figure 5.2 demonstrating significant differences between mild – moderate and mild – severe ASD conditions, as indicated in Figure 5.3 below.

Oneway

ANOVA

9.2 Ability to transition between Tonal Mode components

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	44.435	2	22.217	16.339	.000
Within Groups	33.994	25	1.360		
Total	78.429	27			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: 9.2 Ability to transition between Tonal Mode components
Tukey HSD

(I) Severity of condition	(J) Severity of condition	Mean Difference (I–J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Mild	Moderate	2.032*	.467	.001	.87	3.19
	Severe	3.615*	.747	.000	1.76	5.48
Moderate	Mild	-2.032*	.467	.001	-3.19	-.87
	Severe	1.583	.753	.109	-.29	3.46
Severe	Mild	-3.615*	.747	.000	-5.48	-1.76
	Moderate	-1.583	.753	.109	-3.46	.29

*. The mean difference is significant at the 0.05 level.

***Figure 5.3** ANOVA and Tukey post-hoc tests investigating the relationship between condition severity and ability to transition between levels in Terpsichore’s Tonal Mode.*

In terms of responsiveness to the demands of levels, as measured through survey ratings related to Question 9.3, the most prevalent ratings amongst participants are 8 (approximately 36%) and 7 (25%). Only 14% exhibit a higher rating, while responses for the remaining 25% were scored between 3 and 6. The above distribution of scores highlights that various difficulties arose throughout the interface completion process, something principally justified by the mostly unfamiliar subject matter compared to learners’ daily habits, combined with content aspects regarded as either unintelligible or overwhelming. The average rating of 6.96, in conjunction with 8 and 7 as the most common scores, provide a slightly positive outlook on learners’ aptitude in performing activities in a manner compliant with the on-screen and tutor directions. Results among different groups of condition severity are highly significant as well, as demonstrated by the ANOVA results of $[F(2,25) = 16.031,\ p = .00]$, with the same Tukey post-hoc test showing demonstrate the same significant differences between groups compared to the cases of Figures 5.2 and 5.3, albeit with a $p = .056$ index for the ‘moderate – severe’ pair, thus not implying a significant divergence in results between these two groups.

Figure 5.4 below displays various keywords isolated in NVivo when attempting to assess the areas and levels in which participants are most efficient within *Terpsichore*’s Tonal Mode. It is

[101] Throughout this Chapter, equations measuring F and p refer to one-way ANOVA unless stated otherwise, while pairwise comparisons following ANOVA always refer to a Tukey post-hoc test.

evident that at least 10 of the 28 HP[102] (roughly 36%) perform best in Levels 7, 8, 9 and, sometimes, in 15 and 17. The principal element characterising these levels collectively, is the ability to modify sample phrases displayed on-screen. However, the difference between level sets I = [7, 8, 9] and II = [15, 17] is that set I contains pre-constructed melodies with different pitches, whereas set II is essentially a succession of 'C' notes whose modification was made available by button click repetitions until desired notes and melodies were produced. Reference of tutors to the 'external phrase modification' levels for at least eight of the participants, in conjunction with level evaluations originating from responses to Question 9.9 (see attached Excel file), denotes that, between the aforementioned level sets, 'I' is the most efficient and probable to affect educational and therapeutic potential in a positive manner. This statement is subject to further confirmation by evaluating the individual scores assigned to each of the levels separately, for all 28 participants.

Name	Files	References
Best performance (TM)		
8	1	12
7	1	11
17	1	10
9	1	10
15	1	8
phrase modification	1	8
18	1	7
6	1	7
melody composition from scratch	1	5
11	1	3
petal	1	3
1	1	2
13	1	2
2	1	2
felt exhausted	1	2
social stories	1	2
12	1	1
14	1	1
4	1	1
allowing the expression of senses	1	1
communication enhancement ca...	1	1
main menu	1	1
visual cursor movement	1	1
when complexity is lower	1	1
without high lexical content.	1	1

Figure 5.4 *Areas of the Tonal Mode in which learners perform more comfortably, as demonstrated through NVivo qualitative analysis.*

Level 18, consistent with original composition of melodies without a pre-defined array of notes, is strongly preferred by seven HP, or a 25% of the entire sample, while the concept of emphasis in the level was directly mentioned in five of the cases. This finding consequently indicates that learners would probably be more fascinated with levels centred around alteration of existing phrases than with blank screen environments encouraging unconstrained note input. This is consistent with the remarks presented in Section 1.2 regarding learner inclination to

[102] In NVivo, each of the responses consistent with a specific learner is considered a 'reference' (see Figure 5.4).

'extemporisation' (Wigram 2004) and scrambling (Mannes and Kintsch 1987). Simplicity is a predominant factor affecting increased preferences in note sequence modification levels, which may incidentally be the reason why Franceschini (2010: 18-25) highlighted the restructuring of elements and the choice of notes and chords as core components of his *Reactable*-based music cognition system. Furthermore, Level 6 including the flower petal visual structure and the ability to trigger 'situation songs' (Kolar-Borsky and Holck 2014) induced feelings of appreciation on the part of at least six participants, implying that visual and task-oriented elements assisted in performance increase, with effects on mental health and non-musical goal performance to be investigated at subsequent stages of this Section.

In Figure 5.5, the areas potentially causing concern with respect to familiarisation with the Tonal Mode are presented. The fact that half of the participants did not exhibit serious progression issues, as their supervising tutors reported, is a promising indication of the focus in rendering the software as accessible as possible to individuals with ASD, without detracting from the musical and treatment value of *Terpsichore* whatsoever. On various occasions however, it is obvious that learner performance was hindered, either because the difficulty of provided concepts was rather elevated – true for six participants – or because of content overload that led to the learning process becoming unmanageable and overwhelming, as in the examples of Levels 7 (three HP) and 15 (seven HP).

Level 7, associated with modification of existent musical phrases constructed with letter-format notes (A, B, C etc.), interestingly stimulated excitement and relevant positive feelings for numerous learners as mentioned in the previous paragraph. Nevertheless, the number of boxes, combined with the structure of melodies covering a substantial part of the screen, cannot be neglected, and may be the principal cause of discouraging behaviours for these specific learners. In Level 15, the fact that no prior musical knowledge was detected in all but three participants, justifies why performance was considerably reduced in attempts to satisfy melody production demands in three simultaneously existing staves. As first asserted in Section 3.2.2, the purpose of Level 15 is to offer increased creative freedom options by manipulating the structure of three different staves, and familiarising learners with the differences between the G and F clef. Considering this statement, Figure 5.5 findings by no means suggest that this level should be omitted from educational schedules or eliminated from *Terpsichore* altogether, but should rather be refined in such a manner that each session is devoted to one stave at a time. A pronounced differentiation in attitude is presented in participant R18, whose enrolment in a choir and continuous occupation with multivocal routines triggers her increased interest in operating Level 15; this observation justifies that a broad range of music interests have been taken into account. To summarise, the overall information displayed in Figures 5.4 and 5.5 denotes that the Tonal Mode was operated by most participants without significant issues, and that the tutors' assistance proved crucial in efforts to overcome the complexity of potentially unfamiliar components.

Worst performance (TM)		
no particular problems	1	14
15	1	7
complexity - increased difficulty	1	6
5	1	5
9	1	4
7	1	3
tired after some time	1	3
12	1	2
14	1	2
4 (rhythmic and time values)	1	2
counterpoint	1	2
10 (cursor movement with a variable speed)	1	1
17 (social stories)	1	1
advanced melody modification	1	1
complete words via music	1	1
high frequencies	1	1
on-screen user manual	1	1
reward mode activation	1	1
some challenging parts	1	1

Figure 5.5 *Areas of the Tonal Mode causing greatest concerns amongst learners, as demonstrated through NVivo qualitative analysis.*

The next point of emphasis within the questionnaire concerns the quality of melodies formulated while learners operated the Tonal Mode under sustained tutor supervision. Ratings provided depend on how aurally attractive tutors regarded these melodies, while the workload involved towards an end result constitutes an additional influence. In this context, a high workload signifies large-scale modification of existing patterns and the exploitation of the most components possible within a level to create intelligible and aurally pleasant phrases, whereas simple clicks on limited boxes or successions of the same note are considered examples of inadequate engagement with the interface. Explanation of the ratings takes into consideration, as restated in the previous paragraph, that Levels 15 and 17 incorporate a default melody which however only comprises consecutive C notes, meaning that the musical purpose of these levels is more consistent with original content creation than existing melody modification. Judging from the above, the former objective is satisfied in Levels 15, 17 and 18, whereas the latter is relevant to Levels 7, 8 and 9. The concept of providing coherent response patterns to predefined sequences, as outlined in Levels 13 and 14, cannot be classified in either category as these environments mainly concentrate on the prevention of mechanical repetition and the development of critical thinking as a facilitator of the composition process.

Performance in the melody modification domain is overall promising, as suggested, in answers to Question 9.6, both by the average rating of 7.68 and the prevalence of individual 8 or 9 scores, associated with three-quarters of the sample. This denotes that the existence of an on-screen guideline as to how melodies may be manipulated plays an encouraging role in devising patterns significantly different from the original but with comparable aesthetic value. On the other hand, responses to Question 9.7 provide an indication of slightly increased discomfort in completing concise melodies when learners are not expected to follow a clearly displayed guideline. This is reflected, for example, in the average mark of 7 combined with more frequent occurrences of individual 7 ratings compared to the case of melody adjustment. In an attempt to precisely determine the distribution of responsiveness changes amongst learners, when transitioning from modification to unconstrained composition routines, differences in ratings between these situations, for each individual learner, are shown in the following Table 5.6:

ID	Melody modif. (A)	Original comp. (B)	Difference (A) – (B)	ID	Melody modif. (A)	Original comp. (B)	Difference (A) – (B)
R01	7	8	-1	**R15**	9	7	2
R02	8	8	0	**R16**	10	9	1
R03	7	5	2	**R17**	10	8	2
R04	8	8	0	**R18**	9	9	0
R05	9	8	1	**R19**	9	8	1
R06	8	8	0	**R20**	8	7	1
R07	3	2	1	**R21**	8	8	0
R08	1	2	-1	**R22**	9	9	0
R09	5	5	0	**R23**	8	8	0
R10	4	2	2	**R24**	9	8	1
R11	8	5	3	**R25**	7	7	0
R12	9	9	0	**R26**	8	7	1
R13	8	7	1	**R27**	9	7	2
R14	9	8	1	**R28**	8	9	-1
				Mean	**0.6786**	**SD**	**1.0203**

Table 5.6 *Comparison between the ability of each separate learner to modify specific melodies and to compose original ones, from point zero. Mean and standard deviation (SD) values refer to the (A) – (B) value difference.*

In principle, Table 5.6 confirms the previous argument regarding enhanced performance in the modification domain, not only through the positive average value of the (A) – (B) difference, but also through the fact that only three learners appear to perform better in the task of original composition, whereas 15 out of 28 HP seem to progress through this activity less efficiently. It is additionally evident that learners directed by Tutor 2 exhibit reduced competence in both activities, a trend which has unfolded directly from the start of the analysis and for which a preliminary justification was provided. By conducting a repeated measures ANOVA based on all the numerical values of (A) and (B), it may be noticed that performance differences are significant within this sample, as all associated tests run by SPSS yield the following: $[F(1,27) = 12.385,\ p = .002]$.

Unlike previous instances, the severity index of ASD does not seem to affect performance in domain (B) compared to (A), as a relevant ANOVA results in statistically non-significant differences: $[F(2,25) = 1.927,\ p = .167]$. Supposing that differences in ratings are affected by the ability of learners to maintain their focus as educational subjects become more challenging over time, or by their comfort in transitioning between knowledge fields within the mode, further ANOVA analyses indicate that only the latter factor may influence, by some means[103], the tendency to compose original phrases more comfortably than to alter predetermined ones; for both cases, the results are $[F(3,24) = 1.505,\ p = .239]$ and $[F(3,24) = 9.546,\ p = .071]$ respectively.

Numerical scale responses to Question 9.8 assess the extent to which efforts in composing original melodies have resulted in patterns aesthetically resembling renowned classical music pieces, for each of the learners. Overall, 75% of participants were able to score 7 or better in this category, signifying that their attempts to follow level order and associated points of emphasis proved practically valuable in original composition routines, apart from learners R7 to R11, four of which exhibited, directly from the start of *Terpsichore* occupation, pronounced engagement difficulties as reported by Tutor 2. In terms of musical tastes, the majority of learners were reported to be inclined towards such genres as pop and classical music. Therefore, the non-normative listening and music appreciation tendencies purportedly characterising individuals with ASD (see Section 2.1.2) are not particularly consistent with the research sample, and it can conversely be deduced that the dedication of Challis et al. (B.P. and K. Challis 2008a, 2008b; Challis 2011; Challis et al. 2017, see Section 1.4.2) to relying on Western music conventions in their interfaces proved a valuable source of inspiration for *Terpsichore*'s Tonal Mode, as determined through rating analyses in Questions 9.7 and 9.8.

By juxtaposing answers from the two lattermost questions relevant to original piece composition, it can be observed that, for the research sample, the ability to compose original melodies is a strongly significant indicator of how performance with regards to Western music compliance is affected. A relevant ANOVA test yields the following: $[F(4,23) = 32.349,\ p = .00]$, while subsequent post-hoc testing delivered significant differences in the vast majority of

[103] This assumption is not absolute considering the $p_{crit} = .05$ critical threshold for statistical significance in this study.

situations, apart from the pairs (7-8), (7-9) and (8-9) related to responses in Question 9.7. Condition severity differences are on occasions responsible for varying extents to which produced melodies follow established Western music norms, given ANOVA results of $[F(2, 25) = 7.195,\ p = .003]$. The associated Tukey test confirms that individuals with a mild ASD condition are certainly more efficient in this aspect than severely impacted learners, while comparisons between 'mild – moderate' and 'moderate – severe' pairs are not significant.

Tutors were unanimously confident that the sounds and instruments offered are of an adequate number and character to assist in the satisfaction of musical and treatment objectives. No particular concerns were voiced regarding irritation potentially caused by certain instrument samples, which is mainly due to the variety provided in *Terpsichore* with regards to the character and envelope of each sample; more specifically, such instruments as the flute, characterised by high sustain and attack times, coexisted with the sharper xylophone and piano. In an endeavour to gauge opinions valuable for the development of *Terpsichore* in latter stages, tutors were enquired about the possibility of adding further instruments to the TM to accommodate requirements of their supervising learners. For R2, R22 and R23, the violin is a recommended instrument for future incorporation in *Terpsichore*, while R18 would benefit by the addition of choir voices, something consistent with her occupation with choral singing in her scholar environment.

A more precise estimate of the participant's overall Tonal Mode performance may be provided by the separate evaluations of each level, on a scale from 0 to 10, considering session performance and compatibility with everyday needs as criteria that influence responses to Question 9.10. Appendix IV presents average ratings of all responses that learners recorded in the mode's main menu and constituent levels, combined with the mean performance of each participant throughout the mode. To begin with, all evaluations yielded an above average performance per level (APL), with the highest ratings being recorded in Level 1 (8.64), 6 (8.39) and the Main Menu (8.14) and the lowest ones in Levels 15 (5.86), 16 (6.57) and 17 (6.75). Moreover, by grouping content modification and original composition into sets, respectively S1 = [L7, L8, L9] and S2 = [L15, L17, L18],[104] it is evident that overall reception of levels is more promising in S1 than S2, with associated average ratings being R(S1) = [7.71, 7.68, 7.18] and R(S2) = [5.86, 6.75, 7.36]. As shown in Appendix IV, standard deviations of APL are all higher than 1, a magnitude affected by the noticeably lower ratings in level performance characterising Tutor 2's learners. A noteworthy observation concerns the considerably higher standard deviations from Level 7 onwards, with values above 2, rising to slightly under 3 for the last six

[104] Categorisation took place by taking into account that modification of default C note successions can be regarded as composing a melody from point zero.

levels of the mode. This is a direct consequence of certain learners' inability to progress at latter stages of the interface due to complaints about exhaustion (two learners after Level 6, one after Level 12, all supervised by Tutor 2).

With respect to all-around efficiency for each of the participants (APHP)[105], below average ratings were only recorded for learners R7 to R10, whose salient functional disadvantages deriving from more profound ASD conditions hindered their ability in operating the software and engaging in creative routines, unless strong and continuous reinforcement was provided by Tutor 2. In the remaining 24 cases, performance ratings certainly appear more convincing, ranging from 6.58 (R3) to 9.32 (R14). A powerful indicator of how efficient the TM was in total, after administered sessions were completed, is the quantitative classification of relevant performance magnitudes within the human participant sample. The median value of APHP is 8.18, meaning that half of the learners scored, on average, higher than this figure; moreover, participants scoring above 7 and 8 are respectively classified over the 21st and 32nd percentile of the sample, while exceeding the APHP threshold of 8.5 places a learner in roughly the 60th percentile. The above lead to the conclusion that, when viewed as solely a musical activity without a distinct objective, involvement with *Terpsichore* constitutes a highly positive experience for the majority of participants. This is also reflected in the magnitude of 7.43 related to the average performance jointly concerning all levels and participants, rising to 7.77 if all responses of zero are exempt from the score weighting process, or to 8.18 if all HP supervised by Tutor 2 are excluded. In terms of ASD severity index potentially impacting APHP magnitudes, a similar ANOVA established significant differences between these two factors for the three predetermined severity conditions: $[F(2,25) = 8.945,\ p = .001]$. For the assessment of individual differences, the subsequent Tukey post-hoc test demonstrated statistical significance for the pairs 'mild – severe' and 'moderate – severe', while the magnitude of p for the 'mild – moderate' pair is at .059, only slightly above the study-wide fixed threshold of .05.

5.2.3 Tonal Mode: Specific levels of particular importance

As previously described, the construction of various *Terpsichore* levels has been centred around the fulfilment of various objectives related to the acquisition of creativity and ideally some compositional independence, along with the enhancement of cognitive, mental and sensory skills. In addition, the consideration of individual particularities detected in the literature case

[105] APL = average performance per level. APHP = average performance per human participant.

studies of Chapter 4 in designing selected interface components, attempts to bring *Terpsichore* closer to the therapeutic demands that practitioners encounter in attempts to regulate the lives of ASD learners and foster their development and social inclusion. As, however, the disability is pervasive and thus not observed in the same manner amongst a group of learners, certain software elements perceived as pleasing and rewarding by a specific HP may provoke adverse consequences in other participants, especially taking the complexity of various educational aspects into account, especially as levels progress towards the ultimate objective of unconstrained note-based phrase composition. For instance, Berger (2016: 108) briefly describes the potentially beneficial effects of counterpoint as an advanced musical activity, but to achieve a similar strategy in *Terpsichore*, three staves were required, inducing possible concerns associated with overwhelming visual content or a degree of complexity not universally manageable in learning sessions. Likewise, the amount of information present in Level 7, where users are invited to modify specific parts of the predetermined melodies consisting of letter-form notes portrayed in boxes, may more often than not enhance feelings of confusion and detract from the compositional purpose of this environment. This is the reason justifying the inclusion of Section 10 in the Questionnaire, concentrating on the response of learners to specific levels with relatively special functionalities; relevant responses will be presented in the following paragraphs, allowing the extraction of fundamental remarks employed as part of a broader *Terpsichore*-based discussion in Chapter 6.

<u>Main Menu</u>

Results from Question 10.1, accessed in Appendix IV, refer to the attempt of learners to develop more regulated but simultaneously comfortable movements of the hand, potentially acting as a precursor to broader motor skill development, in similarity to attempts either in enhancing hand stability and use in performing everyday activities (Kurtz 2008: 93-99) or in developing mobility routines in accordance with a provided visual directive (Becchio and Castiello 2012), albeit with an additional auditory content designed to expedite possible improvements. To measure the potential of the Tonal Mode's Main Menu in contributing to hand-based motor skill development, tutors directed learners to engage in two different types of discipline hand movements: the strike of a stable surface at periodic intervals, and the movement of hands in similarity with a typical 'conducting gesture' (Wong, Yuen and Choy 2008) used in orchestral settings.

The ability to maintain a stable pace in achieving hand contact with a solid surface has improved in most participants, something outlined in elevated ratings observed in this aspect after a number of interface sessions have been finalised. Only five learners (R1 and the four of

Tutor 2) were not capable of achieving improvements, while the respective ability of R21 slightly declined, from 8 to 7, which is possibly attributed to the learner's inability to maintain concentration when subject to critical corrective feedback. Moreover, the type and existence of various motor skills is not a prevalent contributor to changes in the aforementioned ability, nor is ASD condition severity such a factor ($p \geq .12$ following ANOVA). Dexterity in the more sophisticated succession of motions used by conductors proved a somewhat more difficult objective to accomplish, as manifested by the increased number of learners who were unable to demonstrate improvements, without deteriorating in this aspect whatsoever. In fact, the average improvement magnitude was 0.892 for periodic hand strikes and 0.857 for 'conducting gestures' (Wong, Yuen and Choy 2008, see above paragraph). As in the previous circumstance, type and existence of different motor skills, or disability severity index, do not significantly affect provided responses ($p \geq .075$ in all cases).

Level 5

The method proposed by Shore (2003, see Section 3.2), expanded to accommodate musical note production for all 26 alphabet letters, has been more favourably received by learners when these are provided with guideline words to produce phrases with. In fact, while employing the corresponding Level 5, such words and phrases as 'MUM', 'SCHOOL' and 'BE FRIENDS', provided in their Greek translations, were formulated as melodies by pressing respective computer keys. Around two-thirds of the sample have recorded ratings 8 or above in this task, demonstrating that the existence of a guideline is highly likely to assist them in satisfying designated requirements. Below average ratings, associated with Tutor 2's human subjects, represent, according to the Tutor, that their engagement efforts were constrained to the mechanical repetition of and adherence to the cues communicated to learners at regular intervals.[106]

An important point to be considered, with regards to Tonal Mode's Level 5, is the potential of learners to transform the instruction of such innovative concepts as joint music composition and word formation, into a series of independent routines suggestive of increased creativity. Let Case 5a[107] be the activity of progressing through Level 5 with guideline words at the user's disposal, and Case 5b be the exact same procedure without the learner having to rely on such assistive tools; findings demonstrate that performance of participants is considerably higher in

[106] The full result description in the attached Microsoft Excel document, presents explanatory evidence of the above.

[107] The number 5 refers to the respective level during which compositional aptitude, through word assembly, is evaluated.

the former case (7.79 as opposed to 6.93). It can be estimated that this discrepancy in ratings is justified by the commonly increased comfort to complete a task when following clearly defined directions. Twachtman-Cullen and Twachtman-Bassett (2011: 29) confirm this statement by asserting that previously unencountered activities are difficult to complete without prior training, even for cognitively advanced ASD learners. More favourable ratings, for instance 8 or above for 44% of the sample, are associated with an elevated ability to formulate musical compositions without the practitioner's need to employ suggestive cues or urge learners to perform out of Case 5a's comfort zone. On the other hand, learners whose performance was rated less positively, relied essentially on miscellaneous words and phrases selected by tutors and presented to participants, whether verbally or in writing, to assist with the completion of the task. The more severe the ASD condition is assessed, the less likely it is for the human subject to successfully engage in the above task ($[F(2,25) = 6.522,\ p = .005]$), which also applies to Case 5a ($[F(2,25) = 5.726,\ p = .009]$). Moreover, pairwise comparisons between 'mild-moderate' and 'mild-severe' groups yield significant differences in both Cases 5a and 5b. Possible cognitive issues that accompany the underlying ASD condition of learners are not significant ($p > .05$) inhibitors of performance in this field. However, the fact that various participants with an additional mental retardation case were able to score 10 in this project, indicates that their interest in music, computers and relevant creative activities partly compensates for the cognitive issues possibly hindering their performance.

The juxtaposition of ratings pertaining to Case 5a with the ones of Case 5b, may be employed as an indication of learners' capacity in composing melodies independently through keyboard presses. Having measured rating differences between Cases 5a and 5b, it is evident that all participants but one, are equally or less adept at composing melodies independently and without external prompting, as demonstrated in Figure 5.6 below. This Figure demonstrates that 36% of participants are similarly efficient in meeting demands related to both cases, while an equal percentage thereof are slightly more capable of formulating musical phrases using word guidelines. In this context, it may be supposed that higher 'Case 5a minus Case 5b' rating differences imply reduced independence in performing the collective task in question. Considering this, two out of five learners are equally or more comfortable in independently translating intelligible words and phrases into music, whereas one out of four have not attained an adequate level of independence in progressing through the compositional requirements set in Level 5. ASD severity condition is not a factor significantly affecting this 'independence index' (a phrase conceived for this purpose), but learners' ability to understand the provided content ($(F(5,22) = 3.067,\ p = .03]$) and to transition between learning components ($(F(5,22) =$

5.227, $p = .003$]) may prove strongly influential, mainly on occasions between mediocre such ratings (6, 7) and more convincing ones (8, 9), as shown in relevant Tukey post-hoc tests.

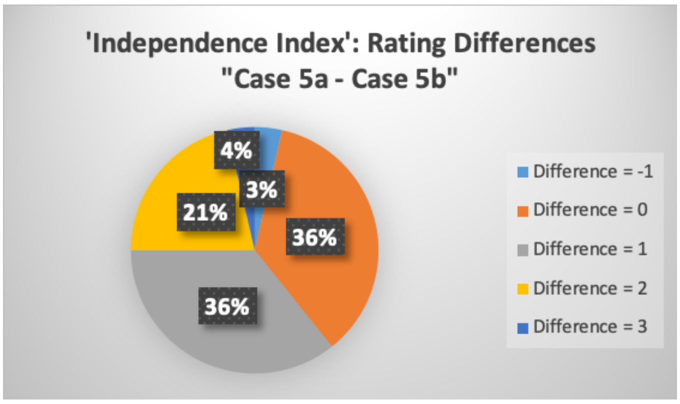


Figure 5.6 *Differences in ratings between Case 5a (formulation of musical phrases using hint words) and Case 5b (zero reliance on external cues).*

<u>**Level 6**</u>

Level 6 is mainly characterised by the floral structure consisting of petals, each associated with a different musical prompt for each intended daily activity. Responses to Question 10.3 of the survey indicate that its place in *Terpsichore* is generally beneficial, mainly considering the different colours and the manner in which petals and prompt photos are organised on screen. Image indicators for various activities, including, but not limited to, waking up, going to school and having lunch, have been principally considered appropriate for the needs of each learner, with all but two responses being rated 8 or higher. In all situations, practitioners were capable of devising 'prescriptive' (see Pasiali 2004) tunes adhering to the pre-set melodies of the Level and adapted to the requirements that each learner was supposed to fulfil.

With respect to the responsiveness of participants to the tasks they were expected to complete whilst being occupied with Level 6, three-quarters scored 8 or higher, indicating that this level strongly assisted them in becoming efficient when engaging in typical casual activities. The average rating of 7.82 provides an overall positive perspective on the above, although it should not be neglected that remaining learners' scores are distributed between 2 and 7, leading to a standard deviation of 1.91 for the sample in question. A series of one-way ANOVA yielded significant relationships between responsiveness ratings and the following factors: severity of ASD condition, overall responsiveness to the Tonal Mode and behaviour towards peers. Interestingly, the lattermost factor's significance in these results is justified by the expected role of parents, relatives and acquainted practitioners known to the participant, in directing learners on how to improve their performance in Level 6. Moreover, after a series of univariate tests performed in order to examine the collective influence of the above factors on level responsiveness, it is discovered that condition severity does not significantly affect performance when examined in conjunction with other factors. However, responsiveness to the Tonal Mode in general, with learners' demeanour towards familiar individuals as a covariate, significantly impacts the potential of learners to confront the general demands of this level (all between-subjects effects yielded $p \leq .05$).

Level 9

The potentially rewarding value of Level 9 was briefly explained in Section 3.2, in conjunction with the relevant remarks of Straus (2016: 700-1). However, a concern was voiced during the GM case studies (see Section 4.5) regarding the level's complicated nature, especially since the attempt to change the identity of the note induces relevant modification to adjacent notes, so that the uniqueness of each different pitch is preserved. This issue, however, did not provoke considerable disquiet amongst learners, at least as manifested by the prevalence of ratings higher than or equal to 7 or 8 (22 and 18 HP in total, respectively). With the exception of learners R7, R8 (both ceased *Terpsichore* use in Level 6 due to tiredness), R9 and R10, all supervised by Tutor 2, Level 9 did not pose considerable problems but was rather met with enthusiasm and eagerness to interactively manipulate existing phrases, even with minimal melodic constraints. Interestingly, 19 out of 28 HP were deemed by their supervising tutors as exhibiting improved emotional state and willingness for creative expression, following a substantial amount of sessions centred around this level, while no signs of deterioration or adverse behaviours were detected.

A brief reference to the distribution of scores in all levels demonstrates that, although participants tend to recreate melodies in Level 8 more comfortably than in Level 9, one person in particular (R20) appears to present increased aptitude in the latter environment as opposed to the former. Taking into account his introverted character and increase verbal incapacity compared to the rest of the sample, the above observed tendency could be considered coincidental, as very little research exists correlating speech incapacity in ASD and preference for dissonant stimuli. However, the purported contribution of tonal music in influencing cerebral function and emotional awareness (Ockelford 2013b: 110-5), especially as far as dissonance detection is concerned (Janata, Tillmann and Bharucha 2002, see Section 2.1.2), possibly plays a role in explaining this differentiation.

Levels 11-12

Question 10.5, pertaining to the comfort of participants in clicking imaginary piano keys with the mouse in Levels 11 and 12, is consistent with the assessment of existent and developing motor skills during *Terpsichore* use, especially given the substantial hand and mouse displacements necessary to exploit the full length of an interactive piano octave. In general terms, most learners completed relevant movements without remarkable problems, as manifested in the 8.42 average rating in respective answers provided, for the 26 participants who continued with the software beyond Level 6. A particularly valuable asset of these levels, as assessed from learner performance, is the embedded feedback mode, which, after being activated, automatically triggers manually enabled notes after a short period of time, by default configured at three seconds. The average score of 8.88 coupled with the existence of 8 or higher ratings at an encouraging 82% of participants, clearly signifies that learners are expected to exhibit improvements in compositional activities when being informed about their progress and shortcomings in this area, as is commonly the case for most daily life aspects. Finally, 71% of HP are capable of seamlessly progressing through Levels 11 and 12, with only one person (R23) potentially requiring a reference instrument, such as the violin (see Section 5.2.2), to facilitate her involvement, and other four exhibiting more extensive difficulties. It is uncertain whether severe ASD symptoms may inhibit a learner's general occupation with the aforementioned levels, considering that a relevant one-way ANOVA yields a p-value slightly above the *.05* statistical significance threshold: $[F(2, 22) = 3.194,\ p = .061]$.

Levels 13-14

The purpose of Levels 13 and 14, to which reference is made in Question 10.6 (see Appendix IV), is the development of independence in completing phrases consistent with the 'question – response pattern' (see Section 3.2 and Ockelford 2013: 204-6), combined with the ability to engage in some form of dialogue without mechanically repeating external prompts. Tutors 1 and 3 indicated, through responses for each of their supervised learners, that these structures appropriately serve the above objective, whereas Tutor 2 was only capable of directing one of her four participants to complete the task.[108] To facilitate the successful completion of both levels, participants took advantage of the on-screen phrase composition guideline and the tutor's feedback, something for instance employed to understand that the notes 'D – E' should be appended to an incomplete structure of 'A – B – C'.

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[108] Tutor 2 reported that two of her learners demonstrated signs of exhaustion from Level 7 onwards, while another one managed to reach Level 12 and ceased occupation thereafter.

Ratings associated with the ability to provide independent melody completions take reliance on the above into account; more specifically, higher frequency in resorting to external simulation tends to reflect lower ratings. A total of 18 participants, amounting to 57% of the sample, have scored 8 or above, indicating that they only required a fundamental level of external guidance to finalise such procedures. Accounts on the levels' effect to improve conversational speech are equally positive, considering that twenty learners exhibit favourable effects regarding this trait, with nine learners assessed as having perfectly benefitted from these levels. Results from participants involved in Levels 13 and 14 designate that participants with varied ASD symptom severity differed in their ability to formulate musical segments without external motivation ($[F(2,22) = 6.157,\ p = .008]$). Conversely, the potential of communication skill development is not significantly influenced by severity index ($[F(2,21) = 3.182,\ p = .062]$) or the extent to which such skills existed prior to *Terpsichore* use ($[F(3,20) = 2.688,\ p = .074]$). Furthermore, it is important to note that, for this sample, the existence of echolalia as a disadvantageous communication routine plays a significant role in learners' ability to provide appropriate phrase completions in these levels, both when the 'Don't know' responses are excluded ($[F(1,23) = 10.295,\ p = .004]$) and when these are included but substituted with zeroes ($[F(1,26) = 27.059,\ p = .00]$). As far as the levels' influence on communication is concerned, no conclusive remarks may be made with concern to echolalia's effect; in fact, this is present only in the latter circumstance ($[F(1,26) = 7.598,\ p = .011]$); exclusion of the 'don't know' cases leads to strongly non-significant results on the above.[110]

In the penultimate Level 17 of the Tonal Mode, associated with original melody composition based on the construction of visual 'Social Stories' (SS, see Section 2.4), most learners have been able to successfully confront compositional demands, as with the majority of levels, something that supports the arguments favouring the use of social stories in musical contexts, as described in Section 2.4. However, the average rating of 7.48 indicates that positive effects on the development of creative music education skills are not as convincing as in the majority of previous examples, even if 57% of participants have still scored 8 or above in this area. A possible explanation pertains to the difficulties arising from the variety of pitches and note durations that can be introduced while operating the level, taking into consideration that complexity of specific learning components has been identified as a worrying issue. In fact, a joint examination of the participants' ability to compose phrases based on social stories, and of

[110] For reasons of precision, responses marked as 'Don't know / Prefer not to say' will henceforth be excluded from the consideration of statistical significance.

their responsiveness to the Tonal Mode in general, presents that these two factors are closely related ($[F(5, 19) = 7.119, p = .001]$).

It is important to highlight that, although Levels 17 and 18 possess similar compositional functionalities, the latter enables users to insert notes in a series of initially blank staves, which does not apply to the former case, as a series of already existent C notes may elicit confusion. It may be speculated that the reluctance to employ stimulating learning aids such as the Reward Mode, may be a factor responsible for the slightly reduced compositional efficiency of learners, based on Staley's (2002, cited in Kalyva 2011: 55) theory related to 'reinforcers' of a social story. Possible difficulties tutors face in selecting appropriate images to support the story may also explain setbacks in Level 17 performance, taking into account that, for 15 participants out of the 25 reaching this stage of *Terpsichore*, the tutor's comfort in loading appropriate images to support the story was judged with a rating of 8 or below.

As a final component of Tonal Mode analysis, Questionnaire Section 10.8 aims to assess the ability of learners to compose fundamental melodies from point zero, as part of Level 18's demands. Twenty-two respondents are highly capable (8 or above) of memorising elements instructed in previous levels in their attempt to formulate complete six-measure phrases. This is consistent with the average profile of an adolescent with ASD in terms of knowledge retention abilities (Sicile-Kira 2006: 36-7, 120-1; Dunn and Harris 2017: 18), with the two authors however asserting that autistic individuals are deficient in critically processing retained parts of information. That said, the majority of responses concerning the quality of melodies produced in Level 18 as per provided instructions, are rather promising, as justified both by the average rating of 7.64 and by the individual participant rating of 8 being the most frequent within the sample. For participants attempting this level, statistically significant pairwise differences are observed between ASD condition severity and ability to memorise previous concepts, $[F(2, 22) = 4.353,\ p = .026]$, but the perceived aesthetic quality does not significantly vary for the three predetermined conditions.

In general, findings related to Question 10.8 may indicate that the majority of Tonal Mode levels were carefully designed to prepare learners in meeting the specialised demands of Level 18, something that justifies why the concept of original composition from point zero was rightfully placed at the end of the mode. The fact that *Terpsichore*'s Tonal Mode has been largely constructed for composition rather than passive reproduction purposes proves, in principle, that a freeform music creation structure may yield beneficial effects to the ASD learner if the appropriate preparatory background elements have been provided in advance.

5.2.4 Soundscape and Indefinite Pitch Mode (SIP): General use

The purpose of prospective learner occupation with *Terpsichore*'s SIP mode is to assess not only the efficiency and therapeutic benefit of soundscapes without a clearly defined tonal content, but also whether preference to a specific mode is presented. The first objective will be determined in the same manner that Sections 5.2.2 and 5.2.3 attempted to examine the responsiveness of various Tonal Mode aspects during the *Terpsichore* instruction sessions, which essentially is the presentation and statistical analysis of findings extracted through responses to Sections 11 and 12 of the Questionnaire (see Appendices III, IV). The second objective will form part of Chapter 6 concentrating on the detailed *Terpsichore*-led discussion, based on the rating comparison between similarly formulated questions related to the Tonal and SIP Modes. Specifically, such a comparison takes into account common factors assessed during the software analysis, such as general responsiveness to levels, ability to provide phrase completions without being aided by third parties, and average learner performance for each mode.

The main principle upon which tutors were directed to instruct the SIP environment is the detachment from the concepts of tonal music and pitched notes, meaning that learners are only expected to produce soundscapes resembling environmental stimuli, and experiment with alternative sound generation methods. Judging from the level description in Section 3.2.3, transition from sound recognition to a variety of composition and manipulation activities aims to address treatable aspects of the underlying ASD conditions and contribute to satisfying the reciprocal education-therapy relationship. Although such case studies as 'Melanie' (Orr, Myles and Carlson 1998 – Section 4.5) have proposed different orders of level instruction to the linear progress from Level 1 to 15, tutors were advised to follow the default level arrangement so that all behaviours, strengths and weaknesses of participants are observed under the same circumstances. The above were aimed at facilitating the learning process especially in classroom settings involving multiple participants at once, allowing however for some flexibility in personalising the elements of emphasis for each level, according to the learner's particularities. Tutors agreed to comply with these recommendations without reservation, especially since they supported the belief that the SIP mode levels are rationally arranged in terms of content.

As far as the ability to transition between levels is concerned (see Question 11.2), learners are on average slightly more comfortable in operating the SIP Mode than the Tonal one, with 7.75 > 7.36 respectively, while answers rated 8 or above are more frequent (22 as opposed to the Tonal Mode's 16). Moreover, significant differences in scores are reported between

Terpsichore's two working modes, given that a repeated measures ANOVA yields [$F(1, 27) = 6.996,\ p = .013$], while one-way ANOVA similarly returns [$F(5, 22) = 40.582,\ p = .00$], with most differences examined through a Tukey post-hoc test being statistically significant.[111] A justified explanation is that no direct musical content is provided, meaning that the majority of learners, who have not received any form of music education beforehand, are not challenged to abandon their comfort zones, similar to the remarks in Sections 1.2, 2.3 and 4.1 concerning ASD individual profiles and reactions to music education practices. Participants with prior musical awareness, specifically R18, R22 and R24, have scored at least 9 in both modes with regards to transitioning abilities; however, non-musicians did not exhibit significantly lower performances than their counterparts ($p = .077$ for the Tonal and $p = .133$ for the SIP Mode).

Question 11.3 investigates the ability of learners to follow directions conveyed by the tutor and the on-screen manual, as question 9.3 has done with regards to the Tonal Mode. Again, learners have delivered slightly improved performances in the SIP Mode on average (7.57 > 6.96), with a 71% of participants (20 in total) achieving ratings of 8 or above as opposed to 50% (14 HP) for the pitch-based environment. In this aspect, observed discrepancies between modes are also significant, as the results of [$F(1, 27) = 7.205,\ p = .012$] and [$F(6, 21) = 17.382,\ p \approx .00$] respectively demonstrate for the same repeated measures and one-way ANOVA as above. Remarks of Ockelford (2013b: 77, 105) on the different manners in which an ASD individual interprets indefinitely pitched stimuli, along with comments made on unconventional pitch perception and timbre preferences (see Section 2.1.2), possibly explain improvements in performance amongst numerous sample participants in the SIP Mode. A significant relationship is observed, following a one-way ANOVA between condition severity and responsiveness to SIP level demands, [$F(1, 26) = 7.063,\ p = .004$], with pronounced differences appearing in all pairs but the 'moderate – severe' one following a Tukey HSD test.

The qualitative presentation of open-ended responses regarding levels where learners exhibited maximum responsiveness, shows that nearly half of the participants have responded positively to all levels. Of the remaining 16, highest responsiveness was reported in Level 4 for eleven learners, while six participants were best occupied with Levels 1 and 6. In terms of sound content and educational objective, the arrangement of different audio clips in a timeline was found highly appealing amongst participants, while the simplicity in Level 1 format and the rotation of virtual on-screen objects, affecting audio volume and panoramic distribution in Level 6, are the primary reasons justifying increased preference to these levels. Interestingly, R18 exhibited encouraging responses in levels where she could detect, through the listening process,

[111] In this example, the transition magnitude for the SIP Mode was chosen as the dependent variable; $p = .00$ is true even after reversing variables in the SIP – TM relationship.

rudimentary elements consistent with tonal music, while R5 was amongst the few learners whose ability to progress through all levels was positively influenced by the activation of the metronome throughout *Terpsichore*.

Not all participants exhibited concerning performances in parts of the SIP mode. However, of the sixteen HP for whom such an issue has been indicated, eleven were discovered most susceptible to Levels 11 and 12, as the sound generation process using granular synthesis and waveform modulation disturbed these learners and sometimes obstructed their progress. For five HP, the high frequencies of generated sounds emerged as a predominant cause for irritation, while the intense and distorted nature of these stimuli was also deemed concerning in selected cases. This observation acquires special importance, as it contests, at least for the *Terpsichore* sample, the opinions expressed by researcher on the therapeutic benefits of granular synthesis in ASD (see Section 3.2), especially with relation to the preference for non-harmonic sound structures (Straus 2011, also see Section 2.1). The research assumptions confirmed as a result of performance analysis in these levels, are the improvement of various communication and behaviour aspects through sound stimuli perceived as 'consonant' or aurally pleasing (Nemesh 2016), combined with spontaneous reactions of the brain and nervous system to dissonant auditory content (Koelsch et al. 2006), despite the above not directly referring to ASD. This essentially implies that the ASD learners of the sample exhibit equivalent behaviours to the common neurotypical person after encountering a sound source incongruent with typical environmental or Western music stimuli. Furthermore, the four HP under the guidance of Tutor 2 exhibited exhaustion on occasions; two of these reported unwillingness to continue at the two-thirds mark, while the other two were still capable of completing the mode.

As in the Tonal Mode case, tutors were asked to provide individual ratings for all learners, in terms of performance in the main menu and the fifteen constituent levels. To start with, mean evaluations for each separate participant throughout the mode are mixed, with the most promising average ratings per human participant (APHP) recorded for such participants as R12, R14 and R26, all scoring above 8.5 following a complete set of SIP Mode sessions. In addition, slightly below half of the study participants demonstrated higher efficiency in this mode than in the Tonal one, while for six learners performance was approximately equal in both modes. Repeated-measures testing concluded that differences in ratings between these modes are recognisably not significant for this sample, meaning that a specific tendency towards improved achievement in either mode cannot be determined. This invalidates the hypothesis presented in the MN case study (Carrington and Graham 2001 – Section 4.8) that the SIP mode could indicatively be favoured in the event of non-existent prior music education, on grounds of the linguistic format of notes, durations and time signatures being absent in the SIP Mode. Mixed results in the assessment of performance differences between modes, correspond to the observations that Khalfa and Peretz (2007) on the similar emotional response of musically illiterate participants to stimuli with and without distinct harmonic content.[112] Finally, APHP results are significantly different for the predetermined ASD conditions ([$F(2, 25) = 4.071$, $p = .029$], $p = .043$ for the 'mild'-'severe' pair).

In terms of average performance per level (APL), ratings of 8 and above were measured for all learners in the Main Menu and in Levels 1, 2 and 4. The 8.75 mean evaluation of the Main Menu is explained by the sole necessity in operating a series of sliders to adjust volume of constituent soundscape components, while the entry-level structure of Level 1 also contributes to its equally favourable average rating of 8.82. The above evaluations, combined with the fact that individual ratings of 10 place participants in the 60th percentile of the sample, obviously result from the plain and straightforward objective of these environments. This statement follows a recommendation on educational component segmentation, as an initial facilitator for young learner achievement and behavioural control (Koegel et al. 2012). These increased performances may also derive from the highly positive, on average, reactions of participants, when informed about their impending occupation with the software (see Question 8.8 in Appendix IV). One-way ANOVA presents a significant relationship between these terms as far as the sample is concerned, [$F(6, 21) = 10.788,\ p \approx .00$], while the regression coefficient, $R^2 = .705$, indicates that initial reaction prior to first *Terpsichore* use may adequately predict increased efficiency in these levels.

Considering the above, the average evaluation for SIP Mode performance amongst all levels and participants, is almost equal to the exact same magnitude for the Tonal Mode (7.45 and 7.43 respectively). On the occasion of full zero response exclusion from the weighting process, an average rating of 7.64 is observed compared to the Tonal Mode's 7.77, while the full exclusion of learners supervised by Tutor 2 yields an average rating of 8.12, which is highly proximate to the Tonal Mode's 8.18. In short, the two comparisons made in accordance with exclusion criteria indicate slightly enhanced efficiency in the Tonal Mode, for learners who actively occupied themselves with *Terpsichore* in whole or partially.

[112] This statement supposes that soundscapes do not comprise pitch-defined elements and thus cannot be regarded as musically harmonic, even if such an environmental stimulus as falling rain or a light wind is not normally a cause for disturbance.

5.2.5 *Soundscape and Indefinite Pitch Mode (SIP): Information on key levels*

Levels 1-2

Having simplicity in mind, introduction to compositional concepts was elected to comprise fundamental audio-visual representations of flowing water, droplets, wind and moving leaves. This strategy remarkably assisted learners in commencing their experience with the mode, as they were highly adept, on average, at recognising the identity of the above stimuli during playback; more specifically, around 90% of participants scored 8 or above in the task outlined in Question 12.1 of the survey, including one learner from the sensitive group supervised by Tutor 2, apparently motivated by the entry-level structure devoid of overwhelming information. The ASD condition severity index appears to induce statistically significant differences in the above trait, $[F(2, 25) = 4.637,\ p = .019]$, lying in the 'mild – moderate' pair, at $p < .03$.

Level 3

In the SIP Mode, Level 3 aims to increase the emotion recognition capacity of *Terpsichore* users, by allowing practitioners and learners to deactivate audio and images related to negative emotional states. Almost all participants had these stimuli activated when the level was in operation, even partially throughout a session, with the exception being R10, R15 and R19. Of the thirteen explanatory comments recorded and processed in NVivo, three highlighted the level's importance in improving awareness of specific feelings, while three directly mentioned a positive contribution to the emotional state of learners.[113] To prevent the risk of wellbeing aggravation, the mode was activated only at specific intervals for two cases, while another two learners, specifically supervised by Tutor 2, employed this level mechanically and without a defined therapeutic purpose; the above are shown in Figure 5.7. Overall results demonstrate a convincing agreement with the reasons why music therapists elect not to conceal negative emotion representations, as these were explained in Section 3.2. A number of responses is in harmony with attempts to induce favourable behaviours and enthusiasm through special means of conveying representations of negative feelings (e.g. Bernad-Ripoll 2007, see Section 3.2), something that reflects the reliance of practitioners on meaningful conversations on the matter, to the extent that these were comprehensible to learners considering the particularities of their ASD condition.

[113] In the current study, no comments on sensory incapacity to understand any emotion were detected.

SIP Level 3 Activation (13 comments)	0
No - possible responsiveness issues	1
Yes - better understanding of emotions	3
Yes - general positive effects	2
Yes - impetus for discussion	1
Yes - improve behaviours	1
Yes - infrequent use	2
Yes - mechanical use	2
Yes - perceptual skill increase	1

Figure 5.7 *Individual comments concerning 13 of 28 learners, regarding the activation – or not – of stimuli expressing sadness and anger in SIP Mode Level 3.*

Level 4

In Level 4, the occupation of learners with the organisation of audio clips into a timeline, so that a dynamic soundscape with periodic crossfades is created, learner responses were promising, with regards to the improvement of temporal and spatial awareness, taking into account. Tutors provided their responses to Question 12.3 of the survey, in such a manner that ratings reflect the gradients between totally negative (0) and totally positive (10) response. Specifically, 68% of HP scored at least 8 in this aspect, while the rating of 9 is the most frequent; moreover, average or negative impact on the identity and source of sounds was recorded in all learners supervised by Tutor 2, as in the majority of previous occasions, while results differed significantly between the three assessed conditions of the disability, $[F(2,25) = 3.485,\ p = .015]$.

Levels 5-6

The operational principle of Levels 5 and 6, where sound sources are positioned at different positions around a circular sound map, appeared to greatly assist participants in developing awareness of sounds and other individuals within their surroundings, as judged by responses to Question 12.4. With the exception of learners under the guidance of Tutor 2, short-term improvements in these perceptual skills were observed as a result of the *Terpsichore* sessions, with ratings of 8 and above characterising three-quarters of the sample. Ratings vary significantly amongst different degrees of concentration pre-*Terpsichore* (ANOVA: $[F(4,23) = 6.482,\ p = .001]$), while significant differences lie between the three groups of negative and at least neutral concentration levels.

The feature of Level 6 that enables rotation of sound sources at varying speeds, appears to also have a remarkably positive impact in the mental state of participants, with indications of strong excitement being present in 20 HP, who have scored 8 or above in the relevant part of Question 12.4. Comments on the strong and concerning points of the SIP Mode were taken into account by tutors when recording ratings, which reflect the favourable reactions of excitement and emotional arousal, especially when rotation speed configuration is such that no rapid movements are observed on-screen. Significantly different ratings are measured amongst groups with varying ASD condition severities ($[F(2,24) = 5.829,\ p = .009]$ and $p = .008$ for the 'mild-severe' pair) and initial degrees of concentration[114] ($[F(4,22) = 9.04,\ p \approx .00]$ and $p < .01$ for all pairs involving the 'negative' condition).

Level 7

Ratings associated with Question 12.5, which refers to Level 7 and its emphasis on the construction of percussive sequences, infer a subtle but positive average effect of this environment on the participants' sensory processing abilities. Three out of four participants have been evaluated with a 7 or above, while scores between the three magnitudes of 7, 8 and 9 are evenly distributed. On the one hand, results demonstrate that percussion instruments stimulated the alertness of most learners through the frequent transfer of acute sound signals into their ears, in parallel to the 'rhythmic entrainment' method (Orr, Myles and Carlson 1998) described in Section 4.4. On the other hand, an influence of underlying sensitivity issues to sharp, low-attack timbres may be supposed. However, one-way ANOVA, with susceptibility to sharp or abrupt sounds being the independent variable, does not produce significant differences between groups who present and lack this characteristic. Nevertheless, it is interesting to mention that the two learners reported to present issues with intermittent sounds, have scored significantly lower than their counterparts, $[F(1,24) = 9.932,\ p = .004]$, although these differences may pertain to the generally increased performances of learners supervised by Tutors 1 and 3 as opposed to the Tutor 2 category.

As part of Question 12.5, it was also deemed important to assess possible changes in gross and fine motor movement, as a result of the percussive sounds heard at periodic intervals. As explained in the 'Melanie' case study in Section 4.4, auditory elements consistent with temporal awareness were proposed as a measure of countering motor skill deficiencies (Thaut et al. 1999; Thaut et al. 2009b; Hardy and LaGasse 2013), and the *Terpsichore* situation seems to be no exception. In fact, 21 HP have improved to various extents in the perceived regulation of motor movements, as manifested by corresponding ratings of 6 or above, while more substantial positive shifts – reflected in scores of 8 or above – characterise at least half of the study participants. Taking into account that number-based responses to these questions were provided for all learners, regardless of the prior existence of noticeable motor incapacity, it is evident that variations in type of motor skill and the existence (or not) of fine motor coordination issues are

[114] These ratings have been measured on the Likert 'positive' to 'negative' scale, with numerical representation used for SPSS coding and quantitative analysis.

responsible for significant differences in results (respectively: $[F(5,20) = 3.088,\ p = .032]$ and $[F(1,24) = 9.662,\ p = .005]$). Conversely, existence of a gross motor deficiency or any form of such incapacity does not significantly impact changes in movement control as a result of rhythmic structure deployment. Similar to previous examples, ratings seem to differ noticeably amongst groups with different assessed degrees of ASD condition ($[F(2,23) = 5.178,\ p = .014]$, $p = .028$ for the 'mild-severe' pair and $p = .054$, slightly above the significance threshold for the 'mild-moderate' pair).

Level 8

The operation of sliders to control low-pass and high-pass filtering for pre-set and loadable sounds in Level 8, aims to assist tutors in applying principles of both ear-training methods proposed in various ASD contexts, which are undesirable frequency filtering (Bérard and Brockett 2011) and gradual familiarisation of learners with comprehensive parts of the audible frequency spectrum (Tomatis 2005).[115] The *Terpsichore* walkthrough video provided to tutors was designed to employ strategies directed towards the reduction of susceptibility to specific frequencies, mainly the ones labelled as 'ultra-high' in the questionnaire (5 to 20 kHz), which were the most irritating for all participants before the outset of interface use. A qualitative analysis of potentially discomforting frequencies before and after *Terpsichore* sessions,[116] indicates that 11 HP have been able to reduce their susceptibility to at least one frequency spectrum, while for the remaining 17 no such noticeable changes were recorded after the occupation with Level 8 for a substantial period of time.

Ultra-high frequencies are the principal area in which the degree of irritation remains unchanged for various learners. As the preloaded samples in the SIP Mode contain frequencies distributed at multiple areas of the audible spectrum, it is possible that no substantial ear contact is made with ultra-high frequencies, especially when these occupy a secondary part of a sound's overall spectral content. Conversely, one participant (R15) initially found to present issues with low-end frequencies seems to have them resolved following the appropriate application of Level 8. Such audio samples as the drone and the blowing wind contain a substantial amount of frequencies merely higher than 20Hz, which may be suppressed through high-pass filtering, or isolated by annihilating all irrelevant frequencies, thanks to knobs available in this level. Reliance on preloaded stimuli was not the only course of action accessible to tutors, who also loaded various samples in existent slots, in an attempt to control the susceptibility of learners;

[115] Section 1.6.2 presents these methods in further detail.

[116] All such responses are accessible through the Microsoft Excel workbook (Section 12) that accompanies the analysis.

even so, the production of more substantial results may be accomplished through a lengthier dedication of tutors in this process, during further *Terpsichore* sessions.

Level 10

Question 12.7 of the survey is formulated in similarity to 10.6, as SIP Mode Level 10 concentrates on the completion of environmental sound sequences using colour-coded structures, relying on the principle behind which Tonal Mode Levels 13 and 14 were constructed, albeit in a simpler manner not indicative of tonal music. Considering the above, tutors have strongly felt, on average, that the sample guidelines provided to assist in independent phrase completion, are explicitly helpful in assisting learners to do so (roughly 86% of responses are rated 8 or above). Moreover, 71% of participants demonstrated strong potential in undertaking dialogical interaction with tutors and supporting individuals while this level was instructed, as reflected in scores from 8 upwards. Participants with echolalia as a diagnosed particularity presented significantly lower performances than their non-echolalic counterparts, with relevant ANOVA respectively yielding $[F(1,25) = 24.636,\ p \approx .00]$ and $[F(1,23) = 8.773,\ p = .007]$. The above results are nonetheless not significant for the three ASD severity conditions specified.

The ability of participants to provide completions to three-component phrases without mechanically copying existent material, is rated 7 or above for 81% of participants, and 8 or above for a slight majority, at 56%. These magnitudes are exactly the same with the ones associated with performance in Levels 13 and 14 of the Tonal Mode, while a relevant within-subject statistical test has not yielded significant differences in ratings between the above two cases. The same applies to the examination of whether either mode's phrase completion structure yields significantly different results. The above may be consistent with the fact that not all participants exhibit either an echolalic condition or a cognitive deficit, not allowing them to comprehend alphabet letters as a form of notation. By assessing rating differences between similar aspects linked to SIP Level 10 and TM Levels 13-14, producing *p*-values of at least .130, it may be concluded that neither echolalia nor the coexistence of mental retardation with ASD appears to affect improved efficiency in either of these components.

Levels 11-12

Levels 11 and 12 base their construction principle on the potential wellbeing benefits induced by granular synthesis explained in Section 3.2. That said, the lowest average ratings per human participant (APHP) appear in this environment, which is principally due to the overwhelming high-frequency content created after a number of settings has been employed. It is however encouraging that the sound generation formula introduced in the SuperCollider code for *Terpsichore* may be modified in real-time by moving parameter sliders as well as hovering around the screen with the mouse, while the Options window within the software allows for unwanted frequencies to be suppressed for all levels, as in the cases of participants R6 and R23. All things considered, participants were on average relatively satisfied with the software's user-friendliness, something reflected in the scores of 7 or higher for 53% of participants.

Ratings associated with responsiveness to the produced sounds reflect the difficulties presented throughout, but not to a worrying extent, as 46% of participants have their reactions to produced sound evaluated at least with a 7. The average response rating of 6.73 infers the occasional signs of irritation induced by the high frequency content, but also takes into account the contribution of tutors in alleviating such disturbances, as manifested in the relatively high percentage of scores above 7. No significant differences in participant ratings, of either user-friendliness or reaction to sounds, are observed amongst groups with different degrees of ASD condition severity.[117]

Level 13

This Level shares a common feature with the previous two ones, which is the reliance on granular synthesis and motivation as part of the complex soundscape composition process. The difference of Level 13 is that such a course of action belongs to the series of constituent activities simulating a laptop orchestra (LOrk) to achieve the above goal. Given the coexistence of natural and modulated environmental stimuli, along with waveform manipulation, granulation and deformation of loaded clips,[118] it is always possible to devise combinations of such elements that would ultimately invoke feelings of arousal and appreciation. This proved to be the case for the vast majority of learners, as promising scores in Question 12.8 prevailed (74% for 7 or higher, 60% for 8 or higher) regarding assessments of mental state evolution whilst Level 13 was employed in *Terpsichore* sessions. The exact same percentages apply to the soundscape aesthetic quality evaluation for Level 13, demonstrating that learners generally benefitted from the versatility offered in an effort to complete meaningful electroacoustic and abstractly pitched compositions. Such predicted effects of the LOrk principle on the enhancement of interactive communication (Snelling 2013: 13; Nason 2014: 170 – see Section 4.6) are potentially verified

[117] The existence of scores below 5 in three participants from the Tutor 3 group, contrary to none supervised by Tutor 2 in the majority of cases, justifies the above observation.

[118] Interface design allows for this level to be simultaneously used over multiple computers (see Section 3.2); however, in the practical study, all learners activated the LOrk elements of Level 13 in succession, on the computer provided.

following these results, something that encourages further investigation on the matter in more sizeable samples subject to *Terpsichore*-led education and treatment. Moreover, the two elements of Question 12.8 are closely related, given that ANOVA yields statistically significant results, $[F(5, 19) = 13.248,\ p \approx .00]$, while a good linear relationship may be established following correlation, $[r(25) = .82, p \approx .00]$. Consequently, these findings constitute an encouraging first step towards the effective application of interventions resembling the LOrk concept in individuals with ASD.

Level 14

To progress seamlessly across Level 14 and ensure optimum quality in recorded sounds, tutors were advised to employ either an external microphone or a set of headphones connected to the computer's microphone input, as alternative methods for the prevention of audio feedback. Despite that, tutors elected to utilise their computers without external aids for the majority of participants, as manifested by responses to Question 12.10 of the survey;[119] on these occasions, the insertion of external noise and other artefacts was countered by considerably reducing or muting the computer's volume while samples were recorded. In addition, tutors deemed the sound processing elements in the Level to be more than sufficient for the needs of learners, while it is highly probable that the sufficiency of sound configuration material plays a role in the overall performance of learners in Level 14 ($[F(4, 20) = 21.568,\ p \approx .00]$ following ANOVA).

Level 15

This level pertains to the concept of 'social stories', where combinations of sound and image are supported to represent a social situation and encourage learners to follow it in their daily lives. Emphasis on this particular level derives from the necessity to provide, at all stages of *Terpsichore*, content appropriate to the personality profile of each learner, in similarity to Tonal Mode Level 17 but with the replacement of notation with environmental and abstractly pitched sounds. To achieve maximum efficiency, it was deemed vital to facilitate the image and sound loading process for the tutor, responsible for guiding learners to select audio based its frequency content and compliance with a specific emotion (such as the 'drone' for relaxation or the 'rainfall' for sadness, as this was done in SIP Level 3). Regardless of the overall personality deficits characterising learners, the procedure of loading sounds and images was positively

[119] A total of 18 'none of the above' responses were recorded, which can be considered 16 in total for the purpose of this study, given that two learners supervised by Tutor 2 discontinued *Terpsichore* use after Level 10.

evaluated by tutors, who responded to Question 12.11 by providing ratings of 9 for eleven HP, while scores of 7 upwards are applicable to a total of twenty-three HP (82% of the sample). Furthermore, for twenty-two participants (79% of the sample), the mode was comfortable in its use at length throughout a session, while indications of excitement and increase tendency to communicate feelings to the tutor demonstrate that the above ratings took into account the Level's compatibility with general attempts to treat the underlying ASD condition in everyday contexts.

It is worth mentioning that one below-par rating of 4 originates from the group of learners supervised by Tutor 3,[120] while also some participants with moderate ASD symptoms (such as R2 and R11) recorded promising performances. Therefore, the ASD condition severity index is unrelated to Level 15 usability, as differences between these magnitudes are not significant. However, further ANOVA deduces that behaviour towards unfamiliar individuals ($[F(4,20) = 5.437,\ p = .004]$) and general emotional state prior to *Terpsichore* use ($[F(3,22) = 6.908,\ p = .002]$) are responsible, on their own, for significant differences in responsiveness ratings for Level 15, even though these two independent variables cannot be considered conjoint factors affecting such scores (two-way ANOVA yielded $p \gg .05$). In a nutshell, the generally positive responses to these types of social stories, considering that tutors provided sensory and spoken guidance to all participants, indicate that the simultaneous consideration of the 'modified social story' (Crozier and Tincani 2005) and 'Picture Exchange Communication System (PECS)' (Bondy and Frost 1994; Hammel and Hourigan 2013: 46-7) concepts may be adapted to *Terpsichore* and its focus on audio-based interventions.

<u>Response to panning controls in various levels</u>

Question 12.12 in the *Terpsichore* assessment survey attempts to determine the effect of levels comprising panning controls (such as 2, 9, 13 and 14) on the ability of learners to perceive the origin of sounds emitted both by environmental sources and by surrounding individuals. The effect of these levels in increasing spatial awareness of audio ranges from subtle (ratings of 7 for 29% of HP) to convincing (ratings of 9 for 32% HP), with learners supervised by Tutor 2 being the only ones rated 5 or below, as in the majority of situations. Results differ significantly amongst groups with different ASD severity conditions ($[F(2,25) = 9.754,\ p = .001]$, $p < .05$ for the pairs 'mild-moderate' and 'mild-severe'), general emotional state evaluations ($[F(3,24) = 5.194,\ p = .007]$, $p < .05$ for the pairs 'rather negative-positive' and 'neutral-positive') and behaviours towards peers ($[F(3,24) = 14.507,\ p \approx .00]$) and unfamiliar

[120] An explanation for this rating is the underlying hostility issues that learner R3 had been frequently facing prior to the start of *Terpsichore* use.

entities ($[F(4, 22) = 3.389,\ p = .026]$). The absolute value of correlation coefficients, for each of the respective independent variables, is at least $|r(28)| = .597$, indicating, in principle, that all four factors may influence the ability of learners to increase their awareness through *Terpsichore* panning controls.

5.3 Post-*Terpsichore* evaluation

Following the completion of all *Terpsichore*-led sessions, it is crucial to determine the effects of the interface and its constituent levels on a broad spectrum of areas associated with a user's musical development and wellbeing treatment. For this reason, all three tutors were invited to provide detailed information on how the behaviours, tendencies and personality profile of supervised learners changed after the finalisation of sessions. Understanding that these shifts are not expected to be permanent and should consequently not be treated as such, findings related to post-*Terpsichore* response concentrate on how the sustained incorporation of the software in classroom and casual contexts is expected to enhance compositional aptitude and provide meaningful wellbeing contributions. In Part C of the questionnaire, the syntax in the majority of questions determines whether the numerical rating scale of 0 to 10 respectively refers to 'totally negative – totally positive', or 'serious deterioration – significant improvement'. Tutors had the option of commenting on their numerical ratings whenever this was required; however, the manner in which questions are formulated generally resolves any uncertainties regarding the extent to which an improvement or unfavourable change has occurred.

5.3.1 Emotional state profile

As the distribution of ratings demonstrates, the effect of *Terpsichore* on the learner's comfort in conveying emotions to peers is convincingly positive, with the prevalence of ratings above 7 being 86% (24 out of 28 HP) as opposed to the four learners supervised by Tutor 2, who did not present noticeable effects. According to responses to the associated Question 13.1, the breadth of timbres and compositional elements in *Terpsichore* constitutes a strong indicator of how creative music interventions assist learners in becoming more extrovert, in similarity with previous attempts to employ music for this objective (Townsend 2014: 687; Berger 2017: 61, 66). Amongst the optional comments recorded to further clarify a response, three are consistent with improved ability of associated learners to externalise emotions and two with decrease in tendency to express negative feelings. Across-the-board improvements were exhibited in this aspect regardless of the assessed pre-*Terpsichore* ability to express emotions; the attempt to establish a relationship between the two via ANOVA yielded no significant differences. However, condition severity is a factor significantly affecting results, $[F(2{,}25) = 4.518,\ p = .021]$, although a *p*-value lower than .05 ($p = .029$) exclusively refers to the 'mild-severe' pair.

Positive effects, even to a slightly reduced extent, have been identified regarding the software's influence on the ability to recognise emotions of peers and decipher their intentions and disposition towards learners, as reflected in answers to Question 13.2. Prevalence of ratings from 8 upwards is considerably high, at 75%, while subpar ratings again characterise the Tutor 2 group. The average rating of 7.82, compared to the 8.36 associated with self-expression, is indicative of the sensory difficulties that various learners within the *Terpsichore* sample possess, especially as these issues explains the tendency of individuals with ASD to become anxious or distressed (Gillott and Standen 2007; Attwood and Scarpa 2013). An interesting observation constitutes the report for learner R4, whose capacity to understand emotions of his frequent acquaintances increased, while issues in doing the same with unfamiliar entities persist. Differences in ratings amongst individuals with varying abilities in comprehending externally expressed emotions are statistically significant ($[F(3{,}24) = 4.515,\ p = .012]$), which is also true when condition severity is the independent variable, ($[F(2{,}25) = 6.550,\ p = .005]$, $p = .004$ for 'mild-severe' and $p = .052$ for 'moderate-severe' pairs).

Responses to Question 13.3, regarding the overall emotional state as a result of comprehensive *Terpsichore* use, are strongly encouraging, given the high incidence of responses (64%) rated 9 and 10 in this area of mental integrity, combined with the average rating of 8.26. Moreover, at least slight improvements (rated 6) characterise all learners but the four ones under the guidance of Tutor 2.[121] Amongst the eleven optional comments provided with regards to the software's influence on emotional state, four indicate delight in using the software, two constitute direct suggestions of increased motivation to compose music as a result of widespread *Terpsichore* use, while for three learners a decent degree of anxiety mitigation was observed. Dependence of results on the index of condition severity is statistically significant, $[F(2{,}24) = 4.283,\ p = .026]$, while Tukey post-hoc testing yields borderline significant differences ($p = .048$) within the 'mild-severe' pair. Furthermore, the vast majority of learners exhibited strong

[121] It is apparent, through most results associated with Tutor 2's learners, that the serious symptoms of ASD prevented them from maximising their educational and therapeutic potential. These provoked tiredness and tendency to become upset, contrary to the 24 participants supervised by Tutors 1 and 3.

increases in their awareness towards sounds they encounter in their everyday lives, such as environmental stimuli and spoken discourse of their peers, as judged by ratings of 8 or above. Significant differences are observed among the three condition severity indexes ($[F(2,25) = 4.747,\ p = .018], p = .016$ for the 'mild-severe' pair).

In an effort to determine the possible influence of underlying emotional state profile and musical task performance on post-*Terpsichore* emotional responses, multiple statistical tests were conducted. Starting with Question 13.1, shifts in ability to externalise emotions is regarded as a dependent variable for statistical analyses. Observed differences are mostly significant when the ANOVA independent variable is performance in Tonal Mode levels pertaining to original composition ($[F(4, 23) = 14.372,\ p \approx .00]$, $p < .05$ for pairs involving the '2' rating group) and melody modification ($[F(7, 20) = 28.875,\ p \approx .00]$). In addition, linear regression analyses respectively yield values of $R^2 = .617$ and $R^2 = .709$; the higher of the two values pertains to Tonal Mode levels for melody modification, which appears to exert a stronger influence on emotional expression than performance in original composition levels.

Supposing that, based on elements and functionality, the original composition of soundscapes is feasible in seven levels of the SIP mode (4, 5, 6, 9, 11, 12 and 13), selecting the mean efficiency rating for these levels as an independent variable yields significant differences in the ability of learners to express emotions ($[F(20,7) = 19.060,\ p \approx .00]$). It is highly possible that a linear relationship exists between such ratings, as a result of relevant regression analysis ($R^2 = .814$). The plot of Figure 5.8 demonstrates that the distribution of ratings almost approximates a straight line with an upward slope ($y = 2.45 + 0.83x$) with this finding being statistically significant ($[F(1, 26) = 114.142,\ p \approx .00]$).[122] This, in simpler terms, means that learners performing better in levels of the SIP Mode with a focus on the original composition of soundscapes, tend to express their emotions more successfully after occupation with *Terpsichore* has concluded.

Furthermore, in the attempt to examine the collective effect of the three above independent variables, multiple regression analysis was conducted, which yielded statistically significant results ($[F(3,24) = 35.651,\ p \approx .00, R^2 = .817, R^2_{adj} = .794]$) but determined that only the parameter of mean rating in SIP Mode composition learners contributes to the prediction in a statistically significant manner ($p = .001$).

[122] Tables 5.7 onwards assist in comprehending the quasi-linear relationship between these variables.

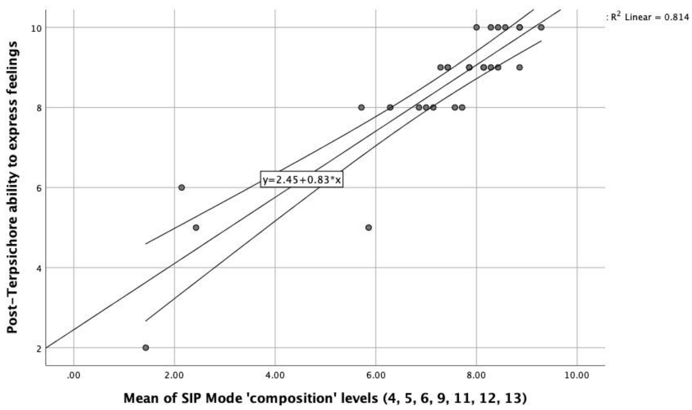

Figure 5.8 *Use of linear regression to assess effect of performance in composition levels of the SIP mode, on the ability to express feelings post-Terpsichore.*

Let V_{TC}, V_{TM} and V_{SC} be three independent variables respectively pertaining to: performance in Tonal Mode composition levels, Tonal Mode melody modification levels, and SIP mode composition levels. Regarding answers to Question 13.2, which are associated with changes in the ability to interpret emotions of surrounding individuals, results of statistical tests, in similarity to the Question 13.1 case, are portrayed in Table 5.7 below. All results are indicative of statistical significance, but a linear relationship of dependency can be more safely assumed for the variables V_{TM} and V_{SC}. Moreover, all three variables may be simultaneously treated as predictors for these emotional responses, thanks to their statistically significant contribution to results. In other words, a pronounced effect of composition and melody modification levels across *Terpsichore* on the ability to interpret feelings of others may be observed for the current human sample. This Table additionally examines the relationship of the above three variables on emotional state change post-*Terpsichore*. Analysis of findings yields that a quasi-linear relationship can be assumed for the variables V_{TM} and V_{SC} as above, while the overall shifts in emotional state may be jointly affected, by means of a linear relationships by all three independent variables if considered simultaneously. However, out of these three variables, only performance in the composition-oriented levels of the SIP Mode may be treated as a reliable predictor for these ratings.

Expression of one's own feelings				
Variable	**One-way ANOVA**	**Significantly different pairs (Tukey post-hoc)**	**ANOVA of Linear Regression Analysis (for R^2)**	**R^2**
V_{TC}	$F(4,23) = 14.372$, $p \approx .00$	All including rating of '2'	$F(1,26) = 41.798$, $p \approx .00$	**.617**
V_{TM}	$F(7,20) = 28.875$, $p \approx .00$	N/A	$F(1,26) = 63.279$, $p \approx .00$	**.709**
V_{SC}	$F(20,7) = 19.060$, $p \approx .00$	N/A	$F(1,26) = 114.142$ $p \approx .00$	**.814**
All variables together (V_{TC}, V_{TM}, V_{SC})				
		Lin. Reg. ANOVA (for R^2)	**Statistically significant predictors**	**Adj. R^2**
		$F(3,24) = 87.827$, $p \approx .00$	V_{SC} ($p_{V_{SC}} = .001$)	**.794**

Perception and understanding of others' feelings				
Variable	***One-way ANOVA***	***Significantly different pairs (Tukey post-hoc)***	***ANOVA of Linear Regression Analysis (for R^2)***	***R^2***
V_{TC}	$F(4,23) = 16.248$, $p \approx .00$	All including rating of '2'	$F(1,26) = 34.356$, $p \approx .00$	**.569**
V_{TM}	$F(7,20) = 23.572$, $p \approx .00$	N/A	$F(1,26) = 129.614$, $p \approx .00$	**.833**
V_{SC}	$F(20,7) = 9.661$, $p \approx .003$	N/A	$F(1,26) = 98.706$, $p \approx .00$	**.792**
All variables together (V_{TC}, V_{TM}, V_{SC})				
		Lin. Reg. ANOVA (for R^2)	**Statistically significant predictors**	**Adj. R^2**
		$F(3,24) = 87.827$, $p \approx .00$	All three ($p_{V_{TC}} = .034, p_{V_{TM}} \approx .00, p_{V_{SC}} = .017$)	**.862**

General emotional state				
Variable	**One-way ANOVA**	**Significantly different pairs (Tukey post-hoc)**	**ANOVA of Linear Regression Analysis (for R^2)**	**R^2**
V_{TC}	$F(4,22) = 13.668$, $p \approx .00$	All including rating of '2' and '5-7'	$F(1,25) = 36.863$, $p \approx .00$	**.596**
V_{TM}	$F(7,19) = 13.348$, $p \approx .00$	N/A	$F(1,25) = 57.728$, $p \approx .00$	**.698**
V_{SC}	$F(20,6) = 5.269$, $p = .024$	N/A	$F(1,25) = 91.397$, $p \approx .00$	**.785**

All variables together (V_{TC}, V_{TM}, V_{SC})			
	Lin. Reg. ANOVA (for R^2)	**Statistically significant predictors**	**Adj. R^2**
	$F(3,23) = 29.073$, $p \approx .00$	V_{SC} ($p_{V_{SC}} = .005$)	**.764**

Table 5.7 *Examination of relationships between changes in emotional state, and performance in composition and melody modification levels of the interface.*

It is also important to examine, from a statistical perspective, whether the special areas addressed in questions related to post-*Terpsichore* emotional state changes reliably reflect the effect of the software on these conditions, a procedure inspired by the *PLAIME* research (Cano and Sanchez-Iborra 2015: 267). This may be measured through a magnitude called 'Cronbach's Alpha' (Russell 2018), which designates a high degree of such consistency if the α-value is close to 1. Suggested SPSS calculation procedures (Ibid.; Laerd Statistics Website 2018) are followed by classifying all numerical responses in Section 13 of the questionnaire. The above lead to an α-value of .978, showing that results are highly consistent and representative of how emotional state has been influenced by occupation with *Terpsichore*.

5.3.2 Behaviour profile

In the *Terpsichore* questionnaire that tutors completed, Section 14 addresses the same areas of learner behaviour as the ones assessed before the onset of software sessions, which include demeanour towards familiar and unfamiliar entities, as well as tendency to inflict damage or self-harm. Reports on sources of potentially adverse learner behaviours are also included, along with rated evaluations on the reactions exhibited following termination of the software under timer expiration, or when a task has not been completed according to directions. Starting with behaviour towards peers and entities encountered in a classroom or therapeutic environment, responses to Question 14.1 reveal pronounced improvements as a result of occupation with *Terpsichore*, with 79% of participants being rated 8 or above and nine participants achieving a perfect score. Throughout the entire process, tutors guided participants on how to operate the software, either independently or with external supervision; however, the fact that constant interpersonal communication took place at all stages of *Terpsichore* instruction may constitute a reasonable explanation for this prevalence of perfect (10) and near-perfect (9) ratings. These results follow relevant observations made on the beneficial outcomes elicited by therapeutic strategies centred around music in behavioural routines towards peers (Whipple 2004; Hillier et al. 2011; Eren 2015). In addition, they aim to inspire therapists to employ the software on a sustained basis, on the hypothesis that such interventions are projected to improve the conduct of even the most seriously affected individuals with ASD (Boso et al. 2007), including the ones belonging to the Tutor 2 group.

The visual representation of ratings in the attached Excel data workbook demonstrates that the highest ratings have been recorded for learners instructed by Tutor 1, followed by Tutors 3 and 2, with significant differences in ratings presented throughout, $[F(2{,}25) = 64.512, p \approx .00]$, with $p < .001$ for all post-hoc tests. Most statistical analyses throughout the *Terpsichore* research yielded significantly divergent ratings only for pairs involving Tutor 2. This contrasting situation probably depends on the differences in how each tutor's personality is perceived by the study participants and contributes to their disposition towards assigned tasks, especially given that everyday communication occurs principally with entities familiar to the learner within the *Terpsichore* study. This belief takes into account the human factor as an integral part of educational processes, as not all individuals are expected to instruct an educational environment in exactly the same manner, even when they are expected to abide by guidelines. The above statement explains the statistical significance of unequal ratings in the '1-3' tutor pair, whereas the generally susceptible character of participants supervised by Tutor 2 has been identified, from the beginning, as a predominant performance inhibitor throughout the interface. Condition severity is also a significant factor explaining differences in learner behaviours ($[F(2{,}25) = 4.905, p = .016]$, with $p < .05$ for the 'mild-severe' pair).

The instruction of *Terpsichore* took place in overall familiar settings for learners, whose exposure to outsiders was infrequent not only during this time, but also throughout their everyday schedule. The above statements resulted in the majority of responses to Question 14.2 being, on average, less favourable by one point compared to the previous Question referring to peers and cooperating teachers (7.35 to 8.36). Thirteen HP have been rated 8 or above in their behaviour shifts towards unfamiliar individuals, while 7 and 8 are the most frequent scores within the sample as opposed to 10 for the previous Question. It is worth mentioning that, for five HP, no direct responses were provided, on grounds of minimal or non-existent prior contact with outsiders. Behaviours varied significantly between groups affected with ASD in a different manner ($[F(2{,}20) = 6.097, p = .009]$, with $p < .05$ for the 'mild-severe' pair), and between tutors ($[F(2{,}20) = 50.779, p \approx .00]$, with $p \leq .003$ for all pairs), with the latter variances being explained in the previous paragraph. However, even more subtle improvements are consistent with a less apprehensive disposition towards unfamiliar entities, as in the case of R23, for whom the tutor reported that musical elements in *Terpsichore* influenced the reduction of such behaviours when perceiving the existence of an outsider.

It is worth mentioning that 43% of learners did not exhibit tendency to inflict damage or self-harm at any instance, while for the remaining ones, such pre-existent issues mostly mitigated (ratings of 7 and above were recorded for 12 participants) or remained unchanged, with the exception of learner R7 (supervised by Tutor 2), who presented intense hostility issues at some point within the *Terpsichore* sessions. Only five out of the twenty-eight participants exhibited adverse behaviours at any point during the instruction process, as deduced through answers to Question 14.4. Three of these belong to the Tutor 2 group and were all reported to present anger as intensive occupation with the software led to their exhaustion, with R9 attempting to provoke self-injury. The remaining two participants did not intermit their occupation with *Terpsichore* under any circumstance, but only demonstrated mild indications of displeasure, in the form of either frail responsiveness to environments with high complexity (R3) or disturbance by the high-frequency sounds often emitted while Levels 11 and 12 of the SIP Mode were in operation. The five affirmative ('Yes') responses tend to characterise more seriously affected ASD cases compared to the negative ('No') ones; relevant ANOVA yields statistically significant results: $[F(2,25) = 5.102, p = .014]$, even if the associated post-hoc test determines that significance (same *p*-value as above) lies in the 'mild-severe' pair only.

The consideration of factors consistent with music and sound composition is an important step in determining how each thematic section of *Terpsichore* has affected behavioural responses in the sample, towards both familiar individuals and outsiders. In both cases, different performances in each separate sector of melody modification and composition using any form of sounds are responsible, in a statistically significant manner, for shifts in learner demeanour. However, as far as behaviours towards peers are concerned, the above observations are inapplicable when all three parameters are considered as joint independent variables. More specifically, only performance in the SIP Mode levels most associated with composition seems to predict the approximately linear relationship ($R^2 = .786$) between this behaviour and overall composition-oriented performance. However, in the second instance, regression analysis indicate that all three parameters can predict, with statistical significance and reliability, learner conduct when facing outsiders. Furthermore, a high linearity is observed when attempting to determine this relationship ($R^2 = .908$, $R^2_{adj} = .894$).

Behaviour towards peers and familiar individuals				
Variable	**One-way ANOVA**	**Significantly different pairs (Tukey post-hoc)**	**ANOVA of Linear Regression Analysis (for R^2)**	**R^2**
V_{TC}	$F(4,23) = 14.839$, $p \approx .00$	All incl. '2', '5-9'	$F(1,26) = 45.781$, $p \approx .00$	**.638**
V_{TM}	$F(7,20) = 19.327$, $p \approx .00$	N/A	$F(1,26) = 69.207$, $p \approx .00$	**.727**
V_{SC}	$F(20,7) = 7.544$, $p = .005$	N/A	$F(1,26) = 106.182$, $\approx .00$	**.803**
All variables together (V_{TC}, V_{TM}, V_{SC})				
		Lin. Reg. ANOVA (for R^2)	**Statistically significant predictors**	**Adj. R^2**
		$F(3,24) = 34.08$, $p \approx .00$	V_{SC} ($p_{V_{SC}} = .006$)	**.786**

Behaviour towards outsiders				
Variable	**One-way ANOVA**	**Significantly different pairs (Tukey post-hoc)**	**ANOVA of Linear Regression Analysis (for R^2)**	**R^2**
V_{TC}	$F(4,18) = 10.938$, $p \approx .00$	All including '2'	$F(1,21) = 25.907$, $p \approx .00$	**.552**
V_{TM}	$F(7,15) = 12.703$, $p \approx .00$	N/A	$F(1,21) = 86.089$, $p \approx .00$	**.804**
V_{SC}	N/A	N/A	$F(1,21) = 108.482$, $p \approx .00$	**.838**
All variables together (V_{TC}, V_{TM}, V_{SC})				
		Lin. Reg. ANOVA (for R^2)	**Statistically significant predictors**	**Adj. R^2**
		$F(3,24)$ $= 62.738$, $p \approx .00$	All three ($p_{V_{TC}} =$ $.004, p_{V_{TM}} \approx .007, p_{V_{SC}} \approx$ $.00$)	**.894**

Table 5.8 *Examination of relationships between changes in learner behaviours, and performance in composition and melody modification levels of the interface.*

Section 14 of the Questionnaire also examined, as part of Question 14.5, the overall reactions of learners towards their tutors in instances when the software is forced to terminate its operation, either because the timer reaches zero or the completion of Reward Mode tasks is unsuccessful. Most learners managed these undesirable occurrences by maintaining the calm and alleviating possible signs of negative behaviour, while three of Tutor 2's learners presented anxiety and sadness governed by their difficulties in progressing from one level to another while the mode is active. One-way ANOVA determines borderline significant differences in scores among the three documented ASD severity conditions, [$F(2,25) = 3.591, p = .043$], however all pairwise Tukey post-hoc test have shown no significant discrepancies between pairs. The joint consideration of all quantifiable responses in Section 14 of the questionnaire, leads to a Cronbach's alpha value of $a = .976$, showing that results are strongly consistent and provide a reliable view of how *Terpsichore* has influenced learner behaviour in general.

5.3.3 Communication and interaction

Following the completion of *Terpsichore* sessions, Section 15 of the questionnaire attempted to examine not only the ability of learners to interact with their surroundings, but also their aptitude in achieving communication in musical terms, characterised by the ability to follow the 'question-response' pattern upon which the so-called 'interaction levels' were constructed.[123] First of all, a convincing majority of participants presented an increased ability to verbally interact with tutors and accompanying peers whilst the sessions were underway, as ratings of 7 and above were reported in this aspect for all but Tutor 2's participants, combined with an average score of 8.25, amongst the highest in the post-*Terpsichore* evaluation part of the questionnaire. Ratings are significantly different for the three distinct ASD condition severities, $[F(2,25) = 5.321, p = .012]$, while the associated post-hoc test yields $p < .05$ for the 'mild-severe' pair.

Before the software was provided to all learners, eight of these were found to exhibit echolalic behaviours and tendencies in everyday communication. After the instruction of *Terpsichore*, this condition was reported to constitute a problem impeding progress and interaction with the software only for four HP, all supervised by Tutor 2 and exhibiting comprehensively severe ASD symptoms. This signifies that not all echolalic individuals within the sample are irresponsive to the task of independent phrase completion and the development of non-mechanical communication routines. As responses to Question 15.2 demonstrate, participants tended to complete the sample phrases in the 'interaction levels' with substantial success and reduced need for guidance (68% of HP were rated 8 or above), a result that does not significantly imply some relation to how seriously a learner is affected by ASD ($[F(2,20) = 3.235, p = .061]$). Occupation with the software altogether led to an increase in the fundamental dialogical communication potential of participants (75% of HP were rated 8 or above), while differences between mildly and severely disabled individuals are significant ($[F(2,25) = 5.056, p = .014]$ for all three conditions, $p = .016$ for the 'mild-severe' pair).

[123] For reasons of recapitulation, Tonal Mode Levels 13 and 14, along with SIP Mode Level 10, explicitly address this issue and are therefore regarded as 'interaction levels', a term conceived for *Terpsichore*.

Furthermore, non-echolalic individuals performed significantly better in post-*Terpsichore* musical and verbal communication tasks than their echolalic counterparts (phrase completion: $[F(1,21) = 10.128, p = .004]$, non-imitative communication: $[F(1,26) = 9.361, p = .005]$). However, this finding is not a definitive indication of echolalia's potential impact on the above performance indexes, as the exclusion of participants guided by Tutor 2 produces non-significant differences. Finally, the statistical interpretations shown in Table 5.9 indicate that roughly 80% of communication behaviours are affected by performance in levels relevant to composition or modification routines, with variable V_{SC} (soundscape composition) being the only significant predictor for such trends.

Communication with surroundings				
Variable	**One-way ANOVA**	**Significantly different pairs (Tukey post-hoc)**	**ANOVA of Linear Regression Analysis (for R^2)**	**R^2**
V_{TC}	$F(4,23) = 17.720$, $p \approx .00$	All excl. '7-8, 7-9, 8-9'	$F(1,26) = 50.742$, $\approx .00$	**.661**
V_{TM}	$F(7,20) = 43.441$, $p \approx .00$	N/A	$F(1,26) = 48.514$, $p \approx .00$	**.698**
V_{SC}	$F(20,7) = 14.514$, $p = .001$	N/A	$F(1,26) = 107.409$, $p \approx .00$	**.805**
All variables together (V_{TC}, V_{TM}, V_{SC})				
		Lin. Reg. ANOVA (for R^2)	**Statistically significant predictors**	**Adj. R^2**
		$F(3,24) = 38.74$, $p \approx .00$	V_{SC} ($p_{V_{SC}} = .021$)	**.807**

Independent music / sound phrase completion				
Variable	**One-way ANOVA**	**Significantly different pairs (Tukey post-hoc)**	**ANOVA of Linear Regression Analysis (for R^2)**	**R^2**
V_{TC}	$F(4,18) = 12.675$, $p \approx .00$	'2-7', '2-8', '2-9'	$F(1,21) = 38.607$, $p \approx .00$	**.648**
V_{TM}	$F(7,15) = 18.437$, $p \approx .00$	N/A	$F(1,26) = 91.988$, $p \approx .00$	**.780**
V_{SC}	$F(16,6) = 23.24$, $p = .00$	N/A	$F(1,26) = 86.653$, $p \approx .00$	**.805**
All variables together (V_{TC}, V_{TM}, V_{SC})				
		Lin. Reg. ANOVA (for R^2)	**Statistically significant predictors**	**Adj. R^2**
		$F(3,19) = 26.314$, $p \approx .00$	V_{SC} ($p_{V_{SC}} = .008$)	**.806**

Ability to provide non-mechanical answers to questions				
Variable	**One-way ANOVA**	**Significantly different pairs (Tukey post-hoc)**	**ANOVA of Linear Regression Analysis (for R^2)**	**R^2**
V_{TC}	$F(4,23) = 14.302$, $p \approx .00$	All incl. '2'	$F(1,26) = 41.172$, $p \approx .00$	**.613**
V_{TM}	$F(7,20) = 33.534$, $p \approx .00$	N/A	$F(1,26) = 85.983$, $p \approx .00$	**.768**
V_{SC}	N/A	N/A	$F(1,26) = 103.540$, $p \approx .00$	**.799**
All variables together (V_{TC}, V_{TM}, V_{SC})				
		Lin. Reg. ANOVA (for R^2)	**Statistically significant predictors**	**Adj. R^2**
		$F(3,24) = 37.426$, $p \approx .00$	V_{SC} ($p_{V_{SC}} = .011$)	**.824**

Table 5.9 *Examination of relationships between communication – interaction tendencies, and performance in composition and melody modification levels of the interface.*

It is also worth mentioning that the ability of *Terpsichore* participants to understand the presence of other individuals in their vicinity, increased noticeably, as suggested by the prevalence of ratings from 8 upwards (82%, 68% rated 9 or 10) in Question 15.3. This finding, combined with the high (8.21) average rating of responses, may be justified by the embodiment of ear-training methods principally introduced in the SIP Mode and the Options window. It additionally confirms the hypotheses formulated as part of the 'Nathan' (Brownell 2002 – Section 4.3) and 'GM' (Yau et al. 2015 – Section 4.4) case studies, both referring to individuals exhibiting an atypical attitude towards other people, on the impact *Terpsichore* may have in strategies to reduce imitative tendencies and enhance communication. Significant performance differences are observed, as in most instances, for the three ASD severity conditions examined ($[F(2,25) = 5.056, p = .014]$, $p = .016$ for the 'mild-severe' pair).

Finally, the calculation of Cronbach's Alpha for *Terpsichore*'s effects on communication takes into consideration all quantifiable responses in Section 15 of the questionnaire, including these that pertain to the perception of other individuals or the ability to compose phrases spontaneously and without mechanical repetition. Such a calculation yields that $a = .989$, indicating almost absolute consistency of these ratings with communication.

5.3.4 Miscellaneous activity information

An important mental state aspect measured during the post-*Terpsichore* analysis is the ability to concentrate on various actions associated with the software itself, and with conventional casual or classroom activities irrelevant to the software. These two sub-questions form part of Question 16.1, and the juxtaposition of their average ratings indicates a slightly improved, on average (7.93 > 7.61), capacity of concentrating in *Terpsichore* than in other activities, even though results on both occasions are promising. The findings confirm that various interventions employed in both modes, may be beneficial in improving concentration on tasks primarily consistent with the interface, as in the examples of 'John' (Nwora and Gee 2009 – Section 4.7) and 'Ted' (Wager 2000, Section 4.9). It is probable that rigorous familiarisation with the software in a manner inspired by Solati's (2016) research on 'intensive music therapy', has shifted learners' attention more towards activities explicitly relevant to it, than in miscellaneous tasks. These statements suggest that future long-term interventions involving *Terpsichore* should concentrate on the frequent return to compositional tasks centred around sharp timbres including percussion, inspired by similar research endeavours consistent with concentration improvement (Guzic et al. 2011; Willemin et al. 2018). It is worth mentioning that ratings pertaining to concentration are not significantly affected by ASD condition severity[124], indicating that *Terpsichore*'s structure potentially elicits concentration improvements in extensive contexts. However, different evaluations of attention span prior to interface use are responsible for statistically significant differences in concentration ratings for software activities ($[F(4,23) = 9.540, p \approx .00]$) and miscellaneous tasks ($[F(4,23) = 15.622, p \approx .00]$).

The software use has also produced a positive outcome simultaneously related to the aspects of communication and behaviour, given the score of 8 or above in Question 16.3, for 77% of HP, with regards to their reactions after a person within their direct involvement has urged them to follow a specific direction or guideline. The same phraseology was employed in Question 7.6, where tutors asked to provide the same information, albeit in a verbal Likert scale of 'positive – negative' as more general information was deemed necessary prior to the examination of reactions to *Terpsichore* in more detail. Considering that ratings of 9 and 10 may be classified as 'positive', 7 and 8 as 'rather positive' and so on, person-by-person comparison of transformed verbal scores indicates that the ability to follow instructions after *Terpsichore* was in operation has improved for seven individuals, deteriorated for three ones and remained

124 The resulting p-value for the case of concentration on non-*Terpsichore* tasks is .061, barely short of the statistical significance threshold.

unchanging for all other HP, whose compliance with directions nonetheless remains at a generally positive level.

Finally, responses provided to Question 16.4 determine that pre-*Terpsichore* motor skill concerns faced by participants have been reasonably alleviated. On average, the 8.25 rating for gross motor skills is representative of improvements made in this area mainly as a result of rhythmic activities (Thaut et al. 1999; Pavone and Ruggieri 2005: 191-2; Thaut and Abiru 2010: 263) and repetitive cues over time, especially when paired with social story interventions (Ockelford 2013b: 195-201). The same applies to the 8.67 average rating relevant to fine motor skills, something that has been helped by the incorporation of various hand movements in the software instruction process, as in the example of Question 10.1 that accompanies the Main Menu. Articulation of phrases and expression of thoughts is another aspect in which the software contributed positively, as is the dexterity to either sing or play a musical instruments – amongst the three individuals who had been doing so prior to research onset. Although the existence of motor skill enhancement elements in *Terpsichore* complies with corresponding proposals in the bibliography analysed throughout Chapters 1, 2 and 4, it is possible that the increased motivation resulting from learners' positive reactions to the successful completion of activities, has beneficially impacted short-term motor functions.

5.3.5 Music awareness, sound perception and creativity

Question 17.1 measures the extent to which *Terpsichore*'s goal of instructing music theory concepts to participants has been fulfilled. In Levels 15 through 18, composition of authentic melodies is encouraged through the recapitulation of fundamental theoretical content instructed in previous levels. According to tutor reports, learners appear to have responded positively to these objectives and subsequently developed some preliminary form of musical literacy, even if report results (average rating of 7.52 – reduced prevalence of 9 and 10 ratings) demonstrate less noticeable positive effects compared to other areas examined. The same applies to Question 17.2, regarding the ability to compose independent melodies without requiring guidance from a qualified music practitioner or acquaintance. The average rating of 7.18, along with the distribution of ratings (79% for 7 or above, 25% for 9 or above), is a clear indication that some successful effort has occurred in composing aurally pleasant melodies, although occasional reinforcement from tutors was required to enhance aesthetic quality.

The generally positive disposition of participants throughout *Terpsichore* has led to a strongly encouraging observation regarding their interest in making composition of tonal music and soundscapes an integral part of their daily lives. First of all, in Question 17.3, perfect scores of 10 have been recorded for 43% of learners in response to their assessment of how motivated they became to engage in tonal composition at future instances. This indicates that the software and primarily its Tonal Mode, stimulated the motivation of learners to release their creativity and discover their imaginative potential. With concern to Question 17.4 and the possible interest in designing and manipulating abstractly pitched soundscapes, a pronounced interest is also perceived, although perfect ratings of 10 are less frequent compared to the tonal music instance. In general terms, seven participants have been reported to exhibit a stronger interest in the pitch-based aspect of music than in soundscapes, six exhibit the opposite tendency, and the remaining 15 are equally motivated to engage in both composition alternatives. The above refutes the hypothesis on the possibly increased preference of ASD learners in the SIP mode, on grounds of content comprehensibility in *Terpsichore* originating from the nonexistence of special symbolism or verbal coding to represent tonal music notation. A joint examination of accounts reporting the unfavourable perception of external non-musical stimuli within the ASD population (Dodd 2005: 44; Frith & Baron-Cohen 1987, cited in Haesen, Boets and Wagemans 2011; Black and Tsumoto 2018), and the apparent preference, on various occasions, for tonal music (Treffert and Wallace 2002; Hammel and Hourigan 2013; Ockelford 2013a, b) and especially classical (Bhatara et al. 2013), constitutes a valid justification of the above argument.

Both response sets referring to *Terpsichore* interest follow the same significance pattern as the above examples following one-way ANOVA by ASD condition severity (Question 17.3: $[F(2,25) = 3.972, p = .032]$, $p = .028$ for the 'mild-severe' pair; Question 17.4: $[F(2,25) = 5.689, p = .009]$, $p = .008$ for the 'mild-severe' pair). This signifies that ratings amongst severely affected ASD participants are significantly lower in contrast to their counterparts. Judging from the scores provided throughout the Questionnaire for learners R7 through R10, it is appears that ratings provided mostly reflect the general difficulties encountered at different parts of the interface, combined with the mechanical movements recorded and the minimal attempt to achieve independence. This, however, does not detract from *Terpsichore*'s potential to inspire learners to compose pitched and non-pitched sound sequences, as answers concerning the vast majority of HP have demonstrated.

Responses to Questions 17.5 and 17.6 essentially constitute a breakdown and restatement of Question 17.2, as far as the ability to independently operate *Terpsichore* menus and levels is concerned. Firstly, although previous remarks do not designate an increased interest in composing soundscapes than tonal melodies, it is evident that the reduced overall complexity of the SIP Mode as opposed to the Tonal Mode enables learners to meaningfully operate levels with a greater degree of independence (TM: 29%, SIP: 50%). Due to the sometimes specialised or sophisticated notions conveyed in the Tonal Mode, occasional requests for assistance towards the completion of tasks constituted a more frequent occurrence (TM: 46%, SIP: 28%). However, the high prevalence of these two responses, accounting, on average, for three-quarters of participants, is an indication of learners' enthusiasm and willpower in completing compositional tasks and employing them to enhance their creativity and wellbeing. Responses associated with the learners supervised by Tutor 2 follow the same trend as previously, while the requirement for substantial tutor interventions was evident only in cases who were explicitly interested in *Terpsichore* but were partially hindered by their mental and cognitive incapacity.

5.4 Overall *Terpsichore* evaluation and tutor feedback

All responses in the *Terpsichore* questionnaire have demonstrated that the majority of participants exhibit generally encouraging performances throughout the software, whether these refer to the development of musical knowledge and compositional aptitude in both the tonal and soundscape domains, or to the treatment of ASD-induced deficiencies in emotional state, behaviour, communication and personality profile. When presented to tutors, the final Section 18 of the questionnaire intended to not only receive information concerning each participant's overall response to the software, but also to gauge educated practitioner opinions on the software's efficiency and future applicability to large-scale curricula and treatment programmes for individuals with ASD.

Analysis of responses to Question 18.1 demonstrate that participants have responded to *Terpsichore*, on average, with pronounced success and enthusiasm, with the rating of 10 being, at 39%, the most frequent amongst all learners; a quarter of HP are characterised by a performance index of 9, while responses of 7 or below only account for 21% of the sample. These results represent the strong approval of *Terpsichore* on most learners' part, while they are additionally indicative of an environment where the prospect of composing music leads to increased enthusiasm and ignites the desire to engage in compositional activities in a more sustained basis. Indicatively, male participant R1 (rated 9) claimed that he enjoyed the software and expressed his eagerness to incorporating it during his daily routines, even if some of its components were considered slightly difficult. Moreover, female participant R3 (rated 7) was happy to employ the software and its constituent levels, despite the need to overcome complexity issues with the assistance of the tutor, while changes to her emotional state were subtle but noticeable to peers, as she was capable of regulating her dismay and anguish caused by underlying family problems. As far as learners in the Tutor 2 group are concerned, ratings are either average or slightly disapproving, due to concentration lapses and tiredness emerging halfway through the instruction process.

Results are significantly different amongst groups supervised by the three tutors participating in the study ($[F(2,25) = 70.982, p \approx .00], p \leq .002$ for all post-hoc tests]) and amongst the three scales of ASD condition severity ($[F(2,25) = 70.982, p \approx .00], p = .01$ for the 'mild-severe' pair]). Taking into additional account the number of sessions devoted by each instructor on the interface (at least 18 for Tutors 1 and 3 as opposed to 6 for Tutor 2),[125] these statistically significant differences may predict, in principle that tutoring practices and the structure of educational plans, in the form of a collective programme or IEP, are responsible for the enhancement of favourable consequences (more information in the following Chapter). It is important to mention that *Terpsichore* performance, as measured through Question 18.1, does not significantly vary between participant genders ($p = .831$). The consideration of age, as the independent variable, leads to significant differences following one-way ANOVA ($[F(9,18) = 5.715, p = .01]$), but does not suggest that age affects *Terpsichore* performance whatsoever, since computed indexes for bivariate correlation, $r(28) = neg(.183)$, and linear regression, $R^2 = .033$, neither suggest the existence of a clear linear relationship, nor are they significant at the $p_{crit} = .05$ level.

As part of Question 18.2, tutors evaluated the extent to which the therapeutic consequences of *Terpsichore*, outlined in mental state improvements and personality development, have been influenced by the educational qualities of the interface associated with sound and music awareness, along with the increased concentration on creativity rather than passive instruction practices. With each response referring to a different participant, the 'strongly agree' answer prevails (61%), followed by the 'moderately agree' (36%) and neutral (4%) responses.[126] In short, tutors concur with the assumption that the mutual relationship between education and therapy in music is fulfilled thanks to *Terpsichore*. Two-way ANOVA between performance ratings, as measured by Question 18.1, and scores in the Tonal Mode composition and melody modification levels (as two independent variables), is indicative of statistically significant differences ($[F = 3.840, p = .036]$), as is one-way ANOVA with mean performance in SIP Mode composition levels serving as the independent variable (($[F(20,7) = 9.850, p = .002]$), something that confirms the arguments provided by tutors on this relationship.

[125] The physical and mental endurance of learners was taken into account in personalising sessions and determining their number and duration in each context, combined with the possibility of *Terpsichore* interfering with the everyday work schedule of practitioners.

[126] On this occasion, as in the rest of this Chapter, percentage values were rounded to the nearest integer.

Instructors participating in the *Terpsichore* research are unanimously approving the *Terpsichore* software, having rated it with a perfect score (10) as part of Question 18.4, in terms of their personal satisfaction whilst they were assigned to instruct the software. These responses are consistent with the positive consequences in educational potential, motivation and various aspects of mental state, discovered in at least four-fifths of the research sample, while they also reflect the continuous interest of tutors to progress with software instruction even during its most challenging parts. Tutors strongly recommend *Terpsichore* to parents, therapists and miscellaneous practitioners associated with mental disability treatment and ASD specialization, as perfect scores indicate in Question 18.5. Finally, they are in unanimous agreement with the belief that the interface has the potential to assist in popularising the concepts of creative music and sound composition, in the endeavour to optimise quality of life for people with ASD.

Below are the three concluding responses of instructors regarding their overall opinion on *Terpsichore*. These indicate their pronounced satisfaction by the software and its potential to render creative music practices a decisive part of the lives of individuals with ASD, while proposing ideas and strategies for future application of the software:

> The software is innovative, very interesting, and close to the interest of learners who love occupying themselves with music and creating music with the assistance of a personal computer. My learners all enjoyed it and are enthusiastic about using it again in the future. They expressed their impatience and often asked me when *Terpsichore* would be used again in class. (Ms. Persefoni-Alexia Sergi [Tutor 1] 2020)

> The software is very well designed, and the breadth of capabilities offered in various knowledge fields relating to music makes it particularly engaging. I wish I had more available time to assist learners in familiarising with it, but I am confident that a less pressurised schedule will allow me to instruct it more gradually and help my students achieve improved results to the ones attained. (Ms. Panagiota Kyriakidou [Tutor 2] 2020)

> The software definitely provides multiple and advanced capabilities for an autistic learner, in an effort to develop various skills and improve daily life. It contains interesting tasks that all learners completed with comfort and eagerness, making them happy and fascinated about music composition. In the future, emphasis on the resolution of problems occasionally caused by sensitivity to high-pitched content is recommended. (Mrs. Chrysoula Papakirykou [Tutor 3] 2020)

5.5 Summary

The purpose of Chapter 5 was to determine the responses and efficiency of the *Terpsichore* software on twenty-eight adolescent and adult participants, in four special education institutions in the Attica region of Greece. Three certified tutors were assigned the task of instructing the contents and constituent modes of the interface over a number of sessions deemed sufficient for this purpose (18 for Tutors 1 and 3, 6 for Tutor 2). In all research instances prior, during and after the *Terpsichore* sessions, instructors completed the detailed Questionnaire that accompanied the software package, as objectively as possible and under active researcher supervision. Their responses to multiple-choice and open-ended questions were logged through the SurveyMonkey online platform, and subsequently extracted for quantitative and qualitative analysis using Microsoft Excel, IBM SPSS and NVivo. Overall results indicate that the vast majority of learners were highly responsive throughout the software and exhibited similar performances in the Tonal and SIP Modes, while simultaneously expressing joy and enthusiasm as a result of their efforts and progression within the interface environment. Their actions not only within *Terpsichore*, but also during their active interaction with tutors, demonstrated an increase in motivation to engage in interpersonal communication and creative compositional tasks, combined with a tendency to eliminate adverse behaviours and regulate their movements when performing software-based and miscellaneous activities.

An estimated 85% of all participants exhibited, on average, at least some noticeable improvements in various areas of mental state, musical cognition and personality profile development, with 70% of sample results reflecting a strongly promising impact of *Terpsichore* on the aforementioned fields. The only exception to this trend pertains to the four learners supervised by Tutor 2, whose substandard performances resulted from tiredness and difficulties in maintaining sustained attention. Most ratings are significantly different between the groups of mildly and severely affected individuals, as well as Tutor 2 and any other instructor, while some differences associated with communication and other mental particularities coexisting with an ASD diagnosis are responsible for the distribution of selected responses. Furthermore, the hypothesis of *Terpsichore*'s compositional elements having a direct impact on aspects consistent with music therapy and mental state rehabilitation may be accurately supported for no less than 80% of participants, which validates tutors' agreement with the belief that music therapy objectives are fulfilled thanks to the incorporation of creative music occupation in the software. Learners and tutors were ultimately pleased with *Terpsichore* and are perfectly eager to recommend the interface to professionals and institutions where treatment of individuals with ASD is at the forefront of their daily occupation.

CHAPTER 6

DISCUSSION: OBSERVATIONS ON *TERPSICHORE* EFFICIENCY AND ASSESSMENT IN RELATION TO RESEARCH AIMS

The attempt to bridge potential knowledge gaps between potentially incongruent areas of theoretical and practical expertise, including psychology, mental disability research, musicology, music therapy and computer science, clearly indicates a primary attempt in evaluating *Terpsichore*'s strong points and areas possibly subject to improvement. The current Discussion intends to determine which instances of *Terpsichore* provide a positive contribution to the overall educational and therapeutic processes, something achievable by explaining how appropriately the learners reacted to these instances and their combinations within the software.

The case study approach implemented in Chapter 4 constitutes a foundation for the extraction of preliminary information regarding the areas in which *Terpsichore* appears to be most efficient and beneficial for the ASD population. However, more precise and comprehensive observations should be established according to the performances of actual participants, to which the software was provided for extensive use under qualified practitioner supervision. The detailed assessment questionnaire should form a constructive basis for the evolution of the current discussion, so that multiple aspects of educational efficiency and therapeutic potential are addressed. In this way, the arguments presented throughout this Chapter will not exclusively constitute a standard evaluation of whether *Terpsichore* assists individuals with ASD in any way, but will rather provide a detailed educational and treatment framework concentrating on composition as a core knowledge field, with a view of acquiring a definitive social impact encouraging practitioners to employ it on a sustained basis in disability contexts.

6.1 Principal observations and comments

6.1.1 Interface design

Despite the requirement of adding and modifying a number of characteristics according to the points of weakness and attention determined through the case study approach, the *Terpsichore* interface is still sufficiently compact to fulfil its desired purposes without excessive complexity being necessary. An example is the combined inclusion of the User Manual and the Reward Mode within the same level, which occupy a substantial portion of the screen. Nevertheless, these enhancements are crucial in providing the necessary guidance to a learner in order to maximise learning potential and gradually work towards the completion of achievements worthy of favourable or congratulatory reinforcement by the tutor, as discussed in Section 3.4. This purpose is also encouraged by the function of the User Manual and the Reward Mode as complementary entities, given that the information discussed in the manual, combined with the recommended task routine that delivers a reward if completed successfully, are directed towards making *Terpsichore* activities more exciting and capable of instigating similar emotions, especially when a learner's ASD condition induces sensory processing abnormalities.

The advantage of *Terpsichore* being compact despite its reliance on several instruction elements, is more evident when the software is evaluated against the 'musicking for all' concept (Holone and Herstad 2012) as described in Section 1.4. The purpose of the current interface matches, to a reasonable extent, the objective set by the authors with regards to favouring proactive involvement in musical activities, without prior musical knowledge serving as a prerequisite (Ibid.). However, the requirement for extensive calibration of external objects is substituted with a user-friendly approach realisable only with minimal equipment, such as a conventional computer setup, to satisfy the same 'musicking' proposal and extend it to targeted creative practices.[127] In *Terpsichore*, this has been achieved through carefully planned colour coding and component structuring to enhance the comprehensibility of each level. All tutors identified and embraced these advantages during both test runs and application to supervised learners, as associated questionnaire responses demonstrate, which evidently constitutes an encouraging sign for the realisation of compositional tasks.

[127] The term 'targeted' is employed to explain the educational regulations and constraints by which the *Terpsichore* interface is governed.

The bibliographical case study research component, examined in Chapter 4, attempted to identify the elements of *Terpsichore* that would expectedly elicit positive shifts in the treatment of individuals within a broad range of different ASD-compliant conditions. However, this approach was also employed during the software construction and prototyping stages, in order to address possible design shortcomings and further optimise on-screen arrangement and functions for efficiency and compliance with the desired educational and therapeutic goals. In other words, *Terpsichore* has been designed in accordance with ‘evidence-based’ practices (Møller et al. 2002; Reichow and Volkmar 2010), taking into account a broad spectrum of actual learners’ characteristics, on which the layout, level arrangement and facilitating enhancements are noticeably dependent.

Such case study learners as ‘Melanie’ (Orr, Myles and Carlson 1998 – Section 4.5) and ‘John’ (Nwora and Gee 2009 – Section 4.7) could achieve increased benefits during *Terpsichore* occupation when commencing instruction through SIP Mode Levels 7 and 8, for reasons associated with rhythmic awareness and suppression of undesirable frequencies. Nevertheless, the collaborative setting of a classroom or a casual setting where instructors and parents contribute to learner supervision and progression, creates the requirement for a more uniform *Terpsichore*-based curriculum to be established. In this manner, the needs for personalisation to foster social inclusion (Campbell and Scott-Kassner 2014: 407-8) are addressed to an extent not necessarily including reorganisation of levels, but rather personalisation of tasks adhering to a sequence originating from the first level. In this situation, the software aims to exploit its educational value and emphasis on creative music and sound composition to formulate a reciprocal ‘education-therapy’ loop, in which the ability to complete educational tasks leads to evidence of emotional arousal and willingness to adopt controlled behaviours, in turn stimulating learner interest to perform compositional activities at length.

The consideration of *Terpsichore* design involves, apart from graphical content and level structure, the quality of sampled and synthesised sounds within the interface. The SuperCollider platform is versatile in the ability to manipulate loaded waveform sounds towards the creation of new content, as well as in the transformation of mathematical algorithms into synthesised audio. In the Tonal Mode, the diversity of timbres at the disposal of learners was deemed sufficient on all cases, even if the violin was proposed, on a few occasions, as a recommended additional instrument sample. Additionally, the sustained and mostly successful efforts to produce melodies imply the defining role that sound selection and parameter configuration played.

In the *Terpsichore* layout, visual differences can be investigated in conjunction with the contrasting learner profiles, as these have been assessed throughout the practical study and the virtual cases and justify the mental condition differences that classify ASDs as pervasive. SIP Mode levels rely predominantly on images with only minimal text[128] as opposed to the TM, which comprises greater amount of verbal content. Upon undertaking the case study analysis, the least possible text was recommended for individuals with perceptible language deficits induced by ASD, as for instance in the case of 'Ted' (Wager 2000, Section 4.9) who would benefit from widespread imagery and a direction by the tutor to emphasise on auditory rather than visual elements of levels, before gradually moving to independent level navigation.

Still, the reliance on verbal content especially after the User Manual and Reward Mode are activated, did not constitute a worrying issue for the majority of actual participants, as responses to Questions 8.1 and 8.5 of the survey designate (see Appendix IV). The underlying existence of cognitive difficulties as an adjunct to ASD, may contribute to some difficulties in verbal comprehension, even though mental retardation coexistence is not responsible for significantly decreased ratings ($p > .05$ following ANOVA). Still, the action of disabling the User Manual and Reward Modes whenever necessary, leaves only letters, plain lexical cues and notation visible on-screen, something in agreement with the previous paragraph's suggestion of limiting complex content to what is absolutely needed. Notation may be regarded as some form of shape-based imagery, so that it is distinguished from scripted material. In addition, note symbols constitute fundamental means of communication in musical terms (Ockelford 2013b: 85-6) upon which the cultivation of creative music and performance skills may be established (Hussain 2018). This argument clarifies that *Terpsichore*'s Tonal Mode should contain some form of intelligible language designed to provide an essential theoretical framework for the completion of levels and associated requirements, something that has indeed contributed to favourable consequences in compositional efficiency, as observed in relevant questionnaire ratings.

An area that would benefit from programming improvements, at future *Terpsichore* editions, would be the granular synthesis algorithm, whose current format tends to elicit the emission of ultra-high frequencies to a point potentially irritating sensitive participants. Verbal or software-based tutor interventions are crucial in alleviating this issue, in similarity to the disposal of inconvenient frequency content for this purpose (Sandé 2017). However, the documented reactions of various participants in these levels assume that the practical application of 'Auditory Integration Training' (AIT) methods (see Section 1.6) should not neglect the existence of high-end frequency sensitivity issues. Specifically, their regulation may be achieved through a lengthy occupation focussing on the repetition, over time, of the potentially irritating levels to reduce susceptibility (Zakari, Poyade and Simmons 2017: 61).

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[128] Reference to 'minimal text' excludes the verbal User Manual and Reward Mode, mainly intended for activation and use by peer tutors of a normally neurotypical state.

6.1.2 Assessment of versatility and association with various ASD treatment methods

The levels included in *Terpsichore*'s both modes, along with the guidelines provided to tutors through both the on-screen User Manual and the walkthrough video, are inspired by various methods described and analysed in Section 1.2, including Nordoff-Robbins, Developmental Therapy (DT), improvisation, 'extemporisation' and DIR-Floortime. Although human participant research did not specifically draw attention to any of these methods, the existence of such an association derives from the attempt to match the content of interface levels with the requirements of learners. This is done on the justification that each different method takes into consideration the components that characterise the learner's overall condition. For instance, in the 'QC' case study (Mottron et al. 1999, Section 4.3), the incorporation of *Terpsichore* levels into learning sessions was based on the age-dependent 'Floortime' method (Greenspan and Wieder 2006) and its pairing with DIR, in accordance with appropriate disability politics deployment to minimise adverse wellbeing consequences (see Section 1.6). Likewise, the 'Ted' case study (Wager 2000, Section 4.10) is congruent with the Nordoff-Robbins music therapy (NRMT) method. Specifically, the Tonal Mode's choice on grounds of suitability, combined with the selection of levels best addressing appropriate treatment areas, complies with the already existent, albeit scattered and unorthodox, musical skills that justify intrinsic music appreciation as a means for employing NRMT (Kim 2004: 322, see Section 1.2).

The practical research component exhibits two important differences to the case study component, as far as the simulation of disability politics methods is concerned. Firstly, in the virtual participant instance, emphasis was given on one specific instruction mode per learner (TM or SIP), according to deficits and particularities induced by ASD. In research involving actual learners, the choice of recommending tutors to instruct both modes during *Terpsichore* sessions obviously aims to render the learning process as equal as possible for all partaking entities, without discrimination. However, the selection of the Tonal Mode as a common starting point for software users, despite possible structural and lexical difficulties, is the existing interest of all participants in popular music genres, such as pop and classical, thus justifying the inherent appreciation of music on which active occupation should commence according to NRMT principles (see Section 1.6).

The second difference pertains to the fact that *Terpsichore* instruction process does not explicitly follow a specific disability politics (DP) method, but rather extracts important points from the most representative strategies in an effort to facilitate familiarisation with key concepts of composition for wellbeing purposes. For instance, the categorisation of both modes into thematic areas of gradually increased difficulties is an example of a 'Developmental Therapy (DT)' alternative being applied, especially considering the method's concentration on step-by-step acquaintance with intended compositional tasks (Aigen 1995; Trautman 2007; Vivanti et al. 2013: 1722) or the use thereof to ideally improve wellbeing on a gradual basis (Gardstrom and Hiller 2010; Goodman 2011: 185).

Inspiration may also be drawn from the TEACCH method, considering the virtual manual and reward structures playing the rudimentary role of an *in vivo* instructor, virtually interacting with learners whenever necessary (Mesibov et al. 2004: 11-6) as an adjunct to the physical tutor, whose role as both an active collaborator and a supervisory observer complies with TEACCH, as is the case with *Terpsichore*'s flexible structure (Ibid.). The above are regarded as contributing factors to behaviour and emotion regulation, as a result of occupation with the interface, even in cases where such changes are subtle and similar to the ones observed in a recent attempt to centre an adult music therapy intervention around TEACCH (Virues-Ortega, Julio and Pastor-Barriuso 2013). The targeted approach followed in the two instruction modes takes into close consideration NRMT's focus on intrinsic music and sound appreciation (Nordoff and Robbins 1971; Kim 2004; McDermott and Hauser 2005: 29), while the ability to filter frequencies wherever required and to form soundscapes with variable frequency content satisfies the requirements set by both AIT sub-methods in efforts to reduce hypersensitivity to initially disturbing sounds (Tomatis 2005; Bérard and Brockett 2011, see Section 5.2.5). In a nutshell, *Terpsichore* concentrates not on a definitive DP strategy employed in conventional music therapy methods, but rather on an innovative combination of characteristics designed to promote creative occupation with sounds.

6.2 Principal areas of software influence

The *Terpsichore* research investigated, amongst others, whether the interface is capable of not only addressing separately the areas of creative music literacy development and composition-based music therapy, but also whether the acquisition of sound awareness and music knowledge, combined with its implementation in targeted composition routines, is responsible for positive changes in diverse aspects of learner wellbeing. As a primary step towards resolving the above matter, it is important to critically discuss the areas in which *Terpsichore* was beneficial for the actual human subjects that participated in the pilot study of Chapter 5, while also considering the expected areas of benefit as these have been deduced through the case study approach of

Chapter 4. This analysis is bound to serve two purposes, which are the determination of the software's most notable effects in music curricula and therapy sessions for individuals with ASD, and the discovery of similarities and differences between case study assumptions and real-world research results. In the *Terpsichore* context, actual research findings always prevail compared to bibliography-based case study assumptions, as the former constitute a first-hand indication over the performance and reactions that real participants exhibit not with sporadic elements that also feature in the interface, but with the exact interface architecture itself. These findings also serve as an impetus for further recommendations to enhance learner performance and reliability of results, considering long-term plans for software commercialisation.

6.2.1 Case study analysis remarks

The bibliography-based analysis assisted in identifying various areas consistent with the instruction of musical concept that are most relevant to the needs and particularities of each participant, along with the areas of mental health treatment in which an interface-based learning structure would be most efficient. The information in question, accessed in detail through Chapter 4, is summarised in Table 6.1 below. The case study analysis reveals that the areas where *Terpsichore*'s implementation in actual human participants may be most effective, are peer communication, regulation of everyday behaviour, motivation to perform tasks and relative pitch development as a foundation for developed musical creativity and compositional aptitude.

ID	Age	Areas of deficiency associated with ASD	Working mode	Key interface elements relevant to music education	Areas of positive impact
1. Mike	12	Sensitivity to loud sounds, lack of internal motivation, hesitancy in communicating, fear of high musical complexity	TM	Identification of notes both as letters and Western music symbols	Musical creativity, cognitive skills, motivation, awareness of the outside world (S), behavioural control (S)

2. QC	≈ 18	Cognitive delays, isolation from others, relative pitch problems, lack of concentration on appropriate tasks, echolalia, not responsive to high musical complexity	TM	Awareness of relative pitch, application in modifiable and fully original melodies, acquaintance with major and minor scales	Relative pitch, musical independence, reduction of stereotypical behaviours, motor skills (S)
3. Nathan	6-9	Oversensitive to other people; communication problems, lack of voice volume control, difficulties in transitioning between learning components	SIP	Rhythm and tempo awareness, phrase completion and formation, basic sound layering	Behaviour and tantrum control, virtual and peer communication, motor skills, improved volume control (S), tolerance of peers (S)
4. GM	9-11	Serious issues in cognition and interaction with others; high tendency to vocalise rather than speak or perform an asked task	TM	Pitch recognition with or without a piano, Schoenberg-inspired note rearrangement	Social integration, word formulation, plain communication, motivation (S)
5. Melanie	11	Cannot speak clearly; has temper tantrums upon request rejection	SIP	Rhythm and tempo awareness, coordinated LOrk-inspired composition	Motor and cognitive skills, communication, creativity, behaviour and outburst control (S)
6. JPH	8	Echolalia; unclear vocalisations to indicate task disapproval; workspace disorganisation affected by abnormal behaviour	SIP and TM	Phrase completion and formation	Communication skills, detachment from echolalia, behavioural control (S), task and workspace coordination (S)

7. John	5	Took time to develop fundamental speech; oversensitive to sensory and auditory stimuli affecting behaviour and concentration; very limited preferred activities due to oversensitivity	SIP	Time-dependent phrase formation	Sensory processing, behavioural control, motivation, task responsiveness, concentration, speech integrity (S), communication (S)
8. MN	13	Only comfortable in adhering to specific routines without change; fear of interaction with others; difficulties in following classroom curricula; susceptibility to tantrums under difficult situations	SIP	Phrase completion and formation	Compositional aptitude, emotion recognition and expression, motivation, linguistic and communication skills (S)
9. Ted	36	Unorthodox piano execution, motor skill deficiency implied by rhythm maintenance problems; very brief or non-existent communication	TM	Musical scales, phrase completion and continuity, basic sound layering, twelve-tone composition	Relative pitch, musical phrasing, plain sentence formation, emotion expression, improvisation skills, concentration, distraction avoidance (S)

Table 6.1 *Critical summary of findings based on the case study approach of Chapter 4. (S) indicates secondary areas of positive impact.*

Findings from the eight learners converge to the assumption that positive effects on peer communication derive chiefly from *Terpsichore* levels associated with the three educational objectives of phrase manipulation and completion, musical response to given patterns, and open-format composition inspired by visual cues and social story representation. For instance, discussed hypotheses on Ted (Wager 2000, Section 4.9) demonstrate that the Level 6-7 and 11-12 pairs manifest themselves as interaction facilitators, as they respectively exploit the association of musical patterns to everyday images of actions and individuals, and the increased perception of musical signals as a result of direct audio-visual feedback. The same applies to the incorporation of structures specific to communication development in Levels 13 and 14 of the Tonal Mode, from which such learners as Ted would be able to benefit as analysed in Section 4.8. Likewise, rhythm-based interventions in the software's SIP Mode may assist Melanie (Orr Myles and Carlson 1998, Section 4.5) in developing responsive behaviours towards other individuals, inspired by the 'rhythmic entrainment' principle (Ibid.) not replicated in the *Terpsichore* study whatsoever.

The case studies also demonstrated *Terpsichore*'s encouraging potential to assist in communicative routines of learners and the treatment of echolalia. The latter condition has occupied a prevalent position in ASD symptomatology since the era of Kanner (1943), while the frequency of imitative behaviours may be a representative magnitude of how severely a person is affected by ASD (Tilton 2009), especially considering that task orders intended for echolalic learner completion via an intermediary may not have a remarkably improved effect than in traditional learner-peer tutor environments (Grossi et al. 2013: 903). Considering that creativity and excitement through interesting activities are two foremost sources of inspiration in constructing *Terpsichore*, the learner's prospective contact with structures including TM Levels 13-14 and SIP Level 10 or 3 – based on emotional expression as a communication instigator – can only be assessed on a positive note. This argument results from the identification of strategies and gradual reconfiguration of virtual *Terpsichore* curricula to direct various learners in detracting from echolalia in everyday contexts and favour non-imitative musical expression instead, as in the examples of Nathan (Brownell 2002, Section 4.3) and JPH (Pasiali 2004, Section 4.6).

According to case study analysis, structures included in *Terpsichore* may prove crucial in the regulation of adverse behaviours. This factor influenced the software's architecture to an important extent, as the decision to add or omit certain elements was governed by the need to restrain unfavourable behaviours that would pose obstacles to the learning process. Impact on behaviour may be interpreted as the reduction and prevention of explosive reactions, or the improved management of information, thus clarifying the distinction between a 'tantrum' and a 'meltdown' as explained in Section 1.2. In the former case, the use of high-duration audio samples, combined with a frequency spectrum invoking relaxation, may prove comforting for Melanie (Orr, Myles and Carlson 1998, Section 4.5) or JPH (Pasiali 2004, Section 4.6), given the potentially positive consequences in behaviour as a result of these stimuli, and especially percussive sounds (Goldman 2002), being included in *Terpsichore*. This statement also applies to Mike (Fang 2009, Section 4.1) whose irritation and susceptibility to tantrums would be alleviated through the selection of instrument samples with a gradual attack, and the suppression of high-frequency content via the Options window. In the case of meltdown prevention, this was made possible through the ability to filter unwanted frequencies and the progressive adjustment of active frequency sub-spectrums, something that would potentially be beneficial for Nathan (Brownell 2002, Section 4.3) and John (Nwora and Gee 2009, Section 4.7).

A number of case studies associated with the Tonal Mode concentrated on *Terpsichore*'s ability to develop the compositional aptitude of learners, obviously considering the orientation of levels towards the use of comprehensive theoretical education to nurture creativity. As observations for such learners as QC (Mottron et al. 1999, Section 4.2) and Ted (Wager 2000, Section 4.9) showed, *Terpsichore* may be particularly effective in countering relative pitch problems, defined by the inability to comprehend pitch and tonality relations between adjacent notes. First of all, this may be justified by the emphasis of initial Tonal Mode levels on the above relationships, combined with the melody modification content in Levels 7 through 9, where some neighbouring notes may be altered, meaning that resulting intervals are frequently different from a major or a minor second;[129] the pertinence of the relative pitch concept to the recognition of intervals has been documented in Section 2.1.1. The relevance of the above observation to the software's compositional objective, derives from the commonly understood convention that a music composition is, by definition, a connection of auditory components, whether tonal (Berger 2002: 112) or soundscape-based (Shealy 1999: 230; Bunt and Stige 2014: 60-1 etc.), in order to provide a coherent result. Clarifying that relative pitch is only applicable to tonal music, the above statement implies that, in a continuum of different pitches, independent notes and phrases should be linked to one another over time, something that epitomises the relative pitch concept and substantiates a learner's need to grow awareness over this connection prior to achieving any compositional capacity.

6.2.2 *Effects on emotional state and behaviour of actual participants*

The real-life research study on *Terpsichore* based on adolescents and adults from secondary and special schools in Greece, was crucial in determining how the software's components directly influenced the participants in a number of areas, thus providing a more reliable outlook on *Terpsichore* than the educated hypotheses of the case study approach. Quantitative and

[129] Clarification example: 'A-C' which is a minor third, or 'A-E' which is a pure fifth.

qualitative responses provided to the questionnaire, indicate that the emotional state and behaviour of most participants has improved noticeably, following a sustained occupation with the software. Insofar as data and results are concerned, the average of all performance ratings associated to post-*Terpsichore* influence on each of these aspects, respectively equals 8.13 and 7.65 out of 10.[130] These values are a strong suggestion of how efficiently *Terpsichore* has assisted in these areas of wellbeing, especially given that these averages would have been higher if the participants of Tutor 2's group, who demonstrated elevated difficulty in operating the software, were excluded from the study (more information in Section 6.2.5). The above statements also take into account the interpretation of ratings in the post-*Terpsichore* domain, and more specifically the fact that a rating of 5 corresponds to neutral influence, with the negative and positive extremes being on either side of the 0-10 numerical scale.

The above results are compliant with the potential effect of *Terpsichore* on the behaviours and mental states of case study learners, irrespective of whether the Tonal or SIP Mode was chosen for analysis. Specifically, five case studies concentrated on behavioural control as an aspect in which the software would intervene positively, and on motivation to perform tasks, which may be considered as an indirect suggestion of emotional stimulation. Positive effects of music-based interventions on behaviour and interest to perform various activities have already been documented in research (Whipple 2004; Accordino, Comer and Heller 2007; Preis et al. 2016 etc.), which is eventually valid for most of *Terpsichore*'s participants, whose engagement in the software over several learning sessions contributed to such positive changes. The organisation of educational and compositional content into levels may also constitute a key cause for these improvements. This argument is justified by the similar principles that govern *Terpsichore*'s targeted approach and the sequence of music therapy 'events' applied by Wigram (2002: 16-17) to his supervising learner, serving objectives that encompass a broad range of wellbeing aspects. The difference between *Terpsichore*-based research and Wigram's study (Ibid.), is that participants in the former example were continuously encouraged to concentrate on the software's composition-based activities, rather than simply perceiving music therapy as a conventional extracurricular routine with basic advancements in theoretical awareness.

In terms of the positive effects observed in the above two aspects, the current study may be compared, to a partial extent, to a research endeavour centred around note-based music composition (Cornacchio 2008), in which two learners with ASD undertook fundamental notation lessons and creative tasks on the above discipline, in a collective environment mainly

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[130] Averages for emotional state and behaviour post-*Terpsichore* have been calculated through the consideration of all quantifiable responses to questions in Sections 13 and 14 of the survey (see Appendix IV).

comprising TD[131] individuals. However, performance ratings in the *Terpsichore* analysis generally denote that the gradual direction from music theory instruction to pattern composition, through the software's comprehensive curriculum, may potentially be more effectual for individuals with ASD than Cornacchio's (2008: 57) evaluation procedure. This is mainly due to the latter programme's focus on musical cognition development for TD participants, as opposed to the ASD ones claimed to exhibit reduced performances (Ibid.: 19). This argument reinforces the belief that *Terpsichore* levels and operating guidelines have been constructed in accordance with appropriate disability politics, combined with the need to avoid instances of disability discrimination in the educational process. In fact, the intuitive environment and interactive reinforcement by feedback and virtual rewards has certainly played a crucial role in promoting calm and enthusiastic behaviours.

6.2.3 Effects on communication

The occupation of participants with *Terpsichore*, which took place in organised classroom and – to a lesser extent – casual settings, had a significantly positive impact in their ability to interact with peers and their independence in musical and spoken discourse. Questionnaire ratings denote increased comfort, on the learners' part, in articulating their thoughts and emotions to tutors and individuals they encounter in their daily routines. This is proven in the average scores associated with responses in Section 15 of the questionnaire, which surpass 8 out of 10 in all instances. All ratings pertaining to any form of communication, whether interpersonal interaction or ability to complete 'question-response' patterns in the software's two modes, are statistically consistent, as demonstrated through the relevant Cronbach's Alpha magnitude ($a = .989$), showing that musical and human interaction are reliable indicators of learner's post-*Terpsichore* communication profile.

Research findings confirm *Terpsichore*'s potential in treating communication deficits, as observed in almost all case studies, while they also highlight the importance of 'question-response' musical phraseology (Ockelford 2013b: 204-6) especially when this is compared to similar type verbal interaction (Thaut 2015). This is due to the mutual relationship by which components in relevant levels[132] abide, simulating the patterns cited by Sterponi and de Kirby (2016: 396) as ordinary human conversation formats. Therefore, reported improvements in these

[131] As stated in the Introduction, TD stands for 'typically developing'.

[132] Explanation: these are Levels 13 and 14 in the Tonal Mode, and Level 10 in the SIP Mode.

fields are congruent not only with positive effects of various music interventions in communication (Brunk 2004; Kern, Wakeford and Aldridge 2007; Lim 2012; Ockelford 2013b etc.), but also with the prevalent position of music as a linguistic and interaction code in wellbeing treatment (Silverman 2007; Markworth 2014: 11-28; Ockelford 2016b). Taking into account Wigram's proposal (2000: 15) on conversational strategies in music therapy to compensate for any existing verbal communication deficits, it is apparent that the inclusion of 'question-response' instruction levels in *Terpsichore* was rightfully chosen for the purposes of participant with ASD. Furthermore, mean scores of 8.12, 7.68 and 7.33 in the respective communication-based levels for all included participants[132,133], along with strongly favourable results with regards to the intended musical and verbal communication objectives, justify that a principal reason behind the development of communication skills is the perception of music as another form of language. Specifically, similar regulations are applied in music as in dialogical speech, meaning that the development of patterns adhering to music-oriented communication, along with the deployment of already acquired music theory knowledge to compose extended phrases, can translate, over time, into more meaningful instances of spoken discourse.

The above statements take into consideration that roughly three-quarters of the HP sample were not diagnosed, prior to the *Terpsichore* study, with echolalia, a condition associated with the systematic replication of speech addressed to the diagnosed person (Kanner 1943; Prizant 1983; Mazzaggio 2019). As stated in Section 5.4, four out of eight learners initially exhibiting echolalic symptoms were capable of completing independent musical activities and conversing fundamentally with their peers, following interface use. Obviously, this argument neither signifies that echolalia has disappeared altogether, nor does it suggest a definitive relationship between existence of echolalia and musical communication aptitude. However, research on the potential of music therapy programmes in alleviating echolalia and increasing learner tendencies to formulate phrases (Edgerton 1994; Lim and Draper 2011; Marom, Gilboa and Bodner 2018 etc.) imply that it is possible to regulate echolalic behaviours by implementing special strategies that combine music with the stimulation of non-mechanical speech. On this occasion, what distinguishes *Terpsichore* from the above studies is that compositional procedures are encouraged to be undertaken by the learners themselves, ideally exhibiting self-confidence and a spirit of taking initiatives and relying less on the guidance of music specialists or other third parties. This means that the regulation of echolalia and the inclination towards deliberate and non-imitative expression are assisted by a strategy that does not rely on the passive repetition of melodies and songs, but on the process of taking initiatives to produce original melodies. In fact,

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[133] Ratings labelled as zero ware excluded, as these refer to levels that a few participants (3 for the TM, 1 for the SIP) did not tackle at all.

music considered recognisable to the learner's conscience is not recommended for individuals with echolalia, on grounds of these auditory cues being mechanically replicated (Schwartzberg and Silverman 2013). This argument certainly reinforces the rationale behind the promotion of self-constructed music and sound content, something that is also applicable to the SIP mode and the development of soundscapes characterised by continuity and a dynamic nature, without being repetitive whatsoever.

6.2.4 Effects on creativity; pitched vs. non-pitched sounds in composition

The construction of *Terpsichore* has been undertaken in order to propose a comprehensive ASD treatment aid that combines didactic elements of music and therapeutic strategies for which music is the driving force. Hence, after the software's evaluation has taken place with respect to its effect on mental state, it is currently important to assess the extent to which the creative potential of participants has evolved, and whether *Terpsichore* has increased their overall interest in music and composition. This judgment takes into consideration that the content of both *Terpsichore* modes is characteristic of the software's attempt to familiarise learners with fundamental concepts in music and audio, by balancing a rule-based approach with sufficient creative freedom. The ability or willingness to abide by regulations and guidelines characterises some individuals with ASD (Filipek et al. 1999: 444; Hope-West 2011: 30; Johnson 2012: 97 etc.), whereas the opposite is true for others (Filipek et al. 1999: 452; Esposito 2007: 5; Raja, Azzoni and Frutacci 2011: 101-3 etc.). Therefore, all possible reactions were considered when putting the targeted composition concept to practice, and this decision did not seem to cause significant concern with respect to the suitability of *Terpsichore*'s educational principles. Instead, performance ratings in Section 17 of the questionnaire indicate that participants embraced the intended compositional objectives of *Terpsichore* and benefitted from the software so that they could embed entry-level creative practices in their everyday lives. The Cronbach's alpha coefficient calculated via the consideration of all responses in the above questionnaire Section, is $a = .968$, which demonstrates high relevance of ratings to the broader category of creativity assessment.[134]

[134] Cronbach's Alpha calculations also consider that non-numbered Likert scale responses are numerically coded in SPSS according to the connotation of the choices (e.g. '5' for full ability to use the software, '0' for unwillingness to engage in sessions).

As mentioned in Chapter 5, only three out of the twenty-eight participants had some form of active occupation or knowledge related to music. For this reason, the familiarisation with theoretical principles of music was deemed necessary, at least by Tutors 1 and 3, to enhance performance in the melody modification, phrase composition and soundscape construction processes. Results described in Section 5.3.5 represent that the software's Tonal Mode is a generally convenient environment for music theory instruction, an area in which most participants responded reasonably well. This translated in a willingness to compose independent musical melodies, even with external guidance from a qualified practitioner as the composition of music is governed by Western music notation and coding systems with which no prior acquaintance existed amongst participants.

The software's potential in assisting the transition from absolute to relative pitch has been outlined in such case studies as QC (Mottron et al. 1999, Section 4.2) and Ted (Wager 2000, Section 4.9), justifying why the TM's functionality is ideal for the satisfaction of this purpose. It is worth noting that intervals between adjacent notes serve as core constituents for a coherent musical composition, judging from the key elements by which contemporary tonal music is governed (Berger 2002: 112; Paul 2005: 813; Korsakova-Kreyn 2015: 4, 8). Consequently, it is fair to assert that the Tonal Mode possesses relative pitch assets, defined by the interpretation of notes not as independent entities, but rather as parts of a phrase with a dynamic and uninterrupted flow. Moreover, successful acquisition and meaningful development of relative pitch skills is considered a vital prerequisite for ASD learners to develop compositional skills, which means that the real-life participants involved in *Terpsichore* were able to develop such awareness en route to becoming more efficient in composition.

It should be taken into account that no tutors have reported any absolute pitch diagnoses accompanying ASD, meaning that the practical study was unable to identify whether competence in recognising independent notes existed throughout the instruction process. The primary characteristic of absolute pitch is that associated individuals exhibit difficulties in recognising tonal relationships and applying existing knowledge into the reproduction or composition of a melody (Kupferstein and Rancer 2016), neither of which applies to any of the above learners. Therefore, the efficiency of participants in melody modification and composition activities constitutes, in principle, a strong case for employing *Terpsichore* in future music and general education settings relevant to ASD treatment, an argument that complies reasonably with case study observations on relative pitch development. In future research endeavours, tutors should be encouraged to administer absolute and relative pitch 'screening' tests (Ibid.) before and after *Terpsichore* has been substantially operated, in order to determine whether potential issues of tonal relationship perception persist or have been alleviated as a direct result of the system's compositional approach.

As far as the SIP Mode is concerned, the format of levels does not rely on text and musical coding as much as the Tonal Mode, something that opted to shift learner attention to the produced audio as a compound result, without the need to be directly concerned about theoretical sound design and audio processing methods. This reasoning is valid for six participants, for whom the software elicited a stronger interest in constructing soundscapes than composing tonal music.[135] However, the opposite is true for seven participants, while another fifteen do not have a special preference of compositional pathway. It is therefore apparent that the opinion on indefinite pitches being favoured to notes on grounds of simplicity and avoidance of flaws in performance (Stramkale 2019: 182) does not apply to the current case; instead, note representations through symbols and letters did not significantly impede progress in the TM, a statement consistent with various research perspectives on the beneficial role of music in ASD treatment (Boso et al. 2007; Carpente 2009; Khetrapal 2009; Ockelford 2013a, b etc.), obviously assuming that these refer to mainstream definition of 'music' where tonal elements commonly play an essential role.

Very limited research exists on whether the occupation with tonal music induces more positive or negative effects in creativity and wellbeing, although a study by Miller (1997) yielded improvements in the understanding of text segments when definitely pitched music, as opposed to indefinitely pitched, was employed in the background. However, an interesting metric that derives from responses in Section 17 of the questionnaire, is the extent of assistance that a participant required throughout the *Terpsichore* study, when operating the Tonal and SIP Modes. Only three participants scored better in the Tonal Mode than in the SIP in terms of comfort, whereas for eight individuals the SIP Mode constituted a more carefree environment, where the need to receive third-party assistance was less frequent. Although differences in coded ratings do not seem to be affected by the learner's capacity in understanding *Terpsichore*'s content ($p \gg .05$ following ANOVA), the less complex architecture of the SIP Mode, and especially its reliance on images in contrast to a musical language framework, justify the tendency of learners to seek for instructor guidance when composing tonal melodies.

To summarise, the response of learners to compositional tasks across the two modes indicates that no separate mode is more efficient in nurturing the creativity of a learner, meaning that *Terpsichore*'s dual environment approach is an innovative attempt at proposing various alternative strategies in composition, in accordance with preferred sounds at any given instance. As part of further comprehensive session arrangements, it would be interesting to employ a

[135] Please refer to Questions 17.3 and 17.4 of the survey (attached Excel file) for relevant ratings.

method where the two modes are not only instructed in the default order of the software – putting the Tonal Mode first – but also in reverse order, so that the potential influence of the initial instruction environment is assessed.

6.2.5 Influence of condition severity and tutoring

As reiterated throughout the analysis, *Terpsichore* has had a pronounced positive impact in musical creativity and mental health treatment. This takes into consideration that out of the study's twenty-eight participants, all but three exhibit a condition classified as 'mild' or 'moderate' through completed questionnaires. It is evident that when tutors provided an estimate of ASD condition severity, they took into consideration the official diagnoses from disability foundations and psychiatric clinics in Attica, and the manner these participants behave to themselves and coexist with peers, as manifested in supporting comments prior to research onset. In addition, none of the participants was considered by tutors, all specialised in music, as not being trainable. Having said that, four of the participants, amounting to 14% of the sample, demonstrated less satisfactory *Terpsichore* performances compared to the majority, while three individuals in the Tonal and one in the SIP Mode reported issues of tiredness and requested to discontinue software occupation at some intermediate point.

The development of a novel project entails various challenges and areas that need to be addressed following extensive research in a wide range of participants. For this reason, the fact that positive effects of software instruction are not universal is an absolutely rational occurrence. This statement acquires predominant importance following the examination of multiple research studies on ASD and music, where exclusions from consideration in human-based testing were due to unrest and lapsed concentration (Colombi et al. 2009: 148), inability to follow the requirements for data collection (de Vries et al. 2010: 931) or low cognitive capacity impeding the completion of directed activities (Taheri et al. 2019). However, the need to lay the groundwork for *Terpsichore*'s optimisation for extensive applicability, requires the assessment of all learners occupied with the software, even if they only attempted to engage with a fraction of their content. In other words, practical research on the interface does not intend to present an idealised outlook, but rather suggest ideas on how the incidence of positive results can be further enhanced, to the point of universal acceptance by a sample group.

The four participants evaluated as significantly less responsive to *Terpsichore*, have all been instructed by Tutor 2 throughout the study. These learners are enrolled in a special rehabilitation institution in Piraeus, which concentrates on the monitoring and treatment of individuals severely impacted by their disability.[136] In contrast to the educational environment of Tutors 1 and 3, directed towards the development of knowledge and pastimes that would render their everyday life interesting and facilitate their inclusion in social contexts that comprise non-disabled people. Providing that supervised interventions took place at periods consistent with a typical academic year in Greece, instructors needed to incorporate *Terpsichore* sessions around their everyday schedule in music classes and time slots devoted to extracurricular tasks. In fact, the high workload of duties embedded in the rehabilitation schedule of Tutor 2's host institution, influenced her decision to instruct the software over six hourly sessions, three for each mode. Furthermore, the one learner (R25) specified by Tutor 3 as having 'severe' autism symptoms, was still able to score 7.11 and 7.38 out of 10 across all levels of the Tonal and SIP modes respectively; similar ratings for R9, the most efficient of Tutor 2's participants, are 4.21 and 6.25. Two factors may representatively explain these differences: number of sessions dedicated to *Terpsichore* and tutoring approach. However, the condition severity factor's importance should not be minimised, as its consideration as an independent variable in one-way ANOVAs almost always led to significant rating differences between mildly and seriously impacted ASD learners, something valid for all severity index pairs in specific Tukey post-hoc tests.

Although participants are the ones who employ *Terpsichore* and are urged to intensify its autonomous use, the contribution of instructors to the performance of learners is indispensable, as the former acquire the responsibility, as per their written consent, to familiarise the latter with the software while ensuring a uniform and seamless learning process (Buzzi et al. 2019). Existing literature on autistic disorders and music therapy contends that tutors should ideally track the progress of learners and adjust their approaches accordingly (Wing 1976: 15), highlight strong and weak points associated with personality profiles (O'Connor Jr. and Jackson 2016: 274-5), foster the introduction of educational elements in various pastimes (Conn 2016: 86) and diminish the gap of incompatibility between ASD and TD individuals through innovative teaching strategies (Tsamoura 2020: 9). Therefore, learner attempts to acquaint themselves with an interface they have never encountered before would not necessarily elicit significantly promising results without a qualified tutor serving as an intermediary.

Inspired by the common belief that task accuracy improvement is a direct consequence of sustained practice and feedback, the tendency to produce more meaningful results increases when an intervention is undertaken over a lengthy timeframe, measured in number of hours. Specifically, the minimum of 18 sessions and 14 hours devoted to the software by Tutors 1 and 3, are significantly larger quantities than the 6 hourly sessions related to Tutor 2. Using average performance per human participant (APHP), for each mode, as the dependent variable, and

[136] See information on the special schools where research took place in Appendix II.

number of *Terpsichore* hours as the independent one, relevant ANOVA designates that individuals occupied with *Terpsichore* for a longer period of time recorded significantly better performances than the ones who dedicated less time in the interface ($[F(4{,}23) = 48.791, p \approx .00]$ for the Tonal Mode, $[F(4{,}23) = 48.791, p \approx .00]$ for the SIP Mode). A series of Tukey post-hoc tests presents that pairwise significant rating differences occur only between the 6-hour magnitude associated with Tutor 2, and any other figure. It may be consequently deduced that endeavours distributed across a substantial number of teaching sessions and hours, are expected to contribute to the absorption of required knowledge and the development of educational and mental state qualities. Critical to this belief is the fact that unpromising behaviours derived more from generalised difficulties in maintaining attention to software demands and less from a possible aversion to the software, whose Tutor 2 nevertheless approved and recommended in ASD music therapy settings, as per her signed consent document.

Emotional and cognitive complications that various individuals with ASD possess are always likely to interfere with the learning process, which was also the case for *Terpsichore*. However, instances of tiredness and apprehension were much more frequent in the four learners supervised by Tutor 2 than in the remaining ones. A critical analysis of questionnaire responses[137] shows that the above is not only caused by the serious nature of their condition. In fact, reported behavioural breakdowns as a result of interaction with unfamiliar environments and information overload (see Question 5.3 in the survey) may also be responsible for this trend. Although a few learners from the groups of Tutors 1 and 3 also exhibited these issues pre-*Terpsichore*, the fact that an increased number of sessions were associated with more promising results is in harmony with corresponding studies on ASD and music therapy, which highlight the value of prolonged training and repetition in task efficiency and wellbeing (Brunk 2004: 90; Holck 2004: 7; Sigafoos et al. 2006: 199; Gold et al. 2009; Robertson 2019: 187 etc.). Parallel to teaching frameworks for TD individuals, a comprehensive instruction curriculum directed towards composition should ensure, on a gradual basis, that important principles are retained in memory before advancing to the instruction of additional material. In future *Terpsichore* research, the reduction of session length and the increase of interface activities over an extended timespan would be a proposed solution to achieve more noticeable outcomes in creativity and wellbeing treatment.

[137] Individual responses are accessible through the attached Excel workbook, while cumulative results are presented in Appendix IV.

6.3 Assessment of the *Terpsichore* project in relation to research aims

In the Introduction, it was clarified that the presented analysis on *Terpsichore* intended to satisfy five areas of research interest for subsequent practitioners in the fields of music technology, music therapy and mental disability treatment. Therefore, the purpose of this Section is to determine the extent to which each separate research aim has been fulfilled, as a result of the actual participant analysis and the case study approach, characterising the methodology on *Terpsichore* testing and the discussion points outlined previously in this Chapter.

6.3.1 Familiarisation with a novel software music interface

'To assess the effectiveness of familiarising autistic individuals, irrespective of music skills, with an innovative music and sound composition platform' *(Introduction).*

An interesting question that arises from the *Terpsichore* research concerns the ability of learners to adapt to the software's original environment, especially when they have not been faced with aspects of typical music and computer curricula, or with the concept of music-based computer interaction altogether. In fact, some of the actual participants had been occupied with computers prior to *Terpsichore*, but only three possessed some prior music or instrument knowledge, while none had used miscellaneous music software before learning sessions took place. The case study deduced, in theory, that the interface sufficiently caters for learners' needs to navigate through musical concepts to develop required musical skill. The human participant research component validates the above assertion, with level-specific performance ratings for the Tonal and SIP Modes serving as an element of proof. The fact that approximately 80% of participants scored 7 or higher across the software, while more than half surpassed the 8 mark, indicates that this novel approach in creative music education was positively met by most learners, several of which have responded to software activities with enthusiasm. Incidentally, a number of participants, especially from the group of Tutor 1, showed willingness, and occasionally impatience, to release their creativity through the software. This statement gains particular importance as tutors did not employ a specific learning and disability politics technique as in the virtual case studies, but rather adopted a hands-on approach encompassing various methods, with an ultimate objective of building learner confidence through music and initiative-taking. For the most part, learners reached a point where they operated the software, and principally its latter levels, with only minimal difficulties, resolved via constant cooperation with the tutor. This is a promising indication of the software's user-friendliness and capacity of being tailored to different learning needs.

With respect to *Terpsichore*'s characterization as 'innovative', the software is one of the first attempts to promote music composition as a step-by-step procedure for which acquaintance with fundamental aspects of music is a prerequisite, and to incorporate occupation with soundscapes and virtual sound installations, as an adjunct to tonal music, for ASD treatment purposes. It draws upon the resourceful elements through which previous researchers attempted to highlight the educational and therapeutic value of music, as explained in Section 6.2.4. It also implements ideas and proposals from Chapter 4's case study approach, not yet embedded explicitly in an ASD-oriented music interface, such as the personification of emotions (Byrne 2012, Section 4.8), the development of relative pitch through adjacent note recognition and 'zygonic' theory (Ockelford 2000; 2013a), and the inclusion of instrument samples with different attack times, inspired by the case study of GM (Yau et al. 2015, Section 4.4). Thanks to the evidence-based principle according to which software construction and prototyping was undertaken, *Terpsichore* presents extended capabilities in addressing various areas of the learner's development and daily routine.

The software's reliance on two working modes, devoted on tonal music and soundscapes, aims to increase its applicability to a broad range of individuals with ASD, since the intrinsic appreciation of music, mentioned in Section 1.6, is irrelevant to musical literacy or the ability to recognise symbolic representations, including note values and accidentals. In this way, individuals not actively occupied with music are presented with an alternative to common music theory, which allow them to freely experiment with sound, combine audio stimuli and perform interesting manipulations with a potentially remedial effect. However, lack of prior knowledge did not constitute an obstacle in the action of learning music theory and composing melodies, mainly thanks to the interface's emphasis on structural simplicity and intuitiveness, with more demanding tasks addressed only at latter stages and with appropriate guidance. Another indication of the above is the fact that statistical analysis did not yield significantly higher performances for the three musically trained learners than their counterparts ($p = .415$ following ANOVA), certainly proving *Terpsichore*'s suitability for any musical skill level.

Familiarisation with the software is consistent, amongst others, with the effort in employing it on a sustained basis. The arrangement of learning sessions in special education establishments represents such an example, on grounds of this procedure allowing learners to complete interface activities without being overwhelmed or discouraged. In addition, the case study descriptions suggest, in principle, that *Terpsichore* has been constructed in accordance with the character of sustained occupation, in similarity to classroom contexts. This is based on the assumption that auditory interventions are most efficient in the intellectual, motor, linguistic and behavioural domains, when these are followed over extended timeframes (Jakobson, Cuddy and Kilgour

2003: 223, 238; Schlaug et al. 2005; Autism Science Foundation 2013; Lindberg et al. 2013; 1, 17-8; Berger 2016: 106-7).

Research on actual participants suggests that sustained occupation with the software is projected to induce more favourable effects in a number of wellbeing aspects. Trainability and session planning play a paramount role in performance optimisation over longer periods, as seen in Figure 6.1 below, where attention should be paid on the general trends and not on individual level results:

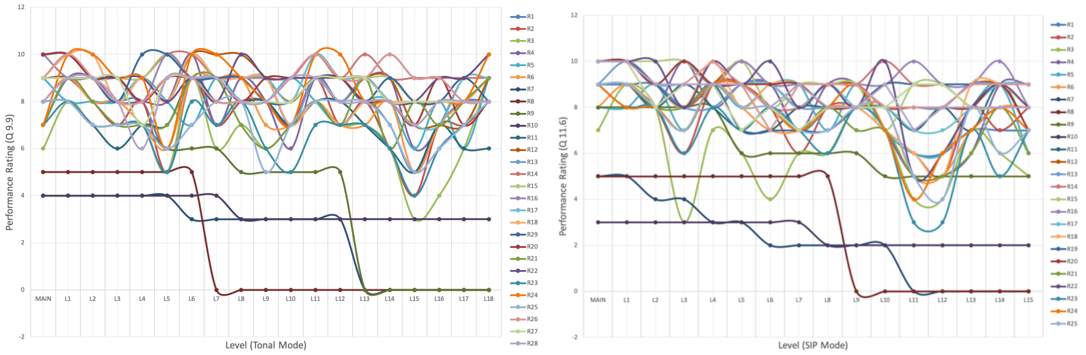

Figure 6.1 *Evolution of performance ratings in the Tonal (left) and SIP (right) modes, for each participant.*

Participants from the groups of Tutors 1 and 3, who occupied themselves more extensively with the software, did not exhibit the downward performance trend, throughout each mode, characterising learners overseen by Tutor 2.[138] Specifically, in the former case, the lowest ratings did not occur towards the end of each mode, meaning that possibly challenging aspects of the software did not cause discouragement to continue with various activities. On occasions where trainability issues arise, efficiency in *Terpsichore* may be enhanced through the dissemination of associated educational planning over a larger amount of shorter sessions, for example lasting half an hour each, and through the extensive utilisation of feedback and reward-based reinforcement to further promote positive reactions. To summarise, this first research aim is accomplished to a promising extent, as the innovative visual and auditory characteristics of *Terpsichore* are important factors in helping individuals with ASD complement their everyday schedule with creative music practices.

[138] In Figures 6.1 and 6.2, ratings specified as ‘zero’ (0) are all consistent with the respective levels not being attempted.

6.3.2 Development of interest in musical activities and creativity

'To determine how the software helps learners realise their creative potential and develop their preferences into a meaningful engagement with composition and music in general' *(Introduction).*

The *Terpsichore* interface was constructed on the hypothesis that an ASD learner, acquainted with principles allowing creation of new material, can engage more meaningfully with the musical process than by simply reproducing auditory segments. This claim has been supported throughout Chapter 1, relying significantly on methods, miscellaneous interfaces and disability politics applications favouring such an approach. Determining whether *Terpsichore* has been designed towards this direction can firstly be traced to the level structure itself. In both working modes, a similar pattern has been observed regarding level functionality, in accordance with a three-step process. This involves, in turn, simple music and sound component identification, small-scale modification of existent phrases, and composition of musical patterns from point zero. For instance, the Tonal Mode begins with structures related to the symbolic and lettered representation of notes and their identification on a 5-line stave. Next, it concentrates on melodic applications in everyday contexts and encourages learners to interact with default patterns by altering their content, and finally enables nearly full freedom for users to implement instructed material in designing melodies for universal appeal (Level 18) and social story representation (Level 17). Likewise, the first few levels of the SIP Mode focus on the identification of environmental stimuli, their correspondence to emotions and the spatial origin of audio signals. Afterwards, learners experiment with the plain recreation of environmental soundscapes, and ultimately acquaint themselves with the more complex yet practical concepts of advanced signal manipulation, laptop ensembles and audio-visual social stories.

In the Tonal mode, the attainment of originality in melody creation refers to the acquisition of abilities ultimately allowing users to devise patterns that are not a direct result of melodies heard, thus implying replication, but rather use fully modifiable templates that provide no indication of pre-existing popular melodies and songs that a user might passively attempt to copy. As levels progress, users are not only encouraged to perform modifications of default melodies' segments, but they are also familiarised with the principles and constraints required for them to accomplish compositional activities spontaneously and without the need to constantly refer to examples of previous levels. In addition, the SIP mode concentrates on the acquaintance with manners used to combine and manipulate sound samples, with a view of eventually undertaking real-time soundscape composition as a result. Therefore, this acquired ability to compose music without the direct need for a human or on-screen intermediary can be interpreted as independence.

The *Terpsichore* layout has not been designed with a view of developing autonomous compositional skills instantly, but exploits the gradual transition from passive to active engagement with music, and from dependency on a peer tutor to virtual feedback methods and then to fully unsupervised occupation. This has been achieved for the most part, although, as previously stated, assistance was occasionally sought to overcome minor difficulties in the formation of melodies, as pitches, note values, accidentals and timelines coexist within the same environment. The process of manipulating existing content proved a slightly more comfortable process than the composition of original melodies, as demonstrated in the overall interface evaluation (Section 5.4); still, the fact that learners attempted to provide new musical identities by any means offered, is an important step towards shifting their focus on composition. Furthermore, the increased emphasis of initial levels on the treatment of wellbeing conditions possibly preventing familiarisation with *Terpsichore,* was centred around the attempt of rendering the overall procedure of exploring the world of music more effortless.

In *Terpsichore,* any segment of substantial duration heavily manipulated dynamically or originally created by the learner can be regarded as evidence of original composition, even though on some occasions the compositional procedure does not include the addition of notes or samples that are later activated via a 'Play' button. Two representative examples are TM Level 12 and SIP Level 13. In the former, users can improvise with the aid of an on-screen single octave piano. The actual process of pressing keys subject to Western music conventions, indirectly communicated in previous levels, constitutes composition or improvisation as such[139], because the user has full control over phrase construction. Similarly, the latter level concentrates on the manipulation of multiple patterns using different principles, towards the generation of a sophisticated soundscape. Consequently, manipulation of audio signals can be regarded as composition per se, because real-time changes in frequency content, duration of constituents and volume respectively correspond to modification in pitch, rhythm and dynamics, three of Berger's (2002: 112) argued basic elements of tonal music, obviously adapted to the SIP Mode.

[139] This is valid on the bases that no attempt to replicate externally composed or commonly known melodies is made.

6.3.3 Achievement of mentally beneficial outcomes or tendencies as a result of composition-oriented musical engagement

'To help learners exploit the acquisition of creative musical skills in an attempt to trigger their emotions, regulate their behaviours, increase their motivation and improve their wellbeing' *(Introduction)*.

Having analysed, in Section 1.3, the areas of music education and therapy that would justify a possible relationship between the two, it is important to determine to which extent the *Terpsichore* structure and virtual session recommendations satisfy the above. Ideally, the interface was designed so that the achievement of such wellbeing benefits, as improved emotional scale, behavioural control, communication and motivation, results from the acquaintance with basic principles characterising today's tonal and soundscape-oriented music (Berger 2002: 112 and Section 1.2). The consideration of case study observations and results from the actual human participant study, will determine whether this relationship is either reciprocal, meaning that *Terpsichore*-led music therapy benefits certain learners in their musical activity, or non-existent, meaning that the two different music occupation aspects are achieved independently.

Music education has been reported to cultivate learner autonomy in performing actions and self-development (Darrow and Armstrong 1999: 17), unleash autistic learners' imaginative potential and increase their capacity in communicating with peers and demonstrating suitable behaviours (Sharma 2008: 57-60; Wheeler 2015: 9; Hammel 2016: 25-8). Section 1.3 attempted, amongst others, to clarify how education-oriented procedures favour the emergence of the above therapeutic effects, considering the belief that positive treatment results of musical concept instruction are not guaranteed (Scott 2017: 12). Various examples from the case study analysis demonstrate that the engagement with an ostensible musical curriculum simulated in *Terpsichore* is expected to assist meaningfully in the treatment of diverse areas, including the ones of confidence and motivation, perceived by the bibliography as direct outcomes of educational processes (Renwick and Reeve 2012; Mac 2014 etc.).

The potential existence of a tangible relationship between compositional skill development and therapeutic outcomes was measured by means of the detailed questionnaire (see Section 3.4.1) through which tutors evaluated the occupation of learners with the software, from a number of perspectives. To begin with, tutors are in strong agreement with the statement that the practical familiarisation with tonal music and non-pitched audio assisted in treating overall mental health condition compromised by ASD, which is an encouraging first indication of the intended relationship. Secondly, the analysis of Sections 5.3 and 5.4 designates that the areas learners appreciated most intensely, are the modification of default melodic patterns, the composition of phrases without a guideline melody, and the design on soundscapes from existing samples positioned in a virtual timeline or combined and displaced through rotation and panning. All these examples may be classified as composition, as none of them favours the passive reproduction of content; instead, they all encourage learners to recognise that they have control, whether partial or full, of the character and quality of a musical passage or soundscape.

The real-life participant study denotes that individuals who performed well in levels pertaining to compositional tasks, tended to present improvements, whether satisfactory or excellent, in aspects of their mental state including, but not limited to, emotional expression, behaviour towards peers and interpersonal interaction. This is evident in the ratings provided to questions on post-*Terpsichore* wellbeing (Sections 13 to 17 of the questionnaire), while recorded optional text comments reveal that successful completion of musical activities increased the enthusiasm of learners, making them grateful for the outcome of their occupation. According to statistical analyses of Section 5.4, performances across different modules in the software, centred around a variety of learning objectives, may contribute significantly to the treatment of issues with emotional recognition and integrity, behaviour and communication adjusted R^2-values of roughly 80% show that a cause-and-effect relationship between education and therapy may be safely assumed. This statistical evaluation supplements the quantitative and qualitative representations of how learner particularities are treated through the knowledge fields and activities addressed in *Terpsichore*.

Based on R^2-values presented in Section 5.4, the alteration of existing melodic content and the formation of soundscapes are the most influential parameters in all areas of wellbeing improvement. This means that promising outcomes in mental health may exist amongst learners who have not performed as strongly in levels associated with original tonal composition, which are 15, 17 and 18 in the Tonal Mode. For instance, in the cases of R1 and R11, who scored less than 7 on average in the aforementioned levels, respective ratings for general emotional state and emotional sate were higher than 8. A reasonable interpretation of the above, is that the overall appreciation of *Terpsichore* mitigated potential reactions of displeasure or anxiety on occasions where independent composition from point zero was deemed complex. In fact, over 85% of learners continued to show signs of eagerness to operate the software and promising behaviours despite resorting to tutor assistance to overcome learning obstacles.

Acquaintance with tonal and sound sample modules within *Terpsichore* can be initially perceived as any other task of interest to learners, something possibly less valid for learners with constrained or stereotypical activity preferences, including John (Nwora and Gee 2009, Section 4.7) and MN (Carrington and Graham 2001, Section 4.8). However, what distinguishes

Terpsichore from other similar activities is the fact that learners are encouraged to practise Western Music conventions and environmental sound exploitation and composition, in a simpler and more intuitive manner with comparison to neurotypical individuals, with concern to recognising that learners may have control over an auditory experience. Thus, the motive to modify such experiences by creating aurally pleasant melodies or soundscapes is a decisive element of distinction from the average leisure activity, whether related to music or not.

Summaries of findings from the case study approach, accessed in Tables 4.1 and 6.1, may lead to the conjecture that music education tasks in *Terpsichore* are more evident in the Tonal than in the SIP Mode, possibly given that most curricula rely on Berger's (2002: 112) purported elements of globally accepted music. However, information in the latter table certifies that a number of SIP Mode levels contain elements whereby fundamental auditory awareness and sound manipulation or composition are achieved, as means of rudimentary music education. Although accounts of soundscape-based audio use especially intended for ASD treatment are limited to date, the importance of sounds contained in this mode was analysed in Section 2.2 with concern to the broader context of mental disabilities, paving the way for its more structured implementation on autistic individuals. This argument, examined alongside the attempt to organise soundscape-based modules in a similar way that the Tonal Mode or other interfaces were built, justifies that potentially encouraging effects on such aspects as communication, motivation and prevention of outbursts derive from initiatives to create original compound soundscapes to a respectable extent. This is reinforced by the fact that highest R^2-values in actual participant research occur insofar SIP Mode composition levels are concerned (see Section 5.5).

The majority of case studies in Chapter 4, have eventually determined that, in the cause and effect relationship of intended objectives, music therapy plays the role of the latter, having been achieved as a result of educational modules in the interface. The same applies through the examination of several comments on learners' post-*Terpsichore* condition, where increase in controlled behaviours, recognition of surroundings, peer communication and miscellaneous therapeutic factors are highlighted, and occasionally mentioned as being affected by music. An example is Tutor 3's reference on the ability of R23 to put her emotions and reactions under control, and on R25 showing emotional arousal after completing music-oriented activities. However, both the virtual and real human participant analyses confirm that the achievement of positive mental health consequences, following *Terpsichore* sessions, may influence on turn the learner's motivation to continue using the software and develop compositional skills. The main argument amongst actual participants who succeeded in operating the software, is that they feel increasingly stimulated to compose music and take advantage of various features that assist creative expression. Moreover, the use of certain behaviour-assisting strategies as an adjunct to

Terpsichore, for such virtual learners as MN (Carrington and Graham, Section 4.8) and Ted (Wager 2000, Section 4.9), are expected to provide the necessary motivation for learners to release their creativity and achieve the software's musical goals to the permissible degree. Finally, from a statistical perspective, multivariate analyses inspired by Section 5.5, but characterised by the inversion of variable dependency, produce similar values of adjusted-R^2 for each area of mental health. These show that the improvement of certain factors as behaviour, emotional state and concentration are likely to assist in the facilitation of compositional procedures, although it is not safe to say that all four parameters simultaneously predict increased educational potential. The above are explained in Tables 6.2 and 6.3.

Dependent Var / **Independent Var**	Emotional state (Q 13.3)	Behaviour (Q 14.1)	Communication (Q 15.1)	Concentration on software (Q 16.1)
TM Composition	.596	.638	.661	.546
TM Modification	.698	.727	.780	.588
SIP Composition	.785	.803	.805	.564
All three (adjusted)	**.764**	**.786**	**.807**	**.564**

Table 6.2 *Influence of educational elements on therapy outcomes, by means of R^2-values.*

Dependent Var / **Independent Var**	TM Composition	TM Modification	SIP Composition	All three (multivar, adj)
Emotional state (Q 13.3)	.596	.698	.785	**.770**
Behaviour (Q 14.1)	.638	.727	.803	**.789**
Communication (Q 15.1)	.661	.780	.805	**.823**
Concentration (Q 16.1)	.546	.588	.564	**.764**
All four (adjusted)	**.697**	**.753**	**.830**	**.403**

Table 6.3 *'Inverted' relationship examination: influence of therapeutic outcomes on educational elements, by means of R^2-values.*

6.3.4 Comparative advantages over existing music-oriented interfaces

'To examine how the novel music and audio platform resolves the gaps present in similar music-oriented interfaces for ASD and special needs' *(Introduction).*

In Section 1.5, it was mentioned that the process of constructing *Terpsichore*, aims, amongst others, to resolve the gaps and deficiencies of interfaces who addressed the four elements of music education, therapy, tonal composition and soundscape formation in manners that would be beneficial for learners with special needs and, most importantly, ASD. Therefore, the purpose of the following paragraphs is to determine how the current software advances the field of music and technology in mental disability treatment, and paves the way for its more widespread application in classroom and casual contexts. First of all, none of the interfaces in question emphasise explicitly on more than two of the aforementioned factors, justifying their inclusion in *Terpsichore* to offer multiple alternatives for occupation with music. This approach may be regarded a part of *Terpsichore*'s novelty compared to previous endeavours, while overall encouraging results are indicative of the positive acclaim it has received from tutors and learners, with only minimal exceptions.[140] Secondly, limitations of interfaces examined in Section 1.4 are not only traced to the constrained areas they address, but they also relate to their functionality and applicability to joint educational and therapeutic contexts.

The final *Terpsichore* prototype is characterised by an open-source design, as it enables qualified developers and tutors to make necessary changes to the SuperCollider code or the Macintosh application resources for reasons of optimisation (Golden 2005: 5-7), in order to prevent sensitivity or discomfort issues from appearing. An example is the substitution of default images and samples of instruments and environmental sounds, with stimuli to which learners are potentially less susceptible, as long as the associated filenames remain the same for reasons of stability. The software's architecture and self-contained character, without the necessity of being operated alongside an external interaction object, contribute to the software's accessibility and cost-effectiveness. This means that the complex structure to be calibrated in *SoundBeam* (Section 1.4.1), *Benemin* (Section 1.4.3) or *RHYME* (Section 1.4.12), accordingly increasing purchase or configuration cost, can be bypassed. In fact, *Terpsichore*'s layout requires the highest possible concentration of learners in order to achieve the completion of tasks, which is not true for the aforementioned interfaces, as they do not include activities that require learners with ASD to become more proactive.

[140] These refer to the less favourable performances of the four learners supervised by Tutor 2.

Terpsichore offers learners the opportunity to perform a variety of targeted tasks, starting from imitative reproduction and progressively moving towards original composition, with a high rate of success as the practical study in Chapter 5 proved. The above principle is considered a notable advancement of the areas addressed in such interface as the *Chrome Music Lab* or the *PLAIME*. The doubt over whether the *Chrome Music Lab* structure (Google 2017) follows a specific pathway towards the completion of desired compositional goals has been resolved in *Terpsichore* and its organisation in levels, even with some flexibility. Moreover, the ability to choose more instruments and experiment with different amounts of creative freedom extends beyond the *PLAIME*'s sole focus on only one instrument and limited activities not consistent with imaginative potential development (Cano and Sanchez-Iborra 2015).

The current software also constitutes proof of the fact that the meaningful occupation with multiple musical activities can be offered at little to no cost with promising results, as its open-source character reflects a free version (Golden 2005: 8, 26), whose transformation into a commercial product would require a considerably reduced price to such interfaces as *Skoog* (Apple Store 2020), *SoundBeam* (SoundBeam Project 2016) or the *Reactable*'s hardware version (Reactable Systems 2020). Even if examples of low-cost previous interfaces are available in the literature, including *VESBALL* (Nath and Young 2015) or *MIDIGrid* (Full Pitcher Music Resources 2014), these exhibit a series of limitations as explained in Section 1.4, mostly centred around the lack of explicit compositional tools or a curriculum-based format to facilitate flexible composition. In particular, *Terpsichore*'s intuitive interface, characterised by different colours and discrete control surfaces, makes navigation within and between tasks more comfortable and allows learners to maintain their focus, in similarity to the structural suggestion of Salgado et al. (2017: 178). The comparison of *Terpsichore*'s sample screenshots of Figure 6.1 below, with the ones of the *MIDIGrid* (Full Pitcher Music Resources 2014), demonstrates the importance of sufficiently sizeable and appealing GUI components in the accuracy of activities. Although the practical research has not identified any performance issues induced by motor skill deficiency of participants, the operation of *Terpsichore* in conjunction with an emulator for smartphones or the iPad (Wilson 2018: 23-4) may provide a touch-screen adaptation of the full software experience.

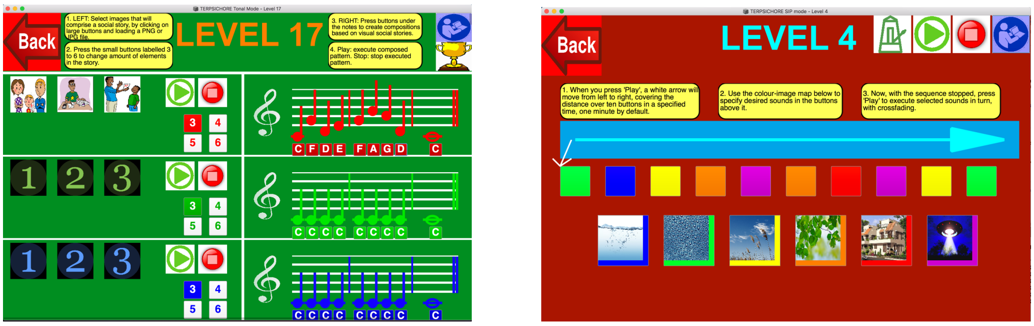

Figure 6.2 *Sample Terpsichore screenshots of TM Level 17 and SIP Level 4.*

Various features in *Terpsichore*'s design were also present, in an alternative form, in previous endeavours, but differ in their adaptation for composition-related tasks so that they encourage learners to take control of their actions and avoid passivity. A first example is the combination of visual social story representations with tools for unconstrained composition, based on the didactic elements of initial levels in both modes. In fact, Greher et al. (2010, see Section 1.4.8) have first addressed this technique in their *SoundScape* project, while their research is directed to adolescent and adult learners, in parallel with *Terpsichore*. Given that the *SoundScape* relies on third-party software normally for use by TD individuals (Greher et al. 2010: 9, 12), this shortcoming is resolved by introducing a simplified form of tonal and abstract music composition, detached from the concept of sequencing potentially regarded as complex by individuals with reduced musical and ICT training, not least when also diagnosed with ASD.

Another example is the familiarisation with different pitches, whether in pre-set melodies (*Music Spectrum*, Lima and Castro 2012), as isolated entities (*PLAIME*, Cano and Sanchez-Iborra 2015) or in conjunction with coloured cues (*Suoniamo*, Buzzi et al. 2019). *Terpsichore* extends beyond these principles by endorsing the connection of music to language as a facilitator for entry-level composition (Section 4.2), and a simplified format in which successive pitches are represented, to instruct relative pitch skills (Section 4.9), as this trait is consistent with intervals and the subsequent organisation of melodies. An element also inspired from the *PLAIME* (Cano and Sanchez-Iborra 2015: 259), albeit depicted as a low-difficulty visual aid, is the numeration of both hands' fingers, in order to serve as a complement to piano-playing procedures, something that would eventually help Ted (Wager 2000, Section 4.9) alleviate his unorthodox playing tendencies.

In terms of soundscape construction and manipulation, *Terpsichore* adds to *Window* by Norman (2012a, b) by allowing users to not only interfere with existing soundscapes, but also alter the panning position of its constituents and modulate recordings. Granular and oscillator synthesis capabilities, also included in the SIP Mode, draw upon its purely instructive role in the *ImmertableApp* (Baldassarri et al. 2016) and are now introduced in *Terpsichore* as a practical component, which the virtual study of MN (Carrington and Graham 2001, Section 4.8) recommended to enhance concentration. Furthermore, frequency filtering has been proposed, as a treatment strategy, for John (Nwora and Gee 2009, Section 4.7), therefore its inclusion in *Terpsichore* complies with the attempt to mitigate his susceptibility to unwanted frequencies, while it also resolves the disadvantage of such interfaces as *Window*, *Music Spectrum* or *RHYME* not possessing capabilities relevant to the suppression of disturbing sound signals.

Terpsichore also contains a number of structures that, despite their inspiration from bibliographical accounts and the case study approach of Chapter 4, have not been incorporated in prior ICT applications. First of all, the ability to match pitches to letters and extend this principle to all twenty-four letters of the English alphabet, has only been examined on a theoretical basis (Shore 2003: 71-4), but proved effective for a large majority of real-life participants, especially when directed to type words on a keyboard to compose melodies. Secondly, modules dedicated to a question-response strategy for musical communication have not been identified in any of the examined interfaces. As explained in Section 1.4, *PLAIME* (Cano and Sanchez-Iborra 2015) and *Suoniamo* (Buzzi et al. 2019) invite learners, amongst others, to reproduce passages instructed beforehand. This principle is more pertinent to replication than meaningful communication in musical terms, since the reduction of stereotypical behaviours is naturally discouraged when a learner is not presented with opportunities to accomplish compositional independence, which *Terpsichore* has achieved, to a substantial extent, as practical research indicates. Thirdly, the existence of multiple sound modules within a same level, resembling the arrangement of a LOrk (see Section 3.4.2), sets the foundations for the subsequent implementation of collaborative sound and virtual installations in ASD treatment planning. Although the pilot study did not require learners to restrict SIP Level 13 usage to a sole module, the possibility of creating a soundscape through components that can be extensively and freely manipulated, assists learners in exploring new auditory possibilities beyond imagination.

A retrospective look at Table 1.1, where *Terpsichore*'s intended characteristics are compared to the ones of related music education and therapy platforms, eventually demonstrates that the intended structural objectives of the current software have been fulfilled. Specifically, familiarisation with tonal music and indefinitely pitched audio, whether sampled or synthesised, are two elements playing a pivotal role in *Terpsichore*, mainly considering the number of levels devoted to each area, and the overall positive response of learners to the available content. The software regards the incorporation of composition in everyday contexts and treatment routines as a procedure for which fundamental theoretical knowledge and environmental sound awareness serve as prerequisites. In this way, the concept of music-making, as outlined for instance in *SoundBeam* (Williams 2017: 18), *Skoog* (Skoogmusic 2020) or *RHYME* and its perspective on 'musicking' (Holone and Herstad 2012), detracts from spontaneous and unguided experimentation with musical elements, and instead becomes more targeted, by balancing the need for creative freedom with manners in which the aesthetic result becomes more pleasant to the ears of a therapist or average listener. A breakdown of responses to Questions 9.7 and 9.8 of the survey indicates that this initiative had positive results in the quality of provided tonal compositions, although non-exclusive adherence to Western music conventions reflects natural activity management difficulties or special melodic preferences, analysed in Section 2.1.2.

The value of *Terpsichore* in supporting the treatment of autistic individuals, is demonstrated not only in the documented benefits of the software in behaviour, concentration, communication and emotional state (see Section 5.3), but also in the connection of selected musical activities to such non-musical features as completion of daily duties (TM Levels 6,7), recognition of emotions (SIP Level 3) and social stories (TM Level 17, SIP Level 15). The difficulty of instruction levels is variable and increases as each mode progresses, but the introduction of a user manual that can be toggled whenever necessary, reduces the tutor's required knowledge of music and ICT to comprehend *Terpsichore*'s principles and communicate them to the learner for prospective use. Few levels were considered by learners as complicated in their operation, such as TM Level 15 pertaining to three-stave counterpoint. In addition, the association of several levels with the design principles discussed throughout the case studies of Chapter 4, is indicative of the software's increased versatility compared to previous interfaces. This means that a freeform occupation with *Terpsichore* opens up numerous opportunities for learning, experimentation and meaningful expression towards oneself and surrounding individuals, while providing several educational pathways in scheduled settings, for learners to maximise their potential and enjoy operating the interface.

6.4 Summary

The Chapter concentrated on the main observations drawn from virtual case studies and actual participant research results pertaining to the *Terpsichore* software. General remarks include the compact nature of the interface, designed to fulfil intended educational and therapeutic purposes without having to increase complexity, and the ability to visually address different cognitive integrity levels. Other points highlighted within the *Terpsichore* layout, are the adherence to the three-step level progression format, ranging from passive reproduction to composition from a blank pattern, and the software's ability to provide, for each different learner, a reliable composition teaching framework associated with a separate music inclusion method compliant with proper disability politics. The procedure of actively instructing *Terpsichore* to real-life learners differed from the case study in the adjustment of educational routines to participant needs, in accordance with relaxed models not strictly defined by a specific DP method, and the equal gravity given to the familiarisation with both interface modes.

Most assumptions made throughout the case studies is verified by the overall responses of real participants in *Terpsichore*, as relevant questionnaire responses showed. The virtual learner approach extracted positive observations on the software's potential to treat adverse behaviours, enhance peer communication and motivation to perform tasks, practically confront the side effects of echolalia and develop relative pitch skills. Post-*Terpsichore* questionnaire evaluations confirmed, for the majority of participants, improvements in emotional state, behavioural control and interaction on interpersonal and musical terms, while the software provided meaningful opportunities for creative expression, especially in the tonal music domain, where varying intervals of adjacent notes are considered useful tools in facilitating composition by means of relative pitch awareness. The severity of particular ASD symptoms, combined with the tutoring approaches and distribution of time schedule on the part of instructors, plays an evident role in performance and satisfaction of non-musical goals, which are best achieved through sustained occupation and reduction of workload between sessions.

This Chapter also assessed the efficiency and usability potential of *Terpsichore*, judged by the extent of compliance to the four research aims outlined in the Introduction. The direction towards original composition simulating classroom and miscellaneous musical curricula, the possibilities given to ensure sustained occupation, the focus on active rather than passive music activities, and the reciprocal education-therapy relationship, were all satisfied to a promising extent. Moreover, the software seems to resolve important gaps of endeavours in music and relevant ICT applications, given its potential to utilise multifaceted and didactically directed composition as the driving force for comprehensive short-term wellbeing improvements, with only minimal effort on the tutor's part to understand the versatile content of the two working modes. All the above findings will serve as an impetus for providing general evaluative comments regarding the interface, its limitations, its social impact in various specialisation and everyday life sectors, and the future steps required for the *Terpsichore* project to play a commercially appealing part of special education advances and innovative treatment.

CHAPTER 7

CONCLUSION AND FUTURE DIRECTIONS

7.1 Overall evaluation of *Terpsichore* and the associated research

Over the course of four years, an extensive focus was given to the construction of a software interface that would not simply address music as a classroom or extracurricular task for inclusion in the lives of individuals with Autism Spectrum Disorders, but would rather direct learners towards the composition of original musical patterns as an engaging and meaningful assistive tool in improving wellbeing aspects. Considering the twofold interpretation of music as either a continuum of strictly defined elements, complying with Western conventions characterising pieces of nowadays (Berger 2002: 112), or any sound and combination thereof within a time and space framework (Shealy 1999: 230; Bunt and Stige 2014: 60-61 etc.), *Terpsichore* was designed with a view of rendering composition an inclusive ASD and mental condition treatment activity for which prior acquaintance with Western music concepts is not required.

The exploration of the ASD framework contrary to other documented mental disabilities has raised such challenges as the reduced predictability of music interface occupation outcomes, considering varying individual characteristics or the concern of learners finding music-related objectives of the software uninteresting. Therefore, the satisfaction of research aims outlined and discussed throughout this Thesis, was directed towards ensuring that targeted educational approaches for music can extend to further non-musical areas of personality development as part of a comprehensive ASD treatment strategy. It is reiterated that research on *Terpsichore* was undertaken with four discrete aims in mind:

- To assess the effectiveness of familiarising autistic individuals, irrespective of music skills, with an innovative music and sound composition platform.
- To determine how the software helps learners realise their creative potential and develop their preferences into a meaningful engagement with composition and music in general.
- To help learners exploit the acquisition of creative musical skills in an attempt to trigger their emotions, regulate their behaviours, increase their motivation and improve their wellbeing.
- To examine how the novel music and audio platform resolves the gaps present in similar music-oriented interfaces for ASD and special needs.

Critical to the satisfaction of the above aims was the project's attempt in ensuring that documented gaps in previously constructed and tested interfaces, mainly with regards to music composition for disabled individuals and ASD-oriented treatment methods, are filled to a respectable extent. Evidently, the role of *Terpsichore* would have been diminished, possibly leading to adverse behavioural and mental condition consequences, if the interface had been designed with either high complexity or numerous modules and features per level, on grounds of maximal satisfaction of shortcomings. Instead, ensuring that the software is characterized by a layout that is plain and intelligible but not oversimplified, can satisfy learning and therapy outcomes more meaningfully. This will also prevent learners from becoming confused or disinterested when attempting to compose music beyond a primary occupation with *Terpsichore* modes and levels.

Various music interventions for autistic individuals have been favoured and suggested as means for improving certain ASD areas of deficiency, including cognitive integrity, peer communication, behaviour and motor coordination. From a theoretical perspective, such methods as Nordoff-Robbins (Nordoff and Robbins 1971; Kim 2004 etc.), the 'improvisational' approach (Edgerton 1994; Wigram 2004 etc.) or 'Developmental Therapy' (Trautman 2007: 104-5; Goodman 2011: 185 etc.) aim to gradually make music composition an integral part of daily learner routines. Although the case study approach concentrated on the assignment of a separate method to each case study human sample, the tutors involved in the actual participant research did not necessary adhere to a specific disability politics technique, but rather instructed the software in a manner deemed to maximise each learner's potential and circumvent potentially disadvantaging characteristics. Nevertheless, teaching frameworks and the eagerness of learners to engage with *Terpsichore* certainly influenced the positive observations made throughout all case studies and the vast majority of real-life learners, since wellbeing management and mental treatment are considered a common denominator of the actual interface and disability politics as a broader field.

The overall *Terpsichore* research has been undertaken in such a manner that results from software applications to actual participants in Greek special education institutions, either reinforce or challenge the observations that derive from the case study approach, where virtual learners were hypothetically subjected to the software's elements. In general terms, the favourable performances of most learners across *Terpsichore*, as reflected in the answers of tutors in the evaluation questionnaire, demonstrate that the content and arrangement of levels was positively received during learning sessions and played a noticeable role in various wellbeing areas. In addition, this clarifies that case study remarks relevant to the software's modes and levels are not arbitrary, but rather result from a critical presentation and juxtaposition of opinions that explicitly or indirectly pertain to the characteristics and particularities of levels. During the real-life testing process, tutors were obviously not expected to strictly abide by the recommended strategies for efficiency optimisation, outlined throughout the case studies. However, the implementation of specific procedures associated with selected levels clarified that *Terpsichore*'s layout proved capable of ensuring an interesting occupation with music, to the point that it promoted versatile creative expression rather than constituting a typical artistic or leisure activity.

In the real-life research component, emphasis given to levels of a distinctive functionality as part of the questionnaire, aimed to determine, in detail, whether their contribution to the learning and therapy process matches the one assumed as part of the case study. This questionnaire approach has overall been beneficial, since associated responses clarify the impact of composition-based training, encountered in these levels, on whether participants were ultimately capable of harnessing *Terpsichore*'s power for their own educational and therapeutic benefit. With the exception of SIP Mode Levels 11 and 12 and the occasionally distressing high frequency content they emit, few inadequacies or instances of discomfort were reported during actual participant research, which confirms the potentially positive response to such environments as reported in the case studies.

The two-component approach of the *Terpsichore* research methodology has assisted in the satisfaction of research aims in principle, a characterisation that can be interpreted from two different perspectives. Firstly, the design of the software has incorporated a substantial number of features leading towards the alleviation of learner weaknesses or abnormalities. The same is valid for the case study analysis structure, centred around a set of hypothetical sessions involving *Terpsichore* levels ideally adhering to the actual order, with some flexibility of changes in level arrangement. Moreover, although the engagement of actual participants with the software in genuine educational settings has provided a more reliable outlook of *Terpsichore*'s suitability for autistic populations, larger sample sizes and testing frameworks are required to draw definitive conclusions on the above statement. However, the success and across-the-board improvement rate of over 85% throughout the software, clearly designates that an appropriate starting direction has been adhered to, in order for the software to ultimately provide a valuable contribution to existing knowledge in music-oriented interfaces for ASD applications, and play a prominent role in the treatment of such individuals.

The overall research on *Terpsichore* clearly determined that the software possesses a distinct potential of encouraging learners to employ sound and music composition in their everyday attempts to adopt favourable behaviours, improve their emotional state, feel more included in society and generally release their positive inner self, personality qualities and creativity. Moreover, the adaptation of composition curricula to ASD frameworks through the interface constitutes a revolutionary approach in the broader music therapy field.

7.2 Implications in everyday lives and musical occupation of autistic learners

Continuation in studies associated with *Terpsichore* beyond the current research will be largely based on how efficiently this software interface can influence both the musical aptitude and the welfare of learners diagnosed with ASD. As research in music-oriented interfaces for the facilitation of disabled people's lives evolves rapidly, thanks to multiple technological innovations appearing in research and on the market, the construction of *Terpsichore* with a vision of original and ideally independent composition at the forefront of ASD treatment acquires particular importance. Difficulties in how autistic individuals manage their lives and relationships with peers may be worrying and uncontrollable, especially in social contexts where discrimination and stigma towards disabled people is a frequent phenomenon. It is therefore important to highlight the sectors and contexts in which *Terpsichore* and its associated research may contribute to maximising, in the long term, the social impact of composition-oriented interventions as addressed in the software.

Findings from the case studies, but most importantly from the real-world human participant research, in various affected aspects of musical, emotional, cognitive and social development may serve as a resourceful point in the embodiment of music in daily activities, whether these exhibit a recreational or educational character. In multiple educational frameworks, miscellaneous objects and programs principally intended for leisure, including board and computer games, have been complemented with concepts and activities simulating actual teaching procedures in a scholar or casual setting; in simpler terms, this is expressed as *learning through play*. A hopeful indication that *Terpsichore* may add to these resources and tailor itself to the requirements of inclusive education for autistic individuals, is the plain, yet not oversimplified, structure of levels, comparable to educational computer games to a satisfactory extent. Moreover, emphasis on step-by-step progression through levels may prevail in ASD teaching, due to the similarity of this character to evolving levels in games, often characterised by the opportunity to reward individuals for their efforts and compliance to tasks and increase their motivation as a result.

Tonal music, soundscape awareness and manipulation and linguistic elements occupy a simultaneous position in *Terpsichore*, in an effort to facilitate composition of auditory and musical phrases to an acceptable standard and, most importantly, assist in relieving ASD symptoms that cause distress to the learner and its surroundings. As this argument justifies that the software is not entirely musical but can be exploited towards alternative goals depending on individual particularities, *Terpsichore* is expected to open up new horizons and possibilities for practitioners not having music as their primary area of specialisation. In other words, this interface has been devised to allow users from different backgrounds and with varying musical competence levels to serve as inclusive education leaders for their child, their relative or anyone diagnosed with an autistic disorder.

The above paragraph exemplifies the role of *Terpsichore* as a 'music interface for all' at least from the instructor's perspective,[142] but this can also be valid insofar as compatibility with different learner target groups is concerned. As the case study approach also showed, some autistic individuals may possess special abilities or cognitive integrity but still exhibit difficulties in regulating emotions and maintaining a sense of discipline. Others may exhibit severe communication and language deficits that would delay their social integration or reduce their adeptness in completing a directed task. Irrespective of the case, a number of levels, whether similar or different, may form part of each learner's IEP according to the symptoms mainly raising the instructor's concern and accordingly influencing the ideal discipline of a specialist assigned to take charge in treating the learner using *Terpsichore* especially under circumstances of moderate and severe autistic conditions. For instance, and to clarify the above, a speech therapist can apply *Terpsichore* to learners with difficulties in articulating or forming words, and such elements as the ones directed to pitch production via the computer keyboard and matching notes to English alphabet letters may assist in delivering anticipated treatment objectives. Likewise, psychologists with an interest in anger management and impulsive

[142] Not to be confused with 'musicking for all', a term not exclusively pertaining to musical activities (Holone and Herstad 2012).

behaviour regulation, regardless of musical aptitude, may refer to the case study approaches and miscellaneous information regarding tantrum reduction or prevention via *Terpsichore*, in order to apply such principles in shifting mood transitions towards a more positive and less explosive direction.

7.3 Future directions

The *Terpsichore* version presented in the current research, is somewhat short of being released as a commercial product, but more than sufficient for purposes of comprehensively assessing the potential effect on a diversified environment of ASD learners.[143] Considering the interface's particular potential in offering personalised experiences to learners willing to add music to their everyday routines as a life-influencing rather than simply artistic occupation, the work to be undertaken beyond the current project should primarily focus on three objectives. These are the re-assessment of *Terpsichore* on actual human participants, the inclusion of additional interaction formats for higher versatility and accessibility, and the amendment of certain interface elements as an important step towards transforming a freeware demo version into a product set for commercial release. Extension of the *Terpsichore* functionality to disabilities beyond ASD may also serve as a long-term goal, something encouraged by the fact that two of the case study learners exhibited two different disabilities at once, even though increased emphasis was given on the autism condition and its effects on their profile.

Prior to making a *Terpsichore* version accessible to human participants, it is first important to consider further developments in the interface itself, justified by the perspective of further increasing accessibility and task versatility within the interface. A first proposal pertains to the inclusion of external operation capabilities that exploit touch, corporal movements and gestures, in an effort to control dynamics and manipulate sounds in real time; such an example has been presented in Section 6.3.4 with respect to touch-screen Macintosh emulators (Wilson 2018: 23-4). In addition, the probability of certain learners being most comfortably acquainted with everyday objects, especially of a substantial size, to create plain and comprehensible melodies and sound patterns, requires various external objects to be configured. In an effort to enhance *Terpsichore*'s versatility and cross-compatibility, such objects include, but are not limited to, a MIDI keyboard, a non-tangible remote interaction device, or a mobile phone calibrated to

[143] The term 'diversified' is consistent with the already documented pervasive nature of Autism Spectrum Disorders.

connect to a computer through a local area network and acquiring comprehensive interaction capabilities via the TouchOSC framework (Hexler Website 2017). Programmers are also encouraged, considering the necessity in adhering to User Manual recommendations, to devise a framework for the correct completion of intended tasks, whereby each specific corporal movement (e.g. horizontal and vertical hand displacements or fluctuations, head shaking, relative body part movements) are associated with a different command execution set.

A second potential enhancement to *Terpsichore* is its extension to different levels of music cognition, linguistic backgrounds and operating systems. Certain autistic individuals may be categorised as high-functioning or savant thanks to the exceptional skills may possess, while the mental and emotional particularities associated with an ASD may not significantly impact musical aptitude. Such people would benefit from the inclusion of further educational and compositional capabilities, including time signature variety besides the standard 4/4 specification, advanced layering and instrument choice, or principles simulating music production for neurotypical individuals. Moreover, software developers occupied with *Terpsichore* should exploit their linguistic knowledge to reconfigure textual parts of a code so that the preferred or understood language is reflected on screen, something paired with a 'Select Language' menu to be added on software launch. In the longer term, language-specific adaptation relates not only to spoken languages other than English, but also to sign or Braille language, respectively understood by individuals with speech understanding deficits or blindness. Finally, thorough programming work is needed to ensure that *Terpsichore* becomes a cross-platform interface that can be seamlessly operated by Linux and Windows users, considering that the procedures explained in Section 3.2.4 solely apply to Macintosh systems, while very limited information is available on SuperCollider-based methods allowing the transformation of textual script into software for other operating systems.

The practical testing process of *Terpsichore* will considerably benefit from its expansion to broader target groups with respect to age, sample size, geographical region and ASD variant. The pervasive nature of the disability initially means that responses of adolescents and adults to the exact interface content are not guaranteed for infants or school pupils, whose naturally fragile personalities should be taken into consideration. Therefore, repeated studies in different settings, not constrained to special education classrooms, are likely to provide a more comprehensive viewpoint of *Terpsichore*'s applicability. Results from the twenty-eight participants involved in the pilot study are generally promising, and are often statistically significant for the different severity conditions specified in the supporting questionnaire. However, this can only be regarded as an encouraging sign for extensive investigation of the software's qualities, leading to increased verification, optimised results and reliable predictions when the sample size is substantially enlarged, for instance to hundreds of participants. Supposing that the frameworks for ASD teaching present diverse particularities amongst countries, large-scale collaboration with international institutions and research bodies is a recommended step towards determining the wider influence of special education blueprints on responses to *Terpsichore*. The identification of individuals with atypical ASD diagnoses including, but not limited to, Asperger syndrome, Savant syndrome and PDD-NOS, will also clarify the possible relationship of diagnostical discrepancies to activity performance, considering that almost all learners in the foregoing study possessed a typical autism diagnosis. Last but not least, important procedures should be followed, for instance within a postdoctoral environment, regarding necessary amendments so that *Terpsichore* can be subsequently sold as a commercial product. Such procedures should involve the collaboration of programmers and caregivers with experts in marketing with an interest in mental disability treatment, outlining the steps towards enabling the distribution of public beta and commercial releases, to extend beyond the intramural environment associated with 'alpha' releases (Goulekas 2002: 11-2). One such amendment may be the replacement of downloaded and sampled visual and auditory stimuli available online (see Images and Sounds) with licensed content either through rights purchase or studio-quality sound recording of instruments and environments. For instance, the use of flowing water and everyday urban sounds should encourage future practitioners to take advantage of suitable landscapes in recording real-time excerpts.

7.4 Concluding statement

The *Terpsichore* project was a first-hand opportunity in exploring various areas of specialisation including music therapy, music programming, psychology and mental disability treatment, in the attempt to provide and support a practical approach based on the endorsement of music and the immersion into the world of sound, as creative activities key to autistic individuals' welfare and quality of life. The study and critical analysis of the literature on music and mental disabilities, but most importantly the practical implementation of a novel interactive software platform with a defined direction towards original composition and targeted creativity, proved a crucial step towards pushing knowledge boundaries and opening new horizons in understanding the special field of mental impairments and the power of music in their treatment. As a result of the above, it can be deduced that the combination of the case study approach and the real-world analysis concentrating on actual human participants, eventually constitutes a valuable resource to be studied and employed as source of inspiration for the attainment of the desired social impact and commercial appeal aspirations. In the ever-evolving sector of music-assisted treatment through technological and computerised means, the pursuit towards *Terpsichore*'s further development and expansion to practical applications is indispensable in long-term endeavours to bring the interface at the forefront of music-assisted treatment procedures over the following years.

APPENDIX I

TERPSICHORE SOFTWARE BRIEF FOR TUTORS

<u>NOTE:</u>

Below you may find a short briefing document that was distributed to interested tutors and practitioners, outlining the importance of the software in learners with ASD, as well as crucial information pertaining to its use. Interested parties were subsequently encouraged to provide Consent Forms, whose content is described and presented in Appendix II. The entire document has been *framed*, so that it is distinguished from the rest of the Text.

University of Kent – Medway Campus
Centre for Music and Audio Technology
PhD Music and Technology
Researcher Full Name: Georgios Kyriakakis

***TERPSICHORE** Software Music Interface*
for learners with Autism Spectrum Disorders
Software Brief

Dear Tutor / Parent / Practitioner / Therapist,

My name is Georgios Kyriakakis and I am a PhD candidate in Music and Technology at the University of Kent, in the United Kingdom. As part of my research, I have developed *Terpsichore*, a software interface for Mac computers, whose aim is to assist individuals with a diagnosed Autism Spectrum Disorder (ASD) compose their own music and environmental soundscapes, using step-by-step music education and sound awareness techniques to nurture this skill. After having conducted bibliographical research in order to highlight the software's strong points, my study's focus on actual human participants aims to determine *Terpsichore*'s effects on areas including, but not limited to, mental health, emotional state, behaviour and musical creativity, so that the goals of music therapy associated with the software ideally result from acquaintance with musical concepts and their application to innovative music-making.

This brief has been designed to inform you about *Terpsichore*'s main elements, intended functionality and suggested use, hoping to persuade you into engaging with the research I have decided to conduct. Should you agree to participate in the research, you are requested to confirm in writing – in the form of a ***consent letter*** – that you used the software, by specifying the name of the institution and number of participants in which you applied it, as well as briefly stating the outcomes of testing the interface to your assigned participants. The results from your work will be used to identify the software's efficiency, sustainability and potential for more extensive use, and will only be employed for research and scientific publication purposes, and *not* for commercial exploitation.

1. What are the key features of *Terpsichore*?

Terpsichore intends to employ various areas of music as the mainspring for mental health improvements through its sustained incorporation in daily schedules. Its innovative character is identified not only in a curriculum-based approach, but also in its focus on the definition of 'music' as any form of sound that is not necessarily bound to tonal music regulations. That said, the software consists of two working modes, of which one relates to note-based music and is called the *Tonal Mode* (TM), whereas the other highlights the general character of sounds without emphasis on pitch, and is therefore named *Soundscape and Indefinite Pitch Mode* (SIP). More specifically, timbres encountered in the TM include, but are not limited to, the piano, the guitar and the saxophone. On the other hand, sounds of flowing water, moving leaves, drones or sounds of an urban environment are examples of audio available in the SIP Mode.

The layout of *Terpsichore* allows learners to acquaint themselves with both aspects of music, which is made possible by the organisation of the software so that both modes are distinguishable on-screen. In an effort to follow a targeted procedure regarding the above, each mode has been split into ***levels***, each associated with a different concept that can be practiced not only in its matching level, but in the entire software in general. Initial tasks in the mode are generally easy, but become harder as levels advance; still, all activities have been designed to be sufficiently manageable for learners with ASD, with or without tutor guidance.

In the Tonal Mode, the order of levels follows a procedure comprising three components: music theory, modification of existing melodies, and composition of short musical passages from scratch. Other areas addressed in-between, are the transformation of letters and words into music, the use of music to represent everyday situations, the and the synthesis of sounds from oscillator tones. In the SIP Mode, the user is mostly focussed on the combination of different audio clips, their arrangement in their timeline, the construction of simple percussion patterns and the familiarisation with entry-level aspects of electroacoustic music.

Both modes are accessed through the software's main menu, where an *Options* window may be also found. From this window, you may control such parameters as the suppression of unwanted frequencies and the activation of a timer that shuts down the software automatically after a specified period of time. In the main menu, buttons symbolised with the letters 'R', 'S' and 'F' relate, respectively, to the recording of in-software routines, the regulation of shouting and distress, and the numbering of fingers in both hands – in case you need to operate the software alongside a piano.

In each level, you may activate up to two enhancement structures. The first one is the *User Manual*, which includes guidelines that assist you in directing the learner to operate the level. In the second one, called the *Reward Mode*, a task appears on-screen that needs to be completed by the learner. If completion is successful, an arpeggio sound is heard to reward the learner. If it is unsuccessful, *Terpsichore* shuts down and needs to be relaunched.

2. Where can I access all the above information in detail?

The *Terpsichore* interface is provided to you together with a walkthrough video of nearly 45 minutes long, in which the procedure of operating the software in its entirety is described. All tasks are shown in order of the designed levels, with the Tonal Mode coming first and the SIP Mode following. As stated above, the interactive User Manual within the software, may be toggled on or off according to your preferences.

3. How can I be reassured about the software's applicability to a learner with ASD?

Terpsichore has been largely designed in accordance with an elaborate bibliographical analysis and virtual participant case study approach, which influenced, to an important extent, the addition of important components in the interface, mainly centred around the alleviation of negative behaviour patterns or emotional breakdowns. In short, *Terpsichore* has been designed with a broad spectrum of learner characteristics in mind, in accordance with an evidence-based approach supported by literature review and analysis.

The software's general difficulty of activities is comparably lower to the one of software packages for typically developing learners. Emphasis is given on images, symbols and letters, while the text-based user manual is mainly addressed to you, as a Tutor / Parent / Practitioner / Therapist, which is why it may be disabled when necessary if deemed to cause confusion. Moreover, the tasks included in the software require learners to possess a fundamental level of trainability. Therefore, you are strongly advised to only distribute the software to learners who you consider to be capable of acquiring at least entry-level new skills and competencies. All the above may reassure you about the software's applicability to learners with ASD.

In the unlikely event that adverse behaviours occur at any point throughout the software, please cease operation immediately and do not resume until the participant has calmed down. You are not obliged to use the software to the end, in case the learner feels tired and reluctant to continue. Responses will be recorded only for the levels that the participant has tackled, and all observations, whether positive or negative, will be taken into consideration in future attempts to optimise the software altogether and increase its applicability.

4. How can I contribute to your research on the software?

If commitments in your household, affiliated institution of employment or daily surroundings allow contact with individuals that have been diagnosed with ASD, you may choose those you consider suitable for testing and experimentation with *Terpsichore*, in accordance with the above guidelines.

To measure the learner's performance in various areas of music competence and wellbeing, including emotional state, behaviour, communication and task concentration, you may use an attached ***Questionnaire*** of 26 pages, with multiple-choice and open-ended questions that may assist in determining how *Terpsichore* has influenced occupation with music and everyday life for these learners. This questionnaire is provided to you as a Word document, but, for reasons of facilitation, you may find an *online format* of this survey, in the following link: _________. All responses will be recorded for PhD research purposes only.

Please note that the majority of open-ended questions are optional, and should be answered only when it is necessary to further explain the selection of an associated multiple-choice response. The latter are, by a majority, displayed in a numbered (0 to 10) or Likert-scale format (examples: 'positive' – 'negative', 'strongly agree' – 'strongly disagree', 'absolutely' – 'not at all').

5. What are the eligibility criteria for a learner to be included in the study?

- There is no lower or upper age or gender limit for the study.
- Be diagnosed with an Autism Spectrum Disorder (ASD), including the following: typical autism, Asperger syndrome, high-functioning autism, Savant syndrome and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS). If miscellaneous diagnosed deficits exist (such as Attention-Deficit / Hyperactivity disorder (ADHD), dyslexia, cerebral palsy, learning difficulties, mental retardation, Rett or Tourette syndrome), participants are only eligible when the above conditions coexist with ASD.
- Be trainable. In this context, trainability refers to the capacity of learning new material, as well as operating a computer in a fundamental level.
- Be in an environment supervised at least by yourself, and ideally by a qualified musician or mental disability practitioner. Learners may follow the instruction purposes either on their own – excluding supervision – or alongside other participants, although data will only be recorded for those who have an ASD condition.
- In case a participant does not like listening to music, for any reason, please contact me via e-mail or phone (both at the end of this Brief) so that I can suggest an alternative strategy for *Terpsichore* teaching. At some point during the Questionnaire, you will also be asked to describe the learner's condition in detail; please kindly contact me if any problems prevent *Terpsichore* from being used altogether.

6. How much time am I supposed to devote to the study?

There is no predefined amount of time that you must mandatorily spend on *Terpsichore*. However, please bear in mind that the time devoted is sufficient to not only progress through the entire content of Tonal and SIP Modes, but also allow learners to occupy themselves with the software substantially, so that noticeable changes and/or developments to musical aptitude and mental condition are presented.

Although all eligible participants will be considered regardless of the time spent by each, a recommended minimum duration would be 8 hours for the Tonal and 6 for the SIP Mode, distributed into different sessions each associated with one or more levels, with some time dedicated to mode revision if required. A suggested session length would be 45 minutes, in similarity to a typical music class. Whatever the case, please allow some time for the instructed concepts to 'sink in', so that these can be employed at subsequent stages of the learning process.

7. What do I need to do to support your research?

Once you have finished testing and instructed the software, and have received sufficient information with respect to how learners responded, please send your responses to the e-mail address specified at the end of this document, or use the SurveyMonkey online link to electronically submit responses. If you do not have direct access to a personal computer after the *Terpsichore* project has been finalised, you may contact me for an alternative private link.

Afterwards, please send, to the same e-mail, a written document (for each separate setting – e.g. school, special education institution, household – in which you administered the testing process), in which you confirm that you agreed to assist in the research and provide data for relevant purposes. The claims you make with regards to *Terpsichore* must be accompanied by an explicit reference to your completed Questionnaire, so that your contribution to the research is considered valid.

In case you are employed by one or more institutions where *Terpsichore* sessions took place, you must provide an official document (specified earlier as a ***consent letter***) certified by stamps from both the institution and its associated authorities, as well as by the Greek Ministry of Education and Religious Affairs. In all cases, your Signature is required for the consent letter and responses to be considered valid.

8. How may I contact you if I have any enquiries?

For anything you may need, including questionnaire and consent letter submission, please contact me in any of the following ways:

E-mail: **gk232@kent.ac.uk**

Post: Mr Georgios Kyriakakis, 40-44 Dodekanissou Street, Piraeus, Attica, Greece, GR-18541

Mobile phone number: +447510412210, +306972619654

I look forward to your involvement in the research and truly hope that you and your learners have a fantastic and rewarding experience with *Terpsichore*. While waiting for your responses, I remain at your full disposal for any further information or clarification you may need.

Thank you very much in advance for your attention, time and contribution.

Best wishes

GEORGIOS (GEORGE) KYRIAKAKIS

APPENDIX II

CONSENT CERTIFICATIONS

NOTES

- Consent certifications have been written by the three tutors who participated in the *Terpsichore* study, confirming their involvement and remarks with concern to the software's applicability to learners with Autism Spectrum Disorders (ASD).

- The certifications were initially written in Greek, and subsequently stamped by various educational authorities in the Attica region of Greece, with the highest one being the Hellenic (Greek) Ministry of Education and Religious Affairs. Official translations into English are provided below, signed by Mr Georgios D. Dalkidis, Translator and Certifying Attorney-at-Law.

- Three tutors provided consent certifications, but Ms Persefoni-Alexia Sergi accumulated data for learners from two schools with which she was affiliated at the time of research. Hence, Ms Sergi provided two different letters, one for each institution.

Athens, 25.06.2019

CERTIFICATION

I, the undersigned, Sergi Persefoni – Alexia, Music Teacher (Special Instruction and Education Teacher of Technological Education -16th rank) at the Comprehensive Special Vocational Junior and Senior High School of Piraeus, hereby certify that I used the "Terpsichore" Music Education Programme created by Georgios Kyriakakis, PhD candidate at the School of Music and Fine Art of the University of Kent, England, on a sample of four (4) individuals on the autism spectrum. The overall conclusion was that this programme can be implemented successfully with individuals on the autism spectrum.

The additional conclusions are included in the questionnaires attached.

The certifier, signature

The Principal, Mavrogianni Maria, signature – stamp

Round official stamp: Hellenic Republic, Ministry of Education and Religious Affairs, Regional Directorate of Primary & Secondary Education of Attica, Directorate of Secondary Education of Piraeus, Comprehensive Vocational Junior and Senior High School of Piraeus

I, the undersigned attorney-at-law, hereby certify that this true and accurate translation
from Greek to English of which language I am a proficient user,
concerns the attached document as specified in the Lawyers' Code
(Article 36, para. 2, Law 4194/2013,
Official Gazette of the Greek Government 208 Issue A 27.09.2013).
Athens, 24th March 2020
The Translator and certifying Attorney-at-law

Georgios D. Dalkidis
Attorney-at-Law
8, Mitsaki Str., Athens
Tel: +30 6974430314
ID nr at the Athens Bar Association: 3323
gdalkidislaw@gmail.com

Athens, 21.06.2019

CERTIFICATION

I, the undersigned, Sergi Persefoni – Alexia, Music Teacher (Teacher of Technological Education -16th rank) at the Comprehensive Special Vocational Junior and Senior High School of Drapetsona, hereby certify that I used the "Terpsichore" Music Education Programme created by Georgios Kyriakakis, PhD candidate at the School of Music and Fine Art of the University of Kent, England, on a specimen of eight (8) individuals on the autism spectrum. The overall conclusion was that this programme can be implemented successfully with individuals on the autism spectrum.

The additional conclusions are included in the questionnaires attached.

The certifier, signature

The Principal, Olympia Lazarou, signature – stamp

Round official stamp: Hellenic Republic, Ministry of Education and Religious Affairs, Regional Directorate of Primary & Secondary Education of Attica, Directorate of Secondary Education of Piraeus, Comprehensive Special Vocational Junior and Senior High School of Drapetsona

I, the undersigned attorney-at-law, hereby certify that this true and accurate translation from Greek to English of which language I am a proficient user, concerns the attached document as specified in the Lawyers' Code (Article 36, para. 2, Law 4194/2013, Official Gazette of the Greek Government 208 Issue A 27.09.2013).
Athens, 24th March 2020
The Translator and certifying Attorney-at-law

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MINISTRY OF EDUCATION, RESEARCH AND RELIGIOUS AFFAIRS
REGIONAL DIRECTORATE OF PRIMARY &
SECONDARY EDUCATION OF ATTICA
DIRECTORATE OF SECONDARY EDUCATION OF PIRAEUS
Special Vocational Education and
Training Workshop of Piraeus
"Anixi" Second Special Vocational Education and
Training Workshop of Piraeus
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Postal Code: 18542 Piraeus
Querries: Sklaveniti Dimitra
Tel. : 0030.2104206007
Fax : 0030.2104206008
E-mail : mail@eeeek-peiraia.att.sch.gr

Piraeus, 14.06.2019
Reference no.: 271

Recipient:
School of Music and Fine Art of the
University of Kent, England

Attn.:
Georgios Kyriakakis

Certification

I, the undersigned, Panagiota Kyriakidou, Music Teacher, hereby certify that I used the "Terpsichore" Music Education Programme created by Georgios Kyriakakis, PhD candidate at the School of Music and Fine Art of the University of Kent, England, on a sample of four (4) individuals on the autism spectrum. The overall conclusion was that this programme can be implemented successfully with individuals on the autism spectrum. The additional conclusions are included in the questionnaires attached.

The certifying Teacher, Kyriakidou Panagiota, signature

The Principal, Sklaveniti Dimitra, signature

Round official stamp: Hellenic Republic, Ministry of Education and Religious Affairs, Regional Directorate of Primary & Secondary Education of Attica, Directorate of Secondary Education of Piraeus, "Anixi" Second Special Vocational Education and Training Workshop of Piraeus

I, the undersigned attorney-at-law, hereby certify that this true and accurate translation from Greek to English of which language I am a proficient user, concerns the attached document as specified in the Lawyers' Code (Article 36, para. 2, Law 4194/2013, Official Gazette of the Greek Government 208 Issue A 27.09.2013).
Athens, 24th March 2020
The Translator and certifying Attorney-at-law

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Piraeus, 26.06.2019
Reference no.: 459

Recipient:
School of Music and Fine Art of the
University of Kent, England

Attn.:
Georgios Kyriakakis

Certification

I, the undersigned, Papakirykou Chrysoula, Music Teacher, hereby certify that I used the "Terpsichore" Music Education Programme created by **Georgios Kyriakakis**, PhD candidate at the School of Music and Fine Art of the University of Kent, England, on a sample of twelve (12) individuals on the autism spectrum. The overall conclusion was that this programme can be implemented successfully with individuals on the autism spectrum.

The additional conclusions are included in the questionnaires attached.

The certifying Teacher, Papakirykou Chrysoula, signature

The Principal, Bebis Ioannis, signature

Round official stamp: Hellenic Republic, Ministry of Education, Research and Religious Affairs, Regional Directorate of Primary & Secondary Education of Attica, Directorate of Secondary Education of Piraeus, Third Junior High School of Piraeus

I, the undersigned attorney-at-law, hereby certify that this true and accurate translation from Greek to English of which language I am a proficient user, concerns the attached document as specified in the Lawyers' Code (Article 36, para. 2, Law 4194/2013, Official Gazette of the Greek Government 208 issue A 27.09.2013).
Athens, 24th March 2020
The Translator and certifying Attorney-at-law

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APPENDIX III

TERPSICHORE QUESTIONNAIRE

QUESTIONNAIRE

This Questionnaire refers to the use and influence on the mental condition and personality characteristics of individuals occupying themselves with the «TERPSICHORE» music and soundscape composition software

Written by: GEORGIOS KYRIAKAKIS, PhD Candidate at the University of Kent, Centre of Music and Audio Technologies
Contact E-mail: gk232@kent.ac.uk, georgesunday@windowslive.com

IMPORTANT NOTES

** This Questionnaire is to be completed by the parent, guard or tutor of each Human Participant (HP) bound to be included in the eventual research.

** Only those HP whose diagnosis is consistent with an Autism Spectrum Disorder (ASD), in whole or in part, are to be included.

** The software includes two operation environments: Tonal Mode (TM) and Soundscape & Indefinite Pitch Mode (SIP). The first includes tasks strictly associated with musical notes, whereas the second places its emphasis on sounds not directly consistent with specific notes.

** In some of the questions, if your status cannot be defined as one of a music professional, tutor or therapist, it is advisable that assistance be sought from such a professional, in order to extract more reliable feedback regarding the quality and musical integrity of the melodies produced by the HP in question.

** Please contact me via the e-mail addresses specified at the start of this Questionnaire, should you have any queries or require further clarification on my part.

** Abbreviations used here: **ASD = Autism Spectrum Disorder, HP = Human Participant, TM = Tonal Mode, SIP = Soundscape & Indefinite Pitch Mode**

INTRODUCTION

0. PERSONAL INFORMATION

- Relationship to Human Participant: ☐ Parent / Guardian ☐ Tutor ☐ Therapist / Doctor ☐ Other (please specify) ______________________________
- Is your profession related to music? ☐ YES ☐ NO

1. HUMAN PARTICIPANT GENERAL INFORMATION

- Year of birth: ________
- Gender: ☐ Male ☐ Female ☐ Prefer not to say

2. MENTAL DISORDER GENERAL INFORMATION

- Month and year of diagnosis (estimate): ____ / ______
- Type of diagnosis:

☐ Typical Autism
☐ Asperger Syndrome
☐ High-functioning Autism
☐ Savant Syndrome
☐ Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS)
☐ Other (please specify) ____

- Estimated severity of condition: ☐ Mild ☐ Moderate ☐ Severe ☐ Don't know / Prefer not to say
- Trainability: ☐ Trainable ☐ Non-trainable ☐ Don't know / Prefer not to say
- Additional diagnosis besides ASD: ☐ YES ☐ NO
  If the answer is YES, please specify the diagnosis: ____
- Does the HP face learning difficulties or mental retardation in addition to ASD?
  ☐ YES ☐ NO

3. MUSICAL PREFERENCES, KNOWLEDGE AND STUDIES

- What is your evaluation of the HP's reaction when being faced with any form of sound?
  ☐ Positive ☐ Probably positive ☐ Neutral ☐ Probably negative ☐ Negative

☐ Don’t know / Prefer not to say

- Does the HP like listening to music? ☐ YES ☐ NO

  *** The following questions are not required to be answered in case the above response is NO

- Preferred genres of music: ____
- Genres of music causing irritation: ____
- Sounds potentially causing irritation: ____

  ____

- Active occupation with music: ☐ YES ☐ NO. If YES, for how long? ______________________
- Knowledge of music theory: ☐ YES ☐ NO
- Knowledge of musical instruments: ☐ YES ☐ NO
- Instrument 1: ☐ Tuition level _______________ ☐ Amateur occupation
- Instrument 2: ☐ Tuition level _______________ ☐ Amateur occupation
- Instrument 3: ☐ Tuition level _______________ ☐ Amateur occupation

A. INITIAL USER CONDITION

*** The following Sections are useful in determining important elements consistent with the general condition of autistic HP under evaluation, with an objective of assisting with tuition and training related to the *Terpsichore* software.

*** The term «initial» refers to the HP condition *prior* to first employing the software in any form.

4. <u>EVALUATION OF EMOTIONAL STATE</u>

4.1 What is your evaluation of the HP’s ability to externalise his emotions towards his surroundings?

☐ Positive ☐ Probably positive ☐ Neutral ☐ Probably negative ☐ Negative

☐ Don’t know / Prefer not to say

Please provide additional information if applicable:

____

____

____

4.2 What is your evaluation of the HP's ability to interpret other people's emotions?

☐ Positive ☐ Rather positive ☐ Neutral ☐ Rather negative ☐ Negative ☐ Don't know / Prefer not to say

Please provide additional information if applicable:

____

____

____

4.3 Based on words and actions, what is your general evaluation of the HP's emotional state?

☐ Positive ☐ Rather positive ☐ Neutral or intensely variable

☐ Rather negative ☐ Negative

☐ Don't know / Prefer not to say

Please provide additional information if applicable:

____

____

____

4.4 Describe how the user feels when being brought in contact with various sounds, and how irritation, if applicable, is subsequently expressed (cries, emotional shifts, aggression etc.)

____

____

____

____

4.5 Which of these are most likely to cause the HP irritation and negative emotional shifts? (multiple answers allowed)

☐ High volume sounds

☐ High duration sounds

☐ Abrupt sounds

☐ Sounds deriving from sharp objects (e.g. fork, knife, guitar, doorbell etc.)

☐ Combination of simultaneous sounds

☐ Intermittent or periodic sounds (e.g. timer, metronome, alarm etc.)

☐ Human speech

☐ Human cries and shouts

☐ Other (please specify) ______________________________________

☐ None of the above
☐ Don't know / Prefer not to say

5. <u>BEHAVIOUR TOWARDS SELF AND OTHERS</u>

5.1 What is your overall evaluation of the HP's behaviour towards peers he is familiar with (e.g. parents, relatives, tutors, professional therapists)?
☐ Positive (calm, no serious problems) ☐ Rather positive ☐ Neutral
☐ Rather negative (frequent outbursts, shouting, sense of disrespect)
☐ Negative (recurring behavioural adversity and/or provocation of uncontrollable situations)
☐ Don't know / Prefer not to say
Please provide additional information if needed: ________________________________
____
____

5.2 What is your overall evaluation of the HP's behaviour towards people he is NOT familiar with?
☐ Positive (calm, no serious problems) ☐ Rather positive ☐ Neutral
☐ Rather negative (frequent outbursts, shouting, sense of disrespect)
☐ Negative (recurring behavioural adversity and/or provocation of uncontrollable situations)
☐ Don't know / Prefer not to say
Please provide additional information if needed: ________________________________
____
____

5.3 Which of these may cause adverse behaviours on the HP's part? (multiple answers allowed)
☐ Directions given by familiar individuals (e.g. parents, tutors)
☐ Directions given by unfamiliar individuals
☐ Corrective feedback and/or warnings
☐ Overwhelming information load
☐ Occupation with undesirable and/or tedious activities
☐ Refusal to accommodate requests

☐ Activity in unfamiliar environments
☐ Other (please specify) ____
☐ None of the above
☐ Don't know / Prefer not to say

5.4 How often does the HP exhibit hostile behaviour towards himself / herself?

☐ Very often ☐ Relatively often ☐ Occasionally ☐ Rarely / Never
☐ Don't know / Prefer not to say

In relation to the above, how often does such behaviour lead to self-injury or damage to his/her surroundings?

☐ Very often ☐ Relatively often ☐ Occasionally ☐ Rarely / Never
☐ Don't know / Prefer not to say

5.5 In your opinion, is listening to music a strategy capable of positively influence the HP's behaviour?

☐ YES ☐ NO

If necessary, please provide examples that justify the above response:

____

____

5.6 In your opinion, is the selection of appropriate sounds capable of positively influencing the HP's behaviour?

☐ YES ☐ NO

If necessary, please provide examples that justify the above response:

____

____

6. <u>COMMUNICATION AND INTERACTION</u>

6.1 What is your overall evaluation of the HP's ability to communicate with his/her surroundings?

☐ Positive (full ability to engage in dialogical conversation for the HP's age)
☐ Rather positive (mild difficulties in constructing concise and intelligible phrases)
☐ Neither positive nor negative (brief or relatively unintelligible discourse)

- ☐ Rather negative (extremely short discourse or articulation of isolated syllables or words)
- ☐ Negative (complete inability to communicate)
- ☐ Don't know / Prefer not to say

Please provide explanatory examples if needed: ____________________________________

____

____

____

6.2 Which of these do you observe in the HP's daily communication routines? (multiple answers allowed)

- ☐ Articulation incapacity
- ☐ Use of isolated speech patterns or sounds
- ☐ Echolalia (mechanical repetition or imitation of words and sentences)
- ☐ Other (please specify) ____
- ☐ None of the above
- ☐ Don't know / Prefer not to say

6.3 Do you deem music to be an appropriate strategy to improve communication skills?

☐ YES ☐ NO

6.4 Do you deem the selection of appropriate sounds to assist in communication skill improvement?

☐ YES ☐ NO

7. <u>MISCELLANEOUS INFORMATION</u>

7.1 What is your evaluation of the HP's ability to concentrate on a specific task for an extended period of time?

- ☐ Positive (rare or inexistent occurrences of concentration deficit)
- ☐ Rather positive ☐ Neither positive nor negative ☐ Rather negative
- ☐ Negative (frequent difficulties in staying focussed even for seconds / minutes)
- ☐ Don't know / Prefer not to say

If necessary, please provide examples of stimuli, objects or situations that would negatively impact the HP's focus: ____

____

____
____

7.2 In which of these sectors is the HP likely to face difficulties, with concern to the coordination of specific body parts or the body altogether?

☐ Gross motor skills (full coordination of body and muscles)

☐ Fine motor skills (coordination of specific body parts including hands, feet and eyes – eye-gaze included)

☐ Oral motor skills (coordination of muscles responsible for speech)

☐ Don't know / Prefer not to say

Please provide additional information if needed: __________________________________
____
____

7.3 What is your evaluation of the HP's ability to follow the curriculum of the educational institution in which he / she is enrolled?

☐ Positive ☐ Rather positive ☐ Neutral ☐ Rather negative ☐ Negative

☐ Don't know / Prefer not to say

7.4 How easy and comfortable is it for the HP to transition between different concepts and exercises within the same knowledge field?

☐ A lot ☐ Rather enough ☐ A little ☐ Not at all

☐ Don't know / Prefer not to say

7.5 What is your evaluation of the HP's ability to follow the increasing difficulty, over time, of an educational curriculum?

☐ Positive ☐ Rather positive ☐ Neutral ☐ Rather negative ☐ Negative

☐ Don't know / Prefer not to say

7.6 What is your evaluation of the HP's reaction towards advice and guidelines provided by people within his/her direct involvement (e.g. parents, tutors)?

☐ Positive ☐ Rather positive ☐ Neutral ☐ Rather negative ☐ Negative

☐ Don't know / Prefer not to say

7.7 Are there any comments or observations you would like to be taken into consideration prior to the start of research?

____

____

____

____

B. *TERPSICHORE* SOFTWARE USE

*** In order to complete Section C of the Questionnaire, the use of both working modes (**Tonal Mode – TM** and **Soundscape & Indefinite Pitch – SIP**) is required. To facilitate the occupation with the software, it is necessary to closely follow the guidelines included *on-screen* in each of the software's levels, as well as the video walkthrough that accompanies the Questionnaire.
*** In the questions where responses may be provided using the numerical values 0 to 10, the number zero refers to the negative extreme ("not at all", "definitely negative") whereas 10 refers to the positive extreme ("absolutely", "definitely positive"). Evaluation of answers will be based on the general reactions of the HP – please provide as objective responses as possible.
*** Responses to questions below should be closely based on the progress and tasks performed by the HP, which you may record and save with the help of the *Record* window, labelled with the letter **R** in *Terpsichore*'s main menu. To do this, in the Mac OS folder of your main hard drive, specified as **/Users/[your username]/Documents/Saved Audio**, create – at each instance – a separate file with the name of each level, also containing the instance or "take" relating to each different recording within the same level (e.g. "Tonal 1-1.wav", "Tonal 1-2.wav", "Tonal 14.wav", "SIP 10.wav").

8. <u>GENERAL INFORMATION</u>

8.1 How would you evaluate the HP's first impression of *Terpsichore* with regards to its Graphical User Interface (GUI)? This includes images, colours, shapes and complexity:

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

8.2 How would you evaluate, from your personal perspective, the overall layout of the software (functional environments, concepts covered, general level of difficulty)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

8.3 How would you evaluate, from your personal perspective, the software, regarding ease of use, before it is provided to the HP?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

8.4 How well do you believe that the concepts and elements presented in *Terpsichore* are compatible with the HP's needs and particularities?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

8.5 How well does the HP comprehend on-screen guidelines presented after activating the User Manual and Reward Mode?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

8.6 To improve and/or control which of the following elements do you intend to use the present software? (multiple answers allowed)

☐ Behaviour towards familiar people (e.g. parents, relatives, tutors, therapists)

☐ Behaviour towards unfamiliar people

☐ Communication with familiar people

☐ Communication with unfamiliar people

☐ Spoken discourse (formation of simple words and/or phrases with intelligible content)

☐ Written discourse (as above)

☐ Emotional state

☐ Concentration

☐ Everyday task planning (e.g. completion of everyday tasks, organisation of activities within a time schedule)

☐ Motor skills (e.g. improvement of time and rhythm awareness, coordination of body parts and/or the body altogether)

☐ Dexterity in playing a musical instrument (existing or new)

☐ Music composition

☐ Music improvisation

☐ None of the above

☐ Don't know / Prefer not to say

8.7 How many sessions were required to complete involvement with *Terpsichore*'s TM? _______

The above translates to how many hours of occupation with the TM? ________

How many sessions were required to complete involvement with *Terpsichore*'s SIP? _______

The above translates to how many hours of occupation with the SIP? ________

8.8 How do you evaluate the initial reaction of the HP, either after being informed about the imminent occupation with the software, or after the *Terpsichore* sessions have started?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide additional information if needed: ________________________________

____

____

____

9. TONAL MODE (TM): OVERALL

9.1 How strongly do you believe that the levels contained in *Terpsichore*'s TM are rationally organised?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

9.2 How easy and comfortable is it for the HP to transition from one knowledge field to another, as sessions advance?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

9.3 How easy is it for the HP to respond to whatever is asked in each of the levels?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

9.4 In which of the levels is the HP most responsive, as far as usage and completion of tasks according to specified on-screen guidelines are concerned? Briefly justify your response.

____

9.5 In which of the levels is the HP least responsive, presents behavioural outbursts or expresses unwillingness to progress? Briefly justify your response.

9.6 How would you evaluate the quality of melodies produced by the HP in the levels where the alteration of existing melodies is possible (as shown in accompanying video)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Any comments on the above (optional):

9.7 How would you evaluate the quality of melodies produced by the HP in the levels where the composition of melodies from a blank document is possible (as shown in accompanying video)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Any comments on the above (optional):

9.8 How strongly would feel that the melodies produced by the HP whilst being occupied with *Terpsichore*'s TM, follow the common principles of Music Theory and Harmony as defined in Western European tonal music?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

9.9 Are the pre-set musical instruments, which can be used while the software is in operation, sufficient for the needs of the HP? ☐ YES ☐ NO

Which other instruments would you like to see added to the software in future instances?

____

____

How helpful would the ability to alter built-in sound samples within *Terpsichore* assist in resolving potential problems?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

9.10 Evaluate, using the numbers 0 to 10, each of the levels *separately*, with regards to the HP's responsiveness to them, as well as their compatibility with everyday needs and influence on daily life routines:

MAIN		10	
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9			

10. <u>TONAL MODE (TM): INFORMATION ON SPECIFIC LEVELS</u>

*** The current Section refers to specific Levels deemed important with respect to the confrontation and improvement of mental, cognitive and everyday characteristics of the HP who employs them. For this reason, and for the purpose of this Section, *not* all levels are mentioned.

10.1 **Main Menu:** This Menu features, amongst others, a series of windows with changing elements over time, according to the 4-beat sequence in a typical 4/4-time signature measure. How would you evaluate the HP's ability to follow a stable speed in hand movement (e.g. on a solid surface, on a computer keyboard) *before* using the menu?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

- How would you evaluate the ability in question *after* the menu has been used for a substantial period of time?

  ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

  ☐ Don't know / Prefer not to say

- How would you evaluate the HP's ability to complete the hand's mechanical movement defined as 'up-down-left-right', *before* using the menu?

  ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

  ☐ Don't know / Prefer not to say

- How would you evaluate the ability in question *after* the menu has been used for a substantial period of time?

  ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

  ☐ Don't know / Prefer not to say

10.2 **Level 5:** How comfortable is it for the HP to create melodies consistent with the simple words or phrases given in the current example: MUM, DAD, KID, SLEEP, SCHOOL, PLAY, MUSIC, FRIEND, I LOVE YOU, GO FOR A WALK, LET'S EAT, BE FRIENDS.

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide further information if necessary: ________________________________

____

____

How easy is it for the HP to construct independent words or phrases whilst *not* having to rely on the above examples?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide further information if necessary: ________________________________

____

____

10.3 **Level 6:** How appropriate are the photos provided in the «petal» structure to represent different situations and actions?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How comfortable is it for you to construct a song, based on the notes of the melodies when activating each petal, with which you will persuade the HP into performing an associated action (e.g. wake up, have lunch, study, go to bed)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you evaluate the HP's responsiveness to the tasks to be completed in accordance with relevant melodies?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

10.4 **Level 9:** How comfortable is it for the HP to produce new melodies, out of the default ones, taking into consideration the limitations imposed by the *Terpsichore* code, which demands that no two notes are identical within the same melody (inspired by A. Schoenberg's 'twelve-tone technique')?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

What is the influence of the current level on the HP's mental state, considering the risks that the above limitation may entail?

☐ Positive ☐ Rather positive ☐ Neutral ☐ Rather negative ☐ Negative

☐ Don't know / Prefer not to say

10.5 **Levels 11-12:** How comfortable is the procedure of pressing imaginary 'piano keys' using mouse clicks?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How useful is the accompanying *feedback mode*, in the HP's attempt to improve the quality and content of produced melodies?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Which of these statements best describes the responsiveness of the HP to the levels in question?

☐ Full comfort in operating the levels autonomously, without the need of external support aids

☐ Requirement for an external musical instrument, not necessarily connected to the software

☐ Requirement for an external musical instrument capable of connecting itself directly to the software

☐ Difficulties in or inability to follow the requirements set by the levels

☐ Don't know / Prefer not to say

10.6 **Levels 13-14:** How much do you feel that the sample phrase completions provided in these levels assist the HP in independently completing phrases without resorting to the mechanical repetition of notes?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you evaluate the HP's ability to independently complete phrases without external stimulation?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

What is the influence of the HP's occupation with the current levels, on his/her ability to communicate dialogically, without engaging in imitative or 'echolalic' communication patterns? (0: totally negative, 5: neutral, 10: totally positive)

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

10.7 **Level 17:** How comfortable is it for you to load images designed to support the *social stories*, which are the main subject of this Level?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you evaluate the HP's ability to compose musical phrases based on the images loaded?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you generally evaluate the usability and compatibility of the current Level, with relation to the HP's attempt in treating mental state and everyday life elements?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

10.8 **Level 18:** How would you evaluate the HP's ability to memorise knowledge and concepts instructed in previous levels, in an attempt to produce aurally pleasant melodies?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you evaluate the quality of melodies produced by the HP, from your own perspective?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide additional information if necessary: ________________________________

____

____

11. <u>SOUNDSCAPE AND INDEFINITE PITCH MODE (SIP): GENERAL INFORMATION</u>

11.1 How strongly do you believe that the levels contained in *Terpsichore*'s TM are rationally organised?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

11.2 How comfortable is it for the HP to respond to whatever is asked in each of the levels?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

11.3 How comfortable is it for the HP to transition from one knowledge field to another, as sessions advance?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

11.4 In which of the levels is the HP most responsive, as far as usage and completion of tasks according to specified on-screen guidelines are concerned? Briefly justify your response.

____

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11.5 In which of the levels is the HP least responsive, presents behavioural outbursts or expresses unwillingness to progress? Briefly justify your response.

____

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____

____

11.6 Evaluate, using the numbers 0 to 10, each of the levels *separately*, with regards to the HP's responsiveness to them, as well as their compatibility with everyday needs and influence on daily life routines:

MAIN		8	
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	

11.7 How often was the metronome mode (percussion background to dictate rhythm) required whilst soundscapes were being composed and modified by the HP? In other words, how indispensable was such a procedure deemed?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12. <u>SOUNDSCAPE AND INDEFINITE PITCH MODE (SIP): INFORMATION ON SPECIFIC LEVELS</u>

*** Similarly to Section 10, the current Section refers to the levels considered particularly important with concern to treating and improving the HP's mental state, cognitive and everyday characteristics. For this reason, *not* all levels are mentioned.

12.1 **Levels 1-2:** How comfortably can the HP recognise the sounds presented in each of the levels (water, droplets, wind, moving leaves)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.2 **Level 3:** How much would you agree that the audio-visual material provided, directed towards the representation and personification of mental states, influences the HP's capability of recognising diverse feelings?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Whilst *Terpsichore*'s SIP was being instructed, were sounds and images representing feelings of sadness or anger used (considering the option of disabling them at any point)?

☐ YES ☐ NO

Briefly justify your response: ____

____

____

____

12.3 **Level 4:** How positively does the ability to insert and reproduce different sound clips on an imaginary cursor timeline affect the HP's awareness of time and space?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.4 **Levels 5-6:** How positively does the ability to activate sound clips panned in various positions (left, right, centre) affect the HP's perception of sounds and people in close proximity?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

In Level 6, how does the option of rotating audio sources around the sound map's centre affect the mental state of the HP?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.5 **Level 7:** How strongly does the arrangement of phrases using percussion instruments assist in increasing the HP' perceptual skills?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How strongly does the above arrangement facilitate the management of the HP's body part movement (hands, feet, head etc.)? In other words, would you agree with the statement that gentle and controlled movements tend to become more frequent than abrupt or spasmodic ones?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.6 **Level 8:** In which of these frequency sub-spectra is the HP particularly sensitive *before* first using this level?

☐ Very high (5-20kHz) ☐ High (1-5kHz) ☐ High-Mid (500-1000Hz) ☐ Low-Mid (200-500Hz)

☐ Low (50-200Hz) ☐ Very low (20-50Hz) ☐ General issues regardless of frequency

☐ No problems caused by external sounds ☐ Don't know / Prefer not to say

In which frequency sub-spectra is the HP sensitive *after* the level has been used for an extended period of time?

☐ Very high (5-20kHz) ☐ High (1-5kHz) ☐ High-Mid (500-1000Hz) ☐ Low-Mid (200-500Hz)

☐ Low (50-200Hz) ☐ Very low (20-50Hz) ☐ General issues regardless of frequency

☐ No problems caused by external sounds ☐ Don't know / Prefer not to say

12.7 **Level 10:** How much do you feel that the sample phrase completions provided in these levels assist the HP in independently completing phrases without resorting to the mechanical repetition of audio clips?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you evaluate the HP's ability to independently complete phrases without external stimulation?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

What is the influence of the HP's occupation with the current levels, on his/her ability to communicate dialogically, without engaging in imitative or 'echolalic' communication patterns? (0: totally negative, 5: neutral, 10: totally positive)

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.8 **Levels 11-12:** From the HP's perspective, please evaluate these levels with regards to:

ease of use: ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

responsiveness to audio: ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Important note: This question is vital because the construction of phrases using granular synthesis and modulation is a rather particular soundscape formation procedure, giving rise to the requirement of determining its influence in the HP's mental condition.

How comfortably can the HP modify the resulting sound's various parameters, irrespective of whether he/she is influenced by the capability of understanding written indications?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.9 **Level 13:** How does the simultaneous activation of contrasting sounds, towards the formation of a soundscape, affect the mental state of the HP?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you evaluate the quality of soundscapes produced whilst the HP uses the level?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.10 **Level 14:** What did you employ, in conjunction with the computer, to record different sounds ready for modification by the HP?

☐ External microphone ☐ Headphones ☐ None of the two (just the computer)

How sufficient do you judge the elements presented in the level window, as far as the attempt to modify recorded sound sources is concerned?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.11 **Level 15:** How comfortable is it for you to load images designed to support the *social stories*, which are the main subject of this Level?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you evaluate the HP's ability to compose musical phrases based on the images loaded?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How would you generally evaluate the usability and compatibility of the current Level, with relation to the HP's attempt in treating mental state and everyday life elements?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

12.12 **Various levels:** In cases where the option of modifying *panning position* is viable, how easy is it for the HP to perceive the position and direction of presented sounds – in other words, whether these derive from the left, from the right, occupy variable positions vacillating between left and right (etc.)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

C. FINAL USER CONDITION

*** The term «final» condition refers to the period following the use of the software after an extended period of time.

*** Do not complete anything in Part D unless you have ensured that the software has been employed for a sufficient period of time, until tangible results have been observed. However, this Part *must* be completed as a prerequisite of including results in the overall *Terpsichore* research.

13. <u>EVALUATION OF EMOTIONAL STATE</u>

13.1 How did *Terpsichore* influence the HP's ability to externalise personal feelings towards his/her surroundings?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide further information if applicable: ______________________________

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13.2 How did *Terpsichore* influence the HP's ability to recognise and interpret other people's feelings?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide further information if applicable: ______________________________

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13.3 How did *Terpsichore* influence the overall emotional state of the HP?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide further information if applicable: ______________________________

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13.4 How did *Terpsichore* influence the HP's responsiveness to various environmental sounds, as well as sound content produced by other individuals (e.g. speech, shouts etc.)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide further information if applicable: ______________________________

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13.5 Of the sound categories initially determined as responsible for adverse behaviours or irritation on the HP's part (see Question 4.5), are there still any ones that continue to disturb the HP, to an either similar or elevated extent? Please provide relevant information.

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____

14. BEHAVIOUR TOWARDS SELF AND OTHERS

14.1 How did *Terpsichore* influence the HP's behaviour towards individuals he/she knows (e.g. parents, relatives, teachers, professional therapists)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ Don't know / Prefer not to say

Please provide relevant information if applicable: ________________________________

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14.2 How did *Terpsichore* influence the HP's behaviour towards unfamiliar individuals?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ Don't know / Prefer not to say

Please provide relevant information if applicable: ________________________________

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14.3 How did occupation with *Terpsichore* affect the HP's tendency to exhibit hostile behaviour towards himself / herself?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How has the tendency to cause damage or self-injury changed as a result of *Terpsichore* use?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

14.4 Were there moments during which occupation with *Terpsichore* negatively affected the HP's behaviour? ☐ YES ☐ NO

If the answer is YES, please provide explanatory examples:

____

____

____

____

14.5 How would you evaluate the HP's reaction when the software shuts down after failure to complete a task or after the timer has reached zero?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

15. <u>COMMUNICATION AND INTERACTION</u>

15.1 How did *Terpsichore* influence the HP's ability to communicate with his/her surroundings?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide relevant information if applicable: __________________________

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15.2 Has '*echolalia*' been identified as an issue to be dealt with during *Terpsichore* use?

☐ YES ☐ NO

How did *Terpsichore* influence the HP's capacity of producing independent phrases not characterised by mechanical repetition?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

How did *Terpsichore* influence the ability to provide independent answers to questions asked by the supervising individual towards the HP?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

15.3 How did *Terpsichore* influence the HP's capability of perceiving the existence of other individuals within his/her surroundings, combined with their position within the three-dimensional space?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

16. <u>MISCELLANEOUS ACTIVITY INFORMATION</u>

16.1 After extended use of *Terpsichore*, how would you judge the HP's ability to concentrate on activities directly associated with the software?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

As a result of occupation with *Terpsichore*, how would you judge the HP's ability to concentrate on various activities not relevant to the software itself?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide additional information if needed: ____________________________________

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16.2 What is your post-*Terpsichore* evaluation of the HP's ability to provide answers to questions asked by close surroundings?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

16.3 What is your post-*Terpsichore* evaluation of the HP's ability to follow the curriculum of the educational institution in which he / she is enrolled?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

16.4 What is your post-*Terpsichore* evaluation of the HP's reaction towards advice and guidelines provided by people within his/her direct involvement (e.g. parents, tutors)?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
☐ Don't know / Prefer not to say

16.5 Evaluate, using numbers from 0 to 10, the software's influence on the following aspects, after this has been used for a substantial period of time (0: strongly negative, 5: neutral, 10: strongly positive). If you are unsure about an element, please leave the field blank.

Gross motor skills: ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
☐ Don't know / Prefer not to say

Fine motor skills: ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
☐ Don't know / Prefer not to say

Oral motor skills: ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
☐ Don't know / Prefer not to say

Musical instrument skills (relating to existing musical instrument knowledge):
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ Don't know / Prefer not to say

17. MUSIC AND SOUND AWARENESS, CREATIVITY

17.1 How strongly do you believe that *Terpsichore* has contributed to the acquisition of theoretical knowledge on the HP's part? Note: *to answer this question please consider the HP's ability to engage in independent occupation with the Tonal Mode's various levels.*

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
☐ Don't know / Prefer not to say

Please provide additional information if needed: ______________________________

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____

17.2 How strongly do you believe that *Terpsichore* enhanced the HP's ability to compose new melodies and soundscapes independently, without receiving guidance from a third party?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
☐ Don't know / Prefer not to say

17.3 How did occupation with *Terpsichore* affect the HP's interest in creating note-based tonal music?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don’t know / Prefer not to say

17.4 How did occupation with *Terpsichore* affect the HP’s interest in creating and modifying soundscapes based on environmental sounds?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don’t know / Prefer not to say

17.5 For the *Tonal Mode*, which of the following phrases best represents the HP after a substantial period of occupation with the software?

☐ Full comfort in creating and reproducing melodies without the need for guidance

☐ Requirement for fundamental guidelines to create melodies

☐ Ability to create melodies only with substantial interventions (videos, third-party tutors)

☐ Unorthodox occupation with the Tonal Mode without a specific goal

☐ Incapacity of responding to the requirements of the levels

☐ Unwillingness to use the Tonal Mode altogether

☐ Don’t know / Prefer not to say

17.6 For the *SIP Mode*, which of the following phrases best represents the HP after a substantial period of occupation with the software?

☐ Full comfort in creating and reproducing soundscapes without the need for guidance

☐ Requirement for fundamental guidelines to create soundscapes

☐ Ability to create soundscapes only with substantial interventions (videos, third-party tutors)

☐ Unorthodox occupation with the SIP Mode without a specific goal

☐ Incapacity of responding to the requirements of the levels

☐ Unwillingness to use the SIP Mode altogether

☐ Don’t know / Prefer not to say

17.7 Provided that the HP plays a musical instrument, how strongly do you believe that the ability to play it, combined with the level of dexterity (if applicable), have improved as a result of occupation with *Terpsichore*?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don’t know / Prefer not to say

D. CONCLUSION

18. OVERALL EVALUATION

18.1 How well do you believe that the HP has responded to *Terpsichore* overall?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

Please provide additional information if needed: ________________________________

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18.2 What is your judgment of the opinion that the changes in mental condition and autism-compliant characteristics have been influenced by the development of music and sound awareness capabilities as a result of *Terpsichore* occupation?

☐ Strongly agree ☐ Moderately agree ☐ Neither agree nor disagree

☐ Moderately disagree ☐ Strongly disagree ☐ Don't know / Prefer not to say

Please provide additional information if needed: ________________________________

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____

18.3 Has the HP used, either before or during *Terpsichore*-based sessions, with any other music or sound training software? ☐ YES ☐ NO

If the answer is YES, which computer programs have been used?

____________________ / ____________________ / ____________________ /

____

If the answer is YES: In comparison with other programs used, how would you judge *Terpsichore* in terms of efficiency and applicability to the HP's needs? (0: certainly worse / unapplicable, 5: neutral, 10: much better and more useful).

(A) ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

(B) ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

(C) ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don't know / Prefer not to say

(D) ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don’t know / Prefer not to say

Please provide additional information if needed: ______________________________

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18.4 From your personal viewpoint, how satisfied are you with *Terpsichore* overall?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don’t know / Prefer not to say

18.5 How strongly would you recommend *Terpsichore* to parents, therapists and special tutors associated with ASD learners and relevant study fields?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

☐ Don’t know / Prefer not to say

18.6 What is your judgment of the opinion that *Terpsichore* may constitute an important step towards the establishment of music and sound composition as a useful and prevalent occupation directed towards the improvement of ASD learners’ quality of life?

☐ Strongly agree ☐ Moderately agree ☐ Neither agree nor disagree

☐ Moderately disagree ☐ Strongly disagree ☐ Don’t know / Prefer not to say

Please provide additional information if needed: ______________________________

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18.7 Any other general comments to be taken into consideration: ______________________

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APPENDIX IV

QUESTIONNAIRE RESPONSES

Total number of Human Participants: 28

Tutors assigned to complete questionnaire: 3

- Ms. PERSEFONI - ALEXIA SERGI, tutor for special needs education (completed 12 questionnaires, 8 and 4 in each of her two affiliated institutions)
- Mrs. PANAGIOTA KYRIAKIDOU, tutor for special needs education (completed 4 questionnaires)
- Mrs. CHRYSOULA PAPAKIRYKOU, secondary education tutor (completed 12 questionnaires)

N.B.: Pie charts (for the most part) and graphs are visible where necessary; in a minority of cases, the presentation of data in a text format has been deemed sufficient.

All surveys and preliminary results have been conducted in *SurveyMonkey* (www.surveymonkey.com).

An Excel file, downloadable via DropBox, is also available for all individual responses recorded, including open-ended ones:

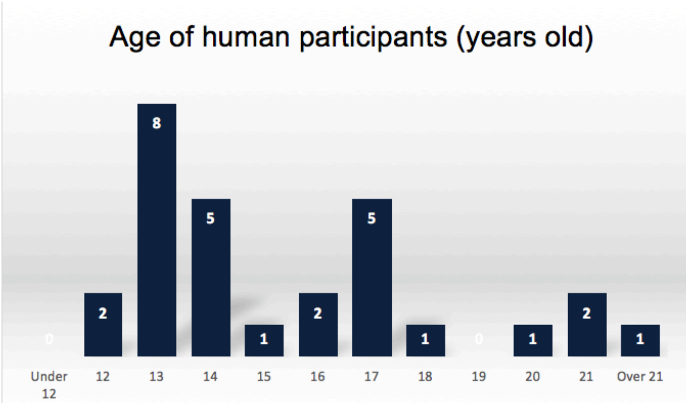
INTRODUCTION

0. PERSONAL INFORMATION

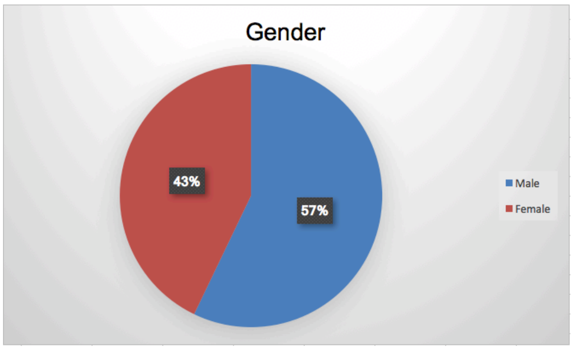
- Relationship to Human Participant (HP): ***People who completed the questionnaire are all tutors***
- Is your profession related to music? → **YES,** in all instances

1. <u>HUMAN PARTICIPANT GENERAL INFORMATION</u>

- Age of HP (Note: The 'over 21' participant is aged 29)

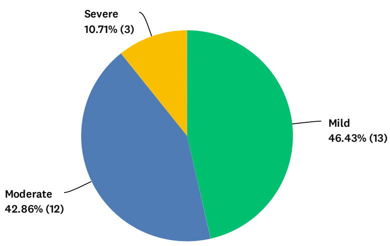


- Gender: **16 male, 12 female**



2. <u>MENTAL DISORDER GENERAL INFORMATION</u>

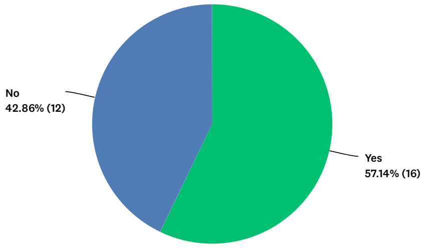
- Type of diagnosis: **26** with **typical autism**, **1** with **Asperger's syndrome**, **1** with **high-functioning autism (HFA)**
- Estimated severity of condition: **13 mild, 12 moderate, 3 severe**



ANSWER CHOICES	RESPONSES	
Mild	46.43%	13
Moderate	42.86%	12
Severe	10.71%	3
Don't know / Prefer not to say	0.00%	0
TOTAL		28

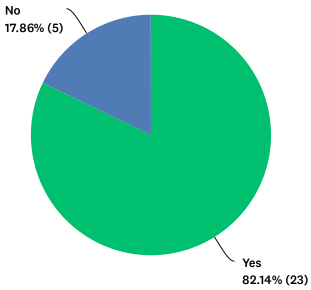
- All tutors consider their supervised HP to be **trainable**

- **17** out of **28** HP have been diagnosed with an additional disorder besides ASD.



ANSWER CHOICES	RESPONSES	
Yes	57.14%	16
No	42.86%	12
TOTAL		28

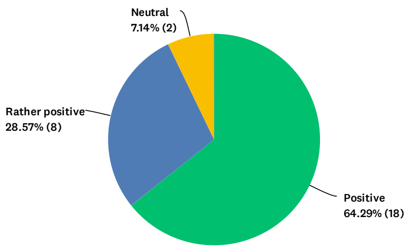
- All ASD diagnoses have been undertaken by a series of certified centres, clinics and hospitals in the Piraeus region of Attica.
- In **23** out of **28** cases, the HP has some form of mental retardation or learning difficulties in addition to ASD.



ANSWER CHOICES	RESPONSES	
Yes	82.14%	23
No	17.86%	5
TOTAL		28

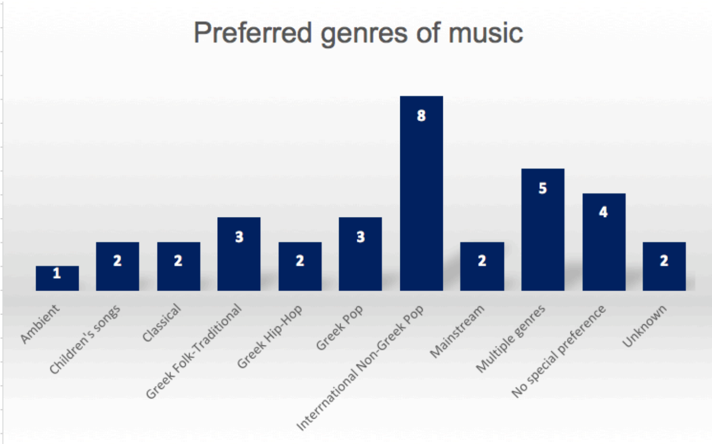
3. <u>MUSICAL PREFERENCES, KNOWLEDGE AND STUDIES</u>

- What is your evaluation of the HP's reaction when being faced with any form of sound? 18 answered *positive*, 8 *rather positive*, 2 *neutral*. No negative responses recorded.



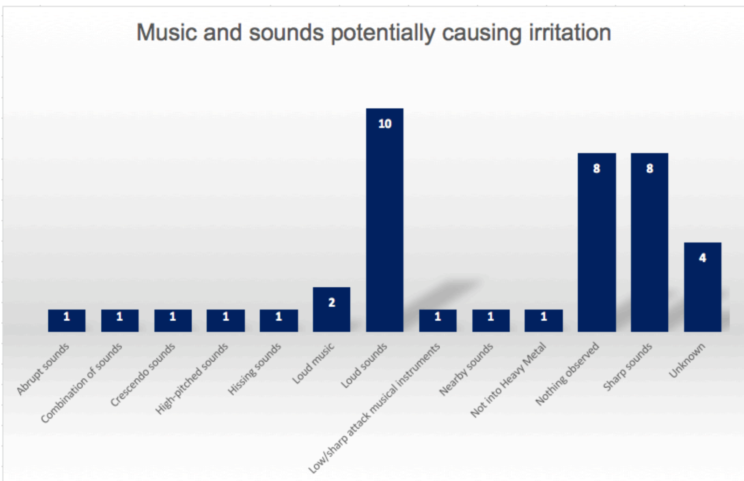
ANSWER CHOICES	RESPONSES	
Positive	64.29%	18
Rather positive	28.57%	8
Neutral	7.14%	2
Rather negative	0.00%	0
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

- All users have been reported to like listening to music.
- NVivo qualitative analysis has given the following information on the HPs' preferred genres of music (N.B.: Total amounts to over 28 as some respondents had multiple clearly defined genres of music; the tab "multiple genres" is the exact response that the tutor has given on each of the respective learners. This is valid for other subsequent questions where the sum of responses is greater than 28).



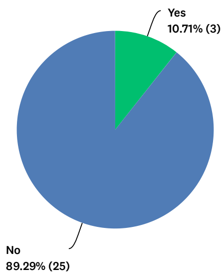
Preferred genres of music	Number of learners
Ambient	1
Children's songs	2
Classical	2
Greek folk-traditional	3
Greek hip-hop	2
Greek pop	3
International non-Greek pop	8
Mainstream	2
Multiple genres	5
No special preference	4
Unknown	2

- Music and sounds potentially causing irritation (again resulting from NVivo analysis):



Stimuli causing irritation	Number of learners
Abrupt sounds	1
Combination of sounds	1
Crescendo sounds	1
High-pitched sounds	1
Hissing sounds	1
Loud music	2
Loud sounds	10
Low/sharp attack musical instruments	1
Nearby sounds	1
Not into Heavy Metal	1
Nothing observed	8
Sharp sounds	8
Unknown	4

- Active occupation with music: **NO** for **25 HP**, **YES** for the remaining **three**.
- In the question 'If YES, for how long?', one HP had been playing a musical instrument (guitar) for three years prior to survey completion, another had been enrolled in a choir for three years and a third one expressed strong interest in music despite the sole knowledge acquired coming from school.



ANSWER CHOICES	RESPONSES	
Yes	10.71%	3
No	89.29%	25
TOTAL		28

- As mentioned before, only **one** HP plays a musical instrument (guitar). That same person has pre-existent fundamental music theory knowledge. **26** do not have music theory knowledge, while for the **one** final HP no relevant information is known.

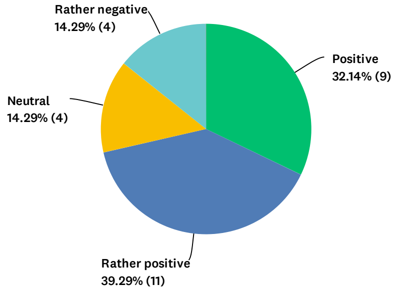
A. INITIAL USER CONDITION

N.B.: The option 'Don't know / Prefer not to say' was omitted from the current Appendix, in all cases where no such responses were recorded. Zero-percent responses were also omitted from pie charts.

In open-ended responses, trends were observed through Excel and NVivo. As responses in such questions were optional, information is not necessarily available for all 28 human subjects.

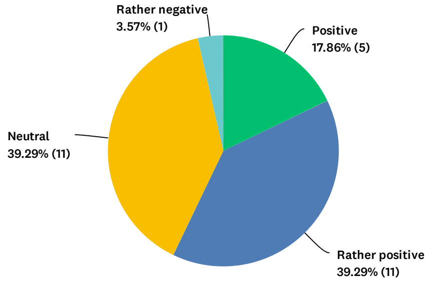
4. EVALUATION OF EMOTIONAL STATE

4.1 What is your evaluation of the HP's ability to externalise emotions towards his/her surroundings?



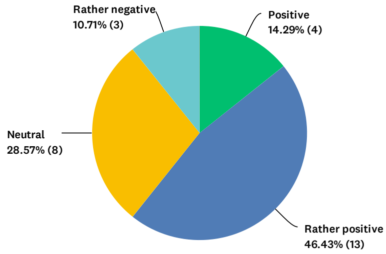
ANSWER CHOICES	RESPONSES	
Positive	32.14%	9
Rather positive	39.29%	11
Neutral	14.29%	4
Rather negative	14.29%	4
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

4.2 What is your evaluation of the HP's ability to interpret other people's emotions?



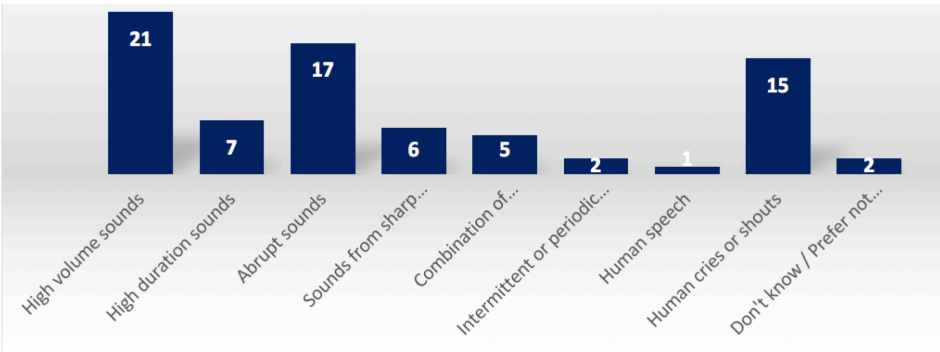
ANSWER CHOICES	RESPONSES	
Positive	17.86%	5
Rather positive	39.29%	11
Neutral	39.29%	11
Rather negative	3.57%	1
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

4.3 Based on words and actions, what is your general evaluation of the HP's emotional state?



ANSWER CHOICES	RESPONSES	
Positive	14.29%	4
Rather positive	46.43%	13
Neutral	28.57%	8
Rather negative	10.71%	3
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

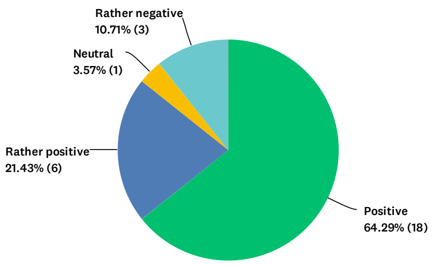
4.5 Which of these are most likely to cause the HP irritation and negative emotional shifts? (multiple answers allowed)



Cause of irritation	Number of learners
High volume sounds	21
High duration sounds	7
Abrupt sounds	17
Sounds from sharp objects	6
Combination of sounds	5
Intermittent or periodic sounds	2
Human speech	1
Human cries or shouts	15
Don't know / Prefer not to say	2

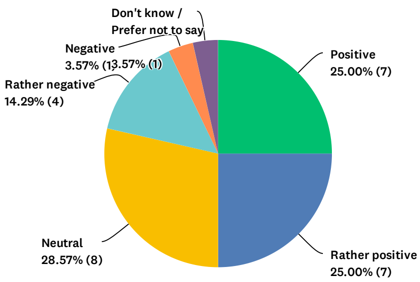
5. <u>BEHAVIOUR TOWARDS SELF AND OTHERS</u>

5.1 What is your overall evaluation of the HP's behaviour towards peers he/she is familiar with (e.g. parents, relatives, tutors, professional therapists)?



ANSWER CHOICES	RESPONSES	
Positive	64.29%	18
Rather positive	21.43%	6
Neutral	3.57%	1
Rather negative	10.71%	3
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

5.2 What is your overall evaluation of the HP's behaviour towards people he/she is NOT familiar with?



ANSWER CHOICES	RESPONSES	
Positive	25.00%	7
Rather positive	25.00%	7
Neutral	28.57%	8
Rather negative	14.29%	4
Negative	3.57%	1
Don't know / Prefer not to say	3.57%	1
TOTAL		28

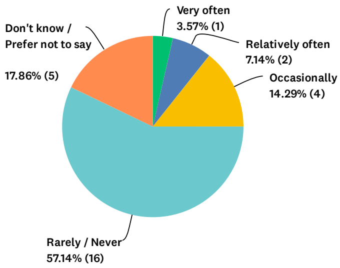
5.3 Which of these may cause adverse behaviours on the HP's part? (multiple answers allowed)

Answer choices	Responses	Response %
Directions by familiar individuals (e.g. parents, tutors)	0	0,00%
Directions by unfamiliar individuals	3	10,71%
Corrective feedback and/or warnings	13	46,43%
Overwhelming information load	5	17,86%

Occupation with undesirable and/or tedious activities	9	32,14%
Refusal to accommodate requests	4	14,29%
Activity in unfamiliar environments	9	32,14%
None of the above	7	25,00%
Don't know / Prefer not to say	3	10,71%
Other (please specify)	2	7,14%

N.B.: The two 'Other' responses were: adverse behaviours of classmates, and misbehaving routines of classmates towards teachers and other peers.

5.4 How often does the HP exhibit hostile behaviour that may lead to self-injury or damage?

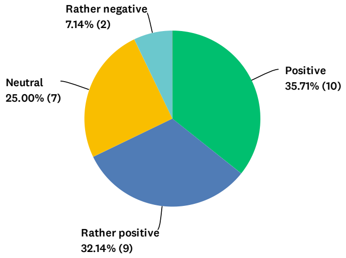


ANSWER CHOICES	RESPONSES	
Very often	3.57%	1
Relatively often	7.14%	2
Occasionally	14.29%	4
Rarely / Never	57.14%	16
Don't know / Prefer not to say	17.86%	5
TOTAL		28

- In Questions 5.5 and 5.6, it has been confirmed that selecting appropriate music and sounds could, as per the tutors' responses, have a positive effect in all the HPs' behaviours.

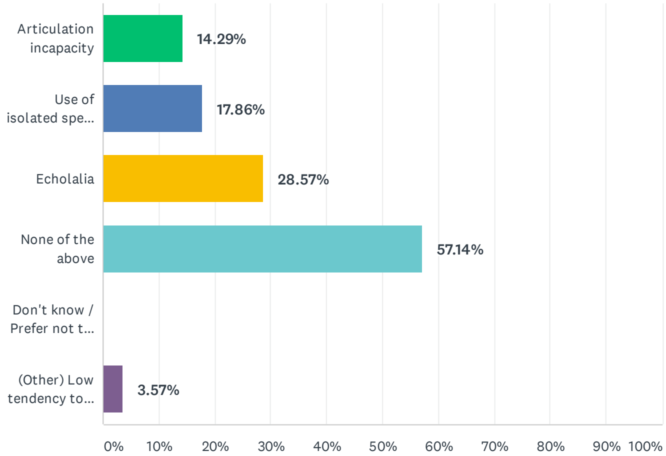
6. COMMUNICATION AND INTERACTION

6.1 What is your overall evaluation of the HP's ability to communicate with his/her surroundings?



ANSWER CHOICES	RESPONSES	
Positive	35.71%	10
Rather positive	32.14%	9
Neutral	25.00%	7
Rather negative	7.14%	2
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

6.2 Which of these do you observe in the HP's daily communication routines? (multiple answers allowed)

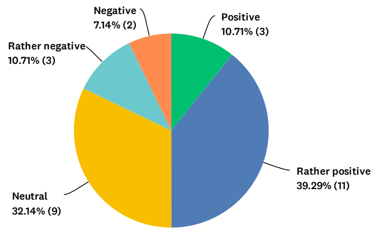


ANSWER CHOICES	RESPONSES	
Articulation incapacity	14.29%	4
Use of isolated speech patterns or sounds	17.86%	5
Echolalia	28.57%	8
None of the above	57.14%	16
Don't know / Prefer not to say	0.00%	0
(Other) Low tendency to speak	3.57%	1
Total Respondents: 28		

- As far as Questions 6.3 and 6.4 are concerned, all tutors have indicated that the careful selection of music and sounds suitable to the learners' condition can positively impact their communication routines and skills.

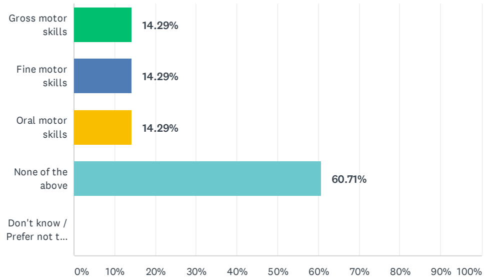
7. MISCELLANEOUS INFORMATION

7.1 What is your evaluation of the HP's ability to concentrate on a specific task for an extended period of time?



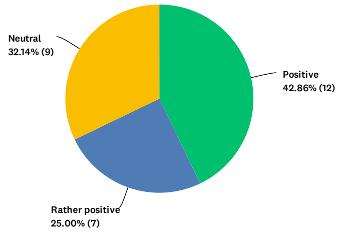
ANSWER CHOICES	RESPONSES	
Positive	10.71%	3
Rather positive	39.29%	11
Neutral	32.14%	9
Rather negative	10.71%	3
Negative	7.14%	2
Don't know / Prefer not to say	0.00%	0
TOTAL		28

7.2 In which of these sectors is the HP likely to face difficulties, with concern to the coordination of specific body parts or the body altogether?



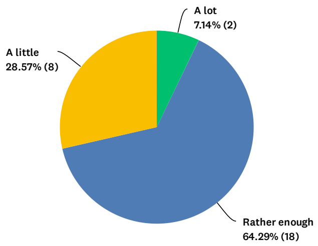
ANSWER CHOICES	RESPONSES	
Gross motor skills	14.29%	4
Fine motor skills	14.29%	4
Oral motor skills	14.29%	4
None of the above	60.71%	17
Don't know / Prefer not to say	0.00%	0
Total Respondents: 28		

7.3 What is your evaluation of the HP's ability to follow the curriculum of the educational institution in which he / she is enrolled?



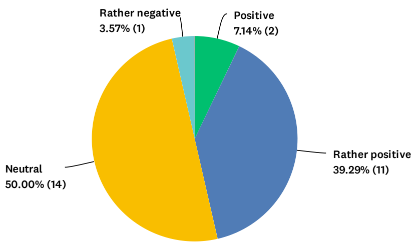
ANSWER CHOICES	RESPONSES	
Positive	42.86%	12
Rather positive	25.00%	7
Neutral	32.14%	9
Rather negative	0.00%	0
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

7.4 How comfortable is it for the HP to transition between different concepts and exercises within the same knowledge field?



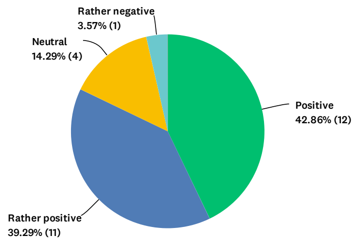
ANSWER CHOICES	RESPONSES	
A lot	7.14%	2
Rather enough	64.29%	18
A little	28.57%	8
Not at all	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

7.5 What is your evaluation of the HP's ability to follow the increasing difficulty, over time, of an educational curriculum?



ANSWER CHOICES	RESPONSES	
Positive	7.14%	2
Rather positive	39.29%	11
Neutral	50.00%	14
Rather negative	3.57%	1
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

7.6 What is your evaluation of the HP's reaction towards advice and guidelines provided by people within his/her direct involvement (e.g. parents, tutors)?



ANSWER CHOICES	RESPONSES	
Positive	42.86%	12
Rather positive	39.29%	11
Neutral	14.29%	4
Rather negative	3.57%	1
Negative	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

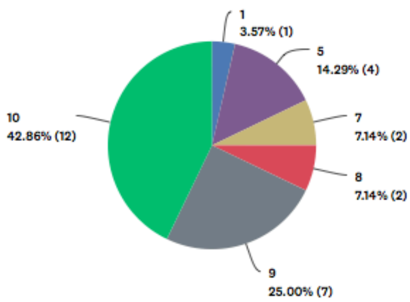
B. *TERPSICHORE* SOFTWARE USE

N.B.: All 'basic statistics' information has been extracted from SurveyMonkey results for each question. Due to the website's labelling format, all magnitudes but standard deviation have values of 1 point less than displayed. See example below for Question 8.1, where the maximum value is 11, whereas no larger numbers than 10 could be input. This does not apply to Questions 8.7 and 16.5, where all values coincide with the ones displayed in the website.

BASIC STATISTICS				
Minimum	Maximum	Median	Mean	Standard Deviation
2.00	11.00	10.00	9.36	2.22

8. <u>GENERAL INFORMATION</u>

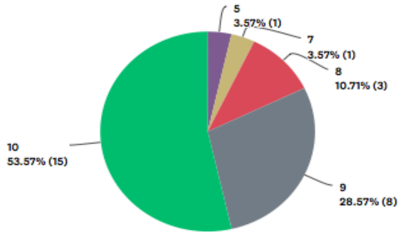
8.1 How would you evaluate the HP's first impression of *Terpsichore* with regards to its Graphical User Interface (GUI)? This includes images, colours, shapes and complexity:



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	0.00% 0	0.00% 0	0.00% 0	14.29% 4	0.00% 0	7.14% 2	7.14% 2	25.00% 7	42.86% 12	0.00% 0	28	8.36

Minimum	Maximum	Median	Mean	Standard deviation
1	10	9	8.36	2.22

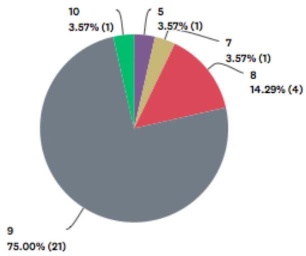
8.2 How would you evaluate, from your personal perspective, the overall layout of the software (functional environments, concepts covered, general level of difficulty)?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	0.00% 0	3.57% 1	10.71% 3	28.57% 8	53.57% 15	0.00% 0	28	9.21

Minimum	Maximum	Median	Mean	Standard deviation
5	10	10	9.21	1.15

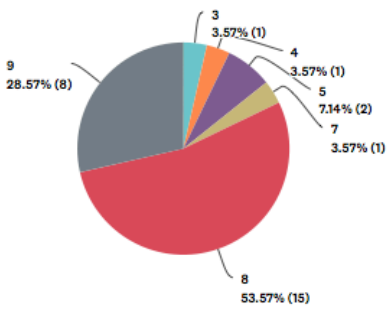
8.3 How would you evaluate, from your personal perspective, the software, regarding ease of use, before it is provided to the HP?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	0.00% 0	3.57% 1	14.29% 4	75.00% 21	3.57% 1	0.00% 0	28	8.68

Minimum	Maximum	Median	Mean	Standard deviation
6	11	9	8.68	0.89

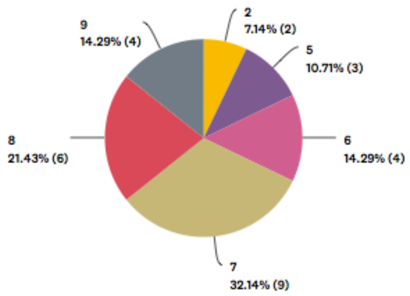
8.4 How well do you believe that the concepts and elements presented in *Terpsichore* are compatible with the HP's needs and particularities?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	3.57% 1	3.57% 1	7.14% 2	0.00% 0	3.57% 1	53.57% 15	28.57% 8	0.00% 0	0.00% 0	28	7.71

Minimum	Maximum	Median	Mean	Standard deviation
3	9	8	7.71	1.53

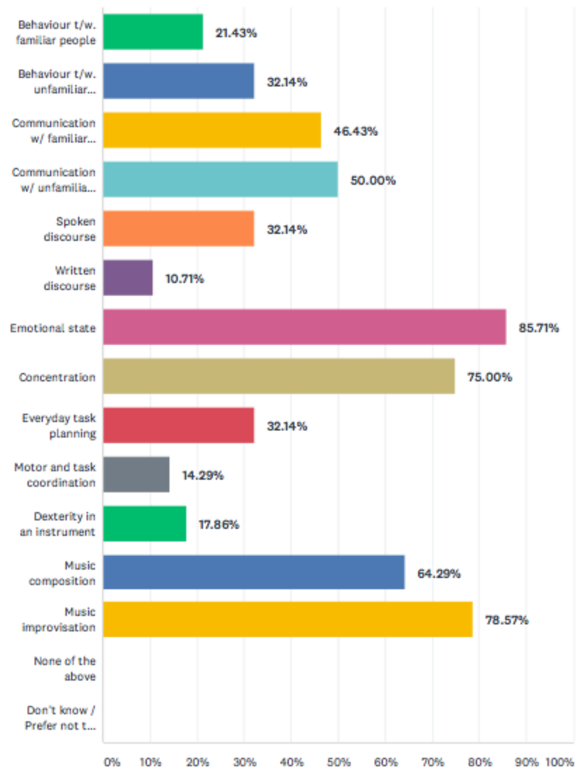
8.5 How comprehensible are the on-screen guidelines presented after activating the User Manual and Reward Mode?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	7.14% 2	0.00% 0	0.00% 0	10.71% 3	14.29% 4	32.14% 9	21.43% 6	14.29% 4	0.00% 0	0.00% 0	28	6.79

Minimum	Maximum	Median	Mean	Standard deviation
3	9	8	6.79	1.76

8.6 To improve and/or control which of the following elements do you intend to use the present software? (multiple answers allowed; all percentages add up to over 100%)



8.7 (a) How many sessions were required to complete involvement with *Terpsichore*'s TM?

(a) The above translates to how many hours of occupation with the TM?

(b) How many sessions were required to complete involvement with Terpsichore's SIP?

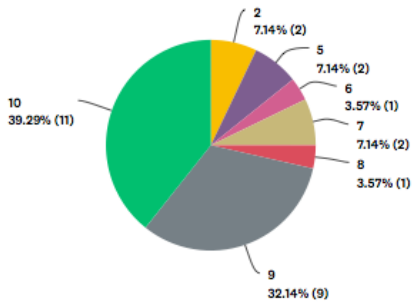
(d) The above translates to how many hours of occupation with the SIP?

Q 8.7	Minimum	Maximum	Median	Mean	Standard deviation
(a)	3	12	10	9.64	2.86
(b)	3	10	8	7.93	2.20
(c)	3	12	8	8.29	2.63
(d)	3	10	6	6.57	2.09

Average length per TM session: $(a \div b) * 60 =$ **49.36 minutes**

Average length per SIP session: $(c \div d) * 60 =$ **47.55 minutes**

8.8 How do you evaluate the initial reaction of the HP, either after being informed about the imminent occupation with the software, or after the *Terpsichore* sessions have started?

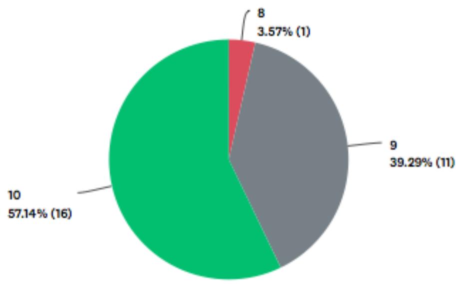


0	1	2	3	4	5	6	7	8	9	10	ΔΓ/ΔΑ	TOTAL	WEIGHTED AVERAGE
0.00%	0.00%	7.14%	0.00%	0.00%	7.14%	3.57%	7.14%	3.57%	32.14%	39.29%	0.00%		
0	0	2	0	0	2	1	2	1	9	11	0	28	8.32

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.32	2.28

9. <u>TONAL MODE (TM): OVERALL</u>

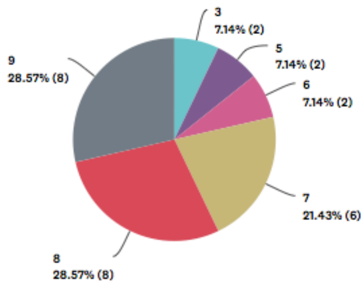
9.1 How strongly do you believe that the levels contained in *Terpsichore*'s TM are logically organised?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	39.29% 11	57.14% 16	0.00% 0	28	9.54

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.32	2.28

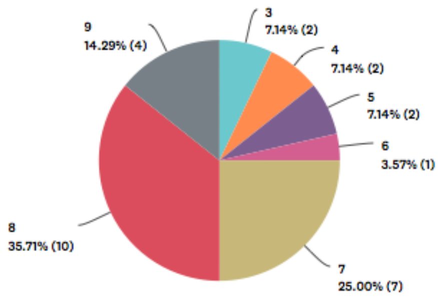
9.2 How easy and comfortable is it for the HP to transition from one knowledge field to another, as sessions advance?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	7.14% 2	0.00% 0	7.14% 2	7.14% 2	21.43% 6	28.57% 8	28.57% 8	0.00% 0	0.00% 0	28	7.36

Minimum	Maximum	Median	Mean	Standard deviation
8	10	10	9.54	0.57

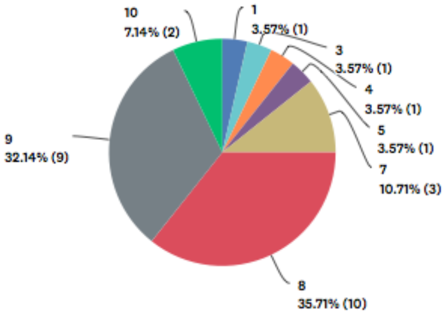
9.3 How easy is it for the HP to respond to whatever is asked in each of the levels?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	7.14% 2	7.14% 2	7.14% 2	3.57% 1	25.00% 7	35.71% 10	14.29% 4	0.00% 0	0.00% 0	28	6.96

Minimum	Maximum	Median	Mean	Standard deviation
3	9	7.50	6.96	1.74

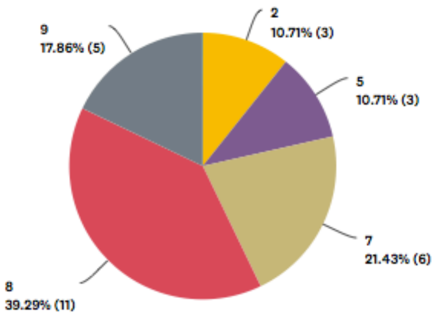
9.6 How would you evaluate the quality of melodies produced by the HP in the levels where the alteration of existing melodies is possible (as shown in accompanying video)?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	0.00% 0	3.57% 1	3.57% 1	3.57% 1	0.00% 0	10.71% 3	35.71% 10	32.14% 9	7.14% 2	0.00% 0	28	7.68

Minimum	Maximum	Median	Mean	Standard deviation
1	10	8	7.68	2.04

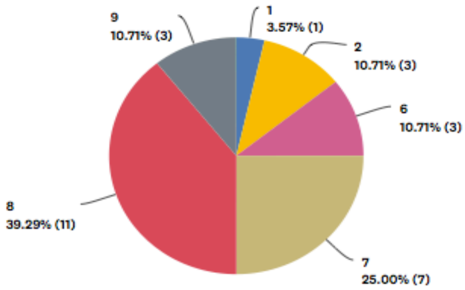
9.7 How would you evaluate the quality of melodies produced by the HP in the levels where the composition of melodies from a blank document is possible (as shown in accompanying video)?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	10.71% 3	0.00% 0	0.00% 0	10.71% 3	0.00% 0	21.43% 6	39.29% 11	17.86% 5	0.00% 0	0.00% 0	28	7.00

Minimum	Maximum	Median	Mean	Standard deviation
2	9	8	7.00	2.05

9.8 How strongly do you feel that the melodies produced by the HP whilst being occupied with *Terpsichore*'s TM, follow the common principles of Music Theory and Harmony as defined in Western European tonal music?



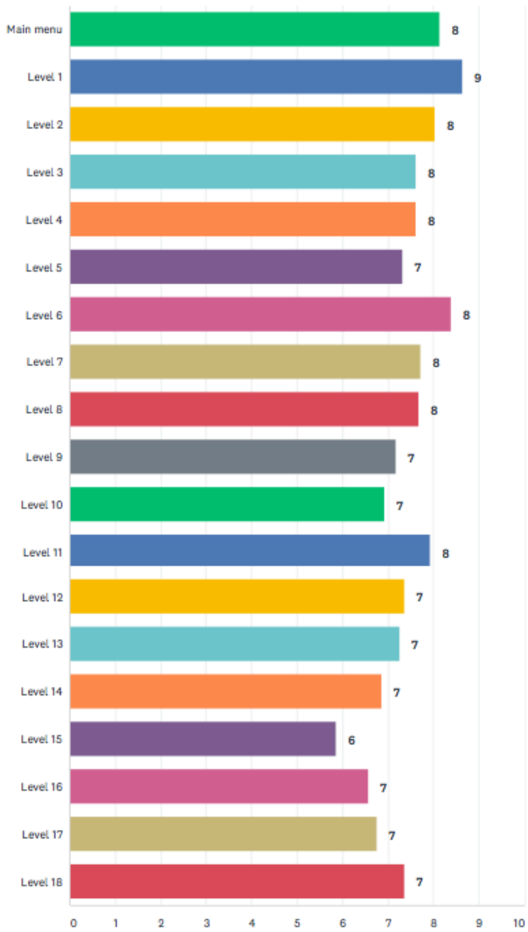
0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	10.71% 3	0.00% 0	0.00% 0	0.00% 0	10.71% 3	25.00% 7	39.29% 11	10.71% 3	0.00% 0	0.00% 0	28	6.75

Minimum	Maximum	Median	Mean	Standard deviation
1	9	7.50	6.75	2.20

9.9 Are the pre-set musical instruments, which can be used while the software is in operation, sufficient for the needs of the HP? → Unanimous **YES** response

Tutors have indicated that, in **4** of the **28** learners, an additional instrument is recommended to be added: the *violin* in three cases, and *choir voices* in the remaining one.

9.10 Evaluate, using the numbers 0 to 10, each of the levels *separately*, with regards to the HP's responsiveness to them, as well as their compatibility with everyday needs and influence on daily life routines:



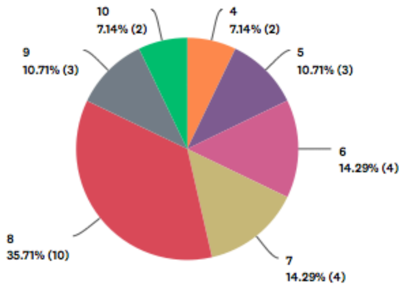
Level	Total rating for 28 HP	Average rating	Standard deviation
Main Menu	228	**8.14**	**1.77**
1	242	**8.64**	**1.67**
2	225	**8.04**	**1.55**
3	213	**7.61**	**1.40**
4	213	**7.61**	**1.47**
5	205	**7.32**	**1.87**
6	235	**8.39**	**1.80**
7	216	**7.71**	**2.20**
8	215	**7.68**	**2.24**
9	201	**7.18**	**2.19**
10	194	**6.93**	**2.07**
11	222	**7.93**	**2.34**
12	206	**7.36**	**2.17**

13	203	**7.25**	**2.80**
14	192	**6.86**	**2.77**
15	164	**5.86**	**2.66**
16	184	**6.57**	**2.65**
17	189	**6.75**	**2.64**
18	206	**7.36**	**2.64**

Participant ID	Average performance per participant	Participant ID	Average performance per participant
R1	**7.53**	R15	**8.84**
R2	**7.42**	R16	**9.00**
R3	**6.58**	R17	**8.79**
R4	**8.16**	R18	**8.53**
R5	**7.95**	R19	**8.84**
R6	**7.68**	R20	**8.63**
R7	**2.37**	R21	**7.63**
R8	**1.84**	R22	**8.89**
R9	**4.21**	R23	**6.68**
R10	**3.42**	R24	**8.63**
R11	**7.16**	R25	**7.11**
R12	**8.74**	R26	**8.79**
R13	**8.63**	R27	**8.47**
R14	**9.32**	R28	**8.21**
		Average	**7.43**

10. <u>TONAL MODE (TM): INFORMATION ON SPECIFIC LEVELS</u>

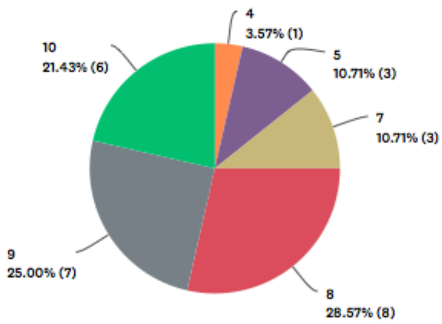
10.1 This Menu features, amongst others, a series of windows with changing elements over time, according to the 4-beat sequence in a typical 4/4-time signature measure. How would you evaluate the HP's ability to follow a stable speed in hand movement (e.g. on a solid surface, on a computer keyboard) *before* using the menu?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	7.14% 2	10.71% 3	14.29% 4	14.29% 4	35.71% 10	10.71% 3	7.14% 2	0.00% 0	28	7.21

Minimum	Maximum	Median	Mean	Standard deviation
4	10	8	7.21	1.61

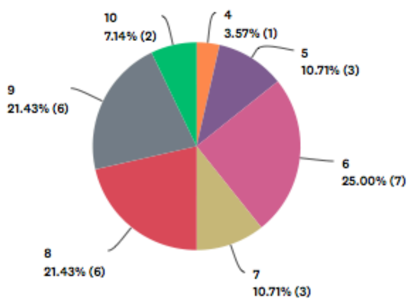
How would you evaluate the ability in question *after* the menu has been used for a substantial period of time?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	10.71% 3	0.00% 0	10.71% 3	28.57% 8	25.00% 7	21.43% 6	0.00% 0	28	8.11

Minimum	Maximum	Median	Mean	Standard deviation
4	10	8	8.11	1.65

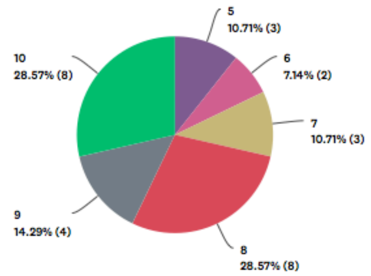
How would you evaluate the HP's ability to complete the hand's mechanical movement defined as 'up-down-left-right', *before* using the menu?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	10.71% 3	25.00% 7	10.71% 3	21.43% 6	21.43% 6	7.14% 2	0.00% 0	28	7.29

Minimum	Maximum	Median	Mean	Standard deviation
4	10	7.50	7.29	1.62

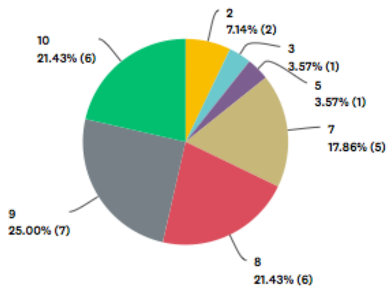
How would you evaluate the ability in question *after* the menu has been used for a substantial period of time?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	10.71% 3	7.14% 2	10.71% 3	28.57% 8	14.29% 4	28.57% 8	0.00% 0	28	8.14

Minimum	Maximum	Median	Mean	Standard deviation
5	10	8	8.14	1.62

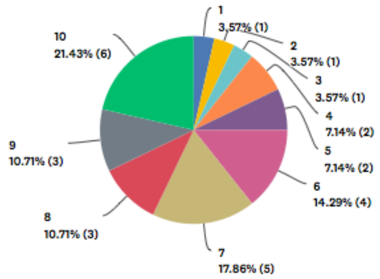
10.2 **Level 5:** How comfortable is it for the HP to create melodies consistent with the simple words or phrases given in the current example: MUM, DAD, KID, SLEEP, SCHOOL, PLAY, MUSIC, FRIEND, I LOVE YOU, GO FOR A WALK, LET'S EAT, BE FRIENDS…? (N.B.: phrases were translated into Greek for pilot study purposes)



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	7.14% 2	3.57% 1	0.00% 0	3.57% 1	0.00% 0	17.86% 5	21.43% 6	25.00% 7	21.43% 6	0.00% 0	28	7.79

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.79	2.24

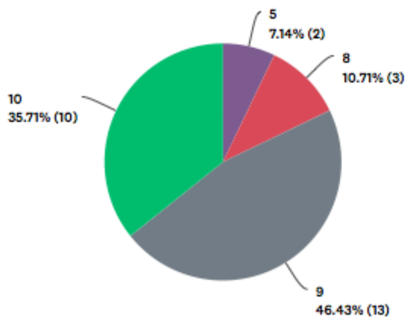
How easy is it for the HP to construct independent words or phrases whilst *not* having to rely on the above examples?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	3.57% 1	3.57% 1	7.14% 2	7.14% 2	14.29% 4	17.86% 5	10.71% 3	10.71% 3	21.43% 6	0.00% 0	28	6.93

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.79	2.24

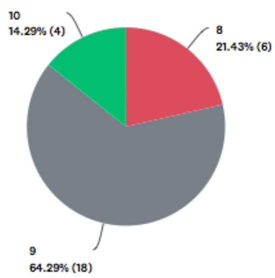
10.3 **Level 6:** How appropriate are the photos provided in the «petal» structure to represent different situations and actions?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	7.14% 2	0.00% 0	0.00% 0	10.71% 3	46.43% 13	35.71% 10	0.00% 0	28	8.96

Minimum	Maximum	Median	Mean	Standard deviation
5	10	9	8.96	1.27

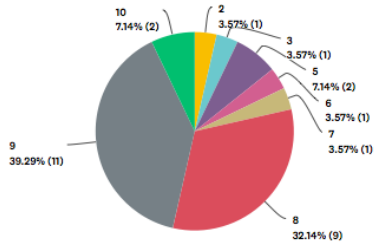
How comfortable is it for you *[note: the tutor]* to construct a song, based on the notes of the melodies when activating each petal, with which you will persuade the HP into performing an associated action (e.g. wake up, have lunch, study, go to bed)?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	21.43% 6	64.29% 18	14.29% 4	0.00% 0	28	8.93

Minimum	Maximum	Median	Mean	Standard deviation
8	10	9	8.93	0.59

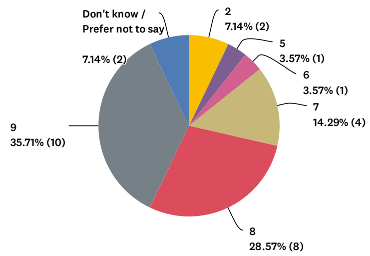
How would you evaluate the HP's responsiveness to the tasks to be completed in accordance with relevant melodies?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	3.57% 1	0.00% 0	7.14% 2	3.57% 1	3.57% 1	32.14% 9	39.29% 11	7.14% 2	0.00% 0	28	7.82

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.82	1.91

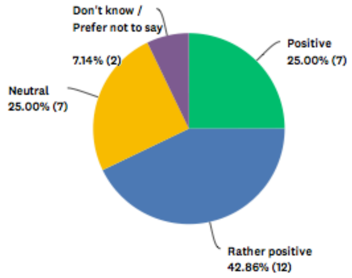
10.4 **Level 9:** How comfortable is it for the HP to produce new melodies, out of the default ones, taking into consideration the limitations imposed by the *Terpsichore* code, which demands that no two notes are identical within the same melody (inspired by A. Schoenberg's 'twelve-tone technique')?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	7.14% 2	0.00% 0	0.00% 0	3.57% 1	3.57% 1	14.29% 4	28.57% 8	35.71% 10	0.00% 0	7.14% 2	28	7.58

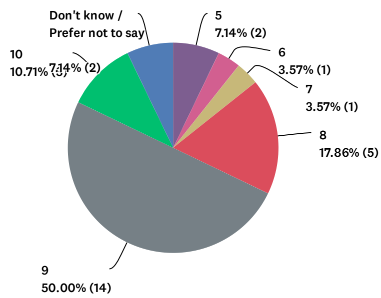
Minimum	Maximum	Median	Mean	Standard deviation
2	9	8	7.58	1.90

What is the influence of the current level on the HP's mental state, considering the risks that the above limitation may entail?



ANSWER CHOICES	RESPONSES	
Positive	25.00%	7
Rather positive	42.86%	12
Neutral	25.00%	7
Rather negative	0.00%	0
Negative	0.00%	0
Don't know / Prefer not to say	7.14%	2
TOTAL		28

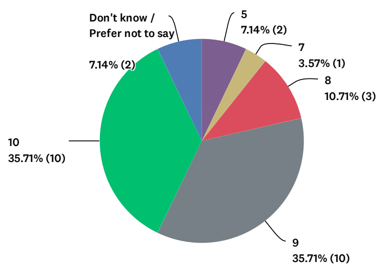
10.5 **Levels 11-12:** How comfortable is the procedure of pressing imaginary 'piano keys' using mouse clicks?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	7.14% 2	3.57% 1	3.57% 1	17.86% 5	50.00% 14	10.71% 3	7.14% 2	28	8.42

Minimum	Maximum	Median	Mean	Standard deviation
5	10	9	8.42	1.31

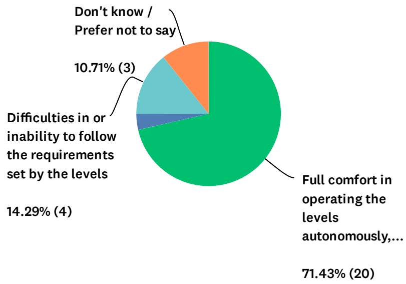
How useful is the accompanying *feedback mode*, in the HP's attempt to improve the quality and content of produced melodies?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	7.14% 2	0.00% 0	3.57% 1	10.71% 3	35.71% 10	35.71% 10	7.14% 2	28	8.88

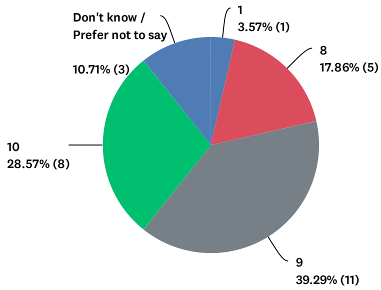
Minimum	Maximum	Median	Mean	Standard deviation
5	10	9	8.88	1.37

Which of these best describes the responsiveness of the HP to the levels in question?



ANSWER CHOICES	RESPONSES	
Full comfort in operating the levels autonomously, without the need of external support aids	71.43%	20
Requirement for an external musical instrument, not necessarily connected to the software	3.57%	1
Requirement for an external musical instrument capable of connecting itself directly to the software	0.00%	0
Difficulties in or inability to follow the requirements set by the levels	14.29%	4
Don't know / Prefer not to say	10.71%	3
TOTAL		28

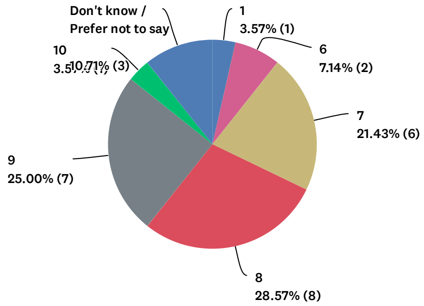
10.6 **Levels 13-14:** How much do you feel that the sample phrase completions provided in these levels assist the HP in independently completing phrases without resorting to the mechanical repetition of notes?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	17.86% 5	39.29% 11	28.57% 8	10.71% 3	28	8.80

Minimum	Maximum	Median	Mean	Standard deviation
1	10	9	8.80	1.74

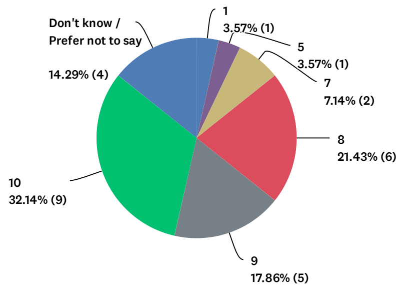
How would you evaluate the HP's ability to independently complete phrases without external stimulation?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00%	3.57%	0.00%	0.00%	0.00%	0.00%	7.14%	21.43%	28.57%	25.00%	3.57%	10.71%		
0	1	0	0	0	0	2	6	8	7	1	3	28	7.68

Minimum	Maximum	Median	Mean	Standard deviation
1	10	8	7.68	1.69

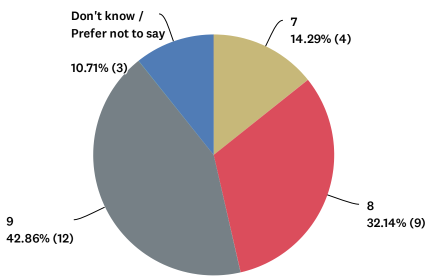
What is the influence of the HP's occupation with the current levels, on his/her ability to communicate dialogically, without engaging in imitative or 'echolalic' communication patterns?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00%	3.57%	0.00%	0.00%	0.00%	3.57%	0.00%	7.14%	21.43%	17.86%	32.14%	14.29%		
0	1	0	0	0	1	0	2	6	5	9	4	28	8.46

Minimum	Maximum	Median	Mean	Standard deviation
1	10	9	8.46	2.00

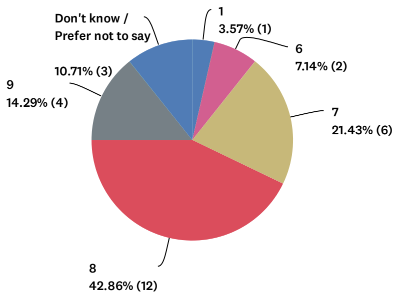
10.7 **Level 17:** How comfortable is it for you to load images designed to support the *social stories*, which are the main subject of this Level?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	14.29%	32.14%	42.86%	0.00%	10.71%		
0	0	0	0	0	0	0	4	9	12	0	3	28	8.32

Minimum	Maximum	Median	Mean	Standard deviation
7	9	8	8.32	0.73

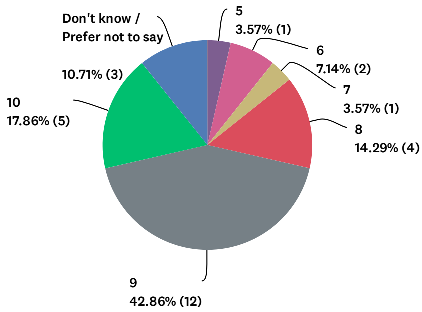
How would you evaluate the HP's ability to compose musical phrases based on the images loaded?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00%	3.57%	0.00%	0.00%	0.00%	0.00%	7.14%	21.43%	42.86%	14.29%	0.00%	10.71%		
0	1	0	0	0	0	2	6	12	4	0	3	28	7.48

Minimum	Maximum	Median	Mean	Standard deviation
1	9	8	7.48	1.55

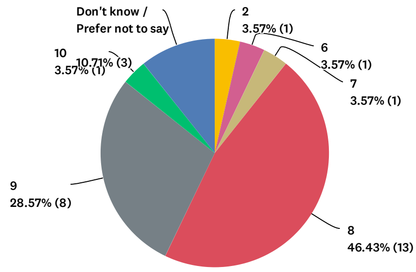
How would you generally evaluate the usability and compatibility of the current Level, with relation to the HP's attempt in treating mental state and everyday life elements?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00%	0.00%	0.00%	0.00%	0.00%	3.57%	7.14%	3.57%	14.29%	42.86%	17.86%	10.71%		
0	0	0	0	0	1	2	1	4	12	5	3	28	8.56

Minimum	Maximum	Median	Mean	Standard deviation
7	10	9	8.56	1.30

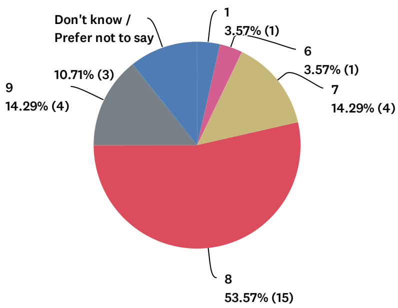
10.8 **Level 18:** How would you evaluate the HP's ability to memorise knowledge and concepts instructed in previous levels, in an attempt to produce aurally pleasant melodies?



0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	6 (7)	7 (8)	8 (9)	9 (10)	10 (11)	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	0.00% 0	3.57% 1	3.57% 1	46.43% 13	28.57% 8	3.57% 1	10.71% 3	28	8.04

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	8.04	1.46

How would you evaluate the quality of melodies produced by the HP, from your own perspective?

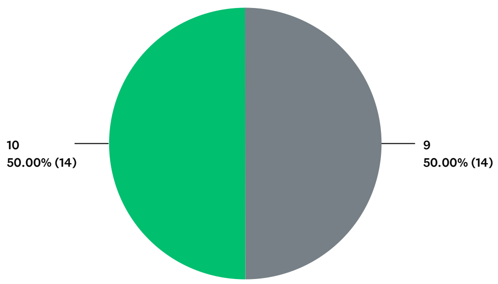


0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	14.29% 4	53.57% 15	14.29% 4	0.00% 0	10.71% 3	28	7.64

Minimum	Maximum	Median	Mean	Standard deviation
1	9	8	7.64	1.52

11. SOUNDSCAPE AND INDEFINITE PITCH MODE (SIP): GENERAL INFORMATION

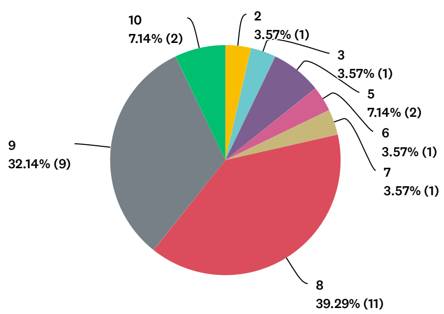
11.1 How strongly do you believe that the levels contained in *Terpsichore*'s SIP are rationally organised?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	50.00% 14	50.00% 14	0.00% 0	28	9.50

Minimum	Maximum	Median	Mean	Standard deviation
9	10	9.50	9.50	0.50

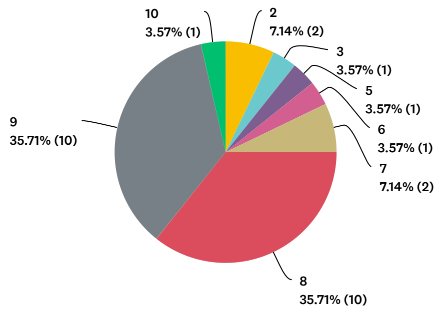
11.2 How easy and comfortable is it for the HP to transition from one knowledge field to another, as sessions advance?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	3.57% 1	0.00% 0	7.14% 2	3.57% 1	3.57% 1	39.29% 11	32.14% 9	7.14% 2	0.00% 0	28	7.75

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.75	1.88

11.3 How easy is it for the HP to respond to whatever is asked in each of the levels?

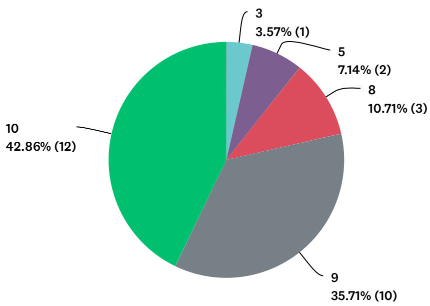


0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	7.14% 2	3.57% 1	0.00% 0	3.57% 1	3.57% 1	7.14% 2	35.71% 10	35.71% 10	3.57% 1	0.00% 0	28	7.57

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.57	2.08

12. <u>SOUNDSCAPE AND INDEFINITE PITCH MODE (SIP): INFORMATION ON SPECIFIC LEVELS</u>

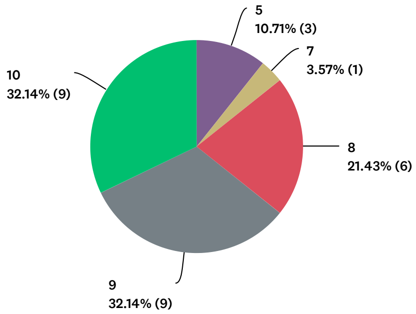
12.1 **Levels 1-2:** How comfortably can the HP recognise the sounds presented in each of the levels (water, droplets, wind, moving leaves)?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	3.57% 1	0.00% 0	7.14% 2	0.00% 0	0.00% 0	10.71% 3	35.71% 10	42.86% 12	0.00% 0	28	8.82

Minimum	Maximum	Median	Mean	Standard deviation
3	10	9	8.82	1.71

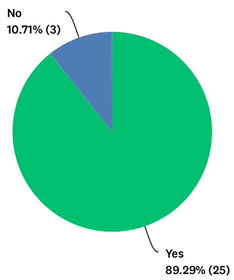
12.2 **Level 3:** How much would you agree that the audio-visual material provided, directed towards the representation and personification of mental states, influences the HP's capability of recognising diverse feelings?



0	1	2	3	4	5	6	7	8	9	10		TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	10.71% 3	0.00% 0	3.57% 1	21.43% 6	32.14% 9	32.14% 9	0.00% 0	28	8.61

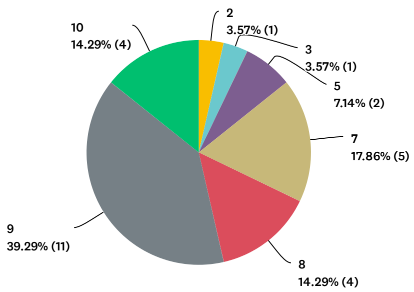
Minimum	Maximum	Median	Mean	Standard deviation
5	10	9	8.61	1.50

Whilst *Terpsichore*'s SIP was being instructed, were sounds and images representing feelings of sadness or anger used (considering the option of disabling them at any point)?



ANSWER CHOICES	RESPONSES	
Yes	89.29%	25
No	10.71%	3
TOTAL		28

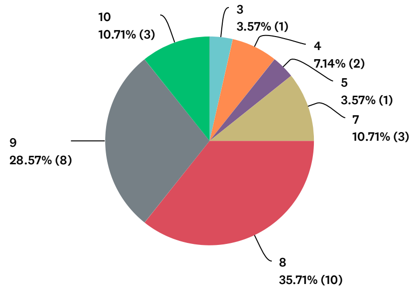
12.3 **Level 4:** How positively does the ability to insert and reproduce different sound clips on an imaginary cursor timeline affect the HP's awareness of time and space?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	3.57% 1	0.00% 0	7.14% 2	0.00% 0	17.86% 5	14.29% 4	39.29% 11	14.29% 4	0.00% 0	28	7.89

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	8.04	1.46

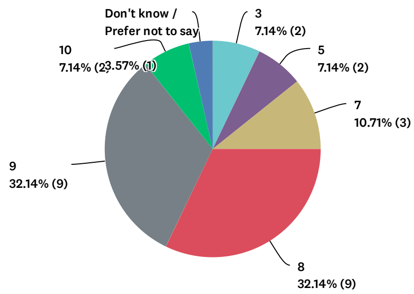
12.4 **Levels 5-6:** How positively does the ability to activate sound clips panned in various positions (left, right, centre) affect the HP's perception of sounds and people in close proximity?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	3.57% 1	7.14% 2	3.57% 1	0.00% 0	10.71% 3	35.71% 10	28.57% 8	10.71% 3	0.00% 0	28	7.82

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	7.89	1.99

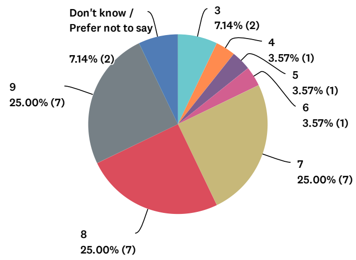
In Level 6, how does the option of rotating audio sources around the sound map's centre affect the mental state of the HP?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	7.14% 2	0.00% 0	7.14% 2	0.00% 0	10.71% 3	32.14% 9	32.14% 9	7.14% 2	3.57% 1	28	7.78

Minimum	Maximum	Median	Mean	Standard deviation
3	10	8	7.82	1.77

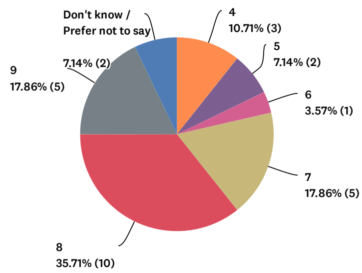
12.5 **Level 7:** How strongly does the arrangement of phrases using percussion instruments assist in increasing the HP' perceptual skills?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	7.14% 2	3.57% 1	3.57% 1	3.57% 1	25.00% 7	25.00% 7	25.00% 7	0.00% 0	7.14% 2	28	7.27

Minimum	Maximum	Median	Mean	Standard deviation
3	9	8	7.27	1.74

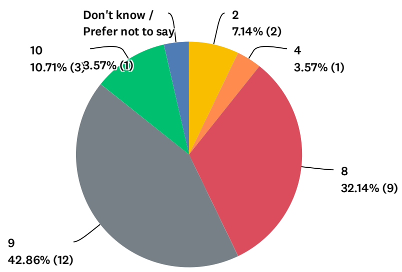
How strongly does the above arrangement facilitate the management of the HP's body part movement (hands, feet, head etc.)? In other words, how strongly would you agree that gentle and controlled movements tend to become more frequent than abrupt or spasmodic ones?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	10.71% 3	7.14% 2	3.57% 1	17.86% 5	35.71% 10	17.86% 5	0.00% 0	7.14% 2	28	7.23

Minimum	Maximum	Median	Mean	Standard deviation
4	9	8	7.23	1.58

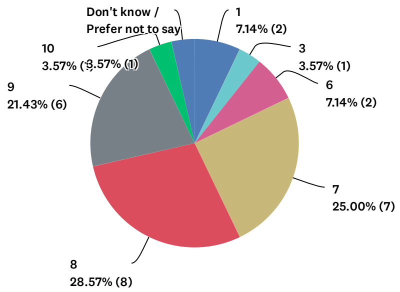
12.7 **Level 10:** How much do you feel that the sample phrase completions provided in these levels assist the HP in independently completing phrases without resorting to the mechanical repetition of audio clips?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	7.14% 2	0.00% 0	3.57% 1	0.00% 0	0.00% 0	0.00% 0	32.14% 9	42.86% 12	10.71% 3	3.57% 1	28	8.07

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.07	2.04

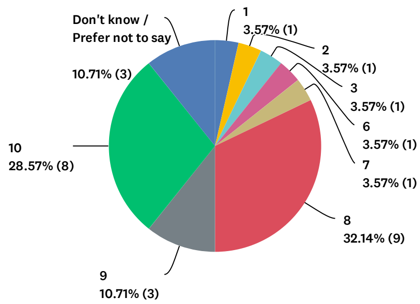
How would you evaluate the HP’s ability to independently complete phrases without external stimulation?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	7.14% 2	0.00% 0	3.57% 1	0.00% 0	0.00% 0	7.14% 2	25.00% 7	28.57% 8	21.43% 6	3.57% 1	3.57% 1	28	7.19

Minimum	Maximum	Median	Mean	Standard deviation
1	10	8	7.19	2.19

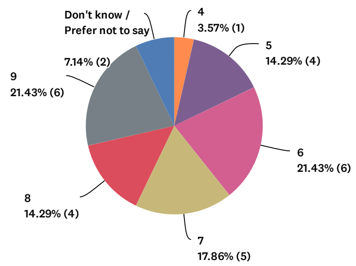
What is the influence of the HP’s occupation with the current levels, on his/her ability to communicate dialogically, without engaging in imitative or ‘echolalic’ communication patterns?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	3.57% 1	3.57% 1	0.00% 0	0.00% 0	3.57% 1	3.57% 1	32.14% 9	10.71% 3	28.57% 8	10.71% 3	28	7.92

Minimum	Maximum	Median	Mean	Standard deviation
1	10	8	7.92	2.45

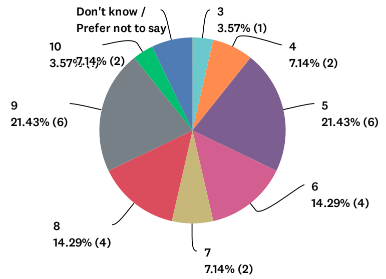
12.8 **Levels 11-12:** From the HP's perspective, please evaluate these levels with regards to their ease of use:



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	14.29% 4	21.43% 6	17.86% 5	14.29% 4	21.43% 6	0.00% 0	7.14% 2	28	6.96

Minimum	Maximum	Median	Mean	Standard deviation
4	9	7	6.96	1.51

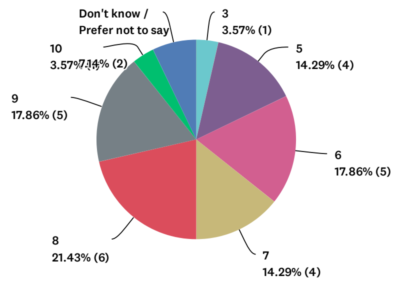
From the HP's perspective, please evaluate these levels as far as responsiveness to audio is concerned:



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	3.57% 1	7.14% 2	21.43% 6	14.29% 4	7.14% 2	14.29% 4	21.43% 6	3.57% 1	7.14% 2	28	6.73

Minimum	Maximum	Median	Mean	Standard deviation
3	10	6.50	6.73	1.93

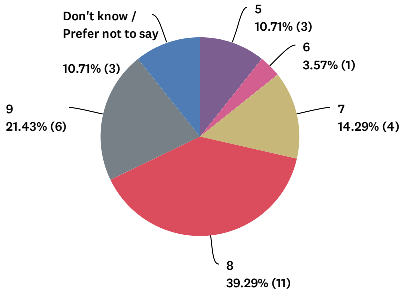
How comfortably can the HP modify the resulting sound's various parameters, irrespective of whether he/she is influenced by the capability of understanding written indications?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	3.57% 1	0.00% 0	14.29% 4	17.86% 5	14.29% 4	21.43% 6	17.86% 5	3.57% 1	7.14% 2	28	7.08

Minimum	Maximum	Median	Mean	Standard deviation
3	10	7	7.08	1.66

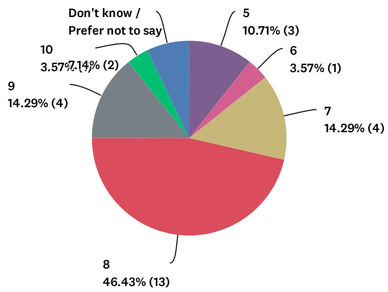
12.9 **Level 13:** How does the simultaneous activation of contrasting sounds, towards the formation of a soundscape, affect the mental state of the HP?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	10.71% 3	3.57% 1	14.29% 4	39.29% 11	21.43% 6	0.00% 0	10.71% 3	28	7.64

Minimum	Maximum	Median	Mean	Standard deviation
5	9	8	7.64	1.23

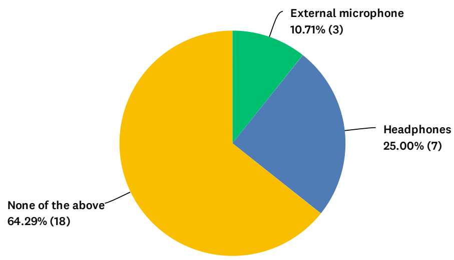
How would you evaluate the quality of soundscapes produced whilst the HP uses the level?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	10.71% 3	3.57% 1	14.29% 4	46.43% 13	14.29% 4	3.57% 1	7.14% 2	28	7.65

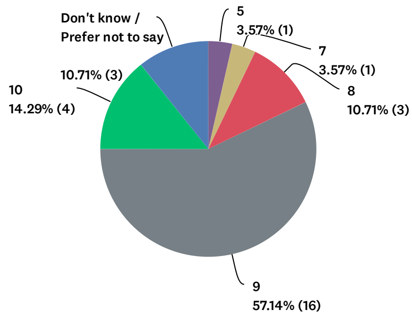
Minimum	Maximum	Median	Mean	Standard deviation
5	10	8	7.65	1.24

12.10 **Level 14:** What did you employ, in conjunction with the computer, to record different sounds ready for modification by the HP?



ANSWER CHOICES	RESPONSES	
External microphone	10.71%	3
Headphones	25.00%	7
None of the above	64.29%	18
TOTAL		28

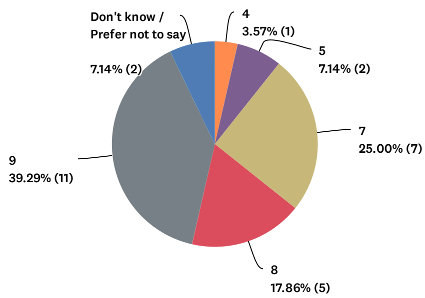
How sufficient do you judge the elements presented in the level window, as far as the attempt to modify recorded sound sources is concerned?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	0.00% 0	3.57% 1	10.71% 3	57.14% 16	14.29% 4	10.71% 3	28	8.80

Minimum	Maximum	Median	Mean	Standard deviation
5	10	9	8.80	1.02

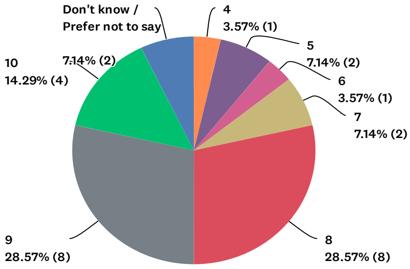
12.11 **Level 15:** How comfortable is it for you to load images and sounds designed to support the *social stories*, which are the main subject of this Level?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	7.14% 2	0.00% 0	25.00% 7	17.86% 5	39.29% 11	0.00% 0	7.14% 2	28	7.77

Minimum	Maximum	Median	Mean	Standard deviation
4	9	8	7.77	1.40

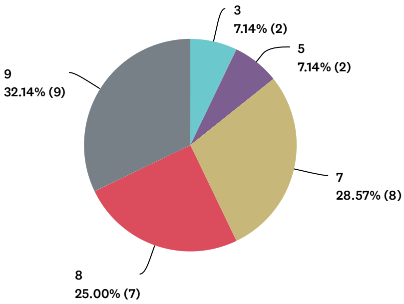
How would you generally evaluate the usability and compatibility of the current Level, with relation to the HP's attempt in treating mental state and everyday life elements?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	7.14% 2	3.57% 1	7.14% 2	28.57% 8	28.57% 8	14.29% 4	7.14% 2	28	8.08

Minimum	Maximum	Median	Mean	Standard deviation
4	10	8	8.08	1.57

12.12 **Various levels:** In cases where the option of modifying *panning position* is viable, how easy is it for the HP to perceive the position and direction of presented sounds – in other words, whether these derive from the left, from the right, occupy variable positions vacillating between left and right (etc.)?



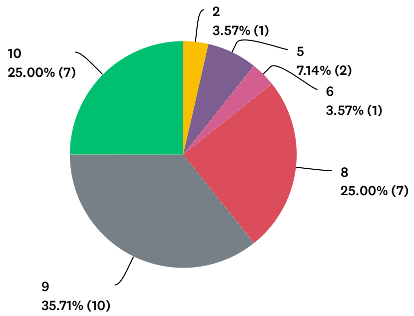
0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	7.14% 2	0.00% 0	7.14% 2	0.00% 0	28.57% 8	25.00% 7	32.14% 9	0.00% 0	0.00% 0	28	7.46

Minimum	Maximum	Median	Mean	Standard deviation
3	10	6.50	6.73	1.93

C. FINAL USER CONDITION

13. EVALUATION OF EMOTIONAL STATE

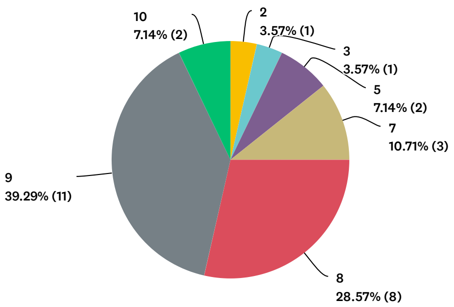
13.1 How did *Terpsichore* influence the HP's ability to externalise personal feelings towards his/her surroundings?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	7.14% 2	3.57% 1	0.00% 0	25.00% 7	35.71% 10	25.00% 7	0.00% 0	28	8.36

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.36	1.82

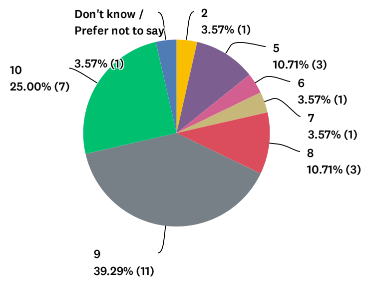
13.2 How did *Terpsichore* influence the HP's ability to recognise and interpret other people's feelings?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	3.57% 1	0.00% 0	7.14% 2	0.00% 0	10.71% 3	28.57% 8	39.29% 11	7.14% 2	0.00% 0	28	7.82

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.82	1.89

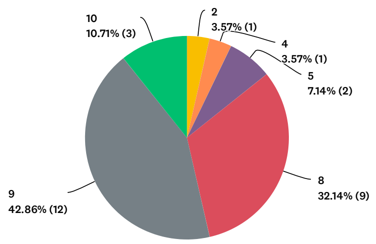
13.3 How did *Terpsichore* influence the overall emotional state of the HP?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	10.71% 3	3.57% 1	3.57% 1	10.71% 3	39.29% 11	25.00% 7	3.57% 1	28	8.26

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.26	1.97

13.4 How did *Terpsichore* influence the HP's responsiveness to various environmental sounds, as well as sound content produced by other individuals (e.g. speech, shouts etc.)?

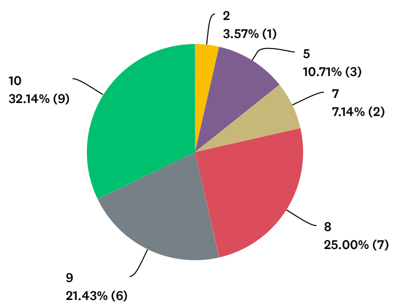


0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	3.57% 1	7.14% 2	0.00% 0	0.00% 0	32.14% 9	42.86% 12	10.71% 3	0.00% 0	28	8.07

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.07	1.83

14. <u>BEHAVIOUR TOWARDS SELF AND OTHERS</u>

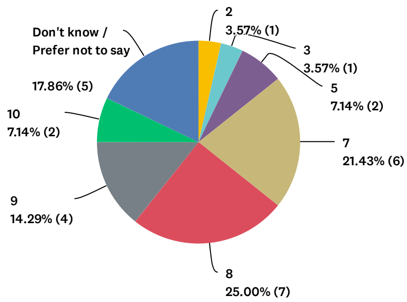
14.1 How did *Terpsichore* influence the HP's behaviour towards individuals he/she knows (e.g. parents, relatives, teachers, professional therapists)?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	10.71% 3	0.00% 0	7.14% 2	25.00% 7	21.43% 6	32.14% 9	0.00% 0	28	8.25

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.25	1.94

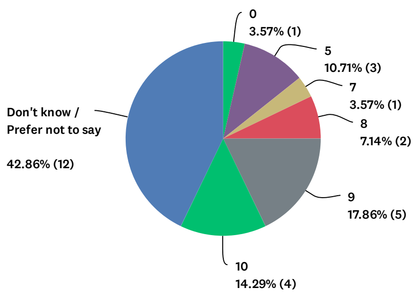
14.2 How did *Terpsichore* influence the HP's behaviour towards unfamiliar individuals?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	3.57% 1	0.00% 0	7.14% 2	0.00% 0	21.43% 6	25.00% 7	14.29% 4	7.14% 2	17.86% 5	28	7.35

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.35	1.95

14.3 How did occupation with *Terpsichore* affect the HP's tendency to exhibit hostile behaviour potentially translating into damage or self-harm?

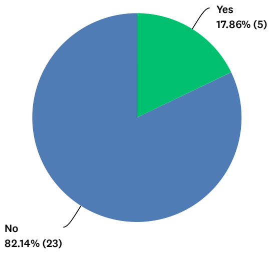


0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
3.57% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	10.71% 3	0.00% 0	3.57% 1	7.14% 2	17.86% 5	14.29% 4	42.86% 12	28	7.69

Minimum	Maximum	Median	Mean	Standard deviation
0	10	9	7.69	2.64

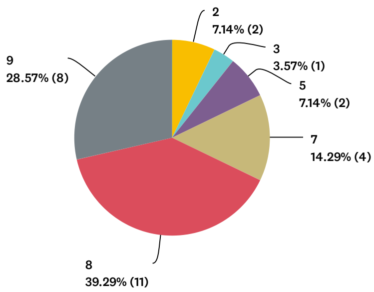
N.B.: All responses marked as 'Don't know / Prefer not to say' indicate that no issues concerning hostility of self-harm had been reported both prior to and during *Terpsichore* use.

14.4 Were there moments during which occupation with *Terpsichore*'s Soundscape and Indefinite Pitch Mode (SIP) negatively affected the HP's behaviour?



ANSWER CHOICES	RESPONSES	
Yes	17.86%	5
No	82.14%	23
TOTAL		28

14.5 How would you evaluate the HP's reaction when the software shuts down after failure to complete a task or after the timer has reached zero?

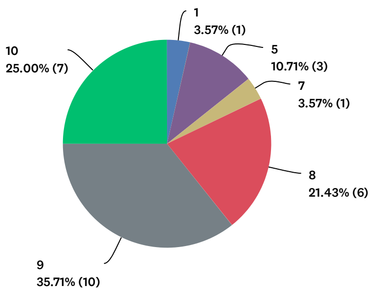


0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	7.14% 2	3.57% 1	0.00% 0	7.14% 2	0.00% 0	14.29% 4	39.29% 11	28.57% 8	0.00% 0	0.00% 0	28	7.32

Minimum	Maximum	Median	Mean	Standard deviation
2	9	8	7.32	2.02

15. COMMUNICATION AND INTERACTION

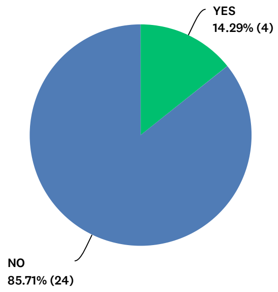
15.1 How did *Terpsichore* influence the HP's ability to communicate with his/her surroundings?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	0.00% 0	0.00% 0	0.00% 0	10.71% 3	0.00% 0	3.57% 1	21.43% 6	35.71% 10	25.00% 7	0.00% 0	28	8.25

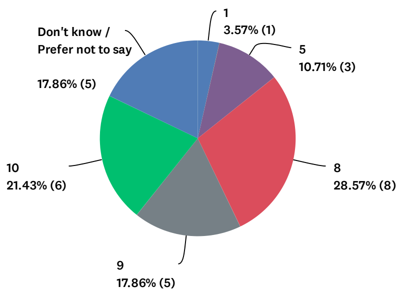
Minimum	Maximum	Median	Mean	Standard deviation
1	10	9	8.25	2.01

15.2 Has ‘*echolalia*’ been identified as an issue to be dealt with during *Terpsichore* use?



ANSWER CHOICES	RESPONSES	
YES	14.29%	4
NO	85.71%	24
TOTAL		28

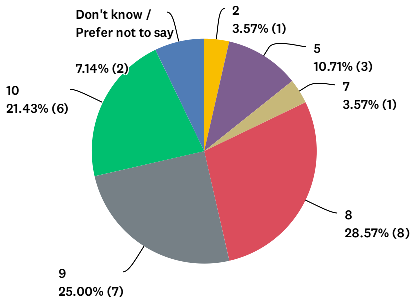
How did *Terpsichore* influence the HP’s capacity of producing independent audio phrases not characterised by mechanical repetition?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	3.57% 1	0.00% 0	0.00% 0	0.00% 0	10.71% 3	0.00% 0	0.00% 0	28.57% 8	17.86% 5	21.43% 6	17.86% 5	28	8.04

Minimum	Maximum	Median	Mean	Standard deviation
1	10	8	8.04	2.14

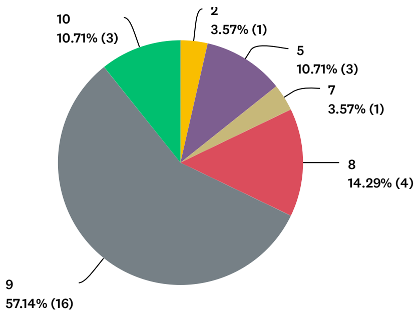
How did *Terpsichore* influence the ability to provide independent answers to questions asked by the supervising individual towards the HP?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	10.71% 3	0.00% 0	3.57% 1	28.57% 8	25.00% 7	21.43% 6	7.14% 2	28	8.12

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8.50	8.12	1.91

15.3 How did *Terpsichore* influence the HP's capability of perceiving the existence of other individuals within his/her surroundings, combined with their position within the three-dimensional space?

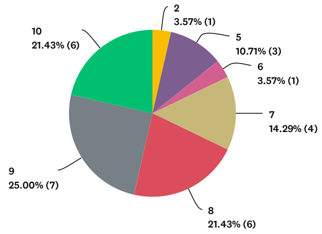


0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	10.71% 3	0.00% 0	3.57% 1	14.29% 4	57.14% 16	10.71% 3	0.00% 0	28	8.21

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.21	1.80

16. MISCELLANEOUS ACTIVITY INFORMATION

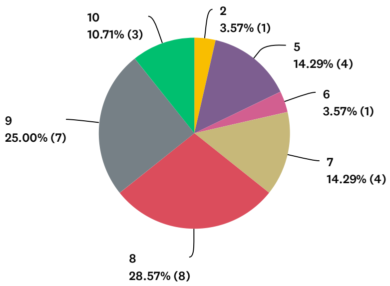
16.1 After extended use of *Terpsichore*, how would you judge the HP's ability to concentrate on activities directly associated with the software?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	10.71% 3	3.57% 1	14.29% 4	21.43% 6	25.00% 7	21.43% 6	0.00% 0	28	7.93

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.93	1.91

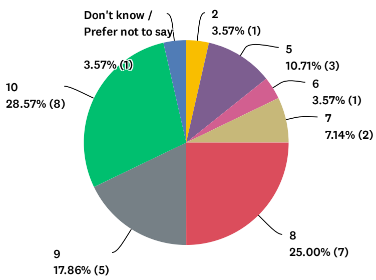
As a result of occupation with *Terpsichore*, how would you judge the HP's ability to concentrate on various activities not relevant to the software itself?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	14.29% 4	3.57% 1	14.29% 4	28.57% 8	25.00% 7	10.71% 3	0.00% 0	28	7.61

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	7.61	1.84

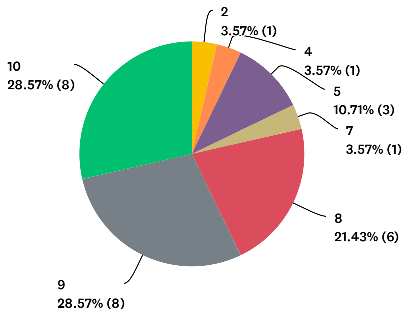
16.2 What is your post-*Terpsichore* evaluation of the HP's ability to follow the curriculum of the educational institution in which he / she is enrolled?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	0.00% 0	10.71% 3	3.57% 1	7.14% 2	25.00% 7	17.86% 5	28.57% 8	3.57% 1	28	8.07

Minimum	Maximum	Median	Mean	Standard deviation
2	10	8	8.07	1.98

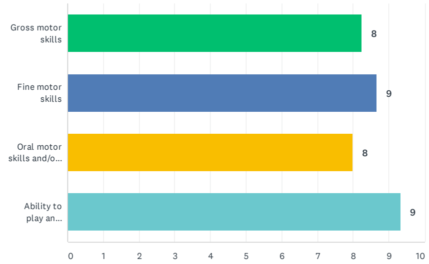
16.3 What is your post-*Terpsichore* evaluation of the HP's reaction towards advice and guidelines provided by people within his/her direct involvement (e.g. parents, tutors)?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	3.57% 1	0.00% 0	3.57% 1	10.71% 3	0.00% 0	3.57% 1	21.43% 6	28.57% 8	28.57% 8	0.00% 0	28	8.14

Minimum	Maximum	Median	Mean	Standard deviation
2	10	9	8.14	2.07

16.4 Evaluate, using numbers from 0 to 10, the software's influence on the following aspects, after this has been used for a substantial period of time (0: strongly negative, 5: neutral, 10: strongly positive). If you are unsure about an element, please leave the field blank.

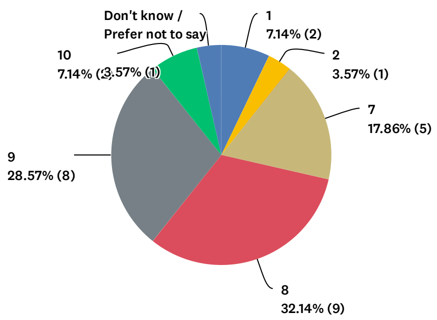


ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
Gross motor skills	8	66	8
Fine motor skills	9	52	6
Oral motor skills and/or discourse	8	72	9
Ability to play an existent musical instrument	9	28	3
Total Respondents: 11			

Type	Minimum	Maximum	Median	Mean	Standard deviation
Gross	5	10	8	8.25	1.64
Fine	7	10	9	8.67	1.37
Oral	6	9	8	8	0.94
Instrument	9	10	9	9.33	0.47

17. MUSIC AND SOUND AWARENESS, CREATIVITY

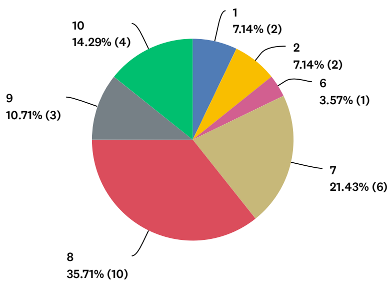
17.1 How strongly do you believe that *Terpsichore* has contributed to the acquisition of theoretical knowledge on the HP's part?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00%	7.14%	3.57%	0.00%	0.00%	0.00%	0.00%	17.86%	32.14%	28.57%	7.14%	3.57%		
0	2	1	0	0	0	0	5	9	8	2	1	28	7.52

Minimum	Maximum	Median	Mean	Standard deviation
1	10	8	7.52	2.35

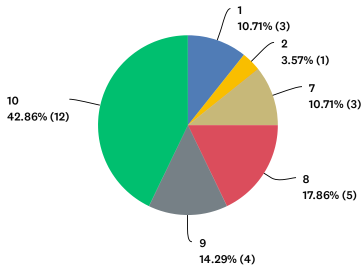
17.2 How strongly do you believe that *Terpsichore* enhanced the HP's ability to compose new melodies and soundscapes independently, without receiving guidance from a third party?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00%	7.14%	7.14%	0.00%	0.00%	0.00%	3.57%	21.43%	35.71%	10.71%	14.29%	0.00%		
0	2	2	0	0	0	1	6	10	3	4	0	28	7.18

Minimum	Maximum	Median	Mean	Standard deviation
1	10	8	7.18	2.54

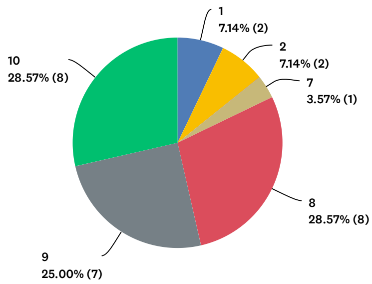
17.3 How did occupation with *Terpsichore* affect the HP's interest in creating note-based tonal music?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	10.71% 3	3.57% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	10.71% 3	17.86% 5	14.29% 4	42.86% 12	0.00% 0	28	7.93

Minimum	Maximum	Median	Mean	Standard deviation
1	10	9	7.93	1.91

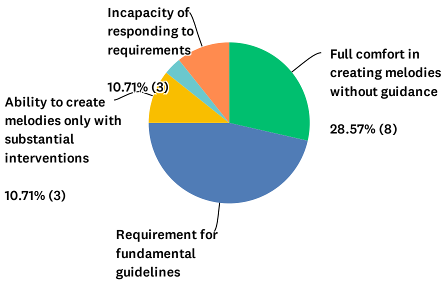
17.4 How did occupation with *Terpsichore* affect the HP's interest in creating and modifying soundscapes based on environmental sounds?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	7.14% 2	7.14% 2	0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	28.57% 8	25.00% 7	28.57% 8	0.00% 0	28	7.86

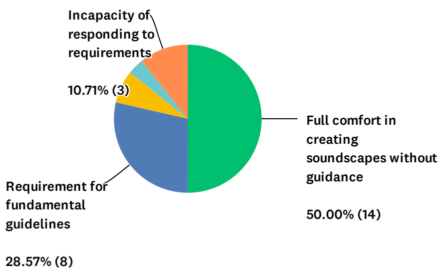
Minimum	Maximum	Median	Mean	Standard deviation
1	10	9	7.86	2.73

17.5 For the *Tonal Mode*, which of the following phrases best represents the HP after a substantial period of occupation with the software?



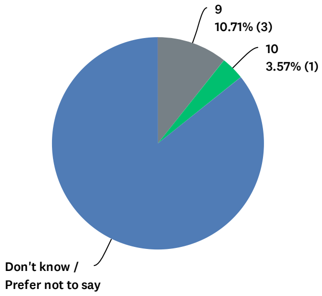
ANSWER CHOICES	RESPONSES	
Full comfort in creating melodies without guidance	28.57%	8
Requirement for fundamental guidelines	46.43%	13
Ability to create melodies only with substantial interventions	10.71%	3
Unorthodox occupation without a specific goal	3.57%	1
Incapacity of responding to requirements	10.71%	3
Unwillingness to use the mode altogether	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

17.6 For the *SIP Mode*, which of the following phrases best represents the HP after a substantial period of occupation with the software?



ANSWER CHOICES	RESPONSES	
Full comfort in creating soundscapes without guidance	50.00%	14
Requirement for fundamental guidelines	28.57%	8
Ability to create soundscapes only with substantial interventions	7.14%	2
Unorthodox occupation without a specific goal	3.57%	1
Incapacity of responding to requirements	10.71%	3
Unwillingness to use the mode altogether	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

17.7 Provided that the HP plays a musical instrument, how strongly do you believe that the ability to play it, combined with the level of dexterity (if applicable), have improved as a result of occupation with *Terpsichore*?

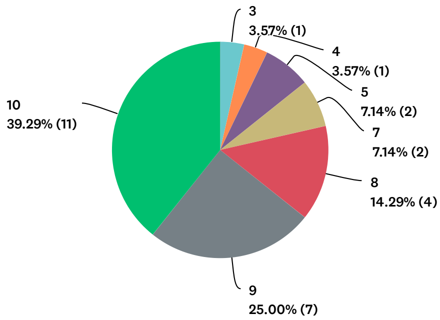


0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	10.71% 3	3.57% 1	85.71% 24	28	9.25

D. CONCLUSION

18. <u>OVERALL EVALUATION</u>

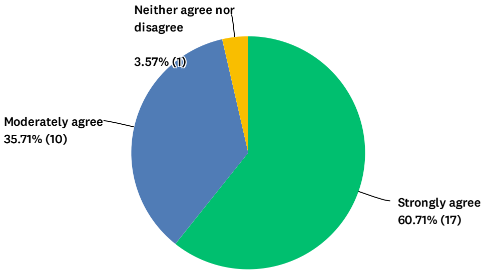
18.1 How well do you believe that the HP has responded to *Terpsichore* overall?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	3.57% 1	3.57% 1	7.14% 2	0.00% 0	7.14% 2	14.29% 4	25.00% 7	39.29% 11	0.00% 0	28	8.43

Minimum	Maximum	Median	Mean	Standard deviation
3	10	9	8.43	1.95

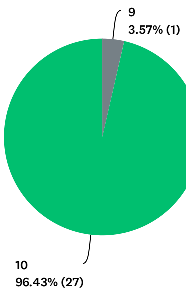
18.2 What is your judgment of the opinion that the changes in mental condition and autism-compliant characteristics have been influenced by the development of music and sound awareness capabilities as a result of *Terpsichore* occupation?



ANSWER CHOICES	RESPONSES	
Strongly agree	60.71%	17
Moderately agree	35.71%	10
Neither agree nor disagree	3.57%	1
Moderately disagree	0.00%	0
Strongly disagree	0.00%	0
Don't know / Prefer not to say	0.00%	0
TOTAL		28

18.3 Has the HP used, either before or during *Terpsichore*-based sessions, with any other music or sound training software? → ***NO in all instances***

18.7 From your personal viewpoint, how satisfied are you with *Terpsichore* overall?



0	1	2	3	4	5	6	7	8	9	10	DON'T KNOW / PREFER NOT TO SAY	TOTAL	WEIGHTED AVERAGE
0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	3.57% 1	96.43% 27	0.00% 0	28	9.96

18.8 How strongly would you recommend *Terpsichore* to parents, therapists and special tutors associated with ASD learners and relevant study fields? → ***10 in all instances***

18.9 What is your judgment of the opinion that *Terpsichore* may constitute an important step towards the establishment of music and sound composition as a useful and prevalent occupation directed towards the improvement of ASD learners' quality of life? → ***'Strongly Agree' in all instances***

<u>CONCLUDING NOTE:</u> All advanced SPSS statistics output files (ANOVA, regression, Cronbach's Alpha etc.), combined with raw data in Excel, SPSS and NVivo, are available as an attachment to this Thesis.

APPENDIX V

DATA ANALYSIS AND INTERPRETATION

Quantative analysis with Microsoft Excel and IBM SPSS

Quantifiable questions in the *Terpsichore* questionnaire concern the number of respondents that have opted for a specific choice among such extreme values as '0' and '10', 'agree' and 'disagree'.[144] However, the requirement for reliability and precision encourages the use of more sophisticated software to provide more detailed insights on the areas to be measured and evaluated. Regarding the quantifiable values being subject to interpretation, it is necessary to focus on a variety of representative magnitudes. Such examples are the mean value of measurements, demonstrating the general response of contacted learners to *Terpsichore*, the statistical significance of relationships between factors, representing the probability of different responses occurring when urging random ASD learners to occupy themselves with the software (Kim 2017, see Section 3.1.2), as well as the effect of certain learning, compositional and software application factors on the musical, mental and cognitive changes that have been documented as a result of sustained *Terpsichore* use.

The questionnaire of Appendix III entails, for the most part, questions whose response choices are standardised and thus can be easily assembled within a Microsoft Excel spreadsheet, while responses not explicitly representing numbers can be recoded as in the draft example of

[144] In the context of Table 3.1, the terms 'strongly agree' and 'strongly disagree' were not used, as the abbreviation 'SD' may be misinterpreted as 'standard deviation', which is referred to in the Table as well.

Table V.1.[145] Transformed data groups can subsequently be inserted into the IBM SPSS software for advanced data analysis, as per relevant guidelines (Hinton, McMurray and Brownlow 2014: 29; Pollock III 2012: 213-4). Although SPSS can process Excel-based data with maximum reliability if ideally represented in numerical form, the need to determine whether certain changes in mental, cognitive and compositional profile are affected by such qualitative factors as gender, trainability level and types of sound potentially causing irritation, requires that respective non-numerical variables be inserted and exploited in SPSS. Tables V.2 and V.3 below assist in explaining the appropriate format of variables included in an SPSS dataset associated with the *Terpsichore* analysis, by presenting variables and indicative responses from the first four Sections of the questionnaire as shown in Appendix III.

	Q1	Q2	Q3	Q4	Q5
R1	Yes	7	A	C1	8
R2	No	6	MA	C4	7
R3	No	8	D	C2	8
R4	Yes	9	N	C3	6
R5	Yes	6	MD	C1	10
R6	Yes	7	D	C2	7
R7	No	6	A	C3	6
R8	No	9	MD	C2	4
R9	Yes	8	N/A	C4	6
R10	No	N/A	D	C3	6
R11	No	7	A	C2	5
R12	No	7	N/A	C1	4

	Q1	Q2	Q3	Q4	Q5
R1	1	7	4	1	8
R2	0	6	3	4	7
R3	0	8	0	2	8
R4	1	9	2	3	6
R5	1	6	1	1	10
R6	1	7	0	2	7
R7	0	6	4	3	6
R8	0	9	1	2	4
R9	1	8	N/A	4	6
R10	0	N/A	0	3	6
R11	0	7	4	2	5
R12	0	7	N/A	1	4
AV	0,417	7,273	1,900	2,333	6,417
SD	0,505	1,160	1,658	1,036	1,737

Table V.1 *(a) Representative sample of a spreadsheet containing raw questionnaire data. (b) Full transformation into numerical values, allowing for such magnitudes as average (AV) and standard deviation (SD) to be calculated.*

[145] This is only a sample of data arrangement, by no means related to exact *Terpsichore*-based data. Q stands for Question and R for Respondent, while abbreviations ‘A, MA, N, MD, D’ respectively refer to the Likert scale of ‘agree, moderately agree, neither of the two, moderately disagree, disagree’.

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	year_of_birth	Numeric	4	0		None	None	6	Center	Scale	Input
2	gender	String	6	0		None	None	6	Center	Nominal	Input
3	diagnosis	String	8	0		None	None	7	Center	Nominal	Input
4	severity	String	8	0	Condition severity (mild, moderate, severe)	None	None	6	Center	Ordinal	Input
5	trainability	String	3	0	Whether HS is trainable	None	None	8	Center	Nominal	Input
6	added_diagnosis	String	16	0	Supplementary Diagnosis to ASD	None	None	11	Center	Nominal	Input
7	sound_response	Numeric	1	0	Reaction to sound (positive, neutral, negative)	None	None	8	Center	Ordinal	Input
8	active_music	String	3	0	Whether HS is actively occupied with music	None	None	8	Center	Nominal	Input
9	q4_3_emo_state	Numeric	8	0	General emotional state pre-Terpsichore	None	None	8	Center	Ordinal	Input
10	q5_1_behav_peer	Numeric	8	0	Behaviour towards peers pre-Terpsichore	None	None	8	Center	Ordinal	Input
11	q7_1_concentr	Numeric	8	0	Ability to concentrate on tasks pre-Terpsichore	None	None	8	Center	Ordinal	Input
12	q13_1_emo_inf	Numeric	2	0	Influence of Terpsichore in emotional state	None	None	9	Center	Scale	Input
13	q14_1_behav_peer_inf	Numeric	2	0	Influence of Terpsichore in behaviour towards peers	None	None	9	Center	Scale	Input
14	q16_1_concentr_inf	Numeric	2	0	Influence of Terpsichore in concentration	None	None	8	Center	Scale	Input
15	theory_inf	Numeric	2	0	Influence of Terpsichore in theory cognition	None	None	8	Center	Scale	Input
16	composition_indep	Numeric	2	0	Influence of Terpsichore in independent composition	None	None	8	Center	Scale	Input

Table V.2 *SPSS Variable View of multiple-choice type variables associated with Sections 1 through 4 of the* Terpsichore *questionnaire.*

	year_of_birth	gender	diagnosis	severity	trainability	added_diagnosis	sound_response	active_music	q4_3_emo_state	q5_1_behav_peer	q7_1_concentr	q13_1_emo_inf	q14_1_behav_peer_inf	q16_1_concentr_inf	theory_inf	composition_indep
1	2008	male	typ_aut	3	no	cerebral_palsy	0	no	4	4	4	8	9	8	8	9
2	2006	female	pdd_nos	1	yes	no	4	yes	3	2	3	9	8	8	7	8
3	2010	female	asperger	2	yes	tourette	2	yes	3	3	1	4	6	6	4	6
4	2009	male	savant	1	yes	speech_impair	3	no	4	3	3	5	5	6	6	6
5	2007	male	high_fun	3	no	anxiety_disord	4	no	3	4	2	7	6	7	5	7
6	2008	male	typ_aut	2	yes	rett	1	yes	2	3	4	6	5	8	6	7

Table V.3 *SPSS Data View associated with the variables specified in Table 3.2, for a random set of samples not necessarily consistent with the exact* Terpsichore *research.*

In Table V.2, variables shown refer to both fundamental characteristics of the human subject (HS) and areas of musical and emotional response, as identified in the respective Appendix III questions. Certain labels were added where it was deemed necessary to explain the content of variables. It can be observed that variables expressing years or miscellaneous text content, not belonging in a defined scale, have been specified as 'Nominal', whereas those referring to a range of options, whether numbers or preference keywords, are considered 'Ordinal' (Morgan and Griego 1998: 25-8). Likewise, years of birth and diagnosis are interpreted as 'Scale' variables, referred to outside SPSS as 'Interval' considering that they may be placed within a clearly defined time continuum (Weinberg and Abramowitz 2015: 5).

Table V.3 below receives data from six randomly chosen human subjects and presents information associated with each of the variables. By employing the 'descriptive statistics' option within SPSS, it is possible to discover fundamental quantities and trends related to some variables (IBM Knowledge Centre 2020). These include mean, median and mode for such ordinal variables as condition severity, responsiveness to audio and emotional state evaluation prior to *Terpsichore* use, and number of learners relative to the entire sample that fulfil a specified research criterion. Figure V.1 shows two representative examples, one for each variable type.

Frequencies

Statistics

Whether HS is trainable

N	Valid	6
	Missing	0

Whether HS is trainable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	2	33.3	33.3	33.3
	yes	4	66.7	66.7	100.0
	Total	6	100.0	100.0	

Frequencies

Statistics

Ability to express emotions

N	Valid	6
	Missing	0
Mean		3.50
Median		4.00
Mode		4
Range		2
Minimum		2
Maximum		4

Ability to express emotions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	16.7	16.7	16.7
	3	1	16.7	16.7	33.3
	4	4	66.7	66.7	100.0
	Total	6	100.0	100.0	

Figure V.1 *Descriptive Statistics representation of the trainability and emotional expressivity variables. Notice the different content presented when the variable is nominal (left) or ordinal (right).*

The process of establishing concise relationships between factors is based on various statistical tests. Firstly, regression analysis investigates the existence of a specific dependency between two research criteria (Srivastava, Shenoy and Sharma 1989: 320, 349), while it can also be employed to assess whether associated results can be safely reproduced in various contexts as having satisfactory 'statistical significance' (Miksza and Elpus 2018: 138). This can also be performed through plain correlation, presenting the extent of dependency between variables (Urdan 2005: 85-87, 143). The *t*-test aims to provide measures on the congruence of data with an initially specified hypothesis[146] concerning the mean value of a quantifiable response associated with a specific human sample (Russell 2018). The ANOVA is preferred in the current research, as differs from the *t*-test in its concentration on measuring the influence of various factors on a specific end result of the undertaken research (Phelps et al. 2005: 193).

In Table V.3, the column labelled 'theory_inf' refers to the influence *Terpsichore* has had on the acquisition of theoretical knowledge, as observed and displayed in the questionnaire by the peer tutor of an ASD learner. Similarly, column 'q13_1_emo_inf' is consistent with Question 13.1 of the survey (see Appendix III) and denotes the effect of *Terpsichore* on the learner's overall emotional condition. By subjecting these columns to 'bivariate correlation' (IBM Knowledge Centre 2020), it can be observed that the two above variables are positively correlated, as shown in Figure V.2. This indicates that learners, within the current sample, who have benefitted strongly from *Terpsichore* with regards to music theory may possess a higher tendency to express positive feelings and successfully communicate them to others. However,

[146] Not only Russell (2018), but also numerous statisticians, commonly refer to such a hypothesis as 'null'.

considering the threshold of $p_{crit} = 0.05$ set in Section 3.1 for statistical significance of results, the value of $p = 0.082 > p_{crit}$ demonstrates that a possible relation between these two values cannot be established, and the attempt to do so via an equation will result in errors more often than desired.

Correlations

		Influence of Terpsichore in emotional state	Influence of Terpsichore in theory cognition
Influence of Terpsichore in emotional state	Pearson Correlation	1	.756
	Sig. (2-tailed)		.082
	N	6	6
Influence of Terpsichore in theory cognition	Pearson Correlation	.756	1
	Sig. (2-tailed)	.082	
	N	6	6

Figure V.2 *SPSS statistical significance example: Investigation of possible dependency of theory knowledge acquisition in the emotional state of learners.*

The substitution of correlation with regression within SPSS allows for more independent variables to be inserted so that their concurrent influence on the dependent variable is evaluated. Linear regression analysis demonstrates, as shown in Figure V.3 below, that higher magnitudes in theoretical knowledge and compositional skills tend to elicit improved emotional states, interpreted through regression values above zero and a relationship represented by the following approximated formula:

$$z = a * x + b * y + c,\ a = 0.095,\ b = 1.293,\ c = -3.336 \text{ OR}$$

$$z = a * x + b * y, \quad a = 0.072, \quad b = 0{,}808$$

where *x* is the influence of *Terpsichore* on theoretical knowledge acquisition and *y* its influence on compositional skill development. An important value to consider is *R-squared*, which determines the percentage of results within a sample that explain a linear relationship between variables, with a more reliable magnitude for multiple independent variables being the *adjusted R-squared* (Pollock III 2012: 159-183). For instance, Figure V.3 yields $R^2_{adj} = .594$, meaning that the possible existence of a mutual variable relationship is valid for roughly 60% of observations.[147]

[147] The above formulas should not represent, in terms of statistical significance, a relationship of dependency due to associated tests not producing a *p*-value lower than the .05 threshold.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.870[a]	.756	.594	1.193

a. Predictors: (Constant), Influence of Terpsichore in independent composition, Influence of Terpsichore in theory cognition

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-3.336	3.440		-.970	.404
	Influence of Terpsichore in theory cognition	.095	.709	.072	.134	.902
	Influence of Terpsichore in independent composition	1.293	.858	.808	1.508	.229

a. Dependent Variable: Influence of Terpsichore in emotional state

Figure V.3 *Use of linear regression to explain the dependency of a music therapy-related variable on two factors associated with music education.*

Whenever an ANOVA between an independent variable and one or more dependent ones produces a *p*-value below the .05 threshold for statistical significance, the attempt to detect differences associated with specific identities or values of the independent variable is vital in the improved interpretation of results, and may be realised through a 'Tukey HSD [Honestly Significantly Different] post-hoc' test (Urdan 2015: 107) complementing the ANOVA. In the pilot example of Table V.4 and Figure V.4, SPSS has produced definite values for *F* and *p* that demonstrate statistically significant differences, thus allowing for a Tukey test to inform a researcher as to which pairs of independent variable magnitudes are responsible for such trends (Coladarci et al. 2011). Figure 3.13 demonstrates that condition severity strongly impacts the effect of *Terpsichore* use in both the ability to express emotions ($[F(2,3) = 18.5,\ p = .021]$) and the development of theoretical knowledge ($[F(2,3) = 37,\ p = .008]$). Let different indexes of ASD condition severity be represented by numbers (1 – mild, 2 – moderate, 3 – severe); Tukey post-hoc tests demonstrate that, in the first case, significant differences exist only between pairs 1-3 ($p = .018$), while in the second instance, the same is true not only for pair 1-3 ($p = .007$) but also for 2-3 ($p = .033$). In both examples, it is evident that data processing through SPSS demonstrates significant changes in emotional state and ability to comprehend music theory principles, when a learner's ASD diagnosis is assessed as either mild or severe.

	severity	q13_1_emo_inf	theory_inf
1	3	6	5
2	1	9	8
3	2	7	7
4	1	9	9
5	3	5	5
6	2	8	7

Table V.4 *Set of values for an arbitrary sample of participants, for the following characteristics (from left to right): ASD condition severity, software influence on emotional state and music theory cognition.*

Oneway

ANOVA

Influence of Terpsichore in emotional state

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.333	2	6.167	18.500	.021
Within Groups	1.000	3	.333		
Total	13.333	5			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Influence of Terpsichore in emotional state
Tukey HSD

(I) Condition severity (mild, moderate, severe)	(J) Condition severity (mild, moderate, severe)	Mean Difference (I–J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	2	1.500	.577	.155	-.91	3.91
	3	3.500*	.577	.018	1.09	5.91
2	1	-1.500	.577	.155	-3.91	.91
	3	2.000	.577	.080	-.41	4.41
3	1	-3.500*	.577	.018	-5.91	-1.09
	2	-2.000	.577	.080	-4.41	.41

*. The mean difference is significant at the 0.05 level.

(c)

Oneway

ANOVA

Influence of Terpsichore in theory cognition

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.333	2	6.167	37.000	.008
Within Groups	.500	3	.167		
Total	12.833	5			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Influence of Terpsichore in theory cognition
Tukey HSD

(I) Condition severity (mild, moderate, severe)	(J) Condition severity (mild, moderate, severe)	Mean Difference (I–J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	2	1.500	.408	.069	-.21	3.21
	3	3.500*	.408	.007	1.79	5.21
2	1	-1.500	.408	.069	-3.21	.21
	3	2.000*	.408	.033	.29	3.71
3	1	-3.500*	.408	.007	-5.21	-1.79
	2	-2.000*	.408	.033	-3.71	-.29

*. The mean difference is significant at the 0.05 level.

(b)

Figure V.4 *One-way ANOVA and post-hoc tests, to examine possible influence of ASD condition severity on (a) emotional state and (b) music theory cognition, for the sample of Table V.4.*

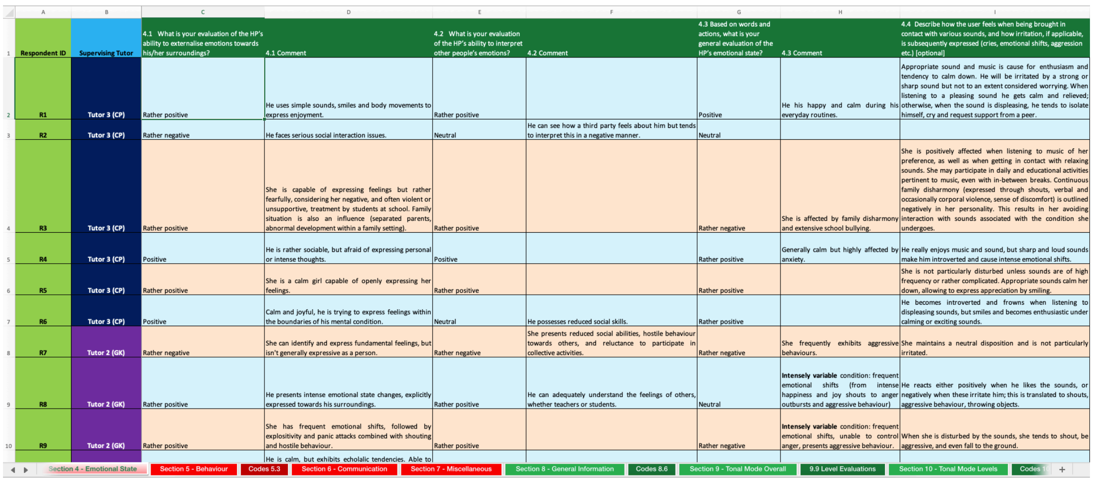
In a nutshell, the reliance on quantitative analysis mainly centred around ANOVA, post-hoc tests and linear regression where applicable, is projected to determine, as part of the practical analysis of Chapter 5, the existence of a potential relationship between music education and music therapy in *Terpsichore*, combined with the factors that potentially cause specific instances of responsiveness or particular behaviours whilst the interface is in use. It is worth mentioning that, on occasions, it may be necessary to assess the effect of an independent variable on the behaviour or trend that is assessed at various research stages, something termed as 'repeated measures ANOVA' (Froehlich and Frierson-Campbell 2013: 241). Moreover, the sample size of $n = 28$ for the *Terpsichore* study may serve as a fundamental departure point for the verification of observed trends where substantially more extensive studies are to be conducted, given the margin of error that may be inserted in *p*-value measurements for selective sample sizes (Ibid.: 239, 241).[148]

[148] All necessary statistical tests have been conducted according to detailed guidelines provided and verified in SPSS by the Laerd Statistics Website (2018).

Qualitative analysis with NVivo

Various parts of the *Terpsichore* questionnaire require that practitioners respond with an open-ended text that does not adhere to a definite multiple-choice, numeric input or Likert scale form. After all relevant answers are accrued, it is generally inconvenient to employ the same software packages and data interpretation tools as the ones used for quantitative analysis, to determine aspects of *Terpsichore* responsiveness through plain text. To resolve this issue, such data will be processed through the NVivo qualitative analysis package, characterised by the potential to group various text segments by subject matter, particular characteristics or different circumstances associated with a broader purpose (Jackson and Bazeley 2019).

As part of the research concerning the interface, NVivo will be employed as an auxiliary tool to assist with the classification of various open-ended questionnaire responses, in order to determine the number of participants with ASD that bear a specific characteristic, such as echolalia or gross motor skill deficiency prior to *Terpsichore* use (see Questions 6.2 and 7.2 in Appendix III). As Edhlund and McDougall (2020: 97-8) assert, it is possible to categorise different segments of text according to a represented thematic section, by creating 'theme nodes', or employ 'case nodes' to connect qualitative responses to more strictly defined lexical or number-based characteristics. The phraseology of survey questions, observed in Appendix III, tends to favour the use of theme nodes, since they are convenient in helping represent the prevalence of specific characteristics within the sample. The deployment of NVivo for *Terpsichore* research purposes, is preceded by the import of an Excel spreadsheet, where all individual responses for the twenty-eight participants are recorded and classified into subject tabs, as depicted in Figure V.5.



	A	B	C	D	E	F	G	H	I
1	Respondent ID	Supervising Tutor	4.1 What is your evaluation of the HP's ability to externalise emotions towards his/her surroundings?	4.1 Comment	4.2 What is your evaluation of the HP's ability to interpret other people's emotions?	4.2 Comment	4.3 Based on words and actions, what is your general evaluation of the HP's emotional state?	4.3 Comment	4.4 Describe how the user feels when being brought in contact with various sounds, and how irritation, if applicable, is subsequently expressed (cries, emotional shifts, aggression etc.) [optional]
2	R1	Tutor 3 (CP)	Rather positive	He uses simple sounds, smiles and body movements to express enjoyment.	Rather positive		Positive	He his happy and calm during his everyday routines.	Appropriate sound and music is cause for enthusiasm and tendency to calm down. He will be irritated by a strong or sharp sound but not to an extent considered worrying. When listening to a pleasing sound he gets calm and relieved; otherwise, when the sound is displeasing, he tends to isolate himself, cry and request support from a peer.
3	R2	Tutor 3 (CP)	Rather negative	He faces serious social interaction issues.	Neutral	He can see how a third party feels about him but tends to interpret this in a negative manner.	Neutral		
4	R3	Tutor 3 (CP)	Rather positive	She is capable of expressing feelings but rather fearfully, considering her negative, and often violent or unsupportive, treatment by students at school. Family situation is also an influence (separated parents, abnormal development within a family setting).	Rather positive		Rather negative	She is affected by family disharmony and extensive school bullying.	She is positively affected when listening to music of her preference, as well as when getting in contact with relaxing sounds. She may participate in daily and educational activities pertinent to music, even with in-between breaks. Continuous family disharmony (expressed through shouts, verbal and occasionally corporal violence, sense of discomfort) is outlined negatively in her personality. This results in her avoiding interaction with sounds associated with the condition she undergoes.
5	R4	Tutor 3 (CP)	Positive	He is rather sociable, but afraid of expressing personal or intense thoughts.	Positive		Rather positive	Generally calm but highly affected by anxiety.	He really enjoys music and sound, but sharp and loud sounds make him introverted and cause intense emotional shifts.
6	R5	Tutor 3 (CP)	Rather positive	She is a calm girl capable of openly expressing her feelings.	Rather positive		Rather positive		She is not particularly disturbed unless sounds are of high frequency or rather complicated. Appropriate sounds calm her down, allowing to express appreciation by smiling.
7	R6	Tutor 3 (CP)	Positive	Calm and joyful, he is trying to express feelings within the boundaries of his mental condition.	Neutral	He possesses reduced social skills.	Rather positive		He becomes introverted and frowns when listening to displeasing sounds, but smiles and becomes enthusiastic under calming or exciting sounds.
8	R7	Tutor 2 (GK)	Rather negative	She can identify and express fundamental feelings, but isn't generally expressive as a person.	Rather negative	She presents reduced social abilities, hostile behaviour towards others, and reluctance to participate in collective activities.	Rather negative	She frequently exhibits aggressive behaviours.	She maintains a neutral disposition and is not particularly irritated.
9	R8	Tutor 2 (GK)	Rather positive	He presents intense emotional state changes, explicitly expressed towards his surroundings.	Rather positive	He can adequately understand the feelings of others, whether teachers or students.	Neutral	**Intensely variable** condition: frequent emotional shifts (from intense happiness and joy shouts to anger outbursts and aggressive behaviour)	He reacts either positively when he likes the sounds, or negatively when these irritate him; this is translated to shouts, aggressive behaviour, throwing objects.
10	R9	Tutor 2 (GK)	Rather positive	She has frequent emotional shifts, followed by explositivity and panic attacks combined with shouting and hostile behaviour.	Rather positive		Rather negative	**Intensely variable** condition: frequent emotional shifts, unable to control anger, presents aggressive behaviour.	When she is disturbed by the sounds, she tends to shout, be aggressive, and even fall to the ground.
				He is calm, but exhibits echolalic tendencies. Able to					

***Figure V.5** Example of a tab in the Excel spreadsheet containing all separate responses.*

To isolate thematic trends in NVivo, the tab containing relevant information will be imported, followed by the subjection of resulting data to detailed scrutiny through the selection of words and sentences that match a specific characteristic or a text-based questionnaire response. This procedure requires the creation of different nodes, each associated with a different subject or trait, combined with the addition of so-called 'child nodes' containing various response types (Jackson and Bazeley 2019), as shown in Figure V.6 below:

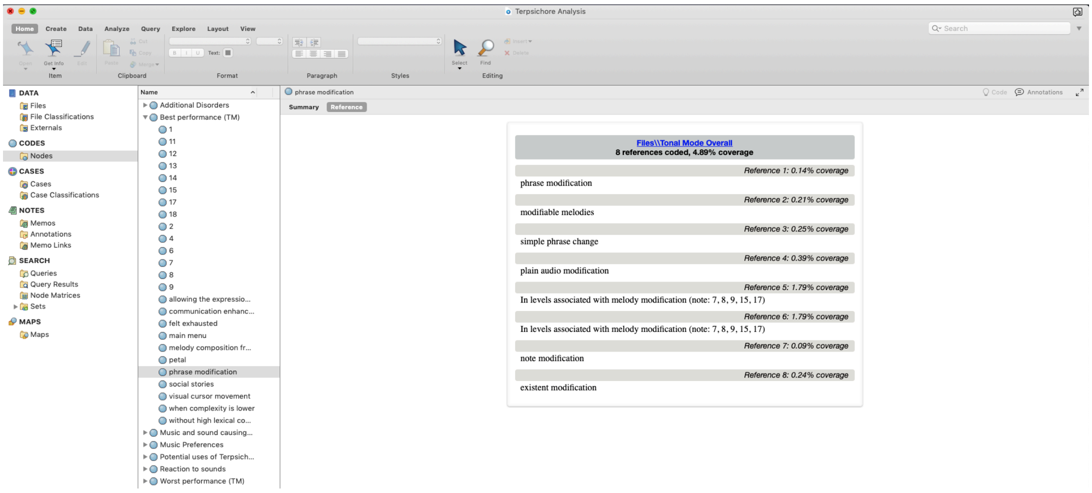


Figure V.6 *Example of an NVivo window where nodes have been created to accommodate different questionnaire responses adhering to specific thematic trends.*

After categorisation of content in NVivo has been completed, different responses can be represented through numeric codes, each associated with a clearly defined trait. For instance, as indicated in Figure V.7 below, the male participant R1, whose response in Question 5.3 is displayed as 'Code 4, 5', has been reported as being susceptible to negative behaviours when being faced with information overload and uninteresting tasks. In an effort to quantify and determine the potential role, as an either independent or dependent variable, of any factor related to learner condition or *Terpsichore,* two approaches may be used. Wherever only one response to a question is allowed, it is possible to simply represent each different choice with an associated identification number in SPSS, in similarity to Figure 3.16. Where a question permits the selection of multiple responses, it possible to either specify a different identification number for a case combination. On selected occasions where one of the relationship variables is the existence of a specific condition, new binary SPSS variables may be created, allowing the representation of the 'yes' and 'no' alternatives with the respective values of 1 and 0.

To summarise, this strategy aims to bridge the gap between the qualitative and quantitative research components, providing more comprehensive insights considering the extent to which specific criteria in an ASD learner's personality, mental condition and emotional state, may affect various aspects of performance throughout the *Terpsichore* project, combined with the consequences, whether positive or less favourable, induced by the sustained occupation with this interface.

5.3 Which of these may cause adverse behaviours on the HP's part? (see Sheet 'Codes 5.3')
Codes 4,5
Codes 2,3,4,5,7
Codes 3,6,7
Code 7

5.3 Which of these may cause adverse behaviours on the HP's part?	
Code ID	**Description**
1	Directions by familiar individuals (parents, tutors)
2	Directions by unfamiliar individuals
3	Corrective feedback and/or warnings
4	Overwhelming information load
5	Occupation with undesirable and/or tedious activities
6	Refusal to accommodate requests
7	Activity in unfamiliar environments

Figure V.7 Example showing responses to a survey question through qualitative statements coded as numbers.

AUDIO-VISUAL MATERIAL

Material relates to the SuperCollider code and software

Images for SuperCollider Code

All images last accessed 25 April 2020 unless stated otherwise. Identity and Hyperlinks shown here, for access.

Acoustic Guitar: http://img2.wikia.nocookie.net/__cb20121224183420/clubpenguin/images/7/70/Acoustic_Sunburst_Guitar_clothing_icon_ID_730.png

Acousmatic Circle: https://acousticecologyuoh.files.wordpress.com/2013/12/photo-1.jpg

ADSR Envelope: http://lindbymusic.com/wp-content/uploads/2016/07/ADSR-1024x511.jpg

Angry Face: https://www.lexisnexis.com/Communities/resized-image.ashx/__size/550x0/__key/communityserver-blogs-components-weblogfiles/00-00-00-00-26/8865.AngryFace_5F00_Facebook_5F00_sentiment.jpg

Back Button: http://www.clker.com/cliparts/2/v/Z/A/g/2/back-button-hi.png

Bass (F) Clef: http://easymusictheory.weebly.com/uploads/1/1/5/7/11577149/4580389.png

Bass Drum: http://www.clker.com/clipart-bass-drum.html

Blue Calm Face: https://img.clipartfest.com/0b8f814ee3b9810849ac6449cf52c1b9_what-its-like-to-work-with-calm-face-clipart_1600-1567.png [Accessed 20 May 2017]

Blue Play Button Icon: http://www.clipartbest.com/cliparts/7ca/Kdp/7caKdpLki.png

Checkmark and Cross: https://depositphotos.com/5489331/stock-photo-right-and-wrong-check-mark.html [Purchased 30 May 2018]

Cheering Crowd: http://www.stickpng.com/img/people/groups/cheering-crowd

Children / Kids: http://images.clipartpanda.com/computer-clipart-for-kids-82610_15845_0.gif

Clockwise: http://worldartsme.com/clockwise-clipart.html

Counterclockwise: http://worldartsme.com/images/counterclockwise-arrow-clipart-1.jpg

Crotchet Rest: https://commons.wikimedia.org/wiki/File:Quarter_note_with_upwards_stem.svg

Default Town Landscape (SIP Level 11): http://wallpapereasy.com/picture/town-traditional-landscape-1920x1080-20461.html/town-traditional-landscape-1920x1080

Default Town Landscape (SIP Level 12):
https://upload.wikimedia.org/wikipedia/commons/8/84/Kos_Town_sunset.jpg

Dice Icon: https://game-icons.net/tags/dice.html [Accessed 15 June 2016, re-coloured with *ColorStrokes for Mac*]

Drone: http://www.nova-labs.org/blog/wp-content/uploads/2014/03/62329308_1389286327.jpg [Accessed 30 May 2018]

Droplets: http://assets.inhabitat.com/wp-content/blogs.dir/1/files/2012/09/water-droplet-computer-537x349.jpg [30 May 2018]

Drumsticks: http://gr.vectorhq.com/psd/drumsticks-psd-406855

Electric Guitar: https://cdn0.iconfinder.com/data/icons/icons-unleashed-vol1/256/-guitar.png

Feedback Icon: http://www.quebecoislibre.org/13/131115-8.html

Fields: http://miriadna.com/desctopwalls/images/max/French-fields.jpg [Accessed 30 May 2018]

Fight: http://images.clipartpanda.com/fight-clipart-cliparti1_fight-clipart_01.jpg

Five Fingers: https://www.pinterest.com/pin/625789310694449858/

G (Treble) Clef [with background]: http://www.freestockphotos.biz/stockphoto/16017

G (Treble) Clef [Transparent]: https://pixabay.com/en/treble-clef-png-key-music-clef-1279909/ - also recoloured in *ColorStrokes for Mac*

Go to Bed: http://clipart-library.com/go-to-bed-clipart.html

Grand Piano: http://sealekeyworks.com/wp-content/uploads/2015/04/Piano-icon1.png [30 May 2018]

Green Arrow Pointing Right:
http://vignette3.wikia.nocookie.net/borderlands/images/6/67/Right_green_arrow.jpg/revision/latest?cb=20110418221914

Green Happy Face: https://img.clipartfest.com/48c1026d56e6b4d444b4dcbe43a7bc58_11-green-smiley-face-free-green-happy-face-clipart_2118-2116.png

Heavy Rain: http://png.clipart.me/previews/e79/blue-raindrops-24328.jpg
https://www.wallpaperup.com/32353/UK_Road_England_Horwich_Trees_Shrubs_nature_landscapes_town_village_buildings_houses_architecture_sky_clouds.html

Leaves: http://6775655.sites.myregisteredsite.com/wp-content/uploads/2012/03/106593525.jpg [Accessed 30 May 2018]

Loop: http://www.iconarchive.com/show/vista-multimedia-icons-by-icons-land/Play-Mode-Repeat-All-Normal-icon.html [also recoloured]

Load File 1: https://www.clker.com/clipart-load.html

Load File 2: https://www.1001freedownloads.com/free-clipart/blue-folder

Load File 3 (for Wave files): http://iconbug.com/detail/icon/327/speaker-sound-/
Lunch: https://www.mycutegraphics.com/graphics/school/kids-eating-lunch.html
Main Menu – Landscape Icon:
https://m1.behance.net/rendition/pm/14148243/disp/5030b454a28c8b6d650f99c71a7249fa.png
Metronome 2: https://www.shareicon.net/tempo-music-beat-metronome-698399
Metronome:
https://lh6.ggpht.com/ZflG2eHwFKwjvGthFQM6KE2mGwWTpqr4mV6PMOq5K7D8tR3QjkWwhHhK4qpqorh9FQ=w300
Minim (in TM Level 18 View):
https://commons.wikimedia.org/wiki/File:Figure_rythmique_blanche_hampe_haut.svg
Minim Rest: http://xoax.net/children/ref/music/incl/notes_rests/
Music Notes Icon (also for Main Menu): http://icons.mysitemyway.com/legacy-icon/003099-blue-jelly-icon-media-music-eighth-notes/
Neutral Face:
https://upload.wikimedia.org/wikipedia/commons/thumb/0/0c/Emoticon_Face_Neutral_GE.png/782px-Emoticon_Face_Neutral_GE.png
Night Landscape: https://w-dog.net/wallpaper/moon-night-landscape-stars-full-moon-sky-beautiful-scene-nature-lonely-tree-landscape-moon-night-landscape-star-full-moon-sky-beautiful-scenes-nature-a-lone-tree-landscape/id/295289/
Number 1: http://www.clker.com/clipart-red-rounded-with-number-1-2.html (also recoloured in green and blue using *ColorStrokes for Mac*
Number 2: http://www.clker.com/clipart-red-rounded-with-number-2-2.html (same as above)
Number 3: http://www.clker.com/clipart-red-rounded-with-number-3-1.html
Number 4: http://www.clker.com/clipart-red-rounded-with-number-4-1.html
Number 5: https://www.clker.com/clipart-red-rounded-with-number-5.html
Number 6: http://www.clker.com/clipart-red-rounded-with-number-6-1.html
Options:
https://www.iconfinder.com/icons/389763/configuration_control_gear_options_preferences_setting_settings_icon#size=512 (Rotated and modified)
Pink Noise: https://i.ytimg.com/vi/f9_pQ7YPZwY/maxresdefault.jpg
Play (activity): http://www.clker.com/clipart-9370.html
Play Button 2: http://www.pngmart.com/image/28973 (optimised for transparency in *Lunapic*, https://www140.lunapic.com/editor/?action=transparent)
Crotchet: https://commons.wikimedia.org/wiki/File:Quarter_note_with_upwards_stem.svg

Record Button 2: https://pixabay.com/en/record-grab-on-media-button-icon-97627/
Record Button Icon: http://barewallsdesign.com/wp-content/uploads/2016/01/record-button-png-record-button.jpg [Accessed 15 June 2016]
Recorder / Flute: http://images.clipartpanda.com/flute-clipart-recorder.png
Red Arrow Pointing Left: http://sorabotka.ener.gov.mk/Sorabotka_files/back2.png [Accessed 30 May 2018]
Red Sad Face: http://www.clker.com/cliparts/P/Z/w/n/R/W/red-smiley-face-hi.png
Reward: https://www.napavalleynow.com/event/end-of-the-year-awards-ceremony/ [Accessed 30 May 2018]
Reverb Icon: http://a5.mzstatic.com/us/r30/Purple5/v4/71/5c/57/715c5736-739f-d4f5-0c61-c79e04cf4917/icon175x175.jpeg
Sad man: https://img.clipartfest.com/2396c4265ab782cdc333e3ce67e08cd7_clip-art-sad-sad-man-clipart_2480-2501.jpeg [Accessed 30 May 2018]
Saw Wave: http://reactable.com/live/manual/icons/oscillator_saw.png
Semibreve:
https://www.iconfinder.com/icons/1119110/note_semibreve_whole_whole_note_icon
School: https://www.pinterest.com/pin/440086194821038230/
Sine Wave: http://reactable.com/live/manual/icons/oscillator_sine.png
Small Town: https://im.proptiger.com/1/152073/6/theme-ambience-tirupati-temple-town-341279.jpeg?width=1336&height=768
Snare: http://gardensiana.com/snare-drum-clip-art.html
Square Wave: https://cdn1.iconfinder.com/data/icons/materia-hardware/24/002_054_sound_wave_square_synth_music-512.png
Social Story Example Image 1: https://www.dreamstime.com/royalty-free-stock-image-parents-angry-their-child-test-fail-image20937416
Social Story Example Image 2: http://4.bp.blogspot.com/-WN8jfIc5DrY/UH2tKMvdPSI/AAAAAAAAAi0/NFxHBfxA87c/s1600/go+to+your+room.jpg
Social Story Example Image 3: https://www.abcteach.com/documents/clip-art-kids-boy-studying-color-i-abcteachcom-27727
Social Story Example Image 4: http://www.tcschools.org/2/News/1231
Stave with 5 Lines: https://www.long-mcquade.com/files/9765/lg_41SdR-sd-uL._SL160_AA160_.gif
Storm: http://hirportal.sikerado.hu/images/kep/201607/storm.jpg [Accessed 30 May 2018]
Study: http://clipart-library.com/boy-studying-cliparts.html

‘Terpsichore’ Main Image: https://www.anticstore.com/terpsichore-muse-la-dance-et-la-poesie-legere-65599P

{Dorigny, M. (17th century). *Terpsichore: Muse de la Danse et de la Poésie Légère*. [Terpsichore: Muse of Dance and Light Poetry]. [Painting]. [Online], see Link above}

Timbales: https://www.pinterest.com/pin/366691594633815495/

Triangle Wave: https://cdn1.iconfinder.com/data/icons/materia-hardware/24/002_053_sound_wave_triangle_synth_music-512.png

Underwater: http://wallpapersafari.com/w/vu0sK4/

User Manual: https://www.shutterstock.com/image-vector/mandatory-action-sign-refer-instruction-manual-204405904 [Purchased 30 May 2018]

Vibrato: http://www.nshos.com/HETERODYNE-VIBRATO.gif

Violin: https://www.pinterest.com/pin/328340629062986764/

Wake Up: http://www.clipsahoy.com/webgraphics3/aw5268.htm

Water: http://i.huffpost.com/gen/1241617/images/o-FRESH-WATER-facebook.jpg

White Noise: https://i.ytimg.com/vi/ekp1zmDvNLQ/maxresdefault.jpg [Accessed 30 May 2018]

Semibreve Rest: https://www.shareicon.net/music-whole-rest-musical-pentagram-notation-signs-749677 (resized and recoloured)

Wind: https://rew2019.files.wordpress.com/2010/01/blowing_wind.jpg

Xylophone: http://images.clipartpanda.com/xylophone-clipart-black-and-white-xylophone.png

Sound Samples

Any sound not included in this list was either recorded through an internal microphone or composed in Logic Pro X.

Acoustic Guitar: http://freesound.org/people/mike_kim2724/sounds/219310/

Baby crying: http://freesound.org/people/klankbeeld/sounds/198411/

Crowd of people talking abstractly: http://freesound.org/people/Corsica_S/sounds/360754/

Drone: http://freesound.org/people/Trebblofang/sounds/172662/

Droplets: http://freesound.org/people/l3ardoc/sounds/212604/

Electric Guitar: http://freesound.org/people/Skirox/sounds/167471/

Fields: http://freesound.org/people/Philip%20Goddard/sounds/180462/

Fighting: http://freesound.org/people/FillMat/sounds/384401/

Grand Piano: https://freesound.org/people/ramas26/sounds/95331/

Heavy rain: http://freesound.org/people/inchadney/sounds/103951/

Leaves: http://freesound.org/people/stereoscenic/sounds/115533/

Night Soundscape: http://freesound.org/people/oyez/sounds/7385/

Recorder (Flute): http://freesound.org/people/JohnLaVine333/sounds/221794/

Small town: http://freesound.org/people/eric5335/sounds/52741/

Thunderstorm: http://freesound.org/people/AVstudent/sounds/344994/

'Uh-oh' Negation: http://www.gazillionaire.com , available from within the bundled game

Underwater: http://freesound.org/people/FonotecadeCanarias/sounds/210820/

Water: http://freesound.org/people/Corsica_S/sounds/61252/

Wind: http://freesound.org/people/stereoscenic/sounds/115533/

Xylophone: http://freesound.org/people/juancamiloorjuela/sounds/204646/

BIBLIOGRAPHY

Aarons, M. and Gittens, T. (1999). *The Handbook of Autism: A Guide for Parents and Professionals*. 2nd edn. London: Routledge.

Abeles, J. (2006). *The Heart of Autism: Motivational Integration Strategies for Caregivers & Professionals*. Arlington, Texas (USA): Future Horizons.

Abraham, M.C. and Flora, S.B. (2008). *Educating the Young Child with Autism Spectrum Disorders: Moving from Diagnosis to Inclusion to Education*. Minneapolis, Minnesota (USA): Key Education Publishing Company.

Accordino, R., Corner, R. and Heller, W.B. (2007). Searching for Music's Potential: A Critical Examination of Research on Music Therapy with Individuals with Autism. *Research in Autism Spectrum Disorders*, 1, 101-115. DOI: 10.1016/j.rasd.2006.08.002.

Addis, L. (2004). *Of Mind and Music*. USA: Cornell University Press. Note: *First published in 1999 and printed in 2004*.

Advanced Brain Technologies USA (2016). *The Listening Programme*. [Online]. USA: Advanced Brain Technologies. Available from: https://advancedbrain.com/the-listening-program/ [Accessed 8 March 2017]. *N.B.: 2008 version of site also cited in:* Nwora, J.A. and Gee, B.M. (2009). A Case Study of a Five-Year-Old Child with Pervasive Developmental Disorder-Not Otherwise Specified Using Sound-Based Interventions. *Occupational Therapy International*, 16(1), 25-43. DOI: 10.1002/oti.263.

Aigen, K. (1995). Cognitive and Affective Processes in Music Therapy with Individuals with Developmental Delays: A Preliminary Model for Contemporary Nordoff-Robbins Practice. *Music Therapy*, 13(1), 13-46. DOI: 10.1093/mt/13.1.13.

Aigen, K. (2014). Music-Centered Dimensions of Nordoff-Robbins Music Therapy. *Music Therapy Perspectives*, 32(1), 18-29. DOI: 10.1093/mtp/miu006.

Albright, L. and Grady, M. (2013). *Accommodating Diversity: Inclusion for all in Early Childhood Programme.* North Carolina (USA): Lulu Press Inc.

Alcántara, J.I., Weisblatt, E.J.L., Moore, B.C.J. and Bolton, P.F. (2004). Speech-In-Noise Perception in High-Functioning Individuals with Autism or Asperger's Syndrome. *Journal of Child Psychology and Psychiatry*, 45(6), 1107-1114. DOI: 10.1111/j.1469-7610.2004.t01-1-00303.x.

Aldridge, D. (2013). Foreword. In: Kern, P. and Humpal, M. eds. *Early Childhood Music Therapy and Autism Spectrum Disorders: Developing Potential in Young Children and their Families*. London: Jessica Kingsley Publishers, pp. 13-16.

Algie, P. (2012). *An Exploration of the Relationship Between TEACCH and a Music Therapy Student's Practice in a Special Education Setting.* [Online]. Wellington, New Zealand: New Zealand School of Music, Master's Thesis / Exegesis. Available from: https://mro.massey.ac.nz/bitstream/handle/10179/3454/02_whole.pdf?sequence=1 [Accessed 24 March 2018].

Allen, R. and Heaton, P. (2010). Autism, Music, and the Therapeutic Potential of Music in Alexithymia. *Music Perception*, 27(4), 251-261. DOI: 10.1525/mp.2010.27.4.251.

Allen, R., Davis, R. and Hill, E. (2013). The Effects of Autism and Alexithymia on Physiological and Verbal Responsiveness to Music. *Journal of Autism and Developmental Disorders*, 43(2), 432-444. DOI: 10.1007/s10803-012-1587-8.

Allen, R., Hill, E. and Heaton, P. (2009). The Subjective Experience of Music in Autism Spectrum Disorder. In: Dalla Bella, S., Snyder, J.S., Kraus, N., Tervaniemi, M., Overy, K., Tillmann, B., Pantev, C. and Schlaug, G. eds. *The Neurosciences and Music III: Disorders and Plasticity: Annals of the New Academy of Sciences, Volume 1169*. Boston, Massachusetts (USA): Blackwell Publishing, pp. 326-331.

American Music Therapy Association / AMTA (2006a). *Music Therapy and Medicine*. [Online]. Silver Spring, Maryland (USA): American Music Therapy Association. Available from: http://www.musictherapy.org/assets/1/7/MT_Medicine_2006.pdf [Accessed 15 May 2018].

American Music Therapy Association / AMTA (2006b). *Music Therapy and Music Education: Meeting the Needs of Children with Disabilities*. [Online]. Silver Spring, Maryland (USA): American Music Therapy Association. Available from: http://www.musictherapy.org/assets/1/7/MT_Music_Ed_2006.pdf [Accessed 12 April 2015].

American Psychiatric Association / APA (2000). *DSM-IV: Diagnostic and Statistical Manual of Mental Disorders*. 4th edn. [Online]. Washington, D.C. (USA): American Psychiatric Association. Available from: https://justines2010blog.files.wordpress.com/2011/03/dsm-iv.pdf [Accessed 10 May 2018].

American Psychiatric Association / APA (2013). *DSM-5: Diagnostic and Statistical Manual of Mental Disorders*. 5th edn. Arlington, Virginia (USA): American Psychiatric Association.

American Psychological [formerly *Psychiatric*] Association / APA (2017). *Psychology Topics: Autism*. [Online]. Washington, D.C. (USA): American Psychological Association. Available from: http://www.apa.org/topics/autism/ [Accessed 4 May 2017].

Amos, P. (2015). Rhythm and Timing in Autism: Learning to Dance. In: Torres, E.B. and Donnellan, A.M. eds. *Autism: The Movement Perspective*. Lausanne (Switzerland): Frontiers Media, pp. 138-152.

Anderson, K. (2008). *The DIR/Floortime Model and its Implementation and Use for Intervention with Children with ASD/PDD*. [Online]. Forest Grove, Orlando (USA): Pacific University (Academic Project). Available from: http://commons.pacificu.edu/cgi/viewcontent.cgi?article=1003&context=otpeds [Accessed 18 February 2016].

Anderson, W.M. and Lawrence, J.E. (2014). *Integrating Music into the Elementary Classroom*. 3rd edn. Boston, Massachusetts (USA): Schirmer, Cengage Learning.

Andersson, A.-P. and Cappelen, B. (2014). Vocal and Tangible Interaction in RHYME. [Online]. In: Stensaeth, K. ed. (2014). *Music, Health, Technology, and Design: Series from the Centre for Music and Health, Vol. 8*. Oslo (Norway): Norwegian Academy of Music, pp. 21-38. https://nmh.brage.unit.no/nmh-xmlui/handle/11250/279834 [Accessed 28 March 2020].

Andersson, G., Lindvall, N., Hursti, T., Carlbring, P. and Andersson, G. (2002). Hypersensitivity to Sound (Hyperacusis): A Prevalence Study Conducted via the Internet and Post. *International Journal of Audiology*, 41(8), 545-554. DOI: 10.3109/14992020209056075.

Andreopoulou, A. and Farbood, M. (2010). Short Term Pitch Memory in Western vs. Other Equal Temperament Tuning Systems. [Online]. *Proceedings of the 7th SMC (Sound and Music Computing) Conference,* Barcelona, Spain, 21-24 July 2010. Available from: http://smcnetwork.org/files/proceedings/2010/72.pdf [Accessed 25 April 2018].

Apel, W. (1972). *Harvard Dictionary of Music*. Cambridge, Massachusetts (USA): The Belknap Press of Harvard University Press.

Apple Store (2017). *Skoogmusic Skoog 2.0 Tactile Musical Interface for iOS and Mac*. [Online]. Available from: https://www.apple.com/uk/shop/product/HJAV2ZM/A/skoogmusic-skoog-20-tactile-musical-interface-for-ios-mac?cid=oas-emeia-domains-apple.co.uk [Accessed 18 April 2020].

Argyle, M. (1988). *Bodily Communication*. 2nd edn (reprinted 2007). London: Routledge.

Ashford, J.B. and LeCroy, C.W. (2013). *Human Behavior in the Social Environment: A Multidimensional Perspective*. Belmont, California (USA): Brooks/Cole, Cengage Learning.

Askew, S. and Lodge, C. (2004). *Gifts, Ping-Pong and Loops – Linking Feedback and Learning*. In: Askew, S. ed. *Feedback for Learning*. 2nd edn (first published 2000). London: Routledge-Falmer.

Asmus, E.P. and Radocy, R.E. (1992). Quantitative Analysis. In: Colwell, R. ed. *Handbook of Research on Music Teaching and Learning*. New York: Schirmer Books, pp. 141-83.

Asperger, H. (1944). *Die 'Autistischen Psychopathen' im Kindesalter [The Autistic Psychopaths in Childhood]*. [German Language]. [Online]. Available from: http://www.neurodiversity.com/library_asperger_1944.pdf [Accessed 25 January 2016].

Aspy, R. and Grossman, B.G. (2011). *The Ziggurat Model Release 2.0: A Framework for Designing Comprehensive Interventions for High-Functioning Individuals with Autism Spectrum Disorders*.

Athinaios, D. (2017). *SuperCollider OSX Standalone*. [Online]. Available from: https://github.com/dathinaios/sc_osx_standalone [Accessed 10 May 2018].

Athos, E.A., Levinson, B., Kistler, A., Zemansky, J., Bostrom, A., Freimer, N. and Gitschier, J. (2007). Dichotomy and Perceptual Distortions in Absolute Pitch Ability. *Proceedings of the National Academic of Sciences of the United States of America (PNAS)*, 104(37), 14795-14800. DOI: 10.1073/pnas.0703868104.

Attwood, T. (1998). *Asperger's Syndrome: A Guide for Parents and Professionals*. London: Jessica Kingsley Publishers.

Attwood, T. (2004). *Exploring Feelings: Cognitive Behaviour Therapy to Manage Anger*. Arlington, Texas (USA): Future Horizons.

Attwood, T. (2006). *Asperger's Syndrome and Problems Related to Stress*. In: Baron, M.G., Groden, J., Groden, G. and Lipstitt, L.P. eds. *Stress and Coping in Autism*. Oxford: Oxford University Press, pp. 351-370.

Attwood, T. (2007). *The Complete Guide to Asperger's Syndrome*. London: Jessica Kingsley Publishers.

Attwood, T. and Garnett, M. (2016). *Exploring Depression and Beating the Blues: A CBT Self-Help Guide to Understanding and Coping with Depression in Asperger's Syndrome (ASD-Level 1).* London: Jessica Kingsley Publishers.

Attwood, T. and Scarpa, A. (2013). Modifications of Cognitive-Behavioral Therapy for Children and Adolescents with High-Functioning ASD and Their Common Difficulties. [Online]. In: Scarpa, A., White, S.W. and Attwood, T. eds. *CBT for Children and Adolescents with High-Functioning Autism Spectrum Disorders*. New York: Guilford Press, pp. 27-44. Available from: https://www.guilford.com/excerpts/scarpa.pdf?t [Accessed 15 March 2020].

Ault, M.J. and Griffen, K. (2013). Teaching with the System of Least Prompts: An Easy Method for Monitoring Progress. *TEACHING Exceptional Children*, 45(3), 46-53. DOI: 10.1177/004005991304500305.

Autism Science Foundation (2013). *Music Therapy May Help Children with Autism*. [Online Blog]. New York: Autism Science Foundation. Available from: https://autismsciencefoundation.wordpress.com/2013/08/ [Accessed 5 May 2018].

Autism Speaks (2010). *How are Asperger Syndrome and High Functioning Autism Different?* [Online]. London: Autism Speaks Inc. Available from: https://www.autismspeaks.org/sites/default/files/documents/as-hfa/diff_as-hfa_tool_kit.pdf [Accessed 25 January 2016].

Autism Speaks (2012). *About Autism*. [Online]. USA: Autism Speaks. Available from: https://www.autismspeaks.org/sites/default/files/sctk_about_autism.pdf [Accessed 18 July 2016].

Autism Speaks (2018). *Social Communication/Emotional Regulation/Transactional Support SCERTS*. [Online]. USA: Autism Speaks. Available from: https://www.autismspeaks.org/what-autism/treatment/social-communication-emotional-regulation-transactional-support-scerts [Accessed 26 May 2018].

Ayotte, J., Peretz, I. and Hyde, K. (2002). *Congenital Amusia: A Group Study of Adults Afflicted with a Music-Specific Disorder*. *Brain*, 125, 238-251. DOI: 10.1093/brain/awf028.

Ayres, A.J. and Robbins, J. (2008). *Sensory Integration and the Child: Understanding Hidden Sensory Challenges*. Los Angeles, California (USA): Western Psychological Sciences.

Bahrick, L.E. and Todd, J.T. (2012). Multisensory Processing in Autism Spectrum Disorder: Intersensory Processing Disturbance as a Basis for Atypical Development. In: Stein, B.E. ed. *The New Handbook of Multisensory Processing*. Cambridge, Massachusetts (USA): The MIT Press, pp. 657-675.

Bakan, M.B. (2014). *Neurodiversity and the Ethnomusicology of Autism*. [Online]. Missoula, Montana (USA): The College Music Society. Available from: http://michaelbakan.com/wp-content/uploads/2010/09/Bakan-Neurodiveristy-and-the-Ethnomusicology-of-Autism-CMS.pdf [Accessed 27 February 2020].

Bakan, M.B. (2015). "Don't Go Changing to Try and Please Me": Combating Essentialism through Ethnography in the Ethnomusicology of Autism. *Ethnomusicology*, 59(1), 116-144. DOI: 10.5406/ethnomusicology.59.1.0116.

Bakan, M.B. (2018). Music and Autism, Representation and Re-presentation: An Ethnomusicological Perspective. In: Fein, E. and Rios, C. eds. *Autism in Translation: An Intercultural Conversation on Autism Spectrum Conditions*. Cham (Switzerland): Palgrave Macmillan, pp. 109-128.

Baird, G., Simonoff, E., Pickles, A., Chandler, S., Loucas, T., Meldrum, D. and Charman, T. (2006). Prevalence of Disorders of the Autism Spectrum in a Population Cohort of Children in South Thames: The Special Needs and Autism Project (SNAP). The Lancet, 368 (9531), 210-215. DOI: 10.1016/S0140-6736(06)69041-7.

Bakshi, U.A. and Bakshi, V.U. (2009). *Automatic Control Systems*. Pune (India): Technical Publications Pune.

Baldassarri, S., Marco, J., Bonillo, C., Cerezo, E. and Beltrán, J.R. (2016). ImmertableApp: Interactive and Tangible Learning Music Environment. In: Kurosu, M. ed. *Human-Computer Interaction: Novel User Experiences, Part III. Proceedings of the 18th International Conference, HCI International 2016,* Toronto, Ontario, Canada, 17-22 July 2016. *Lecture Notes in Computer Science (LNCS),* 9733. Cham (Switzerland): Springer, pp. 365-376. DOI: 10.1007/978-3-319-39513-5_34.

Bánréti, Z. (2010). Recursion in Aphasia. *Clinical Linguistics & Phonetics*, 24(11), 906-914. DOI: 10.3109/02699206.2010.511407.

Barnartt, S., Schriner, K. and Scotch, R. (2001). Advocacy and Political Action. In: Albrecht, G.L., Seelman, K.D. and Bury, M. eds. *Handbook of Disability Studies*. London: Sage Publications, pp. 430-449.

Barnes, C. (2003). Effecting Change; Disability, Culture, and Art? [Online]. Paper presented at: *Proceedings of the 'Finding the Spotlight' Conference, Liverpool Institute for the Performing Arts,* Liverpool. 28-31 May 2003. Available from: https://pdfs.semanticscholar.org/3083/66015761b54b390ea7fc7b714318373ef596.pdf [Accessed 15 April 2020].

Barnes, C. and Mercer, G. (2010). *Exploring Disability*. Cambridge: Polity Press.

Barnes, C. and Mercer, G. (2013). The Politics of Disability and the Struggle for Change. In: Barton, L. ed. *Disability, Politics and the Struggle for Change*. First edition published in 2001 (no actual number of edition mentioned). Abingdon, Oxon: Routledge, pp. 11-23.

Baron-Cohen, S. (1988). Social and Pragmatic Deficits in Autism: Cognitive or Affective? *Journal of Autism and Developmental Disorders*, 18(3), 379-402. DOI: 10.1007/BF02212194.

Baron-Cohen, S., Leslie, A.M. and Frith, U. (1985). Does the Autistic Child Have a 'Theory of Mind'? *Cognition*, 21, 37-46. DOI: 10.1016/0010-0277(85)90022-8.

Baron-Cohen, S., Leslie, A.M. and Frith, U. (1986). Mechanical, Behavioural and Intentional Understanding of Picture Stories in Autistic Children. *British Journal of Developmental Psychology*, 4, 113-125. DOI: 10.1111/j.2044-835X.1986.tb01003.x.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y. and Plumb, I. (2001). 'Reading the Mind in the Eyes' Test Revised Version: A Study with Normal Adults, and Adults with Asperger Syndrome or High-Functioning Autism. *Journal of Child Psychology and Psychiatry*, 42(2), 241-251. DOI: 10.1111/1469-7610.00715.

Baron-Cohen, S., Wheelwright, S., Lawson, J., Griffin, R., Ashwin, C., Billington, J. and Chakrabarti, B. (2005). Emphathizing and Systemizing in Autism Spectrum Conditions. In: Volkmar, F.R., Paul, R., Klin, A. and Cohen, D.J. eds. *Handbook of Autism and Pervasive Developmental Disorders*. 3rd edn. Hoboken, New Jersey (USA): John Wiley and Sons, pp. 628-638.

Barrett, J. (2014). Case Study in Music Education. In: Conway, C.M. ed. *The Oxford Handbook of Qualitative Research in American Music Education*. Oxford: Oxford University Press, pp. 113-132.

Barton, E.E. and Harin, B. (2012). *Educating Young Children with Autism Spectrum Disorders*. London: Sage Publications.

Barton, L. (2013). Disability, Struggle and the Politics of Hope. In: Barton, L. ed. *Disability, Politics and the Struggle for Change*. First edition published in 2001 (no actual number of edition mentioned). Abingdon, Oxon: Routledge, pp. 1-10.

Bate, S. (2013). *Face Recognition and its Disorders*. Basingstoke: Palgrave Macmillan.

Basnett, I. (2001). Health Care Professionals and their Attitudes Toward Decisions Affecting Disabled People. In: Albrecht, G.L., Seelman, K.D., Bury, M. eds. *Handbook of Disability Studies*. London: Sage Publications Ltd., pp. 450-467.

Bauer, S. (1996). *Asperger Syndrome: Through the Lifespan*. [Online]. New York: The Developmental Unit, The Genesee Hospital Rochester. Available from: https://www.aspennj.org/pdf/information/articles/aspergers-syndrome-through-the-lifespan.pdf [Accessed 20 April 2020].

Bauer, W.I. (2014). *Music Learning Today: Digital Pedagogy for Creating, Performing, and Responding to Music*. Oxford: Oxford University Press.

Baxter, H.T., Berghofer, J.A., MacEwan, L., Nelson, J., Peters, K. and Roberts, P. (2007). *The Individualised Music Therapy Assessment Profile*. London: Jessica Kingsley Publishers.

Bayliss, R. and Etchells, J. (2016). The Concept of Health and Wellbeing Across the Lifespan. In: Tonkin, A. and Whitaker, J. eds. *Play in Healthcare for Adults: Using Play to Promote Health and Wellbeing Across the Adult Lifespan*. Abingdon, Oxon: Routledge, pp. 59-69.

Becchio, C. and Castiello, U. (2012). Visuomotor Resonance in Autism Spectrum Disorders. *Frontiers in Integrative Neuroscience*, 6, 110. DOI: 10.3389/fnint.2012.00110.

Beddor, P.S., Krakow, R.A. and Goldstein, L.M. (1986). Perceptual Constraints and Phonological Change: A Study of Nasal Vowel Height. *Phonology Yearbook*, 3, 197-217. DOI: 10.1017/S0952675700000646.

Beinhorn, M. (2015). *Unlocking Creativity: A Producer's Guide to Making Music and Art*. [Kindle]. Milwaukee, Wisconsin (USA): Hal Leonard. Available from: https://www.amazon.co.uk/gp/product/B0112BS15Q/ref=oh_aui_d_detailpage_o00_?ie=UTF8&psc=1 [Accessed 28 March 2018].

Belmonte, M.K., Sexena-Chandhok, T., Cherian, R., Muneer, R., George, L. and Karanth, P. (2015). Oral Motor Deficits in Speech-Impaired Children with Autism. In: Torres, E.B. and Donnellan, A.M. eds. *Autism: The Movement Perspective*. Los Angeles, California (USA): Frontiers Media, pp. 194-201.

Bender, L. (1959). Autism in Children with Mental Deficiency. *American Journal of Mental Deficiency* [Online], 64(1), 81-6. Available from: http://www.neurodiversity.com/library_bender_1959.pdf [Accessed 10 April 2020].

Benveniste, S. (2010). *Incremental Design of Therapeutic Music Games: Theory and Application to the Treatment of Behavioral Disorders and Alzheimer's Disease*. [Online]. Paris, France: École Nationale Supérieure des Mines de Paris, 2010. Available from: https://pastel.archives-ouvertes.fr/pastel-00599137/document [Accessed 20 April 2020].

Bérard, G. and Brockett, S. (2011). *Hearing Equals Behavior: Updated and Expanded*. [Kindle]. Translated into English from French [Bérard, G. (1983). *Audition Égale Comportement*] and updated in 2011. Schaumburg, Illinois (USA): EBooks2Go. Available from: https://www.amazon.co.uk/dp/B06W2HT8HL/ref=docs-os-doi_0 [Accessed / Purchased 23 March 2018].

Berger, D. (2002). *Music Therapy, Sensory Integration and the Autistic Child*. London: Jessica Kingsley Publishers.

Berger, D. (2016). *Eurhythmics for Autism and Other Neurophysiologic Diagnoses: A Sensorimotor Music-Based Treatment Approach*. London: Jessica Kingsley Publishers.

Berger, D. (2017). *Kids, Music 'N' Autism: Bringing out the Music in Your Child.* London: Jessica Kingsley Publishers.

Bergmann, T. (2016). *Music Therapy for People with Autism Spectrum Disorder*. In: Edwards, J. ed. *The Oxford Handbook of Music Therapy*. Oxford: Oxford University Press, pp. 186-209.

Beringer, O. (1999). *Daily Technical Studies for Piano: Piano Collection*. London: Kalmus.

Bernad-Ripoll, S. (2007). Using a Self-as-Model Video Combined with Social Stories™ to Help a Child with Asperger Syndrome Understand Emotions. *Focus on Autism and Other Developmental Disabilities,* 22(2), 100-106. DOI: 10.1177/10883576070220020101.

Bernier, R. and Dawson, G. (2009). The Role of Mirror Neuron Dysfunction in Autism. In: Pineda, J. ed. *Mirror Neuron Systems: The Role of Mirroring Processes in Social Cognition*. New York: Humana Press, a part of Springer Science + Business Media, pp. 261-286.

Bernstorf, E. (2016). Reading Acquisition Frameworks for Music and Language: Layering Elements of Literacy for Students with Exceptionalities. In: Blair, D.V. and McCord, K.A. eds. *Exceptional Music Pedagogy for Children with Exceptionalities*. Oxford: Oxford University Press, pp. 251-277.

Besson, M. and Schön, D. (2001). Comparison Between Language and Music. *The Biological Foundations of Music*, 930, 232-258. DOI: 10.1111/j.1749-6632.2001.tb05736.x.

Betts, D. and Patrick, N.J. (2008). *Hints and Tips for Helping Children with Autism Spectrum Disorders: Useful Strategies for Home, School, and the Community*. London: Jessica Kingsley Publishers.

Bhatara, A., Quinin, E.-M., Fombonne, E. and Levitin, D.J. (2013). Early Sensitivity to Sound and Music Preferences and Enjoyment in Adolescents with Autism Spectrum Disorders. *Psychomusicology: Music, Mind and Brain*, 23(2), 100-108. DOI: 10.1037/a0033754.

Bhattacharya, S.K. (2009). *Control Systems Engineering*. 2nd edn. New Delhi (India): Dorling Kindersley (India) – Pearson Education.

Bieleninik, L., Geretsegger, M., Mössler, K., Assmus, J., Thompson, G., Gattino, G., Elefant, C., Gottfried, T., Igliozzi, R., Muratori, F., Suvini, F., Kim, J., Crawford, M.J., Odell-Miller, H., Oldfield, A., Casey, Ó., Finnemann, J., Carpente, J., Park, A.L., Grossi, E., Gold, C. and Time-A Study Team (2017). Effects of Improvisational Music Therapy vs Enhanced Standard Care on Symptom Severity Among Children with Autism Spectrum Disorder: The Time-A Randomized Clinical Trial. *JAMA*, 8; 318(6), 525-535. DOI: 10.1001/jama.2017.9478.

Billard, A. and Dautenhahn, K. (1997). *Grounding Communication in Situated, Social Robots*. [Online]. Edinburgh: University of Edinburgh. Technical Report. Available from: https://pdfs.semanticscholar.org/f504/fa2749cf02f3280043fd94c50658b625b134.pdf [Accessed 28 April 2020].

Birbaumer, N. and Cohen, L.G. (2007). Brain-Computer Interfaces: Communication and Restoration of Movement in Paralysis. *Journal of Physiology*, 579 (Pt 3), 621-636. DOI: 10.1113/jphysiol.2006.125633.

Blacher, J. and McIntyre, L.L. (2006). Syndrome Specificity and Behavioral Disorders in Young Adults with Intelectual Disability: Cultural Differences in Family Impact. *Journal of Intellectual Disability Research*, 50(3), 184-198. DOI: 10.1111/j.1365-2788.2005.00768.x.

Black, R.S. and Tsumoto, C.A. (2018). Portrayal of Adolescents with Autism Spectrum Disorders in Young Adult Literature. *Exceptionality Education International* [Online], 28(1), 45-66. Available from: https://ir.lib.uwo.ca/cgi/viewcontent.cgi?article=1220&context=eei [Accessed 20 March 2020].

Bluestone, J. (2005). *The Fabric of Autism*. Seattle, Washington (USA): Sapphire Enterprises.

Blumstein, M.R. (2015). Music and Developmental Disabilities. In: Silton, N.R. ed. *Assistive Technologies to Support Children with Developmental Disorders*. Hershey, Pennsylvania (USA): Medical Information Science Reference (an imprint of IGI Global), pp. 292-309.

Boddaert, N., Belin, P., Chabane, N., Poline, J-B., Barthélémy, C., Mouren-Simeoni, M-C., Brunelle, F., Samson, Y. and Zilbovicius, M. (2003). Perception of Complex Sounds: Abnormal Pattern of Cortical Activation in Autism. *American Journal of Psychiatry*, 160, 2057-2060. DOI: 10.1176/appi.ajp.160.11.2057.

Bogdashina, O. (2005). *Communication Issues in Autism and Asperger Syndrome: Do We Speak the Same Language?* London: Jessica Kingsley Publishers.

Bogdashina, O. (2006). *Theory of Mind and the Triad of Perspectives on Autism and Asperger Syndrome: A View from the Bridge*. London: Jessica Kingsley Publishers.

Bogdashina, O. (2016). *Sensory Perceptual Issues in Autism and Asperger Syndrome: Different Sensory Experiences, Different Perceptual Worlds*. 2nd edn. London: Jessica Kingsley Publishers.

Bondy, A.S. and Frost, L.A. (1994). The Picture Exchange Communication System. *Focus on Autistic Behavior*, 9(3), 1-19. DOI: 10.1177/108835769400900301. *N.B.: Title is same with Bondy and Frost (1998), but content of the two articles is different.*

Bondy, A.S. and Frost, L.A. (1998). The Picture Exchange Communication System. *Seminars in Speech and Language*, 19(4), 373-389. DOI: 10.1055/s-2008-1064055.

Bonnel, A., Mottron, L., Peretz, I., Trudel, M., Gallun, E. and Bonnel, A-M. (2003). Enhanced Pitch Sensitivity in Individuals with Autism: A Signal Detection Analysis. *Journal of Cognitive Neuroscience*, 15(2), 226-235. DOI: 10.1162/089892903321208169.

Bono, V. (2017). *Intensive Intervention Delivery in Autism and Early Prediction of Cognitive Outcomes in Children Using Computerised Game and Wireless EEG in Naturalistic Setting*. [Online]. Southampton: University of Southampton. PhD Thesis. Available from: https://eprints.soton.ac.uk/417273/1/Final_thesis.pdf [Accessed 20 April 2018].

Borjon, J.I., Shepherd, S.V., Todorov, A. and Ghazanfar, A.A. (2011). Eye-Gaze and Arrow Cues Influence Elementary Sound Perception. *Proceedings of the Royal Society B: Biological Sciences*, 278 (1714), 1997-2004. DOI: 10.1098/rspb.2010.2306.

Boso, M., Emanuele, E., Minazzi, V., Abbamonte, M., and Politi, P. (2007). Effect of Long-Term Interactive Music Therapy on Behavior Profile and Musical Skills in Young Adults with Severe Autism. *The Journal of Alternative and Complementary Medicine*, 13(7), 709-712. DOI: 10.1089/acm.2006.6334.

Boss, J. (2014). *Schoenberg's Twelve-Tone Music: Symmetry and the Musical Idea*. Cambridge: Cambridge University Press.

Bouvet, L., Donnadieu, S., Valdois, S., Caron, C., Dawson, M. and Mottron, L. (2014). Veridical Mapping in Savant Abilities, Absolute Pitch, and Synesthesia: An Autism Case Study. *Frontiers in Psychology*, 5, 106. DOI: 10.3389/fpsyg.2014.00106.

Bowler, D. (2007). *Autism Spectrum Disorders: Psychological Theory and Research*. London/Chichester: John Wiley and Sons.

Bowler, D.M., Gardiner, J.M. and Grice, S.J. (2000). Episodic Memory and Remembering in Adults with Asperger Syndrome. *Journal of Autism and Developmental Disorders*, 30(4), 295-304. DOI: 10.1023/A:1005575216176.

Bowler, D.M., Matthews, N.J. and Gardiner, J.M. (1997). Asperger's Syndrome and Memory: Similarity to Autism but not Amnesia. *Neuropsychologia*, 35(1), 65-70. DOI: 10.1016/50028-3932(96)00054-1.

Boxill, E.H. (1985). *Music Therapy for the Developmentally Disabled*. Austin, Texas (USA): Pro-Ed Publishers.

Bozdagi, O., Sakurai, T., Papapetrou, D., Wang, X., Dickstein, D.L., Takahashi, N., Kajiwara, Y., Yang, M., Katz, A.M., Scattoni, M.L., Harris, M.J., Saxena, R., Silverman, J.L., Crawley, J.N., Zhou, Q., Hot, P.R. and Buxbaum, J.D. Haploinsufficiency of the autism-associated Shank3 leeds to deficits in synaptic function, social interaction, and social commnunication. *Molecular Autism*, 17(1), 15. DOI: 10.1186/2040-2392-1-15.

Brereton, A. (2007). *Autism: A Guide to Understanding and Helping Your Child.* South Devon: Snowdrop Child Development Consultants.

Brice, R. (2001). *Music Engineering.* 2nd edn. Oxford: Newnes (an imprint of Butterworth – Heinemann).

Brockman, M.M. (2016). Getting to Know Families and Children Diagnosed with Autism Spectrum Disorders. In: Sori, C.F., Hecker, L. and Bachenberg, M.E. eds. *The Therapist's Notebook for Children and Adolescents: Homework, Handouts, and Activities for Use in Psychotherapy*. 2nd edn. Hove, East Sussex: Routledge, pp. 111-114.

Brooks, W. (2007). Pragmatics of Silence. In: Losseff, N. and Doctor, J. eds. *Silence, Music, Silent Music*. Aldershot, Hampshire: Ashgate Publishing, pp. 97-126.

Brown, S.M.K. (1994). Autism and Music Therapy – Is Change Possible, and Why Music? *British Journal of Music Therapy*, 8(1), 15-25. DOI: 10.1177/135945759400800105.

Brown, A.R. and Dillon, S. (2009). Networked Improvisational Musical Environments: Learning Through On-Line Collaborative Music Making. In: Finney, J. and Burnard, P. eds. *Music Education with Digital Technology*. London: Continuum International Publishing Group, pp. 96-106.

Brownell, M.D. (2002). Musically Adapted Social Stories to Modify Behaviours in Students with Autism: Four Case Studies. *Journal of Music Therapy*, 39(2), 117-144. DOI: 10.1093/jmt.39.2.117

Brownell, M.D. and Arbor, A. (2012). Social Stories™: Pairing the Story with Music. In: Kern, P. and Humpal, M. eds. *Early Childhood Music Therapy and Autism Spectrum Disorders: Developing Potential in Young Child and their Families*. London: Jessica Kingsley Publishers, pp. 117-129.

Brunk, B.K. (2004). *Music Therapy: Another Path to Learning and Communication for Children on the Autism Spectrum*. Arlington, Texas (USA): Future Horizons.

Bruscia, K. (1982). Music in The Assessment and Treatment of Echolalia. *Music Therapy*, 2(1), 25-41. DOI: 10.1093/mt/2.1.25.

Bull, R. (2008). Autism and the Family: Group Music Therapy with Mothers and Children. In: Oldfield, A. and Flower, C. eds. *Music Therapy with Children and Their Families*. London: Jessica Kingsley Publishers, pp. 71-88.

Bunt, L. (2003). Music Therapy with Children: A Complementary Service to Music Education? *British Journal of Music Education*, 20(2), 179-195. DOI: 10.1017/S0265051703005370.

Bunt, L. (2012). Music Therapy: A Resource for Creativity, Health and Well-Being Across the Lifespan. [Online]. In: Odena, O. ed. *Musical Creativity: Insights from Music Education Research*. Farnham, Surrey: Ashgate Publishing (an imprint of Routledge). Available from: http://eprints.uwe.ac.uk/16812/1/019%20Bunt_Ch%209.pdf [Accessed 28 March 2018].

Bunt, L. and Stige, B. (2014). *Music Therapy: An Art Beyond Words.* 2nd edn. Hove, East Sussex: Routledge.

Burd, L., Fisher, W. and Kerbeshian, J. (1989). Pervasive Disintegrative Disorder: Are Rett Syndrome and Heller Dementia Infantilis Subtypes? *Developmental Medicine and Child Neurology*, 31(5), 609-616. DOI: 10.1111/j.1469-8749.1989.tb04046.x.

Burdea, G.C. and Coiffet, P. (2003). *Virtual Reality Technology*. 2nd edn. Hoboken, New Jersey (USA): Wiley-Interscience / John Wiley and Sons.

Burgoine, E. and Wing, L. (1983). Identical Triplets with Asperger's Syndrome. *The British Journal of Psychiatry*, 143(3), 261-265. DOI: 10.1192/bjp.143.3.261.

Burnard, P. (2012). *Musical Creativities in Practice*. Oxford: Oxford University Press.

Burns, J.K. (2009). Mental Health and Inequity: A Human Rights Approach to Inequality, Discrimination, and Mental Disability. *Health and Human Rights* [Online], 11(2), 19-31. Available from: https://www.hhrjournal.org/2013/08/mental-health-and-inequity-a-human-rights-approach-to-inequality-discrimination-and-mental-disability/ [Accessed 28 October 2014].

Burnsed, C.V. (1999). *The Classroom Teacher's Guide to Music Education.* 2nd edn. Springfield, Illinois (USA): Charles C. Thomas Publisher Ltd.

Buzzi, M.C., Paolini, G., Senette, C., Buzzi, M. and Paratore, M.T. (2019). Designing an Accessible Web App to Teach Piano to Students with Autism. *CHItaly '19: Proceedings of the*

13th Biannual Conference of the Italian SIGCHI Chapter: Designing the Next Interaction. Padova, Italy, 23-25 September 2019, 4. New York: ACM, pp. 1-12. DOI: 10.1145/3351995.3352037.

Byrne, D. (2012). *How Music Works.* [Google Books]. Edinburgh / London: Canongate Books. Available from: https://books.google.co.uk/books?id=d22UqerzutgC [Accessed 18 April 2020].

Byrne, P. (2000). Stigma of Mental Illness and Ways of Diminishing It. *Advances in Psychiatric Treatment*, 6(1), 65-72. DOI: 10.1192/apt.6.1.65.

Caldwell, P. (2017). *PhoebeCaldwell.com* [Online]. Available from: http://www.phoebecaldwell.com [Accessed 26 April 2017].

Caldwell, P. and Horwood, J. (2008). *Using Intensive Interaction and Sensory Integration: A Handbook for Those Who Support People with Severe Autism Spectrum Disorder*. London: Jessica Kingsley Publishers.

Caltabiano, A. (2010). *The Impact of Music Therapy on the Social Behaviours of Children with Autism in a Structured Outdoor In*

Campbell, J. and Oliver, M. (1996). *Disability Politics: Understanding Our Past, Changing Our Future*. Abingdon, Oxon: Routledge.

Campbell, J.E. and Mears, K.M. (2012). Habilitative Treatms for Children with ASDs: Speech and Occupational Therapy, Assistive Technology. In: Reber, M. ed. *The Autism Spectrum: Scientific Foundations and Treatment*. Cambridge: Cambridge University Press, pp. 217-238.

Campbell, P.S. and Scott-Kassner, C. (2014). *Music in Childhood: From Preschool through the Elementary Grades*. 4th edn. Boston, Massachusetts (USA): Schirmer, Cengage Learning.

Campbell, R.J. (2004). *Campbell's Psychiatric Dictionary*. 8th edn. Oxford: Oxford University Press.

Cano, M.D. and Sanchez-Iborra, R. (2015). On the Use of a Multimedia Platform for Music Education with Handicapped Children: A Case Study. *Computers and Education*, 87, 254-276. DOI: 10.1016/j.compedu.2015.07.010.

Cappelen, B. and Andersson, A.-P. (2018). Cultural Artefacts with Virtual Capabilities Enhance Self-Expression Possibilities for Children with Special Needs. [E-Book]. In: Craddock. G., Doran, C., McNutt, L. and Rice, D. eds. *Studies in Health Technology and Informatics, Vol.*

256: Transforming our World Through Design, Diversity and Education. Oxford: iOS Press, pp. 634-642. DOI: 10.3233/978-1-61499-923-2-634.

Carlile, S., Leong, P. and Hyams, S. (1997). The Nature and Distribution of Errors in Sound Localization by Human Listeners. *Hearing Research*, 114(1-2), 179-196. DOI: 10.1016/S0378-5955(97)00161-5.

Carpente, J.A. (2009). *Contributions of Nordoff-Robbins Music Therapy within a Developmental, Individual-Differences, Relationship-Based (DIR(RTM))/Floortime (TM) Framework to the Treatment of Children with Autism: Four Case Studies*. [Online]. Philadelphia (USA): Temple University. PhD Dissertation. Available from: http://cdm2458-01.cdmhost.com/cdm/ref/collection/p245801coll10/id/42498 [Accessed 29 April 2018].

Carrington, S. and Graham, L. (2001). Perceptions of School by Two Teenage Boys with Asperger Syndrome and their Mothers: A Qualitative Study. *Autism*, 5(1), 37-48. DOI: 10.1177/1362361301005001004.

Carter, A.S., Davis, N.O., Klin, A. and Volkmar, F.R. (2005). Social Development in Autism. In: Volkmar, F.R., Paul, R., Klin, A. and Cohen, D. eds. *Handbook of Autism and Pervasive Developmental Disorders, Volume 1: Diagnosis, Development, Neurobiology, and Behavior*. Hoboken, New Jersey (USA): John Wiley and Sons, pp. 312-334.

Casey, L.B. and Carter, S.L. (2016). *Applied Behavior Analysis in Early Childhood Education: An Introduction to Evidence-Based Interventions and Teaching Strategies*. Abingdon, Oxon: Routledge.

Casserley, C. and Gor, B. (2001). *Disability Discrimination Claims: An Adviser's Handbook*. London: Jordan Publishing Limited.

Cassidy, A. (2014). *Autism and its Causes*. Australia: Pointcook Power Store.

Centres for Disease Control and Prevention, CDC (2014). Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years – Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2010. *Surveillance Summaries* 63 (SS02); 1-21. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6302a1.htm?s_cid=ss6302a1_w [Accessed 3 June 2015].

Čeponiene, R., Lepistö, T., Shestakova, A., Vanhala, R., Alku, P. Näätänen, R. and Yaguchi, K. (2003). Speech-Sound-Selective Auditory Impairment in Children with Autism: They Can

Perceive but Do Not Attend. *Proceedings of the National Academy of Sciences USA*, 100(9), 5567-5572. DOI: 10.1073/pnas.0835631100.

Chakroborty, A. (2017). Touchless Diagnostics. *Imperial Journal of Interdisciplinary Research* 3(3), 284-290. Available from: https://www.onlinejournal.in/IJIRV3I3/044.pdf [Accessed 5 May 2018].

Chalfant, A.M., Rapee, R. and Carroll, L. (2006). Treating Anxiety Disorders in Children with High-Functioning Autism Spectrum Disorders: A Controlled Trial. *Journal of Autism and Developmental Disorders*, 37, 1842-1857. DOI: 10.1007/s10803-006-0318-4.

Challis, B. (2011). Octonic: An Accessible Electronic Musical Instrument. *Digital Creativity*, 22(1), 1-12. DOI: 10.1080/14626268.2011.538703.

Challis, B., Kang, A., Rimmer, R. and Hildred, M. (2017). Enabling Active Interaction with Music and Sound in Multisensory Environments. *EAI (European Alliance for Innovation) Endorsed Transactions on Creative Technologies*, 4(11), 1-8. DOI: 10.4108/eai.5-9-2017.153060.

Challis, B.P. and K. (2008a). Applications for Proximity Sensors in Music and Sound Performance. In: Miesenberger, K., Klaus, J., Zagler, W. and Karshmer, A. eds. *Computers Helping People with Special Needs: Proceedings of the 11th ICCHP International Conference, Linz, Austria, 2008*. Berlin / Heidelberg (Germany): Springer, pp. 1220-1227.

Challis, B.P. and K. (2008b). An Infrared Sound and Music Controller for Users with Specific Needs. *Proceedings of the 7th IDCVRAT with ArtAbilitation (2008),* Maia, Portugal. United Kingdom: University of Reading, pp. 339-345. N.B.: Also referred to as an article in *International Journal on Disability and Human Development*, 10 (2011). DOI: 10.1515/ijdhd.2011.001.

Chambers, P. and Frye, D. (2014). Healthy Development in Children with Autism Spectrum Disorder. In: Gullotta, T.P. and Bloom, M. eds. *Encyclopedia of Primary Prevention and Health Promotion*. New York: Springer Science + Business Media, pp. 703-713. DOI: 10.1007/978-1-4614-5999-6_108.

Charitaki, G. (2015). The Effect of ICT on Emotional Education and Development of Young Children with Autism Spectrum Disorder. *Procedia Computer Science*, 65, 285-293. DOI: 10.1016/j.procs.2015.09.081.

Charman, T. and Baird, G. (2002). Practitioner Review: Diagnosis of Autism Spectrum Disorder in 2- and 3-Year Old Children. *Journal of Child Psychology and Psychiatry*, 43(3), 289-305. DOI: 10.1111/1469-7610.00022.

Charman, T., Pickles, A., Simonoff, E., Chandler, S., Loucas, T., Baird, G. (2011). IQ in Children with Autism Spectrum Disorders: Data from the Special Needs and Autism Project (SNAP). *Psychological Medicine* [Online], 41(3), 619-627. Available from: https://www.cambridge.org/core/journals/psychological-medicine/article/iq-in-children-with-autism-spectrum-disorders-data-from-the-special-needs-and-autism-project-snap/537E71CA95734F4CBBD283DD0BD1717B [Accessed 25 January 2018].

Chedd, N. and Levine, K. (2007). *Replays: Using Play to Enhance Emotional and Behavioral Development for Children with Autism Spectrum Disorders*. London: Jessica Kingsley Publishers.

Chermak, G.D. (2002). Deciphering Auditory Processing Disorders in Children. *Otolaryngologic Clinics of North America*, 35(4), 733-749. DOI: 10.1016/s0030-6665(02)00056-7

Chilvers, R. (2007). *The Hidden World of Autism: Writing and Art by Children with High-Functioning Autism*. London: Jessica Kingsley Publishers.

Chiron, C., Leboyer, M., Leon, F., Jambaque, L., Nuttin, C. and Syrota A. (1995). Spect of the Brain in Childhood Autism: Evidence for a Lack of Normal Hemispheric Asymmetry. *Developmental Medicine & Child Neurology* 37(10), 849-860. DOI: 10.1111/j.1469-8749.1995.tb11938.x.

Christensen-Dalsgaard, B., Donnelly, W. and Griffith, M. (1999). *Flexible Working: New Network Technologies*. Oxford: IOS Press.

Chung, C.-H. and Chen, C.-H. (2017). Augmented Reality Based Social Stories Training System for Promoting the Social Skills of Children with Autism. In: Soares, M., Falcão, C. and Ahram, T.Z. eds. *Advances in Ergonomics Modelling, Usability & Special Populations: Proceedings of the AHFE 2016 International Conference on Ergonomics Modelling, Usability & Special Populations, July 27-31, 2016, Walt Disney World®, Florida, USA*. Switzerland: Springer International Publishing, pp. 495-506.

Cibrian, F.L., Peña, O., Ortega, D. and Tentori, M. (2017). BendableSound: An Eastic Multisensory Surface Using Touch-Based Interactions to Assist Children with Severe Autism

During Music Therapy. *International Journal of Human-Computer Studies*, 107, 22-37. DOI: 10.1016/j.ijhcs.2017.05.003.

Cipani, E. (2011). *Children and Autism: Stories of Triumph and Hope*. New York: Demos Medical Publishing.

Clarke, T-K, Lupton, M.K., Fernandez-Pujals, A.M., Starr, J., Davies, G., Cox, S. Pattie, A., Liewald, D.C., Hall, L.S., MacIntyre D.J., Smith, B.H., Hocking, L.J., Padmanabhan, S., Thomson, P.A., Hayward, C., Hansell, N.K., Montgomery, G.W., Medland, S.E., Martin, N.G., Wright, M.J., Porteous, D.J., Deary, I.J. and McIntosh, A.M. (2016). Common Polygenic Risk for Autism Spectrum Disorder (ASD) is Associated with Cognitive Ability in the General Population. *Molecular Psychiatry* 21, 419-425. DOI: 10.1038/mp.2015.12.

Cleland, J. (2010). *Speech and Prosody in Developmental Disorders: Autism and Down's Syndrome*. [Online]. Musselburgh, Scotland: Queen Margaret University. PhD Thesis. Available from: http://etheses.qmu.ac.uk/622/1/622.pdf [Accessed 6 May 2017].

Cohen, L. (2008). *Asperger's Syndrome: An Introduction for Educators*. [Online]. Monterey, California (USA): Excelligence Learning Corporation. Available from: http://www.earlychildhoodnews.com/earlychildhood/article_view.aspx?ArticleID=252 [Accessed 10 February 2016].

Coladarci, T., Cobb, C.D., Minium, E.W. and Clarke, R.C. (2011). *Fundamentals of Statistical Reasoning in Education*. 3rd edn. Hoboken, New Jersey (USA): John Wiley and Sons.

Collins, M. (2003a). *A Professional Guide to Audio Plug-Ins and Virtual Instruments*. London: Focal Press.

Collins, M. (2003b). Generative Music and Laptop Performance. *Contemporary Music Review*, 22(4), 67-79. DOI: 10.1080/0749446032000156919.

Collins, N. and Olofsson, F. (2006). Klipp AV: Live Algorithmic Splicing and Audiovisual Event Capture. *Computer Music Journal*, 30(2), 8-18. DOI: 10.1162/comj.2006.30.2.8.

Colombi, C., Liebal, K., Tomasello, M., Young, G., Warneken, F. and Rogers, S.J. (2009). Examining Correlates of Cooperation in Autism: Imitation, Joint Attention, and Understanding Intentions. *Autism*, 13(2), 143-163. DOI: http://doi.org/10.1177/1362361308098514.

Colwell, R. and Hewitt, M. (2016). *The Teaching of Instrumental Music*. 4th edn. Abingdon, Oxon: Routledge.

Conallen, K. and Reed, P. (2016). A Teaching Procedure to Help Children with Autistic Spectrum Disorders to Label Emotions. *Research in Autism Spectrum Disorders*, 23, 63-72. DOI: 10.1016/j.rasd.2015.11.006.

Conn, C. (2016). *Play and Friendship in Inclusive Autism Education: Supporting Learning and Development*. Abingdon, Oxon: Routledge.

Constantino, J.N. and Todd, R.D. (2000). Genetic Structure of Reciprocal Social Behavior. *American Journal of Psychiatry*, 157(12), 2043-2045. DOI: 10.1176/appi.ajp.157.12.2043.

Cook Jr., E.H. (1998). Genetics of Autism. *Mental Retardation and Developmental Disabilities Research Reviews*, 4, 113-120. DOI: 10.1016/S1056-4993(18)30061-0.

Cook, T., Roy, A.R.K. and Welker, K.M. (2017). Music as an Emotion Regulation Strategy: An Examination of Genres of Music and their Roles in Emotion Regulation. *Psychology of Music*, (no edition specified), 1-11. DOI: 10.1177/0305735617734627.

Corbett, B.A., Shickman, K. and Ferrer, E. (2008). Brief Report: The Effects of Tomatis Sound Therapy on Language in Children with Autism. *Journal of Autism and Developmental Disorders*, 38(3), 562-6. DOI: 10.1007/s10803-007-0413-1.

Corbett, P. and Corbett, C. (2007). *Missing Out? Autism, Education and Ethnicity: The Reality for Families Today*. London: The National Autistic Society.

Corke, M. (2012). *Approaches to Communication Through Music*. Abingdon, Oxon: Routledge. N.B.: *First Routledge edition, first overall edition published in 2002 by David Fulton Publishers*.

Cornacchio, R. (2008). *Effect of Cooperative Learning on Music Composition, Interactions, and Acceptance in Elementary School Music Classrooms*. [Online]. Eugene, Oregon (USA): University of Oregon. PhD Dissertation. Available from: https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/8156/Cornacchio_Rachel_PhD_Spring2008.pdf [Accessed 2 April 2020].

Corrigan, P.W. and Watson, A.C. (2002). Understanding the Impact of Stigma on People with Mental Illness. *World Psychiatry* [Online], 1(1), 16-20. Available from: http://www.familyvillage.wisc.edu/EVENTS/ethics/Corrigan_Stigma_WP_2002.pdf [Accessed 21 September 2015].

Coucouvanis, J. (2005). *Super Skills: A Social Skills Group Programme for Children with Asperger Syndrome, High-Functioning Autism and Related Challenges*. Shawnee Mission, Kansas (USA): Autism Asperger Publishing Company.

Cousins, M. and Hepworth-Sawyer, R. (2014). *Logic Pro X: Audio and Music Production*. Abingdon, Oxon: Focal Press / Taylor & Francis.

Cox, C. and Warner, D. eds. *Audio Culture, Revised Edition: Readings in Modern Music*. London: Bloomsbury.

Coyne, P., Vandenburg, M.L. and Nyberg, C. (2011). *Developing Leisure Time Skills for Persons with Autism: Structured Playtime Activities with Valuable Support Strategies for Adults*. Arlington, Texas (USA): Future Horizons.

Crane, L., Goddard, L. and Pring, L. (2009). Specific and General Autobiographical Knowledge in Adults with Autism Spectrum Disorders: The Role of Personal Goals. *Memory*, 17(5), 557-576. DOI: 10.1080/09658210902960211.

Cresswell, P. (2009). *Childhood Autism and Asperger's Syndrome*. Norfolk: Poundslammer Publishing.

Crozier, S. and Tincani, M.J. (2005). Using a Modified Social Story to Decrease Disruptive Behavior of a Child with Autism. *Focus on Autism and Other Developmental Disabilities*, 20(3), 150-157. DOI: 10.1177/10883576050200030301.

Cruz-Alcázar, P.P., Vidal-Ruiz, E. and Pérez-Cortés, J.C. (2003). Musical Style Identification Using Grammatical Inference: The Encoding Problem. In: Sanfeliu, A. and Ruiz-Shulcloper, J. eds. *Progress in Pattern Recognition, Speech and Image Analysis: Proceedings of the 8th Iberoamerican Congress on Pattern Recognition (CIARP), Havana, Cuba, 26-29 November 2003*. Berlin / Heidelberg: Springer, pp. 375-382.

Curry, R. (2017). *Cellular Mechanisms of Inhibition in Sound Localization Circuits*. [Online]. Columbus, Ohio (USA): Ohio Department of Higher Education. Available from: https://etd.ohiolink.edu/pg_10?0::NO:10:P10_ETD_SUBID:152314 [Accessed 23 March 2018].

D'Escrivan Rincón, J. (2012). *Cambridge Introduction to Music: Music Technology*. Cambridge: Cambridge University Press.

Dairianathan, E. (2014). Soundscapes. In: Thompson, W.F. ed. *Music in the Social and Behavioural Sciences: An Encyclopedia*. London: Sage Publications Limited, p. 1050.

Dalziel, J. (2003). Implementing Learning Design: The Learning Activity Management System (LAMS). [Online]. In: Crisp, G., Thiele, D., Scholten, I., Barker, S. and Baron, J. eds. *Interact – Integrate – Impact: Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE).* Adelaide, Australia, 7-10 December 2003, pp. 593-596. Available from: https://www.researchonline.mq.edu.au/vital/access/services/Download/mq:8129/DS01 [Accessed 10 March 2018].

Darke, P. (2004). *DAIL (Disability Arts in London) Magazine: An Interview with Dr. Paul Darke.* [Online]. Digital Disability Website. Available from: http://www.digital-disability.com/heritage/publications/dail-disability-arts-in-london/publications/ [Accessed 20 September 2015].

Darrow, A.A. and Adamek, M. (2016). Behavioural Issues in the Music Classroom: Promoting the Successful Engagement of All Students. In: Blair, D.V. and McCord, K.A. (2016). *Exceptional Music Pedagogy for Children with Exceptionalities: International Perspectives*. New York / Oxford: Oxford University Press, pp. 154-175.

Darrow, A.A. and Armstrong, T. (1999). Research on Music and Autism Implications for Music Educators. *National Association for Music Education* 18(1), 15-20. DOI: 10.1177/875512339901800103.

Davis, L.J. (2013). *The End of Identity Politics: On Disability as an Unstable Category*. In: Davis, L.J. ed. *The Disability Studies Reader*. 4th edn. Abindgon, Oxon: Routledge, pp. 263-277.

Dawson, G., Webb, S.J. and McPartland, J. (2010). Understanding the Nature of Face Processing Impairment in Autism: Insights from Behavioral and Electrophysiological Studies. *Developmental Neuropsychology* 27(3), 403-424. DOI: 10.1207/s15326942dn2703_6.

De Bono, E. (1990). *Lateral Thinking: A Textbook of Creativity*. New Edition (no number specified, first published 1970). London: Clays Ltd., St. Ives Plc.

De Campo, A., Hörmann, N., Markum, H., Plessas, W. and Vogt, K. (2007). Sonification of Monopoles and Chaos in QCD. In: Sissakian, A., Kozlov, G. and Kolganova, E. eds. *High Energy Physics: ICHEP 2006, Volume I – Proceedings of the 33rd International Conference,* *Moscow, Russia, 2006.* London: World Scientific Publishing, pp. 367-370. N.B.: *Conference held in 2006 – Proceedings published in 2007.*

De Fossé, L., Hodge, S.M., Makris, N., Kennedy, D.N., Caviness Jr., V.S., McGrath, L., Steele, S., Ziegler, D.A., Herbert, M.R., Frazier, J.A., Tager-Flusberg, H. and Harris, G.J. (2004). Language-Association Cortex Asymmetry in Autism and Specific Language Impairment. *Annals of Neurology* 56(6), 755-766. DOI: 10.1002/ana.20275.

De Marchena, A. and Eigsti, I-M. (2010). Conversational Gestures in Autism Spectrum Disorders: Asynchrony but not Decreased Frequency. *Autism Research* 3(6), 311-322. DOI: 10.1002/aur.159.

De Vries, A.L., Noens, I.L., Cohen-Kettenis, P.T., van Berckelaer-Onnes, I.A. and Doreleijers, T.A. (2010). Autism Spectrum Disorders in Gender Dysphoric Children and Adolescents. *Journal of Autism and Developmental Disorders*, 40(8), 930-6. DOI: 10.1007/s10803-010-0935-9.

Dean, R. (2003). *Hyperimprovisation: Computer-Interactive Sound Improvisation*. Middleton, Wisconsin (USA): A-R Editions.

Deiner, P. (2010). *Inclusive Early Childhood Education: Development, Resources, and Practice*. 5th edn. Belmont, California (USA): Wadsworth, Cengage Learning.

Del Pozzo, J., Roché, M.W. and Silverstein, S.M. (2018). Violent Behavior in Autism Spectrum Disorders: Who's at Risk? *Aggression and Violent Behavior*, 39, 53-60. DOI: 10.1016/j.avb.2018.01.007.

Delano, M. and Snell, M.E. (2006). The Effects of Social Stories on the Social Engagement of Children with Autism. *Journal of Positive Behavior Interventions*, 8(1), 29-42. DOI: 10.1177/10983007060080010501.

Delfos, M.F. and Attwood, T. (2005). *A Strange World: Autism, Asperger's Syndrome, and PDD-NOS: A Guide for Parents, Partners, Professional Carers, and People with ASDs.* London: Jessica Kingsley Publishers.

Denham, S.L., Coath, M., Háden, G.P., Murray, F. and Winkler, I. (2016). Relative Pitch Perception and the Detection of Deviant Core Patterns. In: Van Dijk, P., Baskent, D., Gaudrain, E., De Kleine, E., Wagner, A. and Lanting, C. eds. *Physiology, Psychoacoustics and Cognition in Normal and Impaired Hearing*. London: Springer, pp. 409-418.

Department for Education / Department of Health UK (2015). *Special Educational Needs and Disability Code of Practice: 0 to 25 Years – Statutory Guidance for Organisations which Work with and Support Children and Young People who Have Special Educational Needs or Disabilities*. [Online]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/398815/SEND_Code_of_Practice_January_2015.pdf [Accessed 5 May 2017].

Dettmer, S., Simpson, R.L., Myles, B.S. and Ganz, J.B. (2000). The Use of Visual Supports to Facilitate Transitions of Students with Autism. *Focus on Autism and Other Developmental Disabilities*, 15(3), 163-169. DOI: 10.1177/108835760001500307.

Deutsch, D. (2013). *Absolute Pitch*. In: Deutsch, D. ed. *The Psychology of Music*. 3rd edn. London: Academic Press (an imprint of Elsevier), pp. 141-182.

Devine, A. (2014). *Colour Coding for Learners with Autism: A Resource for Creating Meaning through Colour at Home and School*. London: Jessica Kingsley Publishers.

Dewey, D., Cantell, M. and Crawford, S.G. (2007). Motor and Gestural Performance in Children with Autism Spectrum Disorders, Developmental Coordination Disorder, and/or Attention Deficit Hyperactivity Disorder. *Journal of the International Neurophysiological Society*, 13(2), 246-56. DOI: 10.1017/S1355617707070270.

Di Maria Nankervis, A. (2013). Working Cross-Culturally with Children at Risk. In: Prasad, S., Howie, P. and Kristel, J. eds. *Using Art Therapy with Diverse Populations: Crossing Cultures and Abilities*. London: Jessica Kingsley Publishers, pp. 134-142.

Dietrich, A. and Riam, K. (2010). A Review of EEG, ERP, and Neuroimaging Studies of Creativity and Insight. 136(5), 822-848. DOI: 10.1037/a0019749.

Dodd, S. (2005). *Understanding Autism*. Marrickville, New South Wales (Australia): Elsevier Australia.

Dohn, A., Garza-Villareal, E.A., Heaton, P. and Vuust, P. (2012). Do Musicians with Perfect Pitch Have More Autism Traits than Musicians without Perfect Pitch? An Empirical Study. *PLoS ONE*, 7(5), e37961. DOI: 10.1371/journal.pone.0037961

Donnellan, A.M., Leary, M.R. and Robledo, J.P. (2006). I Can't Get Started: Stress and the Role of Movement Differences in People with Autism. In: Baron, M.G., Groden, J., Groden, G. and Lipsitt, L.P. eds. *Stress and Coping in Autism*. Oxford: Oxford University Press, pp. 205-245.

Donoghue, K., Stallard, P. and Kucia, J. (2010). The Clinical Practice of Cognitive Behavioural Therapy for Children and Young People with a Diagnosis of Asperger's Syndrome. *Clinical Child Psychology and Psychiatry* 16(1), 89-102. DOI: 10.1177/1359104509355019

Dooley, K. and Deutsch, D. (2011). Absolute Pitch Correlates with High Performance on Interval Naming Tasks. *The Journal of the Acoustical Society of America*, 130, 4097. DOI: 10.1121/1.3652861.

Dornelas, A. and Pascual, E. (2016). Echolalia as Communicative Strategy: Fictive Interaction in the Speech of Children with Autism. In: Pascual, E. and Sandler, S. eds. *The Conversation Frame: Forms and Functions of Fictive Interaction*. Amsterdam (Netherlands) / Philadelphia, Pennsylvania (USA): John Benjamins Publishing Company, pp. 343-362.

Douglas, J. (2018). *Lost in Music*. [Online]. United Kingdom: Special Education Needs Magazine. Available from:
https://senmagazine.co.uk/home/articles/senarticles-2/lost-in-music [Accessed 14 May 2018].

Douglas, P.S. (2019). Pre-emptive Intervention for Autism Spectrum Disorder: Theoretical Foundations and Clinical Translation. *Frontiers in Integrative Neuroscience*, 13, 66. DOI: 10.3389/fnint.2019.00066.

Doyle, T. and Arnedillo-Sánchez, I. (2011). Using Multimedia to Reveal the Hidden Code of Everyday Behaviour to Children with Autism Spectrum Disorders (ASDs). *Computers and Education*, 56(2), 357-369. DOI: 10.1016/j.compedu.2010.08.016

Dunn, M. and Harris, L. (2017). *Prosody Intervention for High-Functioning Adolescents and Adults with Autism Spectrum Disorder: Enhancing Communication and Social Engagement through Voice, Rhythm and Pitch*. London: Jessica Kingsley Publishers.

Dunn, M.A, Gomes, H. and Gravel, J. (2008). Mismatch Negativity in Children with Autism and Typical Development. *Journal of Autism and Developmental Disorders* 38, 52-71. DOI: 10.1007/s10803-007-0359-3.

Dunn, W. (2008). *Bringing Evidence into Everyday Practice: Practical Strategies for Healthcare Professionals.* Thorofare, New Jersey (USA): SLACK Incorporated.

Edebol-Tysk, K., Hagberg, B. and Hagberg, G. (1989). Epidemiology of Spastic Tetraplegic Cerebral Palsy in Sweden – II. Prevalence, Birth Data and Origin. *Neuropediatrics*, 20(1), 46-52. DOI: 10.1055/s-2008-1071264.

Edelson, S.M., Arin, D., Bauman, M., Lukas, S.E., Rudy, J.H., Sholar, M. and Rimland, B. (1999). Auditory Integration Training: A Double-Blind Study of Behavioral and Electrophysiological Effects in People with Autism. *Focus on Autism and Other Developmental Disabilities*, 14 (2), 73-81. DOI: 10.1177/108835769901400202.

Edgerton, C.L. (1994). The Effect of Improvisational Music Therapy on the Communicative Behaviours of Autistic Children. [Online]. *Journal of Music Therapy*, 31(1), 31-62. DOI: 10.1093/jmt/31.1.31.

Edhlund, B. and McDougall, A. (2020). *NVivo 12 for Mac Essentials*. Stallarholmen, Sweden: Form & Kunskap AB.

Education and Skills Committee / UK House of Commons (2006). *Special Educational Needs: Third Report of Session 2005-06, Volume III*. [Report]. Great Britain: UK Parliament.

Edwards, J. (2016). *Approaches and Models of Music Therapy*. In: Edwards, J. ed. *The Oxford Handbook of Music Therapy*. Oxford: Oxford University Press, pp. 417-427.

Ehrenzweig, A. (1953). *The Psycho-Analysis of Artistic Vision and Hearing: An Introduction to a Theory of Unconscious Perception*. [Online]. New York: George Braziller. Available from: https://archive.org/stream/psychoanalysisof00ehre#page/110/mode/2up [Accessed 15 April 2020].

Eikeseth, S. (2011). Intensive Early Intervention. In: Matson, J.L. and Sturmey, P. eds. *International Handbook of Autism and Pervasive Developmental Disorders*. New York / London: Springer Science+Business Media, pp. 320-338.

Elahi, M.T., Korayem, A.H., Shariati, A., Meghdari, A., Alemi, M., Ahmadi, E., Taheri, A. and Heidari, R. (2017). "Xylotism": A Tablet-Based Application to Teach Music to Children with Autism. In: Kheddar, A., Yoshida, E., Ge, S.S., Suzuki, K., Cabibihan, J.-J., Eyssel, F. and He, H.S. eds. *Social Robotics: Proceedings of the 9th International Conference, ICSR 2017, Tsukuba, Japan, November 22-24, 2017. Lecture Notes in Artificial Intelligence, vol. 10652*. Cham (Switzerland): Springer, pp. 728-738. DOI: 10.1007/978-3-319-70022-9_72.

Eli, A.C. (2017). "Yousician" – Music Education Platform. *Tehnologii Informatice Și De Comunicații în Domeniul Muzical [Romanian: Information and Communication Technology in the Musical Domain]*, 8(1), 37-41. Available from: https://www.ceeol.com/search/article-detail?id=596853 [Accessed 20 April 2020].

Ellis, P. (1994). Special Sounds for Special Needs: Towards the Development of a Sound Therapy. In: International Society for Music Education (ISME), ed. *Musical Connections: Tradition and Change*: *Proceedings of the 21st World Conference of the International Society for Music Education (Tampa, Florida, USA)*. Victoria (Australia): ISME, pp. 201-206.

Ellis, P. and Van Leeuwen, L. (2002). *Living Sound: Human Interaction and Children with Autism*. Resonances with Music in Education, Therapy and Medicine: Bericht über die Tagung des Arbeitskreises der "International Society for Music Education" (ISME) *[Report on the meeting of the ISME working group (German Language)]*. Cologne (Germany): Verlag Dohr, pp. 33-55.

Emanuele, E., Boso, M., Cassola, F., Broglia, D., Bonoldi, I., Mancini, L., Marini, M. and Politi, P. (2009). Increased Dopamine DRD4 Receptor mRNA Expression in Lymphocytes of Musicians and Autistic Individuals: Bridging the Music-Autism Connection. *Activitas Nervosa Superior Rediviva* [Online], 51(3-4), 142-145. Available from: http://www.rediviva.sav.sk/51i34/142.pdf [Accessed 5 June 2015].

Emmons, P.G. and Anderson, L.M. (2005). *Understanding Sensory Dysfunction: Learning, Development and Sensory Dysfunction in Autism Spectrum Disorders, ADHD, Learning Disabilities and Bipolar Disorder*. London: Jessica Kingsley Publishers.

Encyclopaedia Britannica (1893). *The Encyclopaedia Britannica: A Dictionary of Arts, Sciences and General Literature, Volume II*. Chicago, Illinois (USA): Werner.

Eren, B. (2015). The Use of Music Interventions to Improve Social Skills in Adolescents with Autism Spectrum Disorders in Integrated Music Therapy Sessions. *Procedia – Social and Behavioral Sciences*, 197, 207-213. DOI: 10.1016/j.sbspro.2015.07.125.

Esposito, G. and Pasca, S.P. (2013). Motor Abnormalities as a Putative Endophenotype for Autism Spectrum Disorders. *Frontiers in Integrative Neuroscience*, 11(7), 43. DOI: 10.3389/fnint.2013.00043.

Esposito, L. (2007). *EVERY Student Can Learn: How Differentiating Instruction by Focusing on Learning Styles Can Increase Struggling Students' Confidence, Engagement, and Language Arts Performance in a Second Grade Classroom.* [Online]. Philadelphia, Pennsylvania (USA): Penn State College of Education. Available from: https://ed.psu.edu/pds/teacher-inquiry/2007/espositolinquiry0607.pdf [Accessed 7 April 2020].

Evans, J.G. (1986). *The Health of an Ageing Population*. In: Bittles, A.H. and Collins, K.J. eds. *The Biology of Human Ageing.* Cambridge: Cambridge University Press, pp. 201-214.

Evans, J.L., Alibali, M.W. and McNeil, N.M. (2001). Divergence of Verbal Expression and Embodied Knowledge: Evidence from Speech and Gesture in Children with Specific Language Impairment. *Language and Cognitive Processes*, 16(2/3), 309-331. DOI: 10.1080/01690960042000049.

Faber, J. and King, J. (2017). *How to Talk So Little Kids Will Listen: A Survival Guide to Life with Children Ages 2-7.* New York: Scribner (an imprint of Simon & Schuster).

Fang, E.R. (2009). *Music in the Lives of Two Children with Autism: A Case Study.* [Online]. San Jose (USA): San Jose State University. Master's Thesis. Available from: http://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=4344&context=etd_theses [Accessed 15 January 2016].

Favell, J.E. (1983). *The Management of Aggressive Behavior.* In: Schopler, E. and Mesibov, G.B. eds. *Autism in Adolescents and Adults*. New York: Springer Science + Business Media, pp. 187-222.

Feinstein, A. (2016). We Don't Want to Fit In: A Reflection on the Revolutionary Inclusive Theatre Practices of The Miracle Project and Actionplay for Adolescents on the Autism Spectrum. In: Smagorinsky, P. ed. *Creativity and Community among Autism-Spectrum Youth: Creating Positive Social Updrafts through Play and Performance*. New York: Palgrave Macmillan, pp. 129-152.

Fernald, A. (1985). *Four-Month-Old Infants Prefer to Listen to Motherese*. [Online]. Infant Behavior and Development 8, pp. 181-195. Available from: https://web.stanford.edu/group/langlearninglab/cgi-bin/publications/Fernald%201985.pdf [Accessed 16 April 2018].

Filipek, P.A., Accardo, P.J., Baranek, G.T., Cook Jr., E.H., Dawson, G., Gordon, B., Gravel, J.S., Johnson, C.P., Kallen, R.J., Levy, S.E., Minshew, N.J., Ozonoff, S., Prizant, B.M., Rapin, I., Rogers, S.J., Stone, W.L., Teplin, S., Tuchman, R.F. and Volkmar, F.R. (1999). The Screening and Diagnosis of Autistic Spectrum Disorders. *Journal of Autism and Developmental Disorders*, 29(6), 439-484. DOI: 10.1023/a:1021943802493.

Findling, R.L., Schulz, S.C., Kashani, J.H. and Harlan, E. (2001). *Psychotic Disorders in Children and Adolescents*. London: Sage Publications.

Finke, E.H., Davis, J.M., Benedict, M., Goga, L., Kelly, J., Palumbo, L., Peart, T. and Walters, S. (2017). Effects of a Least-to-Most Prompting Procedure on Multisymbol Message Production in Children with Autism Spectrum Disorder Who Use Augmentative and Alternative Communication. *American Journal of Speech-Language Psychology* [Online], 26, 81-98. Available from: https://ajslp.pubs.asha.org/epdf.aspx?doi=10.1044/2016_ajslp-14-0187 [Accessed / Purchased 26 April 2018].

Finkelstein, V. (2001). *A Personal Journey into Disability Politics*. [Online]. Farsta (Sweden): Independent Living Institute. Available from: http://www.independentliving.org/docs3/finkelstein01a.html [Accessed 30 August 2015].

Finnigan, E. and Starr, E. (2010). Increasing Social Responsiveness in a Child with Autism: A Comparison of Music and Non-Music Interventions. *Autism*, 14(4), 321-348. DOI: 10.1177/1362361309357747.

Fitzgerald, M. and Belgrove, M.A. (2006). The Overlap Between Alexithymia and Asperger's Syndrome. *Journal of Autism and Developmental Disorders*, 36(4), 573-576. DOI: 10.1007/s10803-006-0096-z.

Fitzgibbon, E. (2008). 'I Am Going to Video You!': Behavioural Management in Early Childhood Settings. *TEACH Journal of Christian Education* [Online], 2(2), 18-20. Available from: https://research.avondale.edu.au/teach/vol2/iss2/7/ [Accessed 18 April 2020].

Fitzpatrick, P., Diorio, R., Richardson, M.J. and Schmidt, R.C. (2013). Dynamical Methods for Evaluating the Time-Dependent Unfolding of Social Coordination in Children with Autism. In: Torres, E.B. and Donnellan, A.M. eds. (2015). *Autism: The Movement Perspective*. Los Angeles, California (USA): Frontiers Media, pp. 327-339.

Fitzpatrick, P., Frazier, J.A., Cochran, D.M., Mitchell, T., Coleman, C. and Schmidt, R.C. (2016). Impairments of Social Motor Synchrony Evident in Autism Spectrum Disorder. *Frontiers in Psychology*, 7, Article 1323. DOI: 10.3389/fpsyg.2016.01323.

Flaherty, A.W. (2011). Brain Illness and Creativity: Mechanisms and Treatment Risks. The *Canadian Journal of Psychiatry* 56(3), 132-143. DOI: 10.1177/070674371105600303.

Florian, L. and McLaughlin, M.J. (2008). *Disability Classification in Education: Issues and Perspectives*. London: Corwin Press (an imprint of Sage Publications).

Foley, A. (2017). Musical Movers: Creative Ideas for Using Movement with Young Children. In: Griffiths, F. ed. *Supporting Children's Creativity through Music, Dance, Drama and Art*. 2nd edn. Abingdon, Oxon: Routledge, pp. 107-122.

Fombonne, E. (1999). The Epidemiology of Autism: A Review. *Psychological Medicine*, 29(4), 769-86. DOI: 10.1017/s0033291799008508.

Fombonne, E. (2005). The Epidemiology of Pervasive Developmental Disorders. In: Casanova, M.F. ed. *Recent Developments in Autism Research*. New York: Nova Science Publishers, pp. 1-26.

Fonteles, J.H., Serpa, Y.R., Barbosa, R.G., Rodrigues, M.A.F. and Alves, M.S.P.L. (2018). Gesture-Controlled Interactive Musical Game to Practice Hand Therapy Exercises and Learn Rhythm and Melodic Structures.

Ford, A. (2011). *Illegal Harmonies: Music in the Modern Age*. Collingwood, Victoria (Australia): Black Inc. (an imprint of Schwartz Media Property Ltd.).

Ford, C.J. (2012). Disability Politics in a Time of Capitalist Crisis: Could History Repeat Itself? *New Politics* [Online], Vol. XIV-1, #53. Available from: http://newpol.org/content/disability-politics-time-capitalist-crisis-could-history-repeat-itself [Accessed 30 August 2015].

Forrester, M.A. (2010). Emerging Musicality During the Pre-School Years: A Case Study of One Child. *Psychology of Music*, 38(2), 131-158. DOI: 10.1177/0305735609339452.

Fournier, K.A., Hass, C.J., Naik, S.K., Lodha, N. and Cauraugh, J.H. (2010). Motor Coordination in Autism Spectrum Disorders: A Synthesis and Meta-Analysis. *Journal of Autism and Developmental Disorders* 40(10), 1227-1240. DOI: 10.1007/s10803-010-0981-3.

Fox, M.M. (2012). *Theory of Mind Skills in Young Adults with Autism Spectrum Disorder: Investigating the Influence of Peer Coaches and Mind-Reading Software*. [Online]. Scranton, Pennsylvania (USA): Marywood University. PhD Dissertation. Available from: https://search.proquest.com/docview/1018423126?pq-origsite=gscholar [Accessed 15 April 2018].

Foxton, J.M., Stewart, M.E., Barnard, L., Rodgers, J., Young, A.H., O'Brien, G. and Griffiths, T.D. (2003). Absence of Auditory 'Global Interference' in Autism. *Brain* 126, 2703-2709. DOI: 10.1093/brain/awg274.

Franceschini, A. (2010). *A Practical Approach to Music Theory on the Reactable*. [Online]. Padova Digital University Archive, University of Padova, Thesis for the 'Laurea Specialistica Biennale'. Available from: http://tesi.cab.unipd.it/25033/1/thesis.pdf [Accessed 16 February 2020].

Franceschini, A. (2010). Towards a Practical Approach to Music Theory on the Reactable. [Online]. *Proceedings of the SMC 2010: 7th Sound and Music Computing Conference,* Barcelona, Spain, 21-24 July 2010. Available from: http://oro.open.ac.uk/38698/1/smc2010-paper.pdf [Accessed 5 May 2018].

Frantz, B.L. and Zellis, D.W. (2016). Legal Issues and Autism Spectrum Disorders. In: Tincani, M. and Bondy, A. eds. *Autism Spectrum Disorders in Adolescents and Adults: Evidence-Based and Promising Interventions.* 2nd edn (Paperback Edition 2016, 1st edn. published in 2014). New York: The Guilford Press, pp. 309-324.

Frith, U. (1991). Asperger and his Syndrome. In: Frith, U. ed. *Autism and Asperger Syndrome*. Cambridge: Cambridge University Press, pp. 1-36.

Frith, U. (2003). *Autism: Explaining the Enigma*. 2nd edn. New York / Oxford: Blackwell Publishing.

Frith, U. and Baron-Cohen, S. (1987). Perception in Autistic Children. In: Cohen, D.J. and Donnellan, A.M. eds. *Handbook of Autism and Pervasive Developmental Disorders*. New York: Wiley, pp. 85-102. Cited in: Haesen, B., Boets, B. and Wagemans, J. (2011). A Review of Behavioural and Electrophysiological Studies on Auditory Processing and Speech Perception in Autism Spectrum Disorders. *Research in Autism Spectrum Disorders,* 5(2), 701-714. DOI: 10.1016/j.rasd.2010.11.006.

Frith, U. and Hill, E.L. (2004). *Autism: Mind and Brain*. Oxford: Oxford University Press.

Froehlich, H.C. and Frierson-Campbell, C. (2013). *Inquiry in Music Education: Concepts and Methods for the Beginning Researcher*. Abingdon, Oxon: Routledge.

Furht, B. (2008) [also Editor-in-Chief]. *Encyclopedia of Multimedia*. 2nd edn. New York: Springer Science + Business Media.

Gabriels, R.L. (2002). Therapy: Laying the Foundation for Individual and Family Growth. In: Gabriels, R.L. and Hill, D.E. eds. *Autism – From Research to Individualised Practice*. London: Jessica Kingsley Publishers, pp. 91-126.

Gabrielsson, A. and Lindström, E. (2010). The Role of Structure in the Musical Expression of Emotions. In: Sloboda, J. ed. *Handbook of Music and Emotion: Theory, Research, Applications*. Oxford: Oxford University Press, pp. 367-400.

Gaffney, G.R., Tsai, L.Y., Kuperman, S. and Minchin, S. (1987). Cerebellar Structure in Autism. *American Journal of Diseases of Children*, 141(12), 1330-2. DOI: 10.1001/archpedi.1987.04460120096044.

Gage, N.M., Siegel, B., Callen, M. and Roberts, T.P.L. (2003). Cortical Sound Processing in Children with Autism Disorder: an MEG Investigation. *Auditory and Vestibular Systems* [Online]. 14(16), 2047-2051. DOI: 10.1097/01.wnr.0000090030.46087.4a (DOI link unavailable). Available from: http://www.socsci.uci.edu/~cnllab/Gage_etal_2003a.pdf (Accessed 18 April 2020).

Gaigg, S.B., Gardiner, J.M. and Bowler, D.M. (2008). Free Recall in Autism Spectrum Disorder: The Role of Relational and Item-Specific Encoding. *Neuropsychologia*, 46(4), 983-992. DOI: 10.1080/08098131.2011.566933.

Gaines, K., Bourne, A., Pearson, M. and Kleibrink, M. (2016). *Designing for Autism Spectrum Disorders*. Abingdon, Oxon: Routledge.

Gallardo, R. (2004). *Musicoterapia y Salud Mental* [Music Therapy and Mental Health]. [Spanish Language]. Buenos Aires, Argentina: Ediciones Universo. Cited in: Gattino, G.S., dos Santos Riesgo, R., Longo, D., Loguercio Leite, J.C. and Schüler Faccini, L. (2011). Effects on Relational Music Therapy on Communication of Children with Autism: A Randomized Controlled Study. *Nordic Journal of Music Therapy* [Online], 20(2), 142-154. DOI: 10.1080/08098131.2011.566933.

Gardstrom, S.C. and Hiller, J. (2010). Song Discussion as Music Psychotherapy. *Music Therapy Perspectives*, 28(2), 147-156. DOI: 10.1093/mtp/28.2.147.

Garland, T. (2014). *Self-Regulation Interventions and Strategies: Keeping the Body, Mind & Emotions on Task in Children with Autism, ADHD or Sensory Disorders*. Eau Claire, Wisconsin (USA): PESI Publishing & Media.

Gasston, P. (2013). *The Modern Web: Multi-Device Web Development with HTML5, CSS3, and Javascript*. San Francisco (USA): No Starch Press.

Gattino, G.S., dos Santos Riesgo, R., Longo, D., Loguercio Leite, J.C. and Schüler Faccini, L. (2011). Effects on Relational Music Therapy on Communication of Children with Autism: A Randomized Controlled Study. *Nordic Journal of Music Therapy*, 20(2), 142-154. DOI: 10.1080/08098131.2011.566933.

Gavidia-Payne, S. and ARCN – Australia Raising Children Network (2013). *Building Confidence in your Child with Autism Spectrum Disorder*. [Online]. Australia Raising Children Network / The Australia Parenting Website. Available from: http://raisingchildren.net.au/articles/autism_spectrum_disorder_building_confidence.html/context/1390 [Accessed 18 September 2015].

George, D., Stickle, K., Rachid, F. and Wopnford, A. (2007). The Association Between Types of Music Enjoyed and Cognitive, Behavioral, and Personality Factors of Those Who Listen. *Psychomusicology*, 19(2), 32-56. DOI: 10.1037/h0094035.

Geretsegger, M., Holck, U. and Gold, C. (2012). *Randomised Controlled Trial of Improvisational Music Therapy's Effectiveness for Children with Autism Spectrum Disorders (TIME-A): Study Protocol.* BMC Pediatrics 2012, 12(2). DOI: 10.1186/1471-2431-12-2.

Gerland, G. (2013). *Secrets to Success for Professionals in the Autism Field: An Insider's Guide to Understanding the Autism Spectrum, the Environment and Your Role*. London: Jessica Kingsley Publishers.

Geschwind, D.H. (2011). Genetics of Autism Spectrum Disorders. *Trends in Cognitive Sciences*, 15(9), 409-416. DOI: 10.1016/j.tics.2011.07.003.

Ghaziuddin, M. (2005). *Mental Health Aspects of Autism and Asperger Syndrome*. London: Jessica Kingsley Publishers.

Ghetti, C.M. (2002). Comparison of the Effectiveness of Three Music Therapy Conditions to Modulate Behavior States in Students with Profound Disabilities: A Pilot Study. *Music Therapy Perspectives*, 20(1), 20-30. DOI: 10.1093/mtp/20.1.20.

Ghosh, S. (2009). *Control Systems: Theory and Applications.* 2nd Impression. New Delhi (India): Dorling Kindersley (India).

Gifford, T., Srinivasan, S., Kaur, M., Dotov, D., Wanamaker, C., Dressler, G., Marsh, K. and Bhat, A. (2011). *Using Robots to Teach Musical Rhythms to Typically Developing Children and Children with Autism.* [Online]. Available from: https://www.semanticscholar.org/paper/Using-

Robots-to-Teach-Musical-Rhythms-to-Typically-Gifford/28bab76cc5da54cbf98c1bc92b82d9ec6f0b9920 [Accessed 15 April 2020]

Gillberg, Ch., Gillberg, Ca., Rastam, M. and Wentz, E. (2001). The Asperger Syndrome (and High-Functioning Autism) Diagnostic Interview (ASDI): A Preliminary Study of a New Structured Clinical Interview. *Autism*, 5(1), 57-66. DOI: 10.1177/1362361301005001006

Gillott, A. and Standen, P.J. (2007). Levels of Anxiety and Sources of Stress in Adults with Autism. *Journal of Intellectual Disabilities*, 11(4), 359-370. DOI: 10.1177/1744629507083585.

Gold, C., Solli, H.P., Krüger, V. and Lie, S.A. (2009). Dose-Response Relationship in Music Therapy for People with Serious Mental Disorders: Systematic Review and Meta-Analysis. *Clinical Psychology Review*, 29(3), 193-207. DOI: 10.1016/j.cpr.2009.01.001.

Gold, C., Wigram, T., Mössler, K. and Elefant, C. (2014). Music Therapy for Autism Spectrum Disorder (Review). *Cochrane Database of Systematic Reviews*, 3, 1-54. DOI: 10.1002/14651858.CD004381.pub3.

Golden, B. (2005). *Succeeding with Open Source.* Boston, MA (USA): Addison-Wesley.

Goldman, J. (2002). *Healing Sounds: The Power of Harmonics*. 2nd edn. Rochester, Vermont (USA): Healing Arts Press.

Goodman, J. (2017). Experimenting with *Sound and Silence*: Sonorous Bodies, Sonic Selves, Acoustic Topographies, and Auditory Histories of Schooling. *Paedagogica Historica*, 53(5), 528-541. DOI: 10.1080/00309230.2017.1335334.

Goodman, K.D. (2011). *Music Therapy Education and Training: From Theory to Practice*. Springfield, Illinois (USA): Charles C. Thomas Publisher Ltd.

Goodman, R. and Graham, P. (1996). Psychiatric Problems in Children with Hemiplegia: Cross Sectional Epidemiological Survey. *British Medical Journal*, 312, 1065-1069. DOI: 10.1136/bmj.312.7038.1065.

Google (2017). *Chrome Music Lab*. [Online]. Available from: https://musiclab.chromeexperiments.com/ [Accessed 1 April 2020].

Gordon, E. (2010). *Society and Musical Development: Another Pandora Paradox*. Chicago, Illinois (USA), GIA Publications.

Gosine, C.J., Hawksley, D. and Quinn, S.L. (2017). Community Building Through Inclusive Music Making. *Voices: A World Forum for Music Therapy*, 17(1). DOI: 10.15845/voices.v17i1.893.

Gould, E.R. and Redmond, V. (2014). Parent Involvement. In: Granpeesheh, D., Talbox, J., Najdowski, A.C. and Kornack, J. eds. *Evidence-Based Treatment for Children with Autism: The CARD Model*. Kidlington, Oxford: Academic Press (an imprint of Elsevier), pp. 166-190.

Gould, J.E. (2002). *Concise Handbook of Experimental Methods for the Behavioural and Biological Sciences.* Boca Raton, Florida (USA): CRC Press.

Goulekas, K. (2001). *Visual Effects in a Digital World.* London: Morgan Kaufmann (an imprint of Academic Press).

Grandin, T. (1995). How People with Autism Think. In: Schopler, E. and Mesibov, G.B. eds. *Learning and Cognition in Autism*. New York: Springer Science + Business Media, pp. 137-158.

Grandin, T. (2002). *Teaching Tips for Children and Adults with Autism*. [Online]. Fort Collins, Colorado (USA): Centre for the Study of Autism, Colorado State University. Available from: http://oepf.org/sites/default/files/Teaching%20Tips%20Grandin.pdf [Accessed 19 August 2016].

Grandin, T. and Barron, S. (2005). *The Unwritten Rules of Social Relationships: Decoding Social Mysteries Through the Unique Perspectives of Autism*. Edited by Veronica Zysk. Arlington, Texas (USA): Future Horizons.

Gray, C. (1995). Teaching Children with Autism to 'Read' Social Situations. In: Quill, K.A. ed. *Teaching Children with Autism: Strategies to Enhance Communication and Socialisation*. London: Delmar Publishers Inc., pp. 219-242.

Gray, C. (1998). Social Stories and Comic Strip Conversations with Students with Asperger Syndrome and High-Functioning Autism. In: Schopler, E., Mesibov, G.B., Kunce, L.J. eds. *Asperger Syndrome or High-Functioning Autism? (Current Issues in Autism Book Series*). Berlin / Heidelberg / London: Springer, pp. 167-198. DOI: 10.1007/978-1-4615-5369-4_9.

Gray, C. (2000). *The New Social Story Book*. 2nd edn. (Illustrated / 1st edn. published 1994). Arlington, Texas (USA): Future Horizons.

Gray, C.A. and Garand, J.D. (1993). Social Stories: Improving Responses of Students with Autism with Accurate Social Information. *Focus on Autism and Other Developmental Disabilities*, 8(1), 1-10. DOI: 10.1177/108835769300800101.

Gray, K., Keating, C., Taffe, J., Brereton, A., Einfeld, S. and Tonge, B. (2012). Trajectory of Behavior and Emotional Problems in Autism. *American Journal on Intellectual and Developmental Disabilities*, 117(2), 121-133. DOI: 10.1352/1944-7588-117-2.121.

Greenberg, D.M., Rentfrow, P.J. and Baron-Cohen, S. (2015). Can Music Increase Empathy? Interpreting Musical Experience Through the Empathizing-Systemizing (E-S) Theory: Implications for Autism. *Empirical Musicology Review*, 10(1-2), 80-95. DOI: 10.18061/emr.v10i1-2.4603.

Greenspan, S.I. and Wieder, S. (1998). *The Child with Special Needs: Encouraging Intellectual and Emotional Growth*. London: Perseus Books.

Greenspan, S.I. and Wieder, S. (2006). *Engaging Autism: Using the Floortime Approach to Help Children Relate, Communicate, and Think*. Philadelphia (USA): Da Capo Lifelong Books.

Gregory, A.H., Worrall, L. and Sarge, A. (1996). The Development of Emotional Responses to Music in Young Children. *Motivation and Emotion*, 20(4), 341-348. DOI: 10.1007/BF02856522.

Greher, G.R., Hillier, A., Dougherty, M. and Poto, L. (2010). SoundScape: An Interdisciplinary Music Intervention for Adolescents and Young Adults on the Autism Spectrum. *International Journal of Education & the Arts* [Online], 11(9), 1-27. Available from: https://www.ijea.org/v11n9/v11n9.pdf [Accessed 20 March 2020].

Greve, H.R. (2003). *Organisational Learning from Performance Feedback: A Behavioural Perspective on Innovation and Change*. Cambridge: Cambridge University Press.

Griffiths, T.D., Rees, A., Witton, C., Cross, P.M., Shakkir, R.A. and Green, G.G.R. (1997). Spatial and Temporal Auditory Processing Deficits Following Right Hemisphere Infarction: A Psychophysical Study. *Brain*, 120, 785-794. DOI: 10.1093/brain/120.5.785.

Griggs-Drane, E.R. and Wheeler, J.J. (1997). The Use of Functional Assessment Procedures and Individualized Schedules in the Treatment of Autism: Recommendations for Music Therapists. *Music Therapy Perspectives*, 15(2), 87-93. DOI: 10.1093/mtp/15.2.87.

Grossi, D., Marcone, R., Cinquegrana, T. and Gallucci, M. (2013). On the Differential Nature of Induced and Incidental Echolalia in Autism. *Journal of Intellectual Disability Research*, 57(10), 903-912. DOI: 10.1111/j.1365-2788.2012.01579.x.

Grossman, R.B. and Tager-Flusberg, H. (2008). Reading Faces for Information about Words and Emotions in Adolescents with Autism. *Research in Autism Spectrum Disorders*, 2(4), 681-695. DOI: 10.1016/j.rasd.2008.02.004.

Grüsser, S.M., Thalemann, R., and Griffiths, M.D. (2007). Excessive Computer Game Playing: Evidence for Addiction and Aggression? *CyberPsychology and Behavior*, 10(2), 290-292. DOI: 10.1089/cpb.2006.9956.

Guerrero, N. and Turry, A. (2012). Nordoff-Robbins Music Therapy: An Expressive and Dynamic Approach for Young Children on the Autism Spectrum. In: Kern, P. and Humpal, M. eds. *Early Childhood Music Therapy and Autism Spectrum Disorders: Developing Potential in Young Children and Their Families.* London: Jessica Kingsley Publishers, pp. 130-144.

Gus, L. (2000). Autism: Promoting Peer Understanding. *Educational Psychology in Practice*, 16(4), 461-468. DOI: 10.1080/713666109.

Guthrie, W., Swineford, L.B., Nottke, C. and Wetherby, A.M. (2012). Early Diagnosis of Autism Spectrum Disorder: Stability and Change in Clinical Diagnosis and Symptom Presentation. *The Journal of Child Psychology and Psychiatry*, 54(5), 582-590. DOI: 10.1111/jcpp.12008.

Gutstein, S., Sheely, R.K. (2002). *Relationship Development Intervention with Children, Adolescents and Adults: Social and Emotional Development Activities for Asperger Syndrome, Autism, PDD and NLD.* London: Jessica Kingsley Publishers.

Gutstein, S.E. (2000). *Autism Aspergers: Solving the Relationship Puzzle: A New Developmental Programme that Opens the Door to Lifelong Social & Emotional Growth*. Arlington, Texas (USA): Future Horizons.

Guzic, B.L., Tonkin, K., Donovan, J., Walkovich, D., Demuth, B.R., Walkovich, B., Roberts, J.B. and Bapat, A. (2011). [Online]. Loretto, Pennsylvania (USA): Saint Francis University / CERMUSA. Project Report. Available from: https://static1.squarespace.com/static/574191f24c2f8522317db6b1/t/577bee216a4963d30fb2e6a8/1467739682715/FULL+PercussionAndDistanceLearningAutism.pdf [Accessed 19 March 2020].

Hachman, M. (2016). *Google's Delightful Chrome Music Lab is Designed for Kids Like You*. [Online]. PC World Website. London: IDG Communications. Available from: http://www.pcworld.com/article/3042897/internet/googles-delightful-chrome-music-lab-is-designed-for-kids-like-you.html [Accessed 5 May 2017].

Hadjidimitriou, S.K., Zacharakis, A.I., Doulgeris, P.C., Panoulas, K.J., Hadjileontiadis, L.J. and Panas, S.M. (2011). Revealing Action Representation Processes in Audio Perception Using Fractal EEG Analysis. *IEEE Transactions on Biomedical Engineering,* 58(4), 1120-1129. DOI: 10.1109/TBME.2010.2047016.

Haesen, B., Boets, B. and Wagemans, J. (2011). A Review of Behavioural and Electrophysiological Studies on Auditory Processing and Speech Perception in Autism Spectrum Disorders. *Research in Autism Spectrum Disorders*, 5(2), 701-714. DOI: 10.1016/j.rasd.2010.11.006.

Hall, T.S. (2007). *Improving Self-Efficacy in Problem Solving: Learning from Errors and Feedback*. [Online]. Greensboro, North Carolina (USA): The University of North Carolina at Greensboro (UNCG). PhD Dissertation. Available from: https://libres.uncg.edu/ir/uncg/f/umi-uncg-1514.pdf [Accessed 10 Nov 2016].

Hamilton, A. (2009). The Sound of Music. In: Nudds, M. and O'Callaghan, C. eds. *Sounds & Perception: New Philosophical Essays*. Oxford: Oxford University Press, pp. 146-182.

Hammel, A.M (2016). Twice Exceptional. In: Blair, D.V. and McCord, K.A. eds. *Exceptional Music Pedagogy for Children with Exceptionalities: International Perspectives*. Oxford: Oxford University Press, pp. 16-38.

Hammel, A.M. (2017). *Teaching Music to Students with Special Needs: A Practical Resource*. Oxford: Oxford University Press.

Hammel, A.M. and Hourigan, R. M. (2011). *Teaching Music to Students with Special Needs: A Label-Free Approach*. Oxford: Oxford University Press.

Hammel, A.M. and Hourigan, R. M. (2013). *Teaching Music to Students with Autism*. Oxford: Oxford University Press.

Hammel, A.M. and Hourigan, R. M. (2017). *Teaching Music to Students with Special Needs: A Label-Free Approach*. 2nd edn. Oxford: Oxford University Press. N.B.: Both 2nd and 1st editions (2011, see above) were used as references in the current Thesis.

Hansen, C.H. and Hansen, R.D. (1988). Finding the Face in the Crowd: An Anger Superiority Effect. *Journal of Personality and Social Psychology*, 54(6), 917-924. DOI: 10.1037/0022-3514.54.6.917.

Happé, F. (1999). Understanding Assets and Deficits in Autism – Why Success is More Interesting than Failure. *The Psychologist* [Online], 12(11), 540-546. Available from: https://thepsychologist.bps.org.uk/getfile/3088 [Accessed 15 April 2018].

Happé, F. and Frith, U. (1995). Theory of Mind in Autism. In: Schopler, E. and Mesibov, G. eds. *Learning and Cognition in Autism: Current Issues in Autism*. New York: Plenum Press, pp. 177-197. DOI: 10.1007/978-1-4899-1286-2_10.

Happé, F.G., Mansour, H., Barrett, P., Brown, T., Abbott, P. and Charlton, R.A. (2016). *Demographic and Cognitive Profile of Individuals Seeking a Diagnosis of Autism Spectrum Disorder in Adulthood*. Journal of Autism and Developmental Disorders, 46(11), 3469-3480. DOI: 10.1007/s10803-016-2886-2.

Hardy, M.W., and LaGasse, A.B. (2013). Rhythm, Movement and Autism: Using Rhythmic Rehabilitation Research as a Model for Autism. *Frontiers in Integrative Neuroscience* 7(19). DOI: 10.3389/fnint.2013.00019. Also available in: Torres, E.B. and Donnellan, A.M. eds. (2015). *Autism: The Movement Perspective*. Los Angeles, California (USA): Frontiers Media, pp. 89-97.

Hardy, C., Ogden, J., Newman, J. and Cooper, S. (2016). *Autism and ICT: A Guide for Teachers and Parents*. Abingdon, Oxon: Routledge.

Hargreaves, D. and Lamont, A. (2017). *The Psychology of Musical Development*. Cambridge: Cambridge University Press.

Harms, M.D. (2007). Music Therapy. In: Myles, B.S., Swanson, T.C., Holverstott, J. and Duncan, M.M. eds. *Autism Spectrum Disorders: A Handbook for Parents and Professionals (Volume 1)*. Westport, Connecticut (USA): Praeger Publishers, pp. 227-8.

Harris, H., Israeli, D., Minshew, N., Bonneh, Y., Heeger, D.J., Behrmann, M. and Sagi, D. (2015). Perceptual Learning in Autism: Over-Specificity and Possible Remedies. *Nature Neuroscience*, 18(11), 1574-6. DOI: 10.1038/nn.4129.

Hart, C. (1993). *A Parent's Guide to Autism*. New York (USA): Pocket Books.

Hattier, M.A., Matson, J.L. and Kozlowski, A.M. (2012). Communication Skills in Children with Cerebral Palsy and Autism Spectrum Disorder. *Journal of Developmental & Physical Disabilities*, 24, 85-93. DOI: 10.1007/s10882-011-9256-y.

Hayes, D. (2006). *Primary Education: The Key Concepts*. London: Routledge.

Hayes, D. (2009). *Encyclopedia of Primary Education*. London: Routledge.

Hayes, T. (2016). Music Therapy in the Context of the Special School. In: Edwards, J. ed. *The Oxford Handbook of Music Therapy*. Oxford: Oxford University Press, pp. 176-185.

Headlam, D. (2006). Learning to Hear Autistically. In: Lerner, N.W. and Straus, J.N. eds. *Sounding Off: Theorizing Disability in Music*. Abingdon, Oxon: Routledge, pp. 109-120.

Heaton, P. (2003). Pitch Memory, Labelling and Disembedding in Autism. *The Journal of Child Psychology and Psychiatry*, 44(4), 543-551. DOI: 10.1111/1469-7610.00143.

Heaton, P., Allen, R., Williams, K., Cummins, O. and Happé, F. (2010). Do Social and Cognitive Deficits Curtail Musical Understanding? Evidence from Autism and Down Syndrome. *British Journal of Developmental Psychology*, 26(2), 171-182. DOI: 10.1348/026151007X206776.

Heaton, P., Hermelin, B. and Pring, L. (1998). Autism and Pitch Processing: A Precursor for Musical Ability. *Music Perception*, 15, 291-305. DOI: 10.2307/40285769.

Heaton, P., Pring, L. and Hermelin, B. (2001). Musical Processing in High Functioning Children with Autism. *Annals New York Academy of Sciences*, 930, 443-4. DOI: 10.1111/j.1749-6632.2001.tb05765.x.

Heaton, P., Williams, K., Cummins, O. and Happé, F.G.E. (2007). Beyond Perception: Musical Representation and On-Line Processing in Autism. *Journal of Autism and Developmental Disorders*, 37(7), 1355-1360. DOI: 10.1007/s10803-006-0283-y.

Hefferman, D. (2016). *Sensory Issues for Adults with Autism Spectrum Disorder*. London: Jessica Kingsley Publishers.

Hermelin, B. (2001). *Bright Splinters of the Mind: A Personal Story of Research with Autistic Savants*. London: Jessica Kingsley Publishers.

Hernandez, N., Metzger, A., Magné, R., Bonnet-Brilhault, F., Roux, S., Barthelemy, C. and Martineau, J. (2009). *Neuropsychologia*, 47, 1004-1012. DOI: 10.1016/j.neuropsychologia.2008.10.023.

Herring, S., Gray, K., Taffe, J., Tonge, B., Sweeney, D. and Einfeld, S. (2006). Behaviour and Emotional Problems in Toddlers with Pervasive Developmental Disorders and Developmental Delay: Associations with Parental Mental Health and Family Functioning. *Journal of Intellectual Disability Research*, 50(12), 874-882. DOI: 10.1111/j.1365-2788.2006.00904.x.

Hexler Website (2017). *Hexler.Net: Pixels, Waves and Hyperactivity Disorder*. [Online]. Available from: https://hexler.net/ [Accessed 15 May 2017].

Hier, D.B., LeMay, M. and Rosenberger, P.B. (1979). Autism and Unfavorable Left-Right Asymmetries of the Brain. *Journal of Autism and Developmental Disorders*, 9(2), 153-159. DOI: 10.1007/BF01531531.

Higbee, T.S. and Sellers, T.P. (2011). Verbal Behavior and Communication Training. In: Matson, J.L. and Sturmey, P. eds. *International Handbook of Autism and Pervasive Developmental Disorders*. London: Springer, pp. 367-380.

Hildred, M. (2006). *MIDICreator – Working with People on the Autism Spectrum*. [Interview with Dr. John Biddulph]. [Online]. York: Applaud Interactive. Available from: http://www.applaudinteractive.com/midicreator-working-with-people-on-the-autistic-spectrum/ [Accessed 23 March 2020].

Hill, E., Berthoz, S. and Frith, U. (2004). Brief Report: Cognitive Processing of Own Emotions in Individuals with Autistic Spectrum Disorder and in their Relatives. *Journal of Autism and Developmental Disorders*, 34(2), 229-235. DOI: 10.1023/B:JADD.0000022613.41399.14.

Hillier, A., Greher, G., Poto, N. and Dougherty, M. (2011). Positive Outcomes Following Participation in a Music Intervention for Adolescents and Young Adults on the Autism Spectrum. *Psychology of Music*, 40(2), 201-215. DOI: 10.1177/0305735610386837.

Hillier, A., Greher, G., Queenan, A., Marshall, S. and Kopec, J. (2016). Music, Technology and Adolescents with Autism Spectrum Disorders: The Effectiveness of the Touch Screen Interface. *Music Education Research*, 18(3), 269-282. DOI: 10.1080/14613808.2015.1077802.

Hillier, A., Greher, G.R., Poto, N. and Dougherty, M. (2011). Positive Outcomes Following Participation in a Music Interventions for Adolescents and Young Adults on the Autism Spectrum. *Psychology of Music*, 40(2), 201-215. DOI: 10.1177/0305735610386837

Hillman, J., Snyder, S. and Neubrander, J. (2007). *Childhood Autism: A Clinician's Guide to Early Diagnosis and Integrated Treatment*. Hove, East Sussex: Routledge.

Hilsen, L. (2011). *A Step-By-Step Curriculum for Early Learners with Autism Spectrum Disorders*. London: Jessica Kingsley Publishers.

Hinton, P.R., McMurray, I. and Brownlow, C. (2014). *SPSS Explained*. 2nd edn. Hove, East Sussex: Routledge.

Hitoglou, M., Ververi, A., Antoniadis, A. and Zafeiriou, D.I. (2010). Childhood Autism and Auditory System Abnormalities. *Pediatric Neurology* [Online], 42(5), 309-314. DOI: 10.1016/j.pediatrneurol.2009.10.009.

Hobson, R.P., Ouston, J. and Lee, A. (1989). Naming Emotion in Faces and Voices: Abilities and Disabilities in Autism and Mental Retardation. *British Journal of Developmental Psychology*, 7(3), 237-250. DOI: 10.1111/j.2044-835X.1989.tb00803.x.

Hoekstra, R.A., Bartels, M. and Verweij, C.J.H. (2007). Heritability of Autistic Traits in the General Population. *Archives of Pediatrics and Adolescent Medicine*, 161 (4), 372-377. DOI: 10.1001/archpedi.161.4.372.

Hoemberg, V. (2014). A Neurologist's View on Neurologic Music Therapy. In: Thaut, M. and Hoemberg, V. eds. *Handbook of Neurologic Music Therapy*. Oxford: Oxford University Press, pp. 7-12.

Hoffer, C. (2009). *Music Listening Today*. United Kingdom: Schirmer (Cengage Learning).

Hofman, P.M. and Van Opstal, A.J. (1998). Spectro-Temporal Factors in Two-Dimensional Human Sound Localization. *Journal of the Acoustical Society of America*, 130(5 Pt. 1), 2634-2648. DOI: 10.1121/1.422784.

Holck, U. (2004). Interaction Themes in Music Therapy: Definition and Delimitation. *Nordic Journal of Music Therapy*, 13(1), 3-19. DOI: 10.1080/08098130409478094.

Holone, H. and Herstad, J. (2012). RHYME: Musicking for All. In: Miesenberger, K., Karshmer, A., Penaz, P. and Zagler, W. eds. *Computers Helping People with Special Needs: Proceedings (Part I) of the ICCHP 2012 – International Conference on Computers for Handicapped Persons*, Linz, Austria, July 11-13, 2012. *Lecture Notes in Computer Science* 7382. Berlin / Heidelberg (Germany): Springer, pp. 262-269. DOI: 10.1007/978-3-642-31522-0_39.

Hope-West, A. (2011). *Securing Appropriate Education Provision for Children with Autism Spectrum Disorders: A Guide for Parents and Professionals*. London: Jessica Kingsley Publishers.

Houix, O., Misdariis, N., Susini, P., Bevilacqua, F. and Gutierrez, F. (2013). Sonically Augmented Artifacts: Design Methodology Through Participatory Workshops. In: Aramaki, M., Derrien, O., Kronland-Martinet, R. and Ystad, S. eds. *Sound, Music, and Motion: 10th International Symposium, CMMR 2013, Marseille, France, October 15-18, 2013.* Cham (Switzerland): Springer International Publishing Switzerland, pp. 20-40.

Hourigan, R. and Hammel, A.M. (2017). Understanding the Mind of a Student with Autism in Music Class. *Music Educators Journal*, 104(2), 21-26. DOI: 10.1177/0027432117732386.

Hourigan, R. and Hourigan, A. (2009). Teaching Music to Children with Autism: Understandings and Perspectives. *Music Educators Journal*, 96(1), 40-46. DOI: 10.1177/0027432109341370.

Hove, M.J. and Keller, P.E. (2015). Impaired Movement Timing in Neurological Disorders: Rehabilitation and Treatment Strategies. *Annals of New York Academy of Sciences*, 1337(1), 111-117. DOI: 10.1111/nyas.12615.

Howland, K.M. (2015). Music Therapy for Children with Speech and Language Disorders. In: Wheeler, B.L. ed. *Music Therapy Handbook.* New York: The Guilford Press, pp. 302-314.

Howlin, P. (2002). *Intellectual Disability and Health – Autism*. [Online]. Hatfield: University of Hertfordshire. Available from: intellectualdisability.info/diagnosis/articles/autism [Accessed 15 March 2020].

Hufft, J.M. (2014). *Autism Demystified*: *Disclosing the Mysteries of Autism and Attention Deficit Disorder (ADD)*. [Kindle]. Belfast, Northern Ireland: Ambassador International. Available from: https://www.amazon.co.uk/Autism-Demystified-Disclosing-Mysteries-Attention-ebook/dp/B00LMW1E8M/ref=sr_1_2?s=digital-text&ie=UTF8&qid=1519832338&sr=1-2&keywords=autism+demystified [Accessed 15 February 2018].

Hugill, A. (2012). *The Digital Musician*. 2nd edn. Abingdon, Oxon: Routledge.

Hummelsheim, H. (1999). Rationales for Improving Motor Function. *Current Opinion in Neurology*, 12(6), 697-701. DOI: 10.1097/00019052-199912000-00007.

Humpal, M. and Kern, P. (2012). Strategies and Techniques: Making it Happen for Young Children with Autism Spectrum Disorders. In: Kern, P. and Humpal, M. eds. *Early Childhood Music Therapy and Autism Spectrum Disorders: Developing Potential in Young Children and their Families*. London: Jessica Kinsgley Publishers, pp. 162-180.

Hunt, A.D., Howard, D.M. and Worsdall, J. (2000). Real-Time Interfaces for Speech and Singing. *Proceedings of the 26th Euromicro Conference, Maastricht*, 2, 356-361. DOI: 10.1109/EURMIC.2000.874504.

Hunt, A., Kirk, R. and Neighbour, M. (2004). Multiple Media Interfaces for Music Therapy. *IEEE Multimedia*, 11(3), 50-58. DOI: 10.1109/mmul.2004.12.

Huss, M., Verney, J.P., Fosker, T., Mead, N. and Goswami, U. (2011). Music, Rhythm, Rise Time Perception and Developmental Dyslexia: Perception of Musical Meter Predicts Reading and Phonology. *Cortex*, 47(6), 674-689. DOI: 10.1016/j.cortex.2010.07.010.

Hussain, K.K. (2018). *Leveraging Stimulus Equivalence to Teach Piano to Children with Autism*. [Online]. Melbourne, Florida (USA): Florida Tech University. Master's Thesis. Available from: https://repository.lib.fit.edu/bitstream/handle/11141/2779/HUSSAIN-THESIS-2018.pdf [Accessed 20 March 2020].

Hutchinson, E. (2013). *Sound Connections Action Research Report: Enabling Young Children with Autism through Musical Engagement: A Music Educator's Toolkit*. [Online]. London: London Early Years Music Network (LEYMN) / Sound Connections. Available from: http://www.sound-connections.org.uk/wp-content/uploads/LEYMN-Enabling-Young-Children-with-Autism.pdf [Accessed 25 April 2017].

Hyde, K.L., Samson, F., Evans, A.C. and Mottron, L. (2010). Neuroanatomical Differences in Brain Areas Implicated in Perceptual and Other Core Features of Autism Revealed by Cortical Thickness Analysis and Voxel-Based Morphometry. *Human Brain Mapping*, 31(4), 556-565. DOI: 10.1002/hbm.20887.

Ibañez, L.V., Stone, W.L. and Coonrod, E.E. (2014). Screening for Autism in Young Children. In: Volkmar, F.R., Paul, R., Rogers, S.J. and Pelphrey, K.A. eds. *Handbook of Autism and Pervasive Developmental Disorders, Volume 2*. Hoboken, New Jersey: John Wiley and Sons, pp. 585-608.

IBM Knowledge Centre (2020). *Descriptive Statistics*. [Online]. USA: IBM. Available from: https://www.ibm.com/support/knowledgecenter/en/SSLVMB_23.0.0/spss/tutorials/mi_impute_telco_descriptive-statistics.html [Accessed 20 April 2020].

ICDL (n.d.): *DIR® and the DIRFloortime® Approach*. [Online]. Bethesda, Maryland (USA): The Interdisciplinary Council on Development and Learning, Inc. (ICDL). Available from: http://www.icdl.com/DIR [Accessed 18 February 2016].

Ikram, W., Jeong, Y., Lee, B.., Um, K. and Cho, K. (2015). Smart Virtual Lab Using Hand Gestures. In: Park, J.J. (Jong Hyuk), Chao, H-C, Arabnia, H. and Yen, N.Y. eds. *Advanced Multimedia and Ubiquitous Engineering: Future Information Technology*. Berlin / Heidelberg: Springer, pp. 165-170.

Ingersoll, B. (2008). The Social Role of Imitation in Autism: Implications for the Treatment of Imitation Deficits. *Infants & Young Children* [Online], 21(2), 107-119. Available from: http://depts.washington.edu/isei/iyc/21.2_Ingersoll.pdf [Accessed 24 September 2015].

Iverson, J.M. (2010). Developing Language in a Developing Body: The Relationship Between Motor Development and Language Development. *Journal of Child Language*, 37(2), 229-261. DOI: 10.1017/S0305000909990432.

Ivey, M.L., Heflin, L.J. and Alberto, P. (2004). The Use of Social Stories to Promote Independent Behaviors in Novel Events for Children with PDD-NOS. *Focus on Autism and Other Developmental Disabilities*, 19(3), 164-176. DOI: 10.1177/10883576040190030401.

Jackson, K. and Bazeley, P (2019). *Qualitative Data Analysis with NVivo.* London: Sage Publications.

Jacobs, D.S. and Betts, D.E. (2012). *Everyday Activities to Help Your Young Child with Autism Live Life to the Full: Simple Exercises to Boost Functional Skills, Sensory Processing, Coordination and Self-Care*. London: Jessica Kingsley Publishers.

Jakobson, L.S., Cuddy, L.L. and Kilgour, A. (2003). Time Tagging: A Key to Musicians' Superior Memory. *Music Perception* [Online], 20(3), 307-313. Available from: https://www.researchgate.net/publication/249979655_Time_Tagging_A_Key_to_Musicians'_Superior_Memory [Accessed 5 May 2018].

Jamabo, T.A. and George, I.R. (2014). Music as a Therapy for Depression in Women: A Theoretical Perspective. *International Journal of Academic Research* [Online], 6(4), 227-231.

James Rybka, F. (2011). *Bohuslav Martinu: The Compulsion to Compose*. Plymouth: Scarecrow Press.

Janata, P. (1995). ERP Measures Assay the Degree of Expectancy Violation of Harmonic Contexts in Music. *Journal of Cognitive Neuroscience*, 7(2), 153-164. DOI: 10.1162/jocn.1995.7.2.153.

Janata, P., Tillmann, B. and Bharucha, J.J. (2002). Listening to Polyphonic Music Recruits Domain-General Attention and Working Memory Circuits. *Cognitive, Affective and Behavioral Neuroscience*, 2(2), 121-140. DOI: 10.3768/CABN.2.2.121.

Jayson, L. (2007). *Severe Autism, Denied Support: Struggling to Survive in the Mainstream.* Victoria, British Columbia (Canada): Trafford Publishing.

Jensen, B. (1999). Music Therapy with Psychiatric In-Patients: A Case Study with a Young Schizophrenic Man. In: Wigram, J. and De Backer, J. eds. *Clinical Applications of Music Therapy in Psychiatry*. London: Jessica Kingsley Publishers, pp. 44-60. *N.B.: Digital printing edition also available as of 2003*.

Jepson, B. and Johnson, J. (2007). *Changing the Course of Autism*: *A Scientific Approach for Parents and Physicians.* Boulder, Connecticut (USA): Sentient Publications.

Johnson, S. (2012). *A Clinical Handbook on Child Development Paediatrics.* 2nd edn. Chatswood, New South Wales (Australia): Churchill Livingstone (an imprint of Elsevier).

Jones, D.S. (2005). *Pharmaceutical Statistics*. Reprint (first publication in 2002). London: Pharmaceutical Press.

Jones, J.D. (2006). Songs Composed for Use in Music Therapy: A Survey of Original Songwriting Practices of Music Therapists. *Journal of Music Therapy*, 43(2), 94-110. DOI: 10.1093/jmt/43.2.94.

Jones, N.L., Apling, R.N. and Smole, D.P. (2004). *Individuals with Disabilities Education Act (IDEA): Background and Issues*. Hauppauge, New York State (USA): Nova Science Publishers.

Jones, R.M. (2018). Music Tunes the Brain in Autism. *Science Translational Medicine*, 10, 466. DOI: 10.1126/scitranslmed.aav6056.

Jones, R.S.P., Quigney, C. and Huws, J.C. (2009). First-Hand Accounts of Sensory Perceptual Experiences in Autism: A Qualitative Analysis. *Journal of Intellectual and Developmental Disability*, 28(2), 112-121. DOI: 10.1080/1366825031000147058.

Jordà, S., Geiger, G., Alonson, M. and Kaltenbrunner, M. (2007). The ReacTable: Exploring the Synergy Between Live Music Performance and Tabletop Tangible Interfaces. *Proceedings of the 1st International Conference on Tangible and Embedded Interaction,* Baton Rouge, Louisiana, 15-17 February 2007. DOI: 10.1145/1226969.1226998.

Jordan, R. (1990). The Years Between 6 and 12. In: Ravelli, A.J., Bobbink, A.F., Van Bommel, M.J.E., Magnee, M., Van Deutekom, M.J. and Heemelaar, M.L. eds. *Autism: Professional Perspective and Practice*. London: Springer Science + Business Media, pp. 50-77. *N.B.: Book cover states Ellis, K. as the editor, but the Springer website (link: http://www.springer.com/gp/book/9780412614507) provides editors as stated at the start of the reference.*

Joseph, R. (1988). The Right Cerebral Hemisphere: Emotion, Music, Visual-Spatial Skills, Body-Image, Dreams, and Awareness. Journal of Clinical Psychology [Online], 44(5), 630-673. Available from: http://www.ncbi.nlm.nih.gov/pubmed/2461390 [Accessed 8 February 2016].

Jusczyk, P.W. and Krumhansl, C.L. (1993). Pitch and Rhythmic Patterns Affecting Infants' Sensitivity to Musical Phrase Structure. *Journal of Experimental Psychology: Human Perception and Performance*, 19(3), 627-640. DOI: 10.1037/0096-1523.19.3.627.

Kalyva, E. (2011). *Autism: Educational and Therapeutic Approaches*. 2nd edn. London: Sage Publications. *N.B.: First edition (2005) was published in Greek – Athens, Greece: Papazisi Editions.*

Kamitsubo, K. (2013). 'Yes, I Can Learn!' Blending Music Instruction into Music Therapy. *Journal of Urban Culture Research* [Online], 6, 108-117. Available from: http://www.tci-thaijo.org/index.php/JUCR/article/view/20537/17844 [Accessed 18 September 2016].

Kamps, D.M. (1997). The Behavior Analyst's Role in Facilitating Interventions in General Education Settings. *Journal of Behavioral Education*, 7(1), 81-89. DOI: 10.1023/A:1022845621556.

Kanner, L. (1943). Autistic Disturbances of Affective Contact. *Nervous Child* [Online], 2, 217-250. Available from: http://simonsfoundation.s3.amazonaws.com/share/071207-leo-kanner-autistic-affective-contact.pdf [Accessed 17 April 2020].

Kaplan, B.J., Dewey, D.M., Crawford, S.G. and Wilson, B.N. (2001). The Term 'Comorbidity' is of Questionable Value in Reference to Developmental Disorders: Data and Theory. *Journal of Learning Disabilities*, 34(6), 555-565. DOI: 10.1177/002221940103400608.

Kartasidou, L., Varsamis, P. and Sampsonidou, A. (2012). Motor Performance and Rhythmic Perception of Children with Intellectual and Developmental Disability and Developmental Coordination Disorder. *International Journal of Special Education*, 27(1), 74-80. DOI: 10.1177/002221940103400608.

Kashman, N. and Mora, J. (2005). *The Sensory Connection: Sensory and Communication Strategies that Work!* Arlington, Texas (USA): Future Horizons.

Katagiri, J. (2009). The Effect of Background Music and Song Texts on the Emotional Understanding of Children with Autism. *Journal of Music Therapy*, 46(1), 15-31. DOI: 10.1093/jmt/46.1.15.

Katsiyannis, A., Yell, M.L. and Bradley, R. (2001). Reflections on the 25th Anniversary of the Individuals with Disabilities Education Act. *Remedial and Special Education*, 22(6), 324-334. DOI: 10.1177/074193250102200602.

Kaweski, W. (2011). *Teaching Adeolescents with Autism: Practical Strategies for the Inclusive Classroom*. London: Corwin / Sage Ltd.

Kearney, C., Trull, T.J. (2015). *Abnormal Psychology and Life: A Dimensional Approach*. 2nd edn. Stanford, Connecticut (USA): Cengage Learning.

Kellett, M. (2000). Motivating the Musically Disaffected. In: Clipson-Boyles, S. ed. *Putting Research into Practice in Primary Teaching and Learning*. London: David Fulton Publishers / Routledge, pp. 141-152.

Kemner, C., Verbaten, M.N., Cuperus, J.M., Camfferman, G. and Van Engeland, H. (1995). Auditory Event-Related Brain Potentials in Autistic Children and Three Different Control Groups. *Biological Psychiatry*, 38, 150-165. DOI: 10.1016/0006-3223(94)00247-Z.

Kenlon, S. (2012). *Slackermedia*. USA: Fat Chance Publisher.

Kennelly, J. (2000). The Specialist Role of the Music Therapies in Developmental Programmes for Hospitalised Children. *Journal of Pediatric Health Care*, 14 (2), 56-59. DOI: 10.1067/mph.2000.101838.

Kermit-Canfield, E. and Lopez-Lezcano, F. (2015). *An Update on the Development of OpenMixer*. [Online]. Stanford, California (USA): Stanford University, Centre for Computer Research in Music and Acoustics. Available from:

https://ccrma.stanford.edu/~nando/publications/openmixer_lac2015.pdf [Accessed 12 May 2017].

Kern, P. (2012). Autism Spectrum Disorders Primer: Characteristics, Causes, Prevalence, and Intervention. In: Kern, P. and Humpal, M. eds. *Early Childhood Music Therapy and Autism Spectrum Disorders*. London: Jessica Kingsley Publishers, pp. 23-38.

Kern, P., Wakeford, L. and Aldridge, D. (2007). Improving the Performance of a Young Child with Autism during Self-Care Tasks Using Embedded Song Interventions: A Case Study. *Music Therapy Perspectives*, 25(1), 43-51. DOI: 10.1093/mtp/25.1.43.

Kerr, S.J., Neale, H.R. and Cobb, S.V.G. (2002). Virtual Environments for Social Skills Training: The Importance of Scaffolding in Practice. *Proceedings of the 5th International ACM Conference on Assistive Technologies*, Edinburgh, Scotland, 8-10 July 2002. Edinburgh: ACM, pp. 104-110. DOI: 10.1145/638249.638269.

Khalfa, S. and Peretz, I. (2007). Atypical Emotional Judgments and Skin Conductance Responses to Music and Language in Autism. In: Zhao, L.B. ed. *Autism Research Advances*. New York: Nova Science Publishers, pp. 101-120.

Khalfa, S., Bruneau, N., Rogé, B., Georgieff, N., Veuillet, E., Adrien, J-L., Barthélémy, C. and Collet, L. (2004). Increased Perception of Loudness in Autism. *Hearing Research*, 198, 87-92. DOI: 10.1016/j.heares.2004.07.006.

Khetrapal, N. (2009). Why Does Music Therapy Help in Autism? *Empirical Musicology Review*, 4(1), 11-18. DOI: 10.18061/1811/36602.

Kientz, M.A. and Dunn, W. (1997). A Comparison of the Performance of Children With and Without Autism on the Sensory Profile. *American Journal of Occupational Therapy*, 51(7), 530-537. DOI: 10.5014/ajot.51.7.530.

Kilincaslan, A. and Mukaddes, N.M. (2009). Pervasive Developmental Disorders in Individuals with Cerebral Palsy. *Developmental Medicine & Child Neurology* 51, 289-294. DOI: 10.1111/j.1469-8749.2008.03171.x.

Kim, E.J. (2013). Music Technology-Mediated Teaching and Learning Approach for Music Education: A Case Study from an Elementary School in South Korea. *International Journal of Music Education*, 31(4), 413-427. DOI: 10.1177/0255761413493369.

Kim, J. (2017). Effects of Community-Based Group Music Therapy for Children Exposed to Ongoing Child Maltreatment & Poverty in South Korea: A Block Randomized Controlled Trial. *The Arts in Psychotherapy*, 54, 69-77. DOI: 10.1016/j.aip.2017.01.001.

Kim, J., Wigram, T. and Gold, C. (2008). The Effects of Improvisational Music Therapy on Joint Attention Behaviors in Autistic Children: A Randomized Controlled Study. *Journal of Autism Developmental Disorders*, 38, 1758-1766. DOI: 10.1007/s10803-008-0566-6.

Kim, J., Wigram, T. and Gold, C. (2009). Emotional, Motivational and Interpersonal Responsiveness of Children with Autism in Improvisational Music Therapy. *Autism*, 13(4), 389-409. DOI: 10.1177/1362361309105660.

Kim, Y.S. (2004). The Early Beginnings of Nordoff-Robbins Music Therapy. *Journal of Music Therapy*, 41(4), 321-339. DOI: 10.1093/jmt/41.4.321.

King, B.R. (2012). *Strategies for Building Successful Relationships with People on the Autism Spectrum: Let's Relate!* London: Jessica Kingsley Publishers.

Kinsbourne, M. (1987). Cerebral-Brainstem Relations in Infantile Autism. In: Schopler, E. and Mesibov, G.B. eds. *Neurobiological Issues in Autism*. New York: Springer Science + Business Media, pp. 107-126.

Kirk, R., Abbotson, M., Abbotson, R., Hunt, A., Cleaton, A. (1994). Computer Music in the Service of Music Therapy: the MIDIGRID and MIDICREATOR systems. *Medical Engineering & Physics*, 16(3), 253-258. DOI: 10.1016/1350-4533(94)90046-9

Klein, S.B., Chan, R.L. and Loftus, J. (1999). Independence of Episodic and Semantic Self-Knowledge: The Case of Autism. *Social Cognition*, 17(4), 413-436. DOI: 10.1521/soco.1999.17.4.413.

Klein, S.B., Cosmides, L., Costabile, K.A. and Mei, L. (2002). Is There Something Special About the Self? A Neuropsychological Case Study. *Journal of Research in Personality*, 36, 490-506. DOI: 10.1016/S0092-6566(02)00001-6.

Kluth, P. (2009). *Teaching Students with Autism and Asperger's Syndrome in the Inclusive Classroom*. Port Chester, New York State (USA): National Professional Resources Inc.

Koelsch, S., Fritz, T., van Cramon, D.Y., Müller, K. and Friederici, A. (2006). Investigating Emotion with Music: An fMRI Study. *Human Brain Mapping*, 27(3), 239-250. DOI: 10.1002/hbm.20180.

Knieter, G.L. (2013). *The Nature of Aesthetic Education.* In: Mark, M.L. ed. *Music Education: Source Readings from Ancient Greece to Today.* 4th edn. Abingdon, Oxon: Routledge, pp. 125-128.

Kobayashi, R. and Murata, M. (1998). Behavioral Characteristics of 187 Young Adults with Autism. *Psychiatry and Clinical Neurosciences*, 52(4), 383-390. DOI: 10.1046/j.1440-1819.1998.00415.x.

Koegel, L., Matos-Freden, R., Lang, R. and Koegel, R. (2012). Interventions for Children with Autism Spectrum Disorders in Inclusive School Settings. *Cognitive and Behavioral Practice* 19(3), 401-412. DOI: 10.1016/j.cbpra.2010.11.003.

Koegel, L.K. (2006). *Pivotal Response Treatments for Autism: Communication, Social & Academic Development*. Michigan (USA): Paul H. Brookes.

Kogan, G. (2013). *Gestural Instruments*. [Online]. Available from: http://genekogan.com/works/gestural-instruments/ [Accessed 17 May 2017].

Kolar-Borsky, A. and Holck, U. (2014). Situation Songs – Therapeutic Intentions and Use in Music Therapy with Autism. *Voices: A World Forum for Music Therapy*, 14(2). DOI: 10.15845/voices.v.14i2.744.

Kontogeorgakopoulos, G., Wechsler, R. and Keay-Bright, W. (2014). Camera-Based Motion Tracking and Performing Arts for Persons with Motor Disabilities and Autism. In: Kouroupetroglou, G. ed. *Disability Informatics and Web Accessibility for Motor Limitations*. Hershey, Pennsylvania (USA): IGI Global, pp. 294-322.

Korsakova-Kreyn, M. (2015). *Embodied Cognition in Music*. [Online]. New York: Touro College. Available from: academia.edu/22961455/Embodied_Cognition_in_Music [Accessed 15 April 2018].

Kossyvaki, L. (2018). *Adult Interactive Style Intervention and Participatory Research Designs in Autism: Bridging the Gap between Academic Research and Practice*. Abington, Oxon: Routledge.

Kostelanetz, R. (2003). *Conversing with Cage.* 2nd edn. London: Routledge.

Kourti, V. (2017). Social and Communal Support *[Κοινωνική – Κοινοτική Υποστήριξη] [Greek Language]*. In: Autism Thessaly, ed. *Q&A – Support*. [Online]. Larissa (Greece): Parent and Caregiver Society of People with Autism – Prefecture of Larissa. Available from:

http://www.autismthessaly.gr/wp-content/uploads/2017/04/Q_A_support.pdf [Accessed 20 April 2020].

Koutsomichalis, M. (2013). *Mapping and Visualisation with SuperCollider*. United Kingdom: Packt Publishing.

Kozlowski, A.M., Matson, J.L., Horovitz, M., Worley, J.A. and Neal, D.N. (2011). Parents' First Concerns of Their Child's Development in Toddlers with Autism Spectrum Disorders. *Developmental Neurorehabilitation*, 14(2), 72-78. DOI: 10.3109/17518423.2010.539193.

Krasny, L. (2013). Progress for Remediating and Expanding Social Skills (PROGress). In: Goldstein, S. and Naglieri, J.A. eds. *Intervention for Autism Spectrum Disorders: Translating Science into Practice*. New York: Springer, pp. 169-196.

Kuhl, P.K., Coffey-Corina, S., Padden, D. and Dawson, G. (2005). Links Between Social and Linguistic Processing of Speech in Preschool Children with Autism: Behavioral and Electrophysiological Measures. *Developmental Science*, 8(1), F1-F12. DOI: 10.1111/j.1467-7687.2004.00384.x.

Kupferstein, H. and Rancer, S. (2016). *Perfect Pitch in the Key of Autism: A Guide for Educators, Parents, and the Musically Gifted*. Bloomington, Indiana (USA): iUniverse.

Kupferstein, H. and Walsh, B.J. (2016). Non-Verbal Paradigm for Assessing Individuals for Absolute Pitch. *World Futures: The Journal of New Paradigm Research*, 72, 390-405. DOI: 10.1080/02604027.2014.989780. *N.B.: Article was published online in 2015, but official information states 2016 as the publication year, coinciding with the one of the Journal. Reference was treated as a journal article and not as a chapter of an edited book (published by Abingdon, Oxon: Routledge).*

Kurtz, L.A. (2008). *Understanding Motor Skills in Children with Dyspraxia, ADHD, Autism, and Other Learning Disabilities*. London: Jessica Kingsley Publishers.

Kuttler, S., Myles, B.S. and Carlson, J.K. (1998). The Use of Social Stories to Reduce Precursors to Tantrum Behavior in a Student with Autism. *Focus on Autism and Other Developmental Disabilities*, 13(3), 176-182. DOI: 10.1177/108835769801300306.

LaBelle, B. (2015). *Background Noise: Perspectives on Sound Art*. London: Continuum Books.

Laerd Statistics Website (2018). *Laerd Statistics: We Make Statistics Easy – The Ultimate IBM® SPSS® Statistics Guides*. [Online]. Long Eaton: Lund Research Limited. Available from: https://statistics.laerd.com/ [Accessed 25 January 2020].

LaFrance, D.L., Miguel, C.F., Donahue, J.N. and Fechter, T.R. (2015). A Case Study on the Use of Auditory Integration Training as a Treatment for Stereotypy. *Behavioral Interventions*, 30, pp. 286-293. DOI: 10.1002/bin.1415.

LaGasse, A.B. (2014). Effects of a Music Therapy Group Intervention on Enhancing Social Skills in Children with Autism. *Journal of Music Therapy*, 51(3), 250-275. DOI: 10.1093/jmt/thu012.

Lal, R. and Shahane, A. (2011). TEACCH Intervention for Autism. [Online]. In: Williams, T. ed. *Autism Spectrum Disorders – From Genes to Environment*. London: InTech. Available from: https://www.intechopen.com/books/autism-spectrum-disorders-from-genes-to-environment/teacch-intervention-for-autism [Accessed 25 March 2018].

Lambrchts, G., Maljaars, J., Boonen, H., van Esch, L., van Leeuwen, K. and Noens, I. (2015). Parenting Behavior in Mothers of Preschool Children with ASD: Development of Self-Report Questionnaire. *Autism Research and Treatment*, 2015 (Article ID: 381236). DOI: 10.1155/2015/381236.

Lamme, M.B. (2012). *The Musical Brain: How Music Evokes Emotions and Related Positive Feelings*. [Online]. Utrecht (Netherlands): Utrecht University. Master's Thesis. Available from: https://dspace.library.uu.nl/handle/1874/252465 [Accessed 12 May 2018].

Landa, R.J. (2011). Developmental Features and Trajectories Associated with Autism Spectrum Disorders in Infants and Toddlers. In: Amaral, D., Dawson, G. and Geschwind, D. eds. *Autism Spectrum Disorders*. Oxford: Oxford University Press, pp. 213-228.

Landon, J., Shepherd, D. and Lodhia, V. (2016). A Qualitative Study of Noise Sensitivity in Adults with Autism Spectrum Disorder. *Research in Autism Spectrum Disorders*, 32, 43-52. DOI: 10.1016/j.rasd.2016.08.005.

Landy, S., and Bradley, S. (2014). *Children with Multiple Mental Health Challenges*. New York: Springer Publishing Company.

Lanovaz, M.J., Sladeczek, I.E. and Rapp, J.T. (2011). Effects of Music in Vocal Stereotypy in Children with Autism. *Journal of Applied Behavior Analysis*, 44, 647-651. DOI: 10.1901/jaba.2011.44-647.

Lansing, M.D. (1989). Educational Evaluation. In: Gillberg, C. ed. *Diagnosis and Treatment of Autism*. Proceedings of The State-Of-The-Art-Conference on Autism, Diagnosis and Treatment, held May 8-10, 1989, in Göteborg, Sweden. New York: Springer Science + Business Media, pp. 151-165.

Large, E.W., Palmer, C. (2002). Perceiving Temporal Regularity in Music. *Cognitive Science*, 26(1), 1-37. DOI: 10.1207/s15516709cog2601_1.

Larson-Kidd, S. (2011). *My Child Has Autism, Now What? 10 Steps to Get You Started.* London: Jessica Kingsley Publishers.

Larson, F.V., Wagner, A.P., Jones, P.B., Tantam, D., Lai, M-C, Baron-Cohen, S. and Holland, A.J. (2017). Psychosis in Autism: Comparison of the Features of Both Conditions in a Dually Affected Cohort. *The British Journal of Psychiatry*, 201(4), 269-275. DOI: 10.1192/bjp.bp.116.187682.

Laskaridou, K. (2015). *Autism in Greece and on the TAE Project*. [Online]. Birmingham: Transform Autism Education, University of Birmingham. Available from: birmingham.ac.uk/generic/transform-autism-education/greek-team/terminology.aspx [Accessed 20 April 2020].

Latash, M.L. (2008). *Neurophysiological Basis of Movement*. 2nd edn. Leeds: Human Kinetics.

Lathom-Radocy, W.B. (2014). *Pediatric Music Therapy*. 2nd edn. Springfield, Illinois (USA): Charles C. Thomas Publishing.

Lauter, J.L. (2008). *How Is Your Brain Like a Zebra: A New Human Neurotypology*. USA: Xlibris Corporation.

Lazzarini, V., Yi, S., Ffitch, J., Heintz, J., Brandtsegg, Ø and McCurdy, I. (2016). *Csound: A Sound and Music Computing System*. Switzerland: Springer International Publishing Switzerland.

LDA / Learning Disabilities Association of America (2017). *History*. [Online] [History of the LDA]. Pittsburgh, Pennsylvania (USA): The Learning Disabilities Association of America. Available from: https://ldaamerica.org/about-us/history/ [Accessed 10 May 2017].

Leap Motion Inc. (2017). *Leap Motion* (Website) [Online]. Available from: https://www.leapmotion.com/ [Accessed 17 May 2017].

Lecavalier, L., Snow, A.V. and Norris, M. (2011). Autism Spectrum Disorders and Intellectual Disability. In: Matson, J.L. and Sturmey, P. eds. *International Handbook of Autism and Pervasive Developmental Disorders*. New York / Heidelberg / London: Springer, pp. 37-52.

Lee, L. (2015). Investigating the Impact of Music Activities Incorporating Soundbeam Technology on Children with Multiple Disabilities. *Journal of the European Teacher Education Network*, 10, 1-12. Available from: https://62.28.241.73/index.php/jeten/article/view/61/52 [Accessed 21 March 2020].

Lee, L. (2016). Music Activities for Children with Disabilities: An Example from Taiwan. In: Blair, D.V. and McCord, K. eds. *Exceptional Music Pedagogy for Children with Exceptionalities: International Perspectives*. Oxford / New York: Oxford University Press, pp. 131-153.

Lee, L. & Ho, H.-J. (2018). Exploring Children's Communication Development through the Soundbeam Trigger Modes in the 'Holistic Music Educational Approach for Young Children' Programme. *Malaysian Journal of Music* [Online], 7, 1-19. Available from: http://ojs.upsi.edu.my/index.php/MJM/article/view/835 [Accessed 4 April 2020].

Leo, F., Bolognini, N., Passamonti, C., Stein, B.E. and Làdavas, E. (2008). Cross-Modal Localisation in Hemianopia: New Insights on Multisensory Integration. *Brain*, 131(3), 855-865. DOI: 10.1093/brain/awn003.

Lerdahl, F. and Jackendoff, R.S. (1983). *A Generative Theory of Tonal Music*. London: The MIT Press.

Levitin, D.J. (2011). *This Is Your Brain on Music: Understanding a Human Obsession*. [Kindle]. London: Atlantic Books. Available from: https://www.amazon.co.uk/dp/B00556G7R4/ [Accessed 2 October 2017].

Levitin, D.J., Cole, K., Chiles, M., Lai, Z., Lincoln, A. and Bellugi, U. (2004). Characterizing the Musical Phenotype in Individuals with Williams Syndrome. *Child Neuropsychology*, 10(4), 223-247. DOI: 10.1080/09297040490909288.

Levitin, D.J. and Rogers, S.E. (2005). Absolute Pitch: Perception, Coding, and Controversies. *Trends in Cognitive Sciences* [Online], 9(1), 26-33. Available from: https://www.cell.com/trends/cognitive-sciences/pdf/S1364-6613(04)00294-3.pdf [Accessed 10 March 2018].

Lewis-Brooks, T. (2011). *Soundscapes: The Evolution of a Concept, Apparatus and Method where Ludic Engagement in Virtual Interactive Space is a Supplemental Tool for Therapeutic Motivation.* [Online]. Sunderland: University of Sunderland, Faculty of Arts, Design and Media. PhD Thesis. Published by the Department of Architecture, Design and Media Technology (AD:MT), Aalborg University, Aalborg, Denmark. Available from: http://vbn.aau.dk/files/55871718/PhD.pdf [Accessed 18 April 2018].

Li, A. (2016). *Chrome Music Lab Teaches Kids about Sound and Shows Off the Power of the Web*. [Online]. 9-To-5 Google Website. Available from: https://9to5google.com/2016/03/09/chrome-music-lab/ [Accessed 5 May 2017].

Lidstone, J.S.M., Fernyhough, C., Meins, E. and Whitehouse, A.J.O. (2009). Brief Report: Inner Speech Impairment in Children with Autism is Associated with Greater Nonverbal than Verbal Skills. *Journal of Autism and Developmental Disorders*, 39(8), 1222-1225. DOI: 10.1007/s10803-009-0731-6.

Lim, H.A. (2012). *Developmental Speech – Language Training through Music for Children with Autism Spectrum Disorders: Theory and Clinical Application.* London: Jessica Kingsley Publishers.

Lim, H.A. (2013). Communication and Language Development: Implications for Music Therapy and Autism Spectrum Disorders. In: Kern, P. and Humpal, M. eds. *Early Childhood Music Therapy and Autism Spectrum Disorders: Developing Potential in Young Children and their Families*. London: Jessica Kingsley Publishers, pp. 199-213. *N.B.: Edition number has not been specified, but first publication of the book took place in 2012 prior to the version with the year 2013 next to the Copyright ©.*

Lim, H.A. and Draper, E. (2011). The Effects of Music Therapy Incorporated with Applied Behavior Analysis Verbal Behavior Approach for Children with Autism Spectrum Disorders. *Journal of Music Therapy*, 48(4), 532-550. DOI: 10.1093/jmt/48.4.532.

Lima, C.F. and Castro, S.L. (2011). Musical Expertise Enhances the Recognition of Emotions in Speech Prosody. Emotion, 11(5), 1021-1031. DOI: 10.1037/a0024521.

Lima, D. and Castro, T. (2012). Music Spectrum: A Music Immersion Virtual Environment for Children with Autism. Procedia Computer Science, 14, 111-118. DOI: 10.1109/SBSC.2012.33

Lin, L. and Li, C. (2012). The Application of Computer-Based Training in Autism Treatment. In: Du, Z. ed. (2013). *Proceedings of the 2012 International Conference of Modern Computer Science and Applications*. Berlin/Heidelberg (Germany): Springer, pp. 253-258.

Lindberg, J.S., Iwata, B.A., Roscoe, E.M., Worsdell, A.S. and Hanley, G.P. (2003). Treatment Efficacy of Noncontingent Reinforcement During Brief and Extended Application. Journal of Applied Behavior Analysis, 36, 1-19. DOI: 10.1901/jaba.2003.36-1.

Lindell, A. (2017). Atypical Hemispheric Asymmetries in Autism Spectrum Disorders. In: Casanova, M.F., El-Baz, A. and Suri, J.S. eds. *Autism Imaging and Devices*. Boca Raton, Florida (USA): CRC Press, Taylor & Francis Group, pp. 135-156. DOI: 10.1007/BF01531531.

Lindquist, K.A., Wager, T.D., Kober, H., Bliss-Moreau, E. and Barrett, L.F. (2012). The Brain Basis of Emotion: A Meta-Analytic Review. *Behavioral and Brain Sciences*, 35, 121-202. DOI: 10.1017/S0140525X11000446.

Lipnyagov, P. (2014). *Dubstep Launchpad 24.* [Online]. Available from: https://play.google.com/store/apps/details?id=com.paullipnyagov.dubsteplaunchpad24 [Link discontinued]. Cited in: Psychogios, S. *Musikus: A Natural User Interface System that Enables Non-Musicians to Play and Interact with Music*. [Online]. Edinburgh: University of Edinburgh, Undergraduate 4th Year Project Report, p. 68. Available from: https://project-archive.inf.ed.ac.uk/ug4/20140597/ug4_proj.pdf [Accessed 12 March 2020].

Lipsky, D. (2013). *How People with Autism Grieve, and How to Help: An Insider Handbook.* London: Jessica Kingsley Publishers.

Living Made Easy (2018). *Soundbeam 5*. [Online]. UK: DLF Shaw Trust. Available from: http://www.livingmadeeasy.org.uk/children/musical-instruments-p/soundbeam-5-0110553-2737-information.htm [Accessed 25 May 2015].

Lonie, N. (2015). *Online Safety for Children and Teens on the Autism Spectrum: A Parent's and Carer's Guide.* London: Jessica Kingsley Publishers.

Lonsdale, A.J. and North, A.C. (2011). Why Do We Listen to Music? A Uses and Gratifications Analysis. *British Journal of Psychology*, 102(1), 108-134. DOI: 10.1348/000712610X506831

Lorimer, P.A., Simpson, R.L., Myles, B.S. and Ganz, J.B. (2002). The Use of Social Stories as a Preventative Behavioral Intervention in a Home Setting with a Child with Autism. Journal of *Positive Behavior Interventions*, 4(1), 53-60. DOI: 10.1177/109830070200400109.

Lotspeich, L.J. and Ciaranello, R.D. (1993). The Neurobiology and Genetics of Infantile Autism. *International Review of Neurobiology*, 35, 87-129. DOI: 10.1016/S0074-7742(08)60569-3.

Lovaas, I., Calouri, K. and Jada, J. (1989). The Nature of Behavioural Treatment and Research with Young Autistic Persons. In: Gillberg, C. ed. *Diagnosis and Treatment of Autism*. Proceedings of The State-Of-The-Art-Conference on Autism, Diagnosis and Treatment, Göteborg, Sweden, 8-10 May 1989. New York: Springer Science + Business Media, pp. 285-306.

Loveland, K.A., Tunali-Kotoski, B., Chen, R., Ortegon, J., Pearson, D.A., Brelsford, K.A., and Gibbs, M.C. (1997). Emotion Recognition in Autism: Verbal and Nonverbal Information. *Development and Psychopathology*, 9(3), 579-593. DOI: 10.1017/s0954579497001351.

Lowry, L. (2011). *Follow the Leader: The Power of Imitating Children with Autism*. [Online]. Canada: The Hanen Centre. Available from: http://www.hanen.org/helpful-info/articles/follow-the-leader--the-power-of-imitating-children.aspx [Accessed 10 May 2017].

LSC – The Learning and Skills Council UK (2002). *The Special Educational Needs and Disability Act 2001*. [Online]. United Kingdom: Learning and Skills Council. Available from: http://dera.ioe.ac.uk/15495/7/equality-and-diversity-guidance-02-2002-senda-2001_Redacted.pdf [Accessed 6 May 2017].

Lubet, A. (2010). *Music, Disability and Society*. Philadelphia (USA): Temple University Press.

Lucker, J.R. (2013). Auditory Hypersensitivity in Children with Autism Spectrum Disorders. *Focus on Autism and Other Neurodevelopmental Disabilities*, 28(3), 184-191. DOI: 10.1177/1088357613475810.

Lund, H.H., Henningsen, A. and Nielsen, R. (2009). Modular Robotic System as Multisensory Room in Children's Hospital. [Online]. In: Sugisaka, M. and Takaga, J. eds. *Proceedings of 14th International Symposium on Artificial Life and Robotics, Oita, Japan*. Available from: http://www.e-robot.dk/articles/AROB09_Multisensory-room-childrens-hospital.pdf [Accessed 23 March 2020].

Lyons, T. and Stagliano, K. (2015). *101 Tips for the Parents of Girls with Autism*. New York: Skyhorse Publishing. *N.B.: Two copyright years (2010, 2015) are visible and matching each of the respective authors*.

Mac, D. (2014). *Toddlers and ADHD: Relief for Parents, A Guide for Clinicians and Teachers*. Bloomington, Indiana (USA): Balboa Press.

Macdonald, R.A.R. and Miell, D. (2000). Creativity and Music Education: The Impact of Social Variables. *International Journal of Music Education*, 36, 58-68. DOI: 10.1177/025576140003600107.

Magee, W.L. and Burland, K. (2008). An Exploratory Study of the User of Electronic Music Technologies in Clinical Music Therapy. *Nordic Journal of Music Therapy*, 17(2), 124-141. DOI: 10.1080/08098130809478204.

Maguire, M., Elton, E., Osman, Z. and Nicolle, C.A. (2006). Design of a Virtual Learning Environment for Students with Special Needs. *Human Technology*, 2(1), 119-153. DOI: 10.17011/ht/um.2006162.

Mahlberg, M. (1973). Music Therapy in the Treatment of an Autistic Child. *Journal of Music Therapy*, 10(4), 189-193. DOI: 10.1093/jmt/10.4.189.

Mainela-Arnold, E., Alibali, M.W., Hostetter, A.B. and Evans, J.L. (2014). Gesture-Speech Integration in Children with Specific Language Impairments. *International Journal of Language & Communication Disorders*, 49(6), 761-770. DOI: 10.1111/1460-6984.12115.

Maister, L. and Plaisted-Grant, K.C. (2011). Time Perception and its Relationship to Memory in Autism Spectrum Conditions. *Developmental Science*, 14(6), 1311-1322. DOI: 10.1111/j.1467-7687.2011.01077.x.

Malisova, K., Mania, K., Moysiadou, S. and Kourkoutas, E. (2015). *Tangram Quests: A Tablet Adventure Game Assisting Children with High Functioning Autism to Enhance Their Communicative and Social Skills*. [Online]. Crete, Greece: Technical University of Crete, Music Department. Available from: http://www.music.tuc.gr/kmania/_latest/EDULEARN15 Malisova.pdf [Accessed 21 April 2020].

Mangano, J.J. and Sherman, J.D. (2013). Long-Term Local Cancer Reductions Following Nuclear Plant Shutdown. *Biomedicine International Journal* [Online], 4(1), 12-25. Available from: http://www.bmijournal.org/index.php/bmi/article/view/26 [Accessed 10 August 2016].

Mannes, S.M. and Kintsch, W. (1987). Knowledge Organisation and Text Organisation. *Cognition and Instruction* [Online], 4(2), 91-115. DOI: 10.1207/s1532690xci0402_2. Also available: speakeasydesigns.com/SDSU/student/640/discourse%20processing/7387991.pdf [Accessed 20 April 2020].

Manning, P. (2013). *Electronic and Computer Music*. Oxford: Oxford University Press.

Markowitz, C. (2016). Aging, Estate Planning, and Funding Services for Adults with Autism Spectrum Disorders. In: Tincani, M. and Bondy, A. eds. *Autism Spectrum Disorders in Adolescents and Adults*. Paperback Edition (first published 2014). London: The Guilford Press, pp. 288-308.

Markworth, L. (2014). Without Words: Music as Communication for Children with Autism. *Qualitative Inquiries in Music Therapy* [Online], 9, 1-V. Available from: https://www.barcelonapublishers.com/resources/QIMTV9/QIMT_2014_Markworth.pdf [Accessed 4 April 2020].

Marom, K.M., Gilboa, A. and Bodner, E. (2018). Musical Features and Interactional Functions of Echolalia in Children with Autism Within the Music Therapy Dyad. *Nordic Journal of Music Therapy*, 27(3), 175-196. DOI: 10.1080/08098131.2017.1403948.

Marsh, K.L., Isenhower, R.W., Richardson, M.J., Helt, M., Verbalis, A.D., Schmidt, R.C., and Fein, D. (2013). Autism and Social Disconnection in Interpersonal Rocking. In: Torres, E.B. and Donnellan, A.M. eds. (2015). *Autism: The Movement Perspective*. Los Angeles, California (USA): Frontiers Media, pp. 232-239.

Marshall Cavendish Corporation (2011). *Encyclopedia of Diseases and Disorders*. New York: Marshall Cavendish Corporation.

Martin, H., and Waters, K. (2016). *Jazz: The First 100 Years*. 3rd edn. (Enhanced Media Edition). London: Cengage Learning.

Martin, J. (2012). Toward Original Electronic Music in the Curriculum: Connecting Teaching to Current Compositional Practices. *International Journal of Music Education*, 30(2), 120-132. DOI: 10.1177/0255761412439924.

Martin, L.K. (2012). Applied Behavior Analysis: Introduction and Practical Application in Music Therapy for Young Children with Autism Spectrum Disorders. In: Kern, P. and Humpal, M. eds. *Early Childhood Music Therapy and Autism Spectrum Disorders*. London: Jessica Kingsley Publishers, pp. 101-116.

Martin, L.K., Snell, A.M., Walworth, D. and Humpal, M. (2012). Assessment and Goals: Determining Eligibility, Gathering Information, and Generating Treatment Goals for Music Therapy Services. In: Kern, P. and Humpal, M. eds. *Early Childhood Music Therapy and Autism Spectrum Disorders*. London: Jessica Kingsley Publishers, pp. 79-100.

Martino, L. and Bertolami, M. (2014). Using Music Technology with Children and Adolescents with Visual Impairments and Additional Disabilities. In: Magee, W. ed. *Music Technology in Therapeutic and Health Settings*. London: Jessica Kingsley Publishers, pp. 165-179.

Massey, E. and Goodman, S. (2014). *The Little Book of Mark Making: Little Books with Big Ideas.* 2nd edn. London: Featherstone Education.

Massey, N.G. and Wheeler, J.J. (2000). Acquisition and Generalization of Activity Schedules and their Effects on Task Engagement in a Young Child with Autism in an Inclusive Pre-School Classroom. *Education and Training in Mental Retardation and Developmental Disabilities* [Online], 35(3), 326-335. Available from: https://www.jstor.org/stable/23879654 [Accessed 6 May 2018].

Matasaka, N. (2017). Neurodiversity, Giftedness, and Aesthetic Perceptual Judgment of Music in Children with Autism. *Frontiers in Psychology*, 8, 1595. Available from: DOI: 10.3389/fpsyg.2017.01595.

Matasaka, N. and Perlovsky, L. (2013). Cognitive Interference Can Be Mitigated by Consonant Music and Facilitated by Dissonant Music. *Scientific Reports*, 3, 2028. DOI: 10.1038/srep02028.

Matsuda, S., Minagawa, Y. and Yamamoto, J. (2015). Gaze Behavior of Children with ASD toward Pictures of Facial Expressions. *Autism Research and Treatment*, 2015 (Article ID: 617190), 1-8. DOI:10.1155/2015/617190.

Mayes, S.D. and Calhoun, S.L. (2006). Frequency of Reading, Math, and Writing Disabilities in Children with Clinical Disorders. *Learning and Individual Differences*, 16, 145-157. DOI: 10.1016/j.lindif.2005.07.004.

Mazzaggio, G. (2019). Echolalia as a Communicative Strategy: A Kleefstra-Syndrome Case Study. *Working Papers in Linguistics and Oriental Studies*, 5, 405-427. DOI: 10.13128/QULSO-2421-7220-25975.

McCarthy, M., Carlow, R., Gabriele, K., Hall, M., Moore, J., Woody, R. and Tucker, Jr, J.L. [series editor] (2007). *Better Practice in Music Education (Volume II of Better Practice in Arts Education)*. [Online]. Baltimore, Maryland (USA): Maryland State Department of Education. Available from: http://www.aems-edu.org/PDFs/Better_Practices_Music.pdf [Accessed 20 April 2017]. *N.B.: Published in 2007 but Copyright © is accompanied by year 2003 – no edition is mentioned.*

McCarton, C. (2003). Assessment and Diagnosis of Pervasive Developmental Disorder. In: Hollander, E. ed. *Autism Spectrum Disorders*. Boca Raton, Florida (USA): CRC Press (Taylor and Francis Group), pp. 101-132.

McCleery, J.P., Elliott, N.A., Sampanis, D.S. and Stefanidou, C.A. (2013). Motor Development and Motor Resonance Difficulties in Autism: Relevance to Early Intervention for Language and Communication Skills. In: Torres, E.B. and Donnellan, A.M. eds. (2015). *Autism: The Movement Perspective*. Los Angeles, California (USA): Frontiers Media, pp. 39-58.

McCord, K. (2017). *Teaching the Postsecondary Music Student with Disabilities*. Oxford: Oxford University Press.

McCormick, C., Hepburn, S., Young, G.S. and Rogers, S.J. (2016). *Sensory Symptoms in Children with Autism Spectrum Disorder, Other Developmental Disorders and Typical Development: A Longitudinal Study.* Autism, 20, 572-9. DOI: 10.1177/1362361315599755.

McDaniel, J., Slaboch, K.D. and Yoder, P. (2018). A Meta-Analysis of the Association Between Vocalizations and Expressive Language in Children with Autism Spectrum Disorder. *Research in Developmental Disabilities*, 72, 202-213. DOI: 10.1016/j.ridd.2017.11.010.

McDermott, J. and Hauser, M. (2005). The Origins of Music: Innateness, Uniqueness, and Evolution. *Music Perception*, 23(1), 29-59. DOI: 10.1525/mp.2005.23.1.29.

McGowan, J., Leplâtre, G., McGregor, I. (2017). CymaSense: A Novel Audio-Visual Therapeutic Tool for People on the Autism Spectrum. In: *Proceedings of the 19h International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '17)*. New York: Association for Computing Machinery, pp. 62-71. DOI: 10.1145/3132525.3132539.

McKeown, S. and McGlashon, A. (2015). *Brilliant Ideas for Using ICT in the Inclusive Classroom*. Abingdon, Oxon: Routledge.

McLaughlin, B. and Adler, R.F. (2015). Music Therapy for Children with Intellectual Disabilities. In: Wheeler, B.L. ed. *Music Therapy Handbook*. New York: The Guilford Press, pp. 277-289.

McManmon, M. (2016). *Autism and Learning Differences: An Active Learning Teaching Toolkit*. London: Jessica Kingsley Publishers.

Medland, S.E., Martin, N.G., Wright, M.J., Porteous, D.J., Deary, I.J. and McIntosh, A.M. (2016). Common Polygenic Risk for Autism Spectrum Disorder (ASD) is Associated with

Cognitive Ability in the General Population. *Molecular Psychiatry*, 21, 419-425. DOI: 10.1038/mp.2015.12.

Meletis, C.D. and Barker, J.E. (2004). *Herbs and Nutrients for the Mind: A Guide to Natural Brain Enhancers.* Westport, Connecticut (USA): Praeger Publishers.

Mendelson, J., White, Y., Hans, L., Adebari, R., Schmid, L., Riggsbee, J., Goldsmith, A., Ozler, B., Buehne, K., Jones, S., Shapleton, J. and Dawson, G. (2016). A Preliminary Investigation of a Specialized Music Therapy Model for Children with Disabilities Delivered in a Classroom Setting. *Autism Research and Treatment*, 2016 (Article ID: 617190), 1-8. DOI: 10.1155/2016/1284790.

Menon, V. and Levitin, D.J. (2005). The Rewards of Music Listening: Response and Physiological Connectivity of the Mesolimbic System. *NeuroImage*, 28, 175-184. DOI: 10.1016/j.neuroimage.2005.05.053.

Menon, V., Levitin, D.J., Smith, B.K., Lembke, A., Krasnow, B.D., Glazer, D., Glover, G.H. and McAdams, S. (2002). Neural Correlates of Timbre Change in Harmonic Sounds. *Neuroimage*, 17, 1742-1754. DOI: 10.1006/nimg.2002.1295.

Mesibov, G.B., Browder, D.M. and Kirkland, C. (2002). Using Individualised Schedules as a Component of Positive Behavioral Support for Students with Developmental Disabilities. *Journal of Positive Behaviour Interventions*, 4(2), 73-79. DOI: 10.1177/109830070200400202.

Mesibov, G.B., Shea, V. and Schopler, E. [with Adams, L., Merkler, E., Burgess, S., Mosconi, M. Chapman, S.M., Tanner, C. and Van Bourgondien, M.E.] (2004). *The TEACCH Approach to Autism Spectrum Disorders*. New York: Springer.

Mesman, J., Van Ijzendoorn, M.H. and Bakermans-Kranenburg, M.J. (2009). The Many Faces of the Still-Face Paradigm: A Review and Meta-Analysis. *Developmental Review*, [no volume or pagination specified]. DOI: 10.1016/j.dr.2009.02.001.

Metzner, S. (2016). *Psychodynamic Music Therapy*. In: Edwards, J. ed. *The Oxford Handbook of Music Therapy*. Oxford: Oxford University Press.

Michels, P. (2003). *The Role of the Musical Intelligence in Whole Brain Education*. [Online]. Pretoria, South Africa: University of Pretoria. Doctoral Dissertation. Available from: https://repository.up.ac.za/handle/2263/25521 [Accessed 18 May 2018].

MidiCreator Website (n.d.). *MidiCreator*. [Online]. Link http://midicreator.com has been discontinued. Cited in: Hunt, A.D., Howard, D.M. and Worsdall, J. (2000). Real-Time Interfaces for Speech and Singing. *Proceedings of the 26th Euromicro Conference, Maastricht*, 2, 356-361. DOI: 10.1109/EURMIC.2000.874504.

Miksza, P. and Elpus, K. (2018). *Design and Analysis for Quantitative Research in Music Education.* Oxford: Oxford University Press.

Miller, A. and Chrétien, K. (2007). *The Miller Method: Developing the Capacities of Children on the Autism Spectrum*. London: Jessica Kingsley Publishers.

Miller, L.C. (2007). *Green Ideas*. [Online]. British Columbia, Canada: University of British Columbia, PhD Thesis. Available from: https://open.library.ubc.ca/cIRcle/collections/ubctheses/831/items/1.0100484 [Accessed 10 March 2018].

Miller, L.K. (2014). *Musical Savants: Exceptional Skill in the Mentally Retarded*. [Google E-Book]. New edn. (first published 1989). Hove, East Sussex: Psychology Press. Available from: https://play.google.com/books/reader?id=Bo97AgAAQBAJ&pg=GBS.PP1 [Accessed / Purchased 24 April 2018].

Milne, M., Luerssen, M., Lewis, T., Leibbrandt, R. and Powers, D. (2011). Designing and Evaluating Interactive Agents as Social Skills Tutors for Children. In: Perez-Marin, D. and Pascual-Nieto, I. eds. *Conversational Agents and Natural Language Interaction: Techniques and Effective Practices*. Hershey, Pennsylvania (USA): Information Science Reference (an imprint of IGI Global), pp. 23-49.

Mitchell, M.L. and Jolley, J.M. (2010). *Research Design Explained*. Belmont, California (USA): Wadsworth, Cengage Learning.

Miyazaki, K. (1993). Absolute Pitch as an Inability: Identification of Musical Intervals in a Tonal Context. *Music Perception* [Online], 11(1), 55-72. Available from: http://www.jstor.org/stable/40285599 [Accessed 10 March 2018].

Miyazaki, K. (1995). Perception of Relative Pitch with Different References: Some Absolute-Pitch Listeners Can't Tell Musical Interval Names. *Perception & Psychophysics*, 57(7), 962-970. DOI: 10.3758/BF03205455.

Moat, D. (2013). *Integrative Psychotherapeutic Approaches to Autism Spectrum Conditions*. London: Jessica Kingsley Publishers.

Møller, A.S., Odell-Miller, H. and Wigram, T. (2002). Indications in Music Therapy: Evidence from Assessment That Can Identify the Expectations of Music Therapy as a Treatment for Autistic Spectrum Disorder (ASD): Meeting the Challenge of Evidence Based Practice. *British Journal of Music Therapy* [Online], 16(1), 11-28. DOI: 10.1177/135945750201600104. *N.B.: The text only refers Wigram, T. as the author, but the main page in the Sage Publications website states all three authors mentioned at the start of the citation.*

Molnar-Szakacs, I. and Heaton, P. (2012). Music: A Unique Window into the World of Autism. *Annals of New York Academy of Sciences*, 1252(1), 318-324. DOI: 10.1111/j.1749-6632.2012.06465.x.

Molnar-Szakacs, I. and Ovary, K. (2006). Music and Mirror Neurons: From Motion to 'E'motion. *Society of Cognitive and Affective Neuroscience*, 1(3), 235-241. DOI: 10.1093/scan/nsl029.

Monteith, K., Martinez, T. and Ventura, D. (2012). Automatic Generation of Melodic Accompaniments for Lyrics. [Online]. In: Maher, M.L., Hammond, K., Pease, A., Pérez y Pérez, R., Ventura, D. and Wiggins, G. eds. *Proceedings of the Third International Conference on Computational Creativity, Dublin, Ireland, May 30-June 1, 2012*. Dublin, Ireland: University College Dublin, pp. 86-94. Available from: http://www.computationalcreativity.net/proceedings/ICCC-2012-Proceedings.pdf [Accessed 15 May 2018].

Monteith, K.P. (2012). *Automatic Generation of Music for Inducing Emotive and Physiological Responses.* [Online]. Provo, Utah (USA): Brigham Young University. PhD Dissertation. Available from: http://scholarsarchive.byu.edu/cgi/viewcontent.cgi?article=4752&context=etd [Accessed 27 August 2017].

Monville, D.K. and Nelson, N. (2014). Parental Viewpoints on Change Following Auditory Integration Training for Autism. *Speech-Language Pathology*, 3(2), 41-53. Available from: https://pubs.asha.org/doi/10.1044/1058-0360.0302.41 [Accessed 20 April 2020].

Moreno, S., Bialystok, E., Barac, R., Schellenberg, E.G., Cepeda, N.J. and Chau, T.C. (2009). Short-Term Music Training Enhances Verbal Intelligence and Executive Function. *Psychological Science*, 22(11), 1425-1433. DOI: 10.1177/0956797611416999.

Morgan, G.A. and Griego, O.V. (1998). *Easy Use and Interpretation of SPSS for Windows: Answering Research Questions with Statistics.* London: Lawrence Erlbaum Associates Publishers.

Mottron, L., Peretz, I. and Ménard, L. (2000). Local and Global Processing of Music in High-Functioning Persons with Autism: Beyond Central Coherence? *Journal of Child Psychology and Psychiatry*, 41(8), 1057-1065. DOI: 10.1111/1469-7610.00693.

Mottron, L., Peretz, I., Belleville, S. and Rouleau, N. (1999). Absolute Pitch in Autism: A Case Study. *Neurocase*, 5, 485-501. DOI: 10.1080/13554799908402744.

Moyes, R.A. (2002). *Addressing the Challenging Behaviour of Children with High-Functioning Autism/Asperger Syndrome in the Classroom: A Guide for Teachers and Parents.* London: Jessica Kingsley Publishers.

Mudford, O.C., Cross, B.A., Breen, S., Cullen, C., Reeves, D., Gould, J. and Douglas, J. (2000). Auditory Integration Training for Children with Autism: No Behavioral Benefits Detected. *American Journal on Mental Retardation*, 105(2), 118-129. DOI: 10.1352/0895-8017.

Muhle, R., Trentacoste, S.V. and Rapin, I. (2004). The Genetics of Autism. *Pediatrics*, 113(5), e472-86. DOI: 10.1542/peds.113.5.e472.

Murphy, C.M., Wilson, C.E., Robertson, D.M., Ecker, C., Daly, E.M., Hammond, N., Galanopoulos, A., Dud, I., Murphy, D.G. and McAlonan, G.M. (2016). Autism Spectrum Disorder in Adults: Diagnosis, Management, and Health Servieces Development. *Neuropsychiatric Disease and Treatment*, 12: 1669-1686. DOI: 10.2147/NDT.S65455.

Musacchia, G., Sams, M., Skoe, E. and Kraus, N. (2007). Musicians Have Enhanced Subcortical Auditory and Audio-visual Processing of Speech and Music. *Proceedings of the National Academy of Sciences USA*, 104(40), 15894-8. DOI: 10.1073/pnas.0701498104.

Naftaly, N. (2008). Classroom Modifications. In: Simon, S.R., Forrest, L. and Fishman, E. eds. *V'khol Banayikh: Jewish Education for All*. Los Angeles, California (USA): Torah Aura Productions, pp. 289-304.

Najdowski, A.C. (2014). Introduction to the Center for Autism and Related Disorders Curriculum Series. In: Granpeesheh, D., Talbox, J., Najdowski, A.C. and Kornack, J. eds. *Evidence-Based Treatment for Children with Autism: The CARD Model*. Kidlington, Oxford: Academic Press (an imprint of Elsevier), pp. 191-202.

NAS / National Autistic Society UK (2018). *Meltdowns*. [Online]. Available from: http://www.autism.org.uk/about/behaviour/meltdowns.aspx [Accessed 20 May 2018].

Nason, B. (2014). *The Autism Discussion Page on the Core Challenges of Autism: A Toolbox for Helping Children with Autism feel Safe, Accepted, and Competent.* London: Jessica Kingsley Publishers.

Nath, A. and Young, S. (2015). VESBALL: A Ball-Shaped Instrument for Music Therapy. [Online]. *Proceedings of the International Conference on New Interfaces for Musical Expression, Baton Rouge, LA, USA, May 31-June 3, 2015*. Available from: https://www.nime.org/proceedings/2015/nime2015_252.pdf [Accessed 25 March 2020].

Nauert, R. (2018). *Autistic Kids Tend to Imitate 'Efficiently', not 'Socially'.* [Online]. Psych Central Website. Available from: http://psychcentral.com/news/2013/04/09/autistic-kids-tend-to-imitate-efficiently-not-socially/53604.html [Accessed 15 April 2020].

Nemesh, B. (2016). Family-Based Music Therapy: From Dissonance to Harmony. *Nordic Journal of Music Therapy*, 26(2), 1-18. DOI: 10.1080/08098131.2016.1144638.

Nind, M. and Hewett, D. (2012). *Access to Communication: Developing Basic Communication with People Who Have Severe Learning Difficulties*. 2nd edn. (First Edition 1994). Abingdon, Oxon: David Fulton Publishers.

Njiokiktjien, C., Verschoor, A., De Sonneville, L, Huyser, C., Op het Veld, V. and Toorenaar, N. (2001). Disordered Recognition of Facial Identity and Emotions in Three Asperger Type Autists. *European Child and Adolescent Psychiatry*, 10(79), 79-90. DOI: 10.1007/s007870170050.

Nordoff, P. and Robbins, C. (1971). Music Therapy in Special Education. *Music Therapy*, 8(4), 168-169. DOI: 10.1093/jmt/8.4.168-a.

Nordoff, P. and Robbins C. (1977). *Creative Music Therapy: Individualised Treatment for the Handicapped Child*. New York: John Day Co.

Norman, K. (2004). *Sounding Art: Eight Literary Excursions through Electronic Music*. Aldershot: Ashgate Publishing Ltd.

Norman, K. (2012a). *Katherine Norman*. [Online]. Available from: http://www.novamara.com/ [Accessed 26 April 2017].

Norman, K. (2012b). *Window.* [Online Application]. Available from: http://www.novamara.com/KNpageN/window/desktop.html [Accessed 26 April 2017].

Norman, S. (2003). *Transforming Learning: Introducing SEAL Approaches*. London: Saffire Press (on behalf of SEAL – Society for Effective Affective Learning).

North, A.C. and Hargreaves, D.J. (2005). Brief Report: Labelling Effects on the Perceived Deleterious Consequences of Pop Music Listening. *Journal of Adolescence*, 28, 433-440. DOI: 10.1016/j.adolescence.2004.09.003.

Notas, S. (2006). *Parents and Siblings of Children with Autism: Pervasive Developmental Disorders [Οι γονείς & τα αδέρφια των παιδιών με αυτισμό: Διάχυτες Αναπτυξιακές Διαταραχές] [Greek Language]*. [Online]. Athens (Greece): National Documentation Centre / Hellenic Ministry of Education and Religious Affairs. Available from: http://repository.edulll.gr/edulll/handle/10795/290 [Accessed 20 April 2020].

Notbohm, E. and Zysk, V. (2010). *1001 Great Ideas for Teaching and Raising Children with Autism or Asperger's*. 2nd edn. Arlington, Texas (USA): Future Horizons.

Nwora, J.A. and Gee, B.M. (2009). A Case Study of a Five-Year-Old Child with Pervasive Developmental Disorder-Not Otherwise Specified Using Sound-Based Interventions. *Occupational Therapy International*, 16(1), 25-43. DOI: 10.1002/oti.263.

Nyman, M. (1999). *Experimental Music: Cage and Beyond*. 2nd edn. Cambridge: Cambridge University Press.

O'Connor, J.R. and Jackson, K.N. (2016). The Use of iPad® Devices and "Apps" for ASD Students in Special Education and Speech Therapy. In: Kats, Y. ed. *Supporting the Education of Children with Autism Spectrum Disorders.* Philadelphia, Pennsylvania (USA): IGI Global, pp. 267-283.

O'Malley, A.G. (2015). *The Art of BART: Bilateral Affective Reprocessing of Thoughts as a Dynamic Model for Psychotherapy.* London: Karnac Books.

O'Neill, J.L. (2005). *Through the Eyes of Aliens: A Book about Autistic People*. 6th impression (first published 1999). London: Jessica Kingsley Publishers.

Ockelford, A. (2000). Music in the Education of Children with Severe or Profound Learning Difficulties: Issues in Current U.K. Provision, A New Conceptual Framework, and Proposals for Research. *Psychology of Music*, 28(2), 197-217. DOI: 10.1177/0305735600282009.

Ockelford, A. (2006). Using a Music-Theoretical Approach to Explore the Impact of Disability on Musical Development: A Case Study. In: Lerner, N. and Straus, J. eds. *Sounding Off: Theorizing Disability in Music*. Abingdon, Oxon: Routledge, pp. 137-156.

Ockelford, A. (2013a). *Applied Musicology: Using Zygonic Theory to Inform Music Education, Therapy, and Psychology Research*. Oxford: Oxford University Press.

Ockelford, A. (2013b). *Music, Language and Autism: Exceptional Strategies for Exceptional Minds*. London: Jessica Kingsley Publishers.

Ockelford, A. (2016a). Prodigious Musical Talent in Blind Children with Autism and Learning Difficulties: Identifying and Educating Potential Musical Savants. In: McPherson, G. ed. *Musical Prodigies: Interpretations from Psychology, Education, Musicology & Ethnomusicology*. Oxford: Oxford University Press, pp. 471-495.

Ockelford, A. (2016b). Through a Glass, Vividly: Shedding Light on the Extraordinary Musical Journeys of Some Children on the Autism Spectrum. In: Papageorgi, I. and Welch, G. eds. *Advanced Musical Performance: Investigations in Higher Education Learning*. 2nd edn. Abingdon, Oxon: Routledge, pp. 143-170.

Ockelford, A., Welch, G., Jewell-Gore, L., Cheng, E., Vogiatzoglou, A. and Himonides, E. (2011). Sounds of Intent, Phase 2: Gauging the Music Development of Children with Complex Needs. *European Journal of Special Needs Education*, 26(2), 177-199. DOI: 10.1080/08856257.2011.563606.

Oconnell, A. (2015). *Speech Therapy: What You Need to Know About Speech Therapy for Autism, Speech Therapy for Adults and More*. [Google E-Book]. Egham: Lulu Enterprises. Available from: https://play.google.com/books/reader?id=0h98CgAAQBAJ [Accessed / Purchased 12 May 2017].

Oldfield, A. (2006a). *Interactive Music Therapy – A Positive Approach: Music Therapy at a Child Development Centre*. London: Jessica Kingsley Publishers.

Oldfield, A. (2006b). *Interactive Music Therapy in Child and Family Psychiatry: Clinical Practice, Research and Teaching*. London: Jessica Kingsley Publishers.

Oliver, M. (1984). The Politics of Disability. *Critical Social Policy*, 4(11). DOI: 10.1177/026101838400401103.

Oliver, M. (1990). *The Individual and Social Models of Disability*. [Online]. Paper presented ad Joint Workshop of the Living Options Group and the Research Unit of the Royal College of Physicians (London). Available from: http://disability-studies.leeds.ac.uk/files/library/Oliver-in-soc-dis.pdf [Accessed 25 November 2017].

Oliver, M. (1997). The Disability Movement is a New Social Movement! *Community Development Journal*, 32(3), 244-251. DOI: 10.1093/cdj/32.3.244.

Oliver, M., Sapey, B. and Thomas, P. (2012). *Social Work with Disabled People*. 4th edn. London: Palgrave Macmillan.

Oller, J.W. and Oller, S. (2010). *Autism: The Diagnosis, Treatment and Etiology of the Undeniable Epidemic*. London: Jones and Bartlett Publishers.

Olley, J.G. (1999). Curriculum for Students with Autism. *School Psychology Review* [Online], 28(4), 595-607. DOI: 10.1080/02796015.1999.12085987.

Olm, A., Knight, S. and Petrov, M. (2010). *FileMaker Web Publishing: A Complete Guide to Using the API for PHP*. Plano, Texas (USA): Wordware Publishing.

Omigie, D., Pearce, M.T., Williamson, V.J. and Stewart, L. (2013). Electrophysiologial Correlates of Melodic Processing in Congenital Amusia. *Neuropsychologia*, 51(9), 1749-62. DOI: 10.1016/j.neuropsychologia.2013.05.010.

Onassis Foundation (2019). *Music Loves Autism*. [Online]. Athens (Greece): Onassis Foundation and Cultural Centre. Available from: https://www.onassis.org/whats-on/music-loves-autism [Accessed 20 April 2020].

Orr, T.J., Myles, B.S. and Carlson, J.K. (1998). The Impact of Rhythmic Entrainment on a Person with Autism. *Focus on Autism and Other Developmental Disabilities*, 13(3), 163-166. DOI: 10.1177/108835769801300304.

Ostiz-Blanco, M., Calafi, A.P., Azcárate, M.L. and Carrión, S.G. (2016). ACMUS: Comparative Assessment of a Musical Multimedia Tool. In: Bottino, R., Jeuring, J. and Veltkamp, R.C. eds. *Games and Learning Alliance*. Proceedings of the 5th International Conference, GALA 2016, Utrecht, The Netherlands, December 5-7, 2016. Cham, Switzerland (USA): Springer International Publishing, pp. 321-330.

Padmanaban, N. and Molner, K. (2016). *Explorations in Spatial Audio and Perception for Virtual Reality*. [Online]. Stanford, California (USA): Stanford University. Course Report.

Available from: web.stanford.edu/class/ee267/Spring2016/report_padmanaban_molner.pdf [Accessed 15 April 2020].

Pahl, K. and Rowsell, J. (2005). *Literacy and Education: Understanding the New Literacy Studies in the Classroom*. London: Paul Chapman Publishing (a SAGE Publications company).

Papoušek, M. (1995). Origins of Reciprocity and Mutuality in Prelinguistic Parent-Infant 'Dialogues'. In: Markova, I., Graumann, C.F. and Foppa, K. eds. *Mutualities in Dialogue*. Cambridge: Cambridge University Press, pp. 58-81.

Parenting Aspergers Community (2008). *Do Children with Asperger's Ever Relax?* [Online]. USA: Parenting Aspergers Community. Available from: http://www.parentingaspergerscommunity.com/members/Do-children-with-Aspergers-ever-relax.cfm [Accessed 8 April 2017].

Parra-Damborenea, J. (2014). *Reactblocks: A 3D Tangible Interface for Music Learning*. [Online]. Barcelona (Spain): Pompeu Fabra University. Available from: http://mtg.upf.edu/node/3085 [Accessed 24 March 2020].

Parsons, C.L. and La Sorte, D. (2014). The Effect of Computers with Synthesized Speech and No Speech on the Spontaneous Communication of Children with Autism. *Australian Journal of Human Communication Disorders*, 21(1), 12-31. DOI: 10.3109/asl2.1993.21.issue-1.02.

Parsons, T.D. (2014). Virtual Teacher and Classroom for Assessment of Neurodevelopmental Disorders. In: Lewis Brooks, A., Brahnam, S. and Jain, L.C. eds. *Technologies of Inclusive Well-Being: Serious Games, Alternative Realities, and Play Therapy.* Berlin / Heidelberg / London: Springer, pp. 121-138.

Pasiali, V. (2004). The Use of Prescriptive Therapeutic Songs in a Home-Based Environment to Promote Social Skills Acquisition by Children with Autism: Three Case Studies. *Music Therapy Perspectives*, 22, 11-20. DOI: 10.1093/mtp/22.1.11.

Patel, A.D. (2003). Language, Music, Syntax and the Brain. *Nature Neuroscience*, 6, 674-681. DOI: 10.1038/nn1082.

Patel, A.D. (2008). *Music, Language, and the Brain.* Oxford: Oxford University Press.

Patel, A.D. and Greydanus, D.E. (2012). *Autism Spectrum Disorders: Practical Overview for Pediatricians*. Philadelphia, Pennsylvania (USA): W.B. Saunders (an imprint of Elsevier).

Patel, A.D., Wong, M., Foxton, J., Lochy, A. and Peretz, I. (2008). Speech Intonation Perception Deficits in Musical Tone Deafness (Congenital Amusia). *Music Perception*, 25(4), 357-368. DOI: 10.1525/mp.2008.25.4.357.

Paul, R. (2005). Assessing Communication in Autism Spectrum Disorders. In: Volkmar, F.R., Paul, R., Klin, A. and Cohen, D.J. eds. *Handbook of Autism and Pervasive Developmental Disorders – Volume Two: Assessment, Interventions, and Policy*. 3rd edn. Hoboken, New Jersey (USA): John Wiley & Sons, pp. 799-816.

Paul, R. (2008a). Communication Development and Assessment. In: Chawarska, K., Klin, A. and Volkmar, F.R. eds. *Autism Spectrum Disorder in Infants and Toddlers: Diagnosis, Assessment, and Treatment*. London: The Guilford Press, pp. 76-103.

Paul, R. (2008b). Interventions to Improve Communication. *Child and Adolescent Psychiatric Clinics of North America*, 17(4), 835-x. DOI: 10.1016/j.chc.2008.06.011.

Pavone, L. and Ruggieri, M. (2005). The Problem of Alternative Therapies in Autism. In: Coleman, M. ed. *The Neurology of Autism*. Oxford: Oxford University Press, pp. 173-200.

Paynter, J. (2008). The School Council Secondary Music Project (1973-82). In: Mills, J. and Paynter, J. *Thinking and Making: Selections from the Writings of John Paynter on Music in Education*. Oxford: Oxford University Press, pp. 51-82.

Pelayo, J.M.G. and Sanchez, C.S. (2009). *Music Therapy with Autistic Children: A Multiple Case Study*. [Online]. Angeles City (Philippines): Systems Plus College Foundation. Available from: http://files.eric.ed.gov/fulltext/ED544079.pdf [Accessed 17 January 2016].

Peng, Y.H., Lin, C.W., Mayer, N.M. and Wang, M.L. (2014). Using a Humanoid Robot for Music Therapy with Autistic Children. *Proceedings of the 2014 CACS International Automatic Control Conference, November 26-28, Ambassador Hotel, Kaohsiung, Taiwan*, pp. 156-160. DOI: 10.1109/CACS.2014.7097180.

Peres, S.C., Best, V., Brock, D., Shian-Cunningham, B., Frauenberger, C., Hermann, T., Neuhoff, J.G., Nickerson, L.V. and Stockman, T. (2008). *Auditory Interfaces*. In: Kortum, P. ed. *HCI beyond the GUI: Design for Haptic, Speech, Olfactory, and Other Nontraditional Interfaces*. Burlington, Massachusetts (USA) / London: Morgan Kauffmann Publishers (an imprint of Elsevier), pp. 147-196.

Peretz, I. (2006). The Nature of Music from a Biological Perspective. *Cognition* [Online], 100, 1-32. Available from: http://eamusic.dartmouth.edu/~larry/music1052008/readings/peretz.pdf [Accessed 15 February 2016].

Peretz, I. and Hyde, K.L. (2003). What is Specific to Music Processing: Insights from Congenital Amusia. *Trends in Cognitive Sciences* 7(8), 362-367. DOI: 10.1016/S1364-6613(03)00150-5.

Perle, G. (1991). *Serial Composition and Atonality: An Introduction to the Music of Schoenberg, Berg, and Webern*. Los Angeles, California (USA) / Oxford: University of California Press.

Pfenning, N. (2011). *Elementary Statistics: Looking at the Big Picture*. Boston, Massachusetts (USA): Brooks/Cole, Cengage Learning.

Pfurtscheller, G., Leeb, R., Faller, J. and Neuper, C. (2011). *Brain-Computer Interface Systems Used for Virtual Reality Control.* [Online]. Open-Access Peer-Reviewed Chapter. London: IntechOpen. Available from: https://www.intechopen.com/books/virtual-reality/brain-computer-interface-systems-used-for-virtual-reality-control [Accessed 18 April 2018].

Phelps, R.P., Sadoff, R.H., Ferrara, L. and Warburton, E.C. (2005). *A Guide to Research in Music Education.* Oxford: Scarecrow Press.

Pierangelo, R. and Giuliani, G. (2008). *Teaching Students with Autism Spectrum Disorders: A Step-By-Step Guide for Educators*. London: Corwin Press (a SAGE company).

Ploog, B.O., Scharf, A., Nelson, D. and Brooks, P.J. (2013). Use of Computer-Assistive Technologies (CAT) to Enhance Social, Communicative, and Language Development in Children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, 43, 301-322. DOI: 10.1007/s10803-012-1571-3.

Pollock III, P.H. (2012). *An IBM SPSS® Companion to Political Analysis.* 4th edn. Washington, DC (USA): CQ Press (a division of Sage).

Potidis, S. and Spyrou, T. (2014). Spyractable: A Tangible User Interface Modular Synthesizer. In: Kurosu, M. ed. *Human-Computer Interaction: Advanced Interaction Modalities and Techniques. Proceedings of the 16th International Conference, HCI International 2014, Heraklion, Crete, Greece, June 22-27, 2014*. Cham (Switzerland): Springer, pp. 600-611. DOI: 10.1007/978-3-319-07230-2_57.

Powell, T. (2016). *Recognising Asperger's Syndrome (Autism Spectrum Disorder): Practical Guide to Adult Diagnosis and Beyond*. Abingdon, Oxon: Routledge.

Preis, J., Amon, R., Robinette, D.S. and Rozegar, A. (2016). Does Music Matter? The Effects of Background Music on Verbal Expression and Engagement in Children with Autism Spectrum Disorders. *Music Therapy Perspectives*, 34(1), 106-115. DOI: 10.1093/mtp/miu044.

Presley, C., Gonzalez, A.X., Zawadzki, M. and Brady, L.J. (2011). *Speak, Move, Play and Learn with Children on the Autism Spectrum: Activities to Boost Communication Skills, Sensory Integration and Coordination Using Simple Ideas from Speech and Language Pathology and Occupational Therapy*. London: Jessica Kingsley Publishers.

Priestley, M. (1999). *Disability Politics and Community Care*. London: Jessica Kingsley Publishers. Abstract of book accessed Online. Available from: https://books.google.gr/books/about/Disability_Politics_and_Community_Care.html?id=1HZvzkJ-hxcC&redir_esc=y [Accessed 15 July 2015].

Pritchett, J. (1996). *The Music of John Cage*. 1st Paperback edn. Cambridge: Cambridge University Press.

Prizant, B. (1983). Language Acquisition and Communicative Behaviour in Autism: Toward an Understanding of the 'Whole' of It. *Journal of Speech and Hearing Disorders* [Online], 48, 296-307. Available from: http://barryprizant.com/wp-content/uploads/2015/07/whole_of_it_1983_jshd.pdf [Accessed 20 April 2020].

Prizant, B.M. and Rydell, P.J. (1984). Analysis of Functions of Delayed Echolalia in Autistic Children. *Journal of Speech and Hearing Research* [Online], 27, 183-192. Available from: http://barryprizant.com/wp-content/uploads/2015/07/functions_de_1984.pdf [Accessed 25 July 2016].

Prizant, B.M. and Wetherby, A.M. (2005). Critical Issues in Enhancing Communication Abilities for Persons with Autism Spectrum Disorders. In: Volkmar, F.R., Paul, R., Klin, A. and Cohen, D. eds. *Handbook of Autism and Pervasive Developmental Disorders: Assessment, Interventions, and Policy*. 3rd edn. London: John Wiley & Sons. DOI: 10.1002/9780470939352.ch10.

Prizant, B.M., Wetherby, A.M., Rubin, E. and Laurent, A.C. (2003). The SCERTS Model: A Transactional, Family-Centered Approach to Enhancing Communication and Socioemotional

Abilities of Children with Autism Spectrum Disorder. *Infants and Young Children*, 16(4), 296-316. DOI: 10.1097/00001163-200310000-00004.

Psychogios, S. (2014). *Musikus: A Natural User Interface System that Enables Non-Musicians to Play and Interact with Music*. [Online]. Edinburgh: University of Edinburgh, Undergraduate 4th Year Project Report. Available from: https://project-archive.inf.ed.ac.uk/ug4/20140597/ug4_proj.pdf [Accessed 14 April 2017].

Purtell, R. (2013). Music and the Social Model of Disability. In: Williams, J. ed. *Music and the Social Model: An Occupational Therapist's Approach to Music with People Labelled as Having Learning Disabilities*. London: Jessica Kingsley Publishers, pp. 26-32.

Quill, K.A. (1995). *Teaching Children with Autism: Strategies to Enhance Communication and Socialisation.* London: Delmar Publishers.

Quinn, B.H. and Malone, A. (2011). *Autism, Asperger Syndrome and Pervasive Developmental Disorder: An Altered Perspective*. 2nd edn. London: Jessica Kingsley Publishers.

Quintin, E-M., Bhatara, A., Poissant, H., Fombonne, E. and Levitin, D.J. (2011). Emotion Perception in Music in High-Functioning Adolescents with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, 41(9), 1240-1255. DOI: 10.1007/s10803-010-1146-0.

Radocy, E.R., Boyle, D.J. (2012). *Psychological Foundations of Musical Behaviour*. 5th edn. Springfield, Illinois (USA): Charles C. Thomas Publisher Ltd.

Raja, M., Azzoni, A. and Frustaci, A. (2011). Autism Spectrum Disorders and Suicidality. *Clinical Practice & Epidemiology in Mental Health*, 7, 97-105. DOI: 10.2174/1745017901107010097.

Rakowski, A. (1989). Pitch as a Communication-Code Medium in Music. [Online]. In: Pravica, P. and Dragulic, G. eds. *13. International Congress on Acoustics, Volume III, Themes 6,7,8,9*. Novi Beograd (Belgrade), Serbia: Sava Centar, pp. 3-6. Available from: https://www.icacommission.org/Proceedings/ICA1989Belgrade/ICA13%20Proceedings%20Vol3.pdf [Accessed 27 March 2018].

Rao, P. A. and Landa, R.J. (2014). Association Between Severity of Behavioural Phenotype and Comorbid Attention Deficit Hyperactivity Disorder Symptoms in Children with Autism Spectrum Disorders. *Autism*, 18(3), 272-280. DOI: 10.1177/1362361312470494.

Reactable Systems SL (2020). *Reactable Live! S6*. [Online]. Available from: http://reactable.com/live/ [Accessed 12 April 2020].

Regan, T. (2016). *Understanding Autism in Adults and Aging Adults: Improving Diagnosis and Quality of Life*. USA: Indiego Publishing.

Reichow, B. and Volkmar, F.R. (2010). Social Skills Interventions for Individuals with Autism: Evaluation for Evidence-Based Practices within a Best Evidence Synthesis Framework. *Journal of Autism and Developmental Disorders*, 40(2), 149-166. DOI: 10.1007/s10803-009-0842-0.

Reitan, L. (1992). Does It Really Mean Anything? Some Aspects of Musical Meaning. In: Paynter, J., Howell, T., Orton, R. and Seymour, P. eds. *Companion to Contemporary Musical Thought, Volume 2*. London: Routledge, pp. 625-633.

Remington, A. and Fairnie, J. (2017). A Sound Advantage: Increased Auditory Capacity in Autism. *Cognition* 166, 459-465. DOI: 10.1016/j.cognition.2017.04.002.

Rentfrow, P.J. and Gosling, S.D. (2003). The Do Re Mi's of Everyday Life: The Structure and Personality Correlates of Music Preferences. *Journal of Personality and Social Psychology*, 84, 1236-1256. DOI: 10.1037/0022-3514.84.6.1236.

Renwick, J.M. and Reeve, J. (2012). Supporting Motivation in Music Education. In: McPherson, G.E. and Welch, G.F. eds. *The Oxford Handbook of Music Education, Volume 1*. Oxford / New York: Oxford University Press, pp. 143-162.

Reynolds, E. (2016). *'What Can Music Do?' Rethinking Autism Through Music Therapy*. [Online]. New York: New York University. Available from: https://www.nyu.edu/about/news-publications/news/2016/july/autism-and-neurodiversity-at-nordoff-robbins-center-for-music-th.html [18 April 2020].

Reynolds, B.S. and Hayes, L.J. (2017). Parallels and Incongruities between Musical and Verbal Behaviors. *The Psychological Record*, 67(3), 413-421. DOI: 10.1007/s40732-017-0221-8.

Richman, S. (2006). *Encouraging Appropriate Behavior for Children on the Autism Spectrum: Frequently Asked Questions*. London: Jessica Kingsley Publishers.

Rickard, N.S., Wong, W.W. and Velik, L. (2012). Relaxing Music Counters Heightened Consolidation of Emotional Memory. *Neurobiology of Learning and Memory*, 97, 220-228. DOI: 10.1016/j.nlm.2011.12.005.

Ridder, H.M. (2005). An Overview of Therapeutic Initiatives when Working with People Suffering from Dementia. In: Aldridge, D. ed. *Music Therapy and Neurological Rehabilitation: Performing Health*. London: Jessica Kingsley Publishers, pp. 61-82.

Riggs, D.Y. (2013). *Music Helps Autism*. Williston, North Dakota (USA): Perfect Praise Publishing.

Rigler, M., Rutherford, A. and Quinn, E. (2016). *Developing Workplace Skills for Young Adults with Autism Spectrum Disorder: The Basics College Curriculum*. London: Jessica Kingsley Publishers.

Riley-Hall, E. (2012). *Parenting Girls on the Autism Spectrum: Overcoming the Challenges and Celebrating the Gifts*. London: Jessica Kingsley Publishers.

Rimland, B. and Fein, D. (1988). Special Talents of Autistic Savants. In: Obler, L.K. and Fein. D. eds. *The Exceptional Brain: Neuropsychology of Talent and Special Abilities*. New York: Guilford Press, pp. 474-492. Cited in: Remington, A. and Fairnie, J. (2017). A Sound Advantage: Increased Auditory Capacity in Autism. *Cognition*, 166, 459-465 (citation in p. 464). DOI: 10.1016/j.cognition.2017.04.002.

Rinehart, N., McDonald, R., Stanley-Cary, C. and McGinley, J.L. (2013). Rehabilitation of Developmental Disorders and Motor Dysfunction. In: Iansek, R. and Morris, M.E. eds. *Rehabilitation in Movement Disorders*. Cambridge: Cambridge University Press, pp. 217-230.

Rizqayan, M. and Hermawan, G. (2015). Adventure Game as Learning Media for Introducing Music Interval and Ear Training to Kids. *Proceedings of the 2015 International Conference on Automation, Cognitive Science, Optics, Micro Electro-Mechanical System, and Information Technology (ICACOMIT), Bandung, Indonesia, 29-30 October, 2015*. DOI: 10.1109/ICACOMIT.2015.7440200.

Rizzolatti, G. and Craighero, L. (2004). The Mirror-Neuron System. *Annual Review of Neuroscience*, 27, 169-192. DOI: 10.1146/annurev.neuro.27.070203.144230.

Roads, C. (2004). *Microsound*. 1st Paperback edition (previously published 2001). Cambridge, Massachusetts (USA) / London: The MIT Press.

Roberts, A.L. (2019). *Music and Music Therapy and its Effects on Students with Autism Spectrum Disorders*. [Online]. St. Cloud, Minnesota (USA): St. Cloud State University. Master's Thesis. Available from:

https://repository.stcloudstate.edu/cgi/viewcontent.cgi?article=1093&context=sped_etds [Accessed 20 April 2020].

Roberts, C., Wakefield, G. and Wright, M. (2013). The Web Browser as Synthesizer and Interface. In: Jensenius, A.R. and Lyons, M.J. eds. (2017). *A NIME Reader: Fifteen Years of New Interfaces for Musical Expression*. Cham (Switzerland): Springer, pp. 433-450.

Roberts, K.D. (2010). Topic Areas to Consider When Planning Transition from High School to Postsecondary Education for Students with Autism Spectrum Disorders. *Focus on Autism and Other Developmental Disabilities*, 25(3), 158-162. DOI: 10.1177/1088357610371476.

Robertson, A. (2019). Shared Experience: Learning from Other Modalities in Therapeutic Work with an Adult with Autism Spectrum Condition. In: Dunn, H., Coombes, E., Maclean, E., Mottram, H. and Nugent, J. eds. *Music Therapy and Autism Across the Lifespan: A Spectrum of Approaches.* London: Jessica Kingsley Publishers, pp. 155-178.

Robertson, M. (2017). *Music, Autism and Skoog*. [Online]. Skoog Music Website / Blog. Available from: http://skoogmusic.com/blog/music-autism-skoog/ [Accessed 8 May 2017].

Robson, C. (2002). *Real World Research: A Resource for Social Scientists and Practitioner-Researchers*. 2nd edn. Oxford: Blackwell Publishing.

Robson, C. and McCartan, K. (2016). *Real World Research*. 4th edn. London: John Wiley & Sons.

Rogers, S.J. and Dawson, G. (2010). *Early Start Denver Model for Young Children with Autism: Promoting Language, Learning, and Engagement*. New York: The Guilford Press.

Rogers, S.J., Dawson, G. and Vismara, L.A. (2012). *An Early Start for Your Child with Autism: Using Everyday Activities to Help Kids Connect, Communicate and Learn*. New York: The Guilford Press.

Romano, M., Truzoli, R., Osborne, L.A. and Reed, P. (2014). The Relationship between Autism Quotient, Anxiety, and Internet Addiction. *Research in Autism Spectrum Disorders*, 8(11), 1521-1526. DOI: 10.1016/j.rasd.2014.08.002.

Rosenthal, J.A. (2012). *Statistics and Data Interpretation for Social Work.* New York: Springer.

Rosner, B. (2011). *Fundamentals of Biostatistics*. 7th edn. Boston, Massachusetts (USA): Brooks / Cole, Cengage Learning.

Rosset, D., Santos, A., Da Fonseca, D., Rondan, C., Poinso, F. and Deruelle, C. (2011). More Than Just Another Face in the Crowd: Evidence for an Angry Superiority Effect in Children With and Without Autism. *Research in Autism Spectrum Disorders*, 5(2), 949-956. DOI: 10.1016/j.rasd.2010.11.005.

Rothwell, N. (2014). *Skoogmusic Skoog Control Interface: What Applications Could this Unusual Control Surface Have for the Studio or the Stage Musician?* [Product Review] [Online]. Sound on Sound (SOS) Magazine, November 2014. Cambridge: SOS Publications. Available from: http://www.soundonsound.com/reviews/skoogmusic-skoog [Accessed 14 May 2017].

Russell, J.A. (2018). *Statistics in Music Education Research.* Oxford: Oxford University Press.

Russo, N., Larsson, C. and Kraus, N. (2008). Audio-Vocal System Regulation in Children with Autism Spectrum Disorders. *Experimental Brain Research*, 188(1), 111-124. DOI: 10.1007/s00221-008-1348-2.

Rutter, M. (1983). Cognitive Deficits in the Pathogenesis of Autism. *The Journal of Child Psychology and Psychiatry*, 24(4), 513-531. DOI: 10.1111/j.1469-7610.1983.tb00129.x.

Rutter, M. and Schopler, E. (1987). Autism and Pervasive Developmental Disorders: Concepts and Diagnostic Issues. *Journal of Autism and Developmental Disorders*, 17(2), 159-186. DOI: 10.1007/BF01495054.

Salgado, J., Soares, F., Leão, C.P., Matos, D. and Carvalho, V. (2017). Educational Games for Children with Special Needs: Preliminary Design. *Proceedings of the 2017 4th Experiment@ International Conference (exp.at'17),* Faro, Portugal, 6-8 June 2017. DOI: 10.1109/EXPAT.2017.7984364.

Salleh, S. and Abal Abas, Z. (2016). *Simulation for Applied Graph Theory Using Visual C++.* Boca Raton, Florida (USA): CRC Press (Taylor & Francis Group).

Salvador, K. and Pasiali, V. (2017). Intersections Between Music Education and Music Therapy: Education Reform, Arts Education, Exceptionality, and Policy at the Local Level. *Arts Education Policy Review*, (2), 93-103. DOI: 10.1080/10632913.2015.1060553.

Samson, F., Mottron, L., Jemel, B., Belin, P. and Ciocca, V. (2005). Can Spectro-Temporal Complexity Explain the Autistic Pattern of Performance on Auditory Tasks? *Journal of Autism and Developmental Disorders*, 36(1), 65-76. DOI: 10.1007/s10803-005-0043-4.

San Francisco Tenants Union (1985). *Ellis Act – Disability Definitions.* Referring to Government Code Section 12955.3: 12955.3.

Sandé, J. (2017). *Jodivi: An Application to Target Sound Sensitivity Features in People with Autism Spectrum Disorder*. [Online]. Ottawa, Ontario (Canada): University of Ottawa. MASc Thesis. Available from: https://ruor.uottawa.ca/bitstream/10393/36516/3/Sand%c3%a9_Joel_2017_thesis.pdf [Accessed 18 April 2020].

Sansosti, F.J., Powell-Smith, K.A. and Cowan, R.J. (2010). *High-Functioning Autism/Asperger Syndrome in Schools: Assessment and Intervention*. New York: The Guilford Press.

Sargent, L., Perner, D. and Cook, T. (2012). *Social Skills for Students with Autism Spectrum Disorders and Other Developmental Disorders, Volume 1: Lessons 1-50*. Colorado Springs, Colorado (USA): Council for Exceptional Children.

Schaeffer, P. (1966). *Traité des Objets Musicaux* [Treatise on Musical Objects]. [French Language]. Paris: Seuil. Cited in: Schaeffer, P. (2017). Acousmatics. In: Cox, C. and Warner, D. eds. *Audio Culture, Revised Edition: Readings in Modern Music*. London: Bloomsbury, pp. 95-102.

Schaeffer, P. (2017). Acousmatics. In: Cox, C. and Warner, D. eds. *Audio Culture, Revised Edition: Readings in Modern Music*. London: Bloomsbury, pp. 95-102.

Schlaug, G., Norton, A., Overy, K. and Winner, E. (2005). Effects of Music Training on the Child's Brain and Cognitive Development. *Annals of New York Academy of Sciences*, 1060, 219-230. DOI: 10.1196/annals.1360.015.

Schmidt Peters, J. (2000). *Music Therapy: An Introduction*. 2nd edn. Springfield, Illinois (USA): Charles C. Thomas Publisher Ltd.

Schneck, D.J. and Berger, D.S. (2006). *The Music Effect: Music Physiology and Clinical Applications*. London: Jessica Kingsley Publishers.

Schneider, E. (1999). *Discovering My Autism: Apologia Pro Vita Sua (with Apologies to Cardinal Newman)*. London: Jessica Kingsley Publishers.

Schneider, N. and Goldstein, H. (2010). Using Social Stories and Visual Schedules to Improve Socially Appropriate Behaviours in Children with Autism. *Journal of Positive Behaviour Interventions*, 12(3), 149-160. DOI: 10.1177/1098300709334198.

Schögler, B. (2011). *Dr. Ben Schögler – Co-Inventor of the Skoog*. [Online]. IdeaMensch Website. Available from: https://ideamensch.com/dr-ben-schogler/ [Accessed 8 May 2017].

Schögler, B. (2016). *Autism, Music Therapy and the Scope of Skoog* [Interview with Dr. John Biddulph]. [Online]. United Kingdom: Skoogmusic. Available from: http://skoogmusic.com/blog/autism-music-therapy-and-the-scope-of-skoog-dr-john-biddulph/ [Accessed 14 May 2017].

Schwartzberg, E.T. and Silverman, M.J. (2013). Effects of Music-Based Social Stories on Comprehension and Generalization of Social Skills in Children with Autism Spectrum Disorders: A Randomized Effectiveness Study. *The Arts in Psychotherapy*, 40, 331-337. DOI: 10.1016/j.aip.2013.06.001.

Sciutto, M.J. and Cantwell, C. (2005). Factors Influencing the Differential Diagnosis of Asperger's Disorder and High-Functioning Autism. *Journal of Developmental and Physical Disabilities*, 17, 345-359. DOI: 10.1007/s10882-005-6618-3.

Scott, B. (2015). *Using Behavior Momentum to Teach Non-Echolalic Responses to Children with Autism Spectrum Disorders*. [Online]. Fresno, California (USA): California State University. Master's Thesis. Available from: http://repository.library.fresnostate.edu/bitstream/handle/10211.3/161918/SCOTT_Brittany.pdf?sequence=1 [Accessed 30 April 2018].

Scott, S.J. (2017). *Music Education for Children with Autism Spectrum Disorder: A Resource for Teachers*. Oxford / New York: Oxford University Press.

Seltzer, K. and Bentley, T. (1999). *The Creative Age: Knowledge and Skills for the New Economy*. London: Demos.

Seltzer, M.M., Shattuck, P., Abbeduto, L. and Greenberg, J.S. (2004). Trajectory of Development in Adolescents and Adults with Autism. *Mental Retardation and Developmental Disabilities Research Reviews*, 10, 234-247. DOI: 10.1002/mrdd.20038.

Senator, S. (2005). *Making Peace with Autism: One Family's Story of Struggle, Discovery, and Unexpected Gifts*. London: Trumpeter Books. Note: Link for information on the reference: https://www.dropbox.com/s/2h1c889e7alivqa/Senator%20Screenshot.png?dl=0

Seo, J.H. and Aravindan, P. (2015). Designing Interactive Soft Toys for Children with Autism to Improve Communications Through Sensory Relaxation. *Communications in Computer and*

Information Science, 528, 389-393. Available from: http://link.springer.com/chapter/10.1007/978-3-319-21380-4_66 [Accessed 22 August 2016].

Serhan, R.J. (2011). *Psyche-Smart Autism: The Integrative Approach to Autistic, Asperger's and Sensitive Personalities from the Womb to Longevity*. Albuquerque, New Mexico (USA): Sovereign Research.

Seri, S., Cerquiglini, A., Pisani, F. and Curatolo, P. (1999). Autism in Tuberous Sclerosis: Evoked Potential Evidence for a Deficit in Auditory Sensory Processing. *Clinical Neurophysiology*, 110, 1825-1830. DOI: 10.1016/51388-2457(99)00137-6.

Seri, S., Pisani, F., Thai, J.N. and Cerquiglini, A. (2007). Pre-Attentive Auditory Sensory Processing in Autistic Spectrum Disorder. Are Electromagnetic Measurements Telling Us A Coherent Story? *International Journal of Psychophysiology*, 63, 159-163. DOI: 10.1016/j.ijpsycho.2006.03.013.

Shakespeare, T. and Watson, N. (2001). *Making the Difference: Disability Politics and Recognition*. In: Albrecht, G.L., Seelman, K.D. and Bury, M. eds. *Handbook of Disability Studies*. London: Sage Publications, pp. 546-564.

Shapiro, A. (2014). *Everybody Belongs: Changing Negative Attitudes Toward Classmates with Disabilities*. New publication (no edition number mentioned – first published 2000). Abingdon, Oxon: Routledge.

Sharda, M., Tuerk, C., Chowdhury, R. and Jamey, K. (2018). Music Improves Social Communication and Auditory-Motor Connectivity in Children with Autism. *Translational Psychiatry* 8, 231. DOI: 10.1038/s41398-018-0287-3.

Sharma, M. (2008). *Special Education: Music Therapy*. New Delhi (India): APH Publishing Corporation.

Shaughnessy, N. (2011). Knowing Me, Knowing You: Autism, Kinesthetic Empathy and Applied Performance. [Online]. In: Reynolds, D. and Reason, M. eds. *Kinesthetic Empathy in Creative and Cultural Practices*. Bristol: Intellect, pp. 33-50. Available online via the Kent Academic Repository (KAR) (University of Kent) from: https://kar.kent.ac.uk/31539/ [Accessed 26 January 2018].

Shealy, C.N. (1999). *The Complete Illustrated Encyclopedia of Alternative Healing Therapies*. Shaftesbury: Element Books Ltd.

Sherman, D.A. (2007). *Autism: Asserting Your Child's Right to a Special Education*. Oxford: Oxford Churchill.

Shibazaki, K., Ockelford, A. and Marshall, N.A. (2013). Extending Zygonic Theory to Analyse Patterns of Musical Influence between Children Creating Pieces of Music in Groups, in England and Japan. *Musicae Scientiae*, 17(4), 429-471. DOI: 10.1177/1029864913493109.

Shimizu, H., Yoon, S.Y. and McDonough, C.S. (2010). Teaching Skills to Use A Computer Mouse in Preschoolers with Developmental Disabilities: Shaping Moving a Mouse and Eye-Hand Coordination. *Research in Developmental Disabilities*, 31, 1448-1461. DOI: 10.1016/j.ridd.2010.06.013.

Shore, S. (2003). *Beyond the Wall: Personal Experiences with Autism and Asperger Syndrome*. 2nd edn. Shawnee Mission, Kansas (USA): Autism Asperger Publishing Co.

Shriberg, L.D., Paul, R., McSweeny, J.L., Klin, A.M., Cohen, D.J. and Volkmar, F.R. (2001). Speech and Prosody Characteristics of Adolescents and Adults with High-Functioning Autism and Asperger Syndrome. *Journal of Speech, Language and Hearing Research*, 44(5), 1097-1115. DOI: 10.1044/1092-4388(2001/087).

Shumway-Cook, A. and Woollacott, M. (2007). *Motor Control: Translating Research into Clinical Practice*. 3rd edn. London: Lippincott Williams and Wilkins (a Wolters Kluwer Business).

Sicile-Kura, C. (2006). *Adolescents on the Autism Spectrum*. [Google E-Book]. London: Penguin Random House, Ebury Publishing. Available from: https://play.google.com/books/reader?id=e6U4DwAAQBAJ [Accessed 10 March 2020].

Siegel, B. (2003). *Helping Children with Autism Learn: Treatment Approaches for Parents and Professionals*. Oxford: Oxford University Press.

Siegel, W. (2009). Dancing the Music: Interactive Dance and Music. In: Dean, R. ed. *The Oxford Handbook of Computer Music*. Oxford: Oxford University Press, pp. 191-213.

Sigafoos, J., O'Reilly, M, Ma, C.H., Edrisinha, C., Cannella, H. and Lancioni, G.E. (2006). Effects of Embedded Instruction Versus Discrete-Trial Training on Self-Injury, Correct Responding, and Mood in a Child with Autism. *Journal of Intellectual and Developmental Disabilities*, 31(4), 196-203. DOI: 10.1080/13668250600999160.

Silverman, M.J. (2007). Nonverbal Communication, Music Therapy, and Autism: A Review of Literature and Case Example. *Journal of Creativity in Mental Health*, 3(1), 3-19. DOI: 10.1080/15401380801995068.

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T. and Baird, G. (2008). Psychiatric Disorders in Children with Autism Spectrum Disorders: Prevalence, Comorbidity, and Associated Factors in a Population-Derived Sample. *Journal of the American Academy of Child and Adolescent Psychiatry*, 47(8), 921-929. DOI: 10.1097/CHI.0b013e318179964f.

Simpson, R.L. (2005). Evidence-Based Practices and Students with Autism Spectrum Disorders. *Focus on Autism and Other Developmental Disabilities*, 20(3), 140-149. DOI: 10.1177/10883576050200030201.

Singh, N.N., Lancioni, G.E., Manikam, R., Winton, A.S.W., Singh, A.N.A., Singh, J. and Singh, A.D.A. (2011). A Mindfulness-Based Strategy for Self-Management of Aggressive Behaviour in Adolescents with Autism. *Research in Autism Spectrum Disorders*, 5(3), 1153-1158. DOI: 10.1016/j.rasd.2010.12.012.

Sinha, Y., Silove, N., Wheeler, D. and Williams, K. (2006). Auditory Integration Training and Other Sound Therapies for Autism Spectrum Disorders: A Systematic Review. *Archives of Disease in Childhood*, 91(12), 1018-1022. DOI: 10.1136/adc.2006.094649.

Sinzig, J., Walter, D. and Doepfner, M. (2009). Attention Deficit/Hyperactivity Disorder in Children and Adolescents with Autism Spectrum Disorder: Symptom or Syndrome? *Journal of Attention Disorders*, 13(2), 117-126. DOI: 10.1177/1087054708326261.

Siri, K. (2015). *101 Tips for the Parents of Boys with Autism*. New York: Skyhorse Publishing.

Skewes, J.C. and Gebauer, L. (2016). Brief Report: Suboptimal Auditory Localisation in Autism Spectrum Disorder: Support for the Bayesian Account of Sensory Symptoms. *Journal of Autism and Developmental Disorders*, 46, 2539-2547. DOI: 10.1007/s10803-016-2774-9.

Skoogmusic (2020). *Skoog Music Website*. [Online]. Available from: http://www.skoogmusic.com [Accessed 20 March 2020].

Sloboda, J.A. (2005). *Exploring the Musical Mind: Cognition, Emotion, Ability, Function*. Oxford: Oxford University Press.

Sloboda, J.A. and O'Neill, S.A. (2001). Emotions in Everyday Listening to Music. In: Juslin, P.N. and Sloboda, J.A. eds. *Series in Affective Science. Music and Emotion: Theory and Research*. Oxford: Oxford University Press, pp. 415-429.

Small, C. (2006). Musicking – the Meanings of Performing and Listening. A Lecture. *Music Education Research*, 1(1), 9-22. DOI: 10.1080/1461380990010102.

Smile, S. and Kawamura, A. (2016). Cerebral Palsy and Autism Spectrum Disorder. In: Matson, J.L. ed. *Handbook of Assessment and Diagnosis of Autism Spectrum Disorder*. London: Springer, pp. 357-378.

Smile, S., Dupuis, A., MacArthur, C., Roberts, W. and Fehlings, D. (2013). Autism Spectrum Disorder Phenotype in Children with Ambulatory Cerebral Palsy: A Descriptive Cross-Sectional Study. *Research in Autism Spectrum Disorders*, 7(2), 391-397. DOI: 10.1016/j.rasd.2012.10.008.

Smith, C. (2016). *How We Play Within Lines – Skoog and Structure*. [Online]. Australia: Autism Pedagogy Blog. Available from: http://www.autismpedagogy.com/blog/2016/3/9/skoog [Accessed 18 April 2020].

Smith, C. (2017). *Plan A is for Autism: Using the Affects Model to Promote Positive Behaviour*. 2nd edn. (first published 2015). Abingdon, Oxon: Routledge.

Smith, G. (2017). *Composing Made Easy*. Fenton, Missouri (USA): Mel Bay Publications.

Smith, J., Donlan, J. and Smith, B. (2012). *Helping Children with Autism Spectrum Conditions through Everyday Transitions: Small Changes – Big Challenges*. London: Jessica Kingsley Publishers.

Smith, T. (2012). *Making Inclusion Work for Students with Autism Spectrum Disorders: An Evidence-Based Guide*. New York: The Guilford Press.

Smith, T. and Wick, J. (2008). Controversial Treatments. In: Chawarska, K., Klin, A. and Volkmar, F.R. eds. *Autism Spectrum Disorders in Infants and Toddlers*. London: The Guilford Press, pp. 243-273.

Snelling, S. (2013). *A Cast of Caregivers: Celebrity Stories to Help You Prepare to Care*. Bloomington, Indiana (USA): Balboa Press.

Snyder, A. (2009). Explaining and Inducing Savant Skills: Privileged Access to Lower Level, Less-Processed Information. *Philosophical Transactions of the Royal Society* [Online], 364, 1399-1405. Available from: http://rstb.royalsocietypublishing.org/content/364/1522/1399 [Accessed 23 April 2018].

Sobol, E.S. (2011). *Music Learning in Special Education: Focus on Autism and Developmental Disabilities*. In: Colwell, R. and Webster, P.R. eds. *MENC Handbook of Research on Music Learning – Volume 2: Applications*. Oxford: Oxford University Press, pp. 233-255.

Sofronoff, K., Attwood, T. and Hinton, S. (2005). A Randomised Controlled Trial of a CBT Intervention for Anxiety in Children with Asperger Syndrome. *Journal of Child Psychology and Psychiatry*, 46(11), 1152-1160. DOI: 10.1111/j.1469-7610.2005.00411.x.

Sokhadze, E.M. (2016). Electrophysiological and Behavioral Outcomes of Berard Auditory Integration Training (AIT) in Children with Autism Spectrum Disorder. *Applied Psychopathology and Biofeedback*, 41(4), 405-420. DOI: 10.1007/s10484-016-9343-z.

Solati, S. (2016). *Intensive Music Therapy Process with a Male Adult Client Diagnosed with Autism*. [Online]. Jyväskylä, Finland: University of Jyväskylä, Department of Music. Master's Thesis.
Available from: jyx.jyu.fi/bitstream/handle/123456789/49677/URN%3aNBN%3afi%3ajyu-201605092460.pdf [Accessed 19 March 2020].

Solomon, R. (2012). The PLAY Project: A Train-the-Trainer Model of Early Intervention for Children with Autism Spectrum Disorders. In: Gallo-Lopez, L. and Rubin, L.C. eds. *Play-Based Interventions for Children and Adolescents with Autism Spectrum Disorders*. Hove, East Sussex: Routledge, pp. 249-270.

Soundbeam Brochure (2015). *Soundbeam: The Musical Instrument Everybody Can Play*. [Online]. Bristol: Soundbeam Official Website / The Soundbeam Project. Available from: https://static1.squarespace.com/static/56d802d962cd9424aa8b5eb7/t/571df1b801dbae7d74ee331c/1461580220906/Soundbeam+brochure.pdf [Accessed 18 April 2020].

SoundBeam Project (2016). *SoundBeam Price List*. [Online]. Available from: https://www.soundbeam.co.uk/new-page-3

Soundbeam Website (2015). *Soundbeam for Special Education and Music Therapy*. [Online]. Bristol: The Soundbeam Project. Available from: http://www.soundbeam.co.uk/special-education-music-therapy/ [Accessed 25 May 2015].

Souvignier, T. (2003). *Alfred's Teach Yourself Computer Audio: Everything You Need to Know to Use the Audio Power of Your Computer Now!* Los Angeles, California (USA): Alfred Publishing.

Sridharan, D., Levitin, D.J., Chafe, C.H., Berger, J. and Menon, V. (2007). Neural Dynamics of Event Segmentation in Music: Converging Evidence for Dissociable Ventral and Dorsal Networks. *Neuron*, 55, 521-532. DOI: 10.1016/j.neuron.2007.07.003.

Srinivasan, S.M. and Bhat, A.N. (2013). A Review of 'Music and Movement' Therapies for Children with Autism: Embodied Interventions for Multisystem Development. In: Torres, E.B. and Donnellan, A.M. eds. (2015). *Autism: The Movement Perspective*. Los Angeles, California (USA): Frontiers Media, pp. 98-112.

Srinivasan, S.M., Eigsti, I.M., Neelly, L. and Bhat, A.N. (2016). The Effects of Embodied Rhythm and Robotic Interventions on the Spontaneous and Responsive Social Attention Patterns of Children with Autism Spectrum Disorder (ASD): A Pilot Randomised Controlled Trial. *Research in Autism Spectrum Disorder*, 27, 54-72. DOI: 10.1016/j.rasd.2016.01.004.

Srivastava, U.K., Shenoy, G.V., and Sharma, S.C. (1989). *Qualitative Techniques for Managerial Decisions*. 2nd edn. (Reprint 2005). New Delhi (India): New Age International Ltd.

Stahmer, A.C., Suhrheinrich, J., Reed, S., Schreibman, L. and Bolduc, C. (2011). *Classroom Pivotal Response Teaching for Children with Autism*. London: The Guilford Press.

Staley, M.J. (2002). An Investigation of Social Story Effectiveness Using Reversal and Multiple Baseline Designs. *Dissertation Abstracts International Section B: The Sciences and Engineering* 62, 4770. Cited in: Kalyva, E. (2011). *Autism: Educational and Therapeutic Approaches*. 2nd edn. London: Sage Publications, p. 55. *N.B.: First edition (2005) was published in Greek – Athens, Greece: Papazisi Editions.*

Stamm, M. and Altinsoy, M.E. (2013). Assessment of Binaural-Proprioceptive Interaction in Human-Machine Interfaces. In: Blauert, J. ed. *The Technology of Binaural Listening*. Berlin / Heidelberg / London: Springer, pp. 449-476.

Stanford, A. (2013). *Troubleshooting Relationships on the Autism Spectrums: A User's Guide to Resolving Relationship Problems*. London: Jessica Kingsley Publishers.

Stanutz, S., Wapnick, J., Burack, J.A. (2014). Pitch Discrimination and Melodic Memory in Children with Autism Spectrum Disorders. *Autism*, 18(2), 137-147. DOI: 10.1177/1362361312462905.

Stavros Niarchos Foundation - SNF (2018). *The SNF's Initiatives Against the Greek Crisis Are Almost Completed*. [Online]. Athens (Greece): Stavros Niarchos Foundation. Available from: https://www.snf.org/en/newsroom/news/2018/06/the-snf's-initiatives-against-the-greek-crisis-are-almost-completed/ [Accessed 20 April 2020].

Stensæth, K. (2014). Potentials and Challenges in Interactive and Musical Collaborations Involving Children with Disparate Disabilities. A Comparison Study of how Petronella, with Down Syndrome, and Dylan, with Autism, Interact with the Musical and Interactive Tangible 'WAVE'. [Online]. In: Stensæth, K. ed. (2014). *Music, Health, Technology, and Design: Series from the Centre for Music and Health, Vol. 8*. Oslo (Norway): Norwegian Academy of Music, pp. 67-96. Available from: https://www.semanticscholar.org/paper/Potentials-and-challenges-in-interactive-and-with-A-Stens%C3%A6th/241909c218dd9637799ae5357517ab5baf0cddb7 [Accessed 28 March 2020].

Stensæth, K. and Ruud, E. (2014). An Interactive Technology for Health: New Possibilities for the Field of Music and Health and for Music Therapy? A Case Study of Two Children with Disabilities Playing with 'ORFI'. [Online]. In: Stensæth, K. ed. *Music, Health, Technology, and Design*. Oslo (Norway): Norwegian Academy of Music, pp. 39-66. Available from: https://nmh.brage.unit.no/nmh-xmlui/bitstream/handle/11250/279847/An_interactive_technology_for_health.pdf [Accessed 22 March 2020].

Stensæth, K. and Ruud, E. (2014). An Interactive Technology for Health: New Possibilities for the Field of Music and Health and for Music Therapy? A Case Study of Two Children with Disabilities Playing with 'ORFI'. [Online]. In: Stensæth, K. ed. (2014). *Music, Health, Technology, and Design: Series from the Centre for Music and Health, Vol. 8*. Oslo (Norway): Norwegian Academy of Music, pp. 39-66. Available from: https://nmh.brage.unit.no/nmh-xmlui/handle/11250/279847 [Accessed 28 March 2020].

Sterponi, L. and de Kirby, K. (2016). A Multidimensional Reappraisal of Language in Autism: Insights from a Discourse Analytic Study. *Journal of Autism and Developmental Disorders*, 46, 394-405. DOI: 10.1007/s10803-015-2679-z.

Sterponi, L. and Shankey, J. (2014). Rethinking Echolalia: Repetition as Interactional Resource in the Communication of a Child with Autism. *Journal of Child Language*, 41(2), 275-304. DOI: 10.1017/S0305000912000682.

Stewart, R.W. (2002). Combined Efforts: Increasing Social-Emotional Communication with Children with Autistic Spectrum Disorder Using Psychodynamic Music Therapy and Division TEACCH Communication Programme. In: Davies, A. and Richards, E. eds. *Music Therapy and Group Work: Sound Company*. London: Jessica Kingsley Publishers, pp. 164-187.

Stillman, W. (2010). *The Everything Parent's Guide to Children with Asperger's Syndrome*. 2nd edn. Avon, Massachusetts (USA): Adams Media (an imprint of Simon and Schuster Inc.).

Stone, W.L. and La Greca, A.M. (1986). The Development of Social Skills in Children. In: Schopler, E. and Mesibov, G.B. eds. *Social Behaviour in Autism*. New York: Springer Science + Business Media, pp. 35-60.

Stramkale, L. (2019). Factors Affecting the Acquisition of Playing the Metallophone in Music Lessons. In: *Rural Environment, Education, Personality: Proceedings of the 12th REEP Conference, Jelgava, Latvia, 10-11 May 2019*. Riga (Latvia): Latvia University of Life Sciences and Technologies, pp. 182-189. DOI: 10.22616/REEP.2019.023.

Straus, J. (2011). *Extraordinary Measures: Disability in Music*. Oxford: Oxford University Press.

Straus, J. (2016). Autism and Postwar Serialism as Neurodiverse Forms of Cultural Modernism. In: Howe, B., Jensen-Moultron, S., Lerner, N. and Straus, J. eds. *The Oxford Handbook of Music and Disability Studies*. Oxford: Oxford University Press, pp. 684-706.

Strnadova, I., Cumming, T.M. and Rodriguez, C.D. (2014). Incorporating Mobile Technology into Evidence-Based Practices for Students with Autism. [Online]. In: Silton, N.R. ed. *Innovative Technologies to Benefit Children on the Autism Spectrum*. USA: Marymount Manhattan College, pp. 35-52. Available from: https://pdfs.semanticscholar.org/433a/6e1fb65ab6927dd913eb6c2592df804727f7.pdf [Accessed 15 April 2018].

Strong, J. (1998). *Rhythmic Entrainment Intervention: A Theoretical Perspective*. [Online]. Originally Published in Open Ear Journal 2 (1998). Available from: https://www.stronginstitute.com/resources/rhythmic-entrainment-intervention-a-theoretical-perspective/ [Accessed 15 April 2020].

Strong, J. (2014). *Rhythmic Entrainment Intervention for Adults with Autism*. [Online]. Mount Angel, Oregon (USA): Zoe. Available from: stronginstitute.com/resources/autism-adult-study/ [Accessed 20 April 2020].

Su, H.F.H.A., Lai, L. and Rivera, H.J. (2010). Using an Exploratory Approach to Help Children with Autism Learn Mathematics. *Creative Education*, 1(3), 149-153. DOI: 10.4236/ce.2010.13023.

Sue, Da., Sue, D.W., Sue, Di. and Sue, S. (2013). *Understanding Abnormal Behaviour*. 10th edn. United Kingdom: Wadsworth (Cengage Learning).

SuperCollider Guide (2018a). *Making Standalone Applications*. [Online]. Available from: http://doc.sccode.org/Guides/standalones.html [Accessed 27 May 2018].

SuperCollider Guide (2018b). *SuperCollider 3.10.4 Documentation Home*. [Online]. Available from: http://doc.sccode.org/Help.html [Accessed 15 April 2020]. *N.B.: Different entries are available from within the website using the 'Search' tab.*

Sutton, K. (1984). The Development and Implementation of a Music Therapy Physiological Measures Test. *Journal of Music Therapy*, 21(4), 160-169. DOI: 10.1093/jmt/21.4.160.

Svansdottir, H.B. and Snaedal, J. (2006). Music Therapy in Moderate and Severe Dementia of Alzheimer's Type: A Case-Control Study. *International Psychogeriatrics*, 18(4), 613-621. DOI: 10.1017/S1041610206003206.

Swain, J., French, S. and Cameron, C. (2003). *Controversial Issues in a Disabling Society*. Maidenhead, Berkshire: Open University Press.

Sweeney-Brown, C. (2005). Music and Medicine: Music Therapy Within a Medical Setting. In: Pavlicevic, M. and Wood, V. eds. *Music Therapy in Children's Hospices: Jessies Fund in Action*. London: Jessica Kingsley Publishers, pp. 48-61.

Szatmari, P., Archer, L., Fisman, S., Streiner, D.L. and Wilson, F. (1995). Asperger's Syndrome and Autism: Differences in Behaviour, Cognition and Adaptive Functioning. *Journal of the American Academy of Child & Adolescent Psychiatry*, 34(12), 1662-1671. DOI: 10.1097/00004583-199512000-00017.

Tager-Flusberg, H. and Kasari, C. (2013). Minimally Verbal School-Aged Children with Autism Spectrum Disorder: The Neglected End of the Spectrum. *Autism Research*, 6, 468-478. DOI: 10.1002/aur.1329.

Taheri, A., Meghdari, A., Alemi, M., Pouteremad, H., Poorgoldooz, P., and Roohbakhsh, M. (2016). Social Robots and Teaching Music to Autistic Children: Myth or Reality? In: Agah, A., Cabibihan, J-J., Howard, A.M., Salichs, M.A. and He, H.S. eds. *Social Robotics: Proceedings* *of the 8th International Conference, ICSR 2016, Kansas City, Montana, USA, November 1-3-, 2016. Lecture Notes in Artificial Intelligence, vol. 9979*, pp. 541-550. DOI: 10.1007/978-3-319-47437-3_53.

Taheri, A., Meghdari, A. Alemi, M. and Pouretemad, H. (2019). Teaching Music to Children with Autism: A Social Robotics Challenge. *Scientia Iranica*, 26, 40-58. DOI: 10.24200/SCI.2017.4608.

Takeuchi, A.H. and Hulse, S.H. (1993). Absolute Pitch. *Psychological Bulletin*, 113(2), 345-361. DOI: 10.1037/0033-2909.113.2.345.

Talay-Ongan, A. and Wood, K. (2010). Unusual Sensory Sensitivities in Autism: A Possible Crossroad. *International Journal of Disability, Development and Education*, 47(2), 201-212. DOI: 10.1080/713671112.

Tanaka, J.W., Wolf, J.M., Klaiman, C., Koenig, K., Cockburn, J., Herlihy, L., Brown, C., Stahl, S, Kaiser, M.D., Schultz, R.T. (2010). Using Computerized Games to Teach Face Recognition Skills to Children with Autism Spectrum Disorder: The 'Let's Face It!' Program. *Journal of Child Psychology and Psychiatry*, 51(8), 944-952. DOI: 10.1111/j.1469-7610.2010.02258.x.

Tanaka, J.W., Wolf, J.M., Klaiman, C., Koenig, K., Cockburn, J., Herlihy, L., Brown, C., Stahl, S.S., South, M., McPartland, J.C., Kaiser, M.D. and Schultz, R.T. (2012). The Perception and Identification of Facial Emotions in Individuals with Autism Spectrum Disorders Using the 'Let's Face It!' Emotion Skills Battery. *Journal of Child Psychology and Psychiatry*, 53(12), 1259-1267. DOI: 10.1111/j.1469-7610.2012.02571.x.

Taylor, B.A. (2001). Teaching Peer Social Skills to Children with Autism. In: Maurice, C., Green, G. and Foxx, R. eds. *Making a Difference: Behavioral Intervention for Autism*. Austin, Texas (USA): Pro-Ed, pp. 83-96.

Taylor, C. (2004). *Speech and Language Therapy*. In: Dew-Hughes, D. ed. *Educating Children with Fragile X Syndrome: A Multi-Professional View*. London: Routledge-Falmer, pp. 97-101. Available from: http://www.sxf.uevora.pt/wp-content/uploads/2013/03/Dew-Hughes_2004.pdf [Accessed 18 August 2016].

Taylor, P.G. (2011). *A Beginner's Guide to Autism Spectrum Disorders: Essential Information for Parents and Professionals*. London: Jessica Kingsley Publishers.

Teder-Sälejärvi, W.A., Hillyard, S.A., Röder, B. and Neville, H.J. (1999). Spatial Attention to Central and Peripheral Auditory Stimuli as Indexed by Event-Related Potentials. Cognitive Brain Research, 8(3), 213-227. DOI: 10.1016/S0926-6410(99)00023-3.

Teder-Sälejärvi, W.A., Pierce, K.L., Courchesne, E. and Hillyard, S.A. (2005). Auditory Spatial Localisation and Attention Deficits in Autistic Adults. *Cognitive Brain Research*, 23(2-3), 221-234. DOI: 10.1016/j.cogbrainres.2004.10.021.

Tervo, J. (2001). Music Therapy for Adolescents. *Clinical Child Psychology and Psychiatry,* 6(1), 79-91. DOI: 10.1177/1359104501006001007.

Thaut, M.H. (1988). Rhythmic Intervention Techniques in Music Therapy for Gross Motor Dysfunctions. *The Arts in Psychotherapy*, 15, 127-137. DOI: 10.1016/0197-4556(88)90020-2.

Thaut, M.H. (2005). *Rhythm, Music, and the Brain: Scientific Foundations and Clinical Applications*. Abingdon, Oxon: Routledge.

Thaut, M.H. (2015). The Discovery of Human Auditory-Motor Entrainment and its Role in the Development of Neurologic Music Therapy. *Progress in Brain Research*, 217, 253-266. DOI: 10.1016/bs.pbr.2014.11.030.

Thaut, M.H. and Abiru, M. (2010). Rhythmic Auditory Stimulation in Rehabilitation of Movement Disorders: A Review of Current Research. *Music Perception*, 27(4), 263-269. DOI: 10.1525/MP.2010.27.4.263.

Thaut, M.H., Gardiner, J.C., Holmberg, D., Horwitz, J., Kent, L., Andrews, G., Donelan, B. and McIntosh, G.R. (2009a). Neurologic Music Therapy Improves Executive Function and Emotional Adjustment in Traumatic Brain Injury Rehabilitation. In: Dalla Bella, S., Kraus, N., Overy, K., Pantev, C., Snyder, J.S., Tervaniemi, M., Tillmann, B. and Schlaug, G. eds. *Annals of the New York Academy of Sciences, Volume 1169 - The Neurosciences and Music III: Disorders and Plasticity*. Boston, Massachusetts (USA): Blackwell Publishing, pp. 406-416.

Thaut, M.H., Kenyon, G.P., Schauer, M.L. and McIntosh, G.C. (1999). The Connection Between Rhythmicity and Brain Function: Implications for Therapy of Movement Disorders. *IEEE Engineering in Medicine and Biology*, 18, 101-108. DOI: 10.1109/51/7512991.

Thaut, M.H., Stephan, K.M., Wunderlich, G., Schicks, W., Tellmann, L., Herzog, H., McIntosh, G.C., Seits, R.J. and Hömberg, V. (2009b). Distinct Cortico-Cerebellar Activations in Rhythmic Auditory Motor Synchronisation. *Cortex*, 45(1), 44-53. DOI: 10.1016/j.cortex.2007.09.009.

The Floortime Centre (n.d.). *What is The Greenspan Floortime Approach?* [Online]. Bethesda, Maryland (USA): The Floortime Centre. Available from: http://www.thefloortimecenter.com/what-is-floortime/ [Accessed 18 February 2016].

The Full Pitcher Music Resources (2014). *MIDIGrid for Windows*. [Online]. United Kingdom: The Full Pitcher Music Resources. Available from: http://fullpitcher.co.uk/midigrid/ [Accessed 22 March 2020].

Theodorou, P. and Drigas, A. (2017). ICTs and Music in Sensory and Motor Disabilities. *International Journal of Recent Contributions from Engineering, Science and IT*, 5(2), 4-13. DOI: 10.3991/ijes.v5i2.6386.

Thomas, C.L. (1993). *Music Therapy and Autism: An Exploratory Study*. Madison, Wisconsin (USA): University of Wisconsin, Academic Dissertation.

Thomas, G. (2011). *How to Do your Case Study: A Guide for Students and Researchers*. London: Sage Publications.

Thompson, G.A. and McFerran, K.S. (2015). Music Therapy with Young People Who Have Profound Intellectual and Developmental Disability: Four Case Studies Exploring Communication and Engagement within Musical Interactions. *Journal of Intellectual and Developmental Disability*, 40(1), 1-11. DOI: 10.3109/13668250.2014.965668.

Thompson, S. and Lehmann, A.C. (2004). Strategies for Sight-Reading and Improvising Music. In: Williamon, A. ed. *Musical Excellence: Strategies and Techniques to Enhance Performance*. Oxford: Oxford University Press, pp. 143-162.

Thompson, W.F. ed. (2014). *Music in The Social and Behavioural Sciences: An Encyclopedia.* London: Sage Publications.

Thordarson, S. (2018). *Platypus*. [Online]. Available from: https://www.sveinbjorn.org/platypus [Accessed 10 May 2018].

Tilton, A.J. (2004). *The Everything Parent's Guide to Children with Autism: Know What to Expect, Find the Help You Need, and Get Through the Day.* Avon, Massachusetts (USA): Adams Media.

Tilton. A.J. (2009). *When Your Child Has… Autism*. Avon, Massachusetts (USA): Simon and Schuster.

Times Higher Education (1996). *Disabled Sound Out the Music.* [Online]. Available from: https://www.timeshighereducation.co.uk/news/disabled-sound-out-the-music/94194.article [Accessed 18 May 2015].

Timmermans, H., Van Wolferen, G., Newland, P. and Kunath, S. (2004). MEDIATE: Key Sonic Developments in an Interactive Installation for Children with Autism. [Online]. *Proceedings of the 31st International Computer Music Conference (ICMC),* Miami, Florida (USA), November 1-6, 2004. Available from: https://www.researchgate.net/publication/228742946_MEDIATE_Key_Sonic_Developments_in_an_Interactive_Installation_for_Children_with_Autism [Accessed 20 April 2020].

Timmermans, H. (2015). Sound Spatialisation from a Composer's Perspective. *Proceedings of the 2015 IEEE 2nd VR Workshop on Sonic Interactions for Virtual Environments (SIVE),* Arles, France, 24 March, 2015. DOI: 10.1109/SIVE.2015.7361286.

Timmins, S. (2017). *Developing Resilience in Young People with Autism using Social Stories™*. London: Jessica Kingsley Publishers.

Tjus, T., Heimann, M. and Nelson, K.E. (1998). Gains in Literacy through the Use of a Specially Developed Multimedia Computer Strategy. *Autism*, 2(2), 139-156. DOI: 10.1177/1362361398022003.

Toigo, D.A. (1992). Autism: Integrating a Personal Perspective with Music Therapy Practice. *Music Therapy Perspectives*, 10(1), 13-20. DOI: 10.1093/mtp/10.1.13. Cited in: Wager, K.M. (2000). The Effects of Music Therapy upon an Adult Male with Autism and Mental Retardation: A Four-Year Case Study. *Music Therapy Perspectives*, 18(2), 131-140 (citation in p. 133). DOI: 10.1093/mtp/18.2.131.

Tomatis, A. (2005). *The Ear and the Voice*. 1st English edn. (translated from French *['L'oreille et la voix'],* 1987, 2003). Oxford: Scarecrow Press.

Tomchek, S.D. and Dunn, W. (2007). Sensory Processing in Children With and Without Autism: A Comparative Study Using the Short Sensory Profile. *American Journal of Occupational Therapy*, 61, 190-200. DOI: 10.5014/ajot.61.2.190.

Tooley, M. (2005). *Engineering A Level*. Oxford: Butterworth-Heinemann.

Tordjman, S., Davlantis, K.S., Georgieff, N., Geoffray, M-M., Speranza, M., Anderson, G.M., Xavier, J., Botbol, M., Oriol, C., Bellissant, E., Vernay-Leconte, J., Fougerou, C., Hespel, A., Tavenard, A., Cohen, D., Kermarrec, S., Coulon, N., Bonnot, O. and Dawson, G. (2015). Autism as a Disorder of Biological and Behavioral Rhythms: Toward New Therapeutic Perspectives. *Frontiers in Pediatrics*, 23 February 2015. DOI: 10.3389/fped.2015.00001.

Toth, K., Munson, J., Meltzoff, A.N. and Dawson, G. (2006). Early Predictors of Communication Development in Young Children with Autism Spectrum Disorder: Joint Attention, Imitation, and Toy Play. *Journal of Autism and Developmental Disorders*, 36(8), 993-1005. DOI: 10.1007/s10803-006-0137-7.

Towbin, K.E. (2005). *Pervasive Developmental Disorder Not Otherwise Specified*. In: Volkmar, F.R., Paul, R., Klin, A. and Cohen, D.J. eds. *Handbook of Autism and Pervasive Developmental Disorders*. *Volume 1: Diagnosis, Development, Neurobiology and Behaviour*. 3rd edn. Hoboken, New Jersey (USA): John Wiley and Sons, pp. 165-200.

Townsend, M.C. (2014). *Essentials of Psychiatric Mental Health Nursing: Concepts of Care in Evidence-Based Practice*. Philadelphia, Pennsylvania (USA): F.A. Davis Company.

Trautman, M.L. (2007). Developmental Therapy. In: Myles, B.S. ed. *Autism Spectrum Disorders: A Handbook for Parents and Professionals*, *Volume 1.* Westport, Connecticut (USA): Praeger Publishers, pp. 104-106.

Travis, D.A. (2006). *The Effect of Musical Social Stories™ on Target Behaviors of Preschool Children with Autism Spectrum Disorders: Three Case Studies*. [Online]. Lansing, Michigan (USA): Michigan State University. Master's Thesis. Available from: https://fedcom4a.lib.msu.edu/etd/16786/datastream/OBJ/View/ [Accessed 20 April 2020].

Travis, L.L. and Sigman, M.D. (2000). A Developmental Approach to Autism. In: Sameroff, A.J., Lewis, M. and Miller, S.M. eds. *Handbook of Developmental Psychopathology*. 2nd edn. Heidelberg / London: Springer, pp. 641-655. DOI: 10.1007/978-1-4615-4163-9_34.

Treffert, D.A. (2009). The Savant Syndrome: An Extraordinary Condition. A Synopsis: Past, Present, Future. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1522), 1351-1357. DOI: 10.1098/rstb.2008.0326.

Treffert, D.A. (2015). Special Abilities and Savant Syndrome: An Update on Dr. Rimland's Observations. In: Edelson, S.M. ed. *Infantile Autism: The Syndrome and its Implications for a*

Neural Theory of Behaviour by Bernard Rimland, Ph.D. 2nd edn. (first published 1964). London: Jessica Kingsley Publishers, pp. 240-244.

Treffert, D.A. and Wallace, G.L. (2002). Islands of Genius. *Scientific American*, 286 (6), 76-85. DOI: 10.1038/scientificamerican0602-76.

Trevarthen, C., Aitken, K., Papoudi, D. and Robarts, J. (1998). *Children with Autism: Diagnosis and Interventions to Meet Their Needs*. 2nd edn. / 3rd impression. London: Jessica Kingsley Publishers.

Trezek, B.J., Paul, P.V. and Wang, Y. (2010). *Reading and Deafness: Theory, Research, and Practice*. Clifton Park, New York State (USA): Delmar, Cengage Learning.

Tronick, E. (2007). *The Neurobehavioural and Social-Emotional Development of Infants and Children*. London: W.W. Norton and Company.

Tronick, E., Als, H., Adamson, L., Wise, S. and Berry Brazelton, T. (1978). The Infant's Response to Entrapment Between Contradictory Messages in Face-To-Face Interaction. *Journal of the American Academy of Child Psychiatry* [Online], 17(1), 1-13. Available from: http://www.jaacap.com/article/S0002-7138(09)62273-1/pdf [Accessed 25 April 2017].

Truesdell, C. (2007). *Mastering Digital Audio Production: The Professional Music Workflow with Mac OS X*. Indianapolis (USA): Wiley Publishing.

Tsabary, E. (2014). Music Education Through Innovation: The Concordia Laptop Orchestra as a Model for Transformational Education. [Online]. *Proceedings of the 8th INTED (International Technology, Education, and Development Conference),* Valencia, Spain, 10-12 March 2014. Valencia (Spain): IATED Academy, pp. 657-664. DOI: 10.13140/2.1.3363.4080.

Tsai, L., Jacoby, C.G., Stewart, M.A. and Beisler, J.M. (1982). Unfavourable Left-Right Asymmetries of the Brain and Autism: A Question of Methodology. *The British Journal of Psychiatry*, 140(3), 312-319. DOI: 10.1192/bjp.140.3.312.

Tsamoura, E. (2020). The Integration of Preschool Children with Autism Spectrum Disorder in Kindergartens of General Education. *Open Access Library Journal*, 7(2), 1-16. DOI: 10.4236/oalib.1106037.

Tsatsanis, K.D., Rourke, B.P., Klin, A., Volkmar, F.R., Cicchetti, D., Schultz, D.T. (2003). *Reduced Thalamic Volume in High-Functioning Individuals with Autism*. [Online]. Biological Psychiatry 53(2), 121-129. DOI: 10.1016/S0006-3223(02)01530-5.

Turkington, C. and Anan, R. (2007). *The Encyclopedia of Autism Spectrum Disorders*. New York: Facts on File.

Turner, C. (2011). *Supporting Children with Learning Difficulties: Holistic Solutions for Severe, Profound and Multiple Disabilities*. London: Continuum International Publishing Group.

Turner, V. and Spears, C. (2011). *Rising to New Heights of Communication and Learning for Children with Autism*. London: Jessica Kingsley Publishers.

UK Mental Health Foundation (2015). *Fundamental Facts About Mental Health.* [Online]. United Kingdom: The Mental Health Foundation. Available from: https://www.mentalhealth.org.uk/sites/default/files/fundamental-facts-15.pdf [Accessed 20 March 2016].

United States Department of Education (2000). *A Guide to the Individualized Education Program*. [Online]. Archived Information. Jessup, Maryland (USA): United States Department of Education. Available from: https://ed.gov/parents/needs/speced/iepguide/iepguide.pdf [Accessed 19 April 2020].

United States Department of Education (2018). *Elementary and Secondary Education Act (ESSA), as amended by the Every Student Succeeds Act*. [Online]. ESSA 1965 as amended through P.L. 115-141, Enacted March 23, 2018. Available from: https://legcounsel.house.gov/Comps/Elementary%20And%20Secondary%20Education%20Act%20Of%201965.pdf [Accessed 12 May 2018].

United States Equal Employment Opportunity Commission (US EEOC) (1998). *Disability Discrimination: Employment Discrimination Prohibited by the Americas with Disabilities Act of 1990*.

Urdan, T.C. (2005). *Statistics in Plain English.* Mahwah, New Jersey (USA): Lawrence Erlbaum Associates.

Vaiouli, P., Grimmet, K., Rulch, L.J. (2015). *'Bill Is Now Singing': Joint Engagement and the Emergence of Social Communication of Three Young Children with Autism*. *Autism*, 19(1), 73-83. DOI: 10.1177/1362361313511709.

Valerio, W., Sy, A., Gruber, H. and Griffith Stockman, C. (2011). Examining Music Experiences with Anthony, a Child who has Autism. In: Burton, S.L. and Taggart, C.C. eds. *Learning from Young Children: Research in Early Childhood Music*. Plymouth: Rowman & Littlefield Education, pp. 259-282.

Valle, A. (2016). *Introduction to SuperCollider*. Berlin (Germany): Andrea Valle & Logos Verlag Berlin GmbH.

Van Bakel, M.M.E., Delobel-Ayoub, M., Cans, C., Assouline, B., Jouk, P.-S., Raynaud, J.-P., and Arnaud, C. (2015). Low but Increasing Prevalence of Autism Spectrum Disorders in a French Area from Register-Based Data. *Journal of Autism and Developmental Disorders*, 45(10), 3255-3261. DOI: 10.1007/s10803-015-2486-6.

Van Der Krieke, L. (2013). A Web-Based Tool to Support Shared Decision Making for People with a Psychotic Disorder: Randomized Controlled Trial and Process Evaluation. *Journal of Medical Internet Research*, 15(10). DOI: 10.2196/jmir.2851.

Varèse, E. and Wen-Chung, C. (1966). The Liberation of Sound. *Perspectives of New Music* [Online], 5(1), 11-19. Available from: http://music.arts.uci.edu/dobrian/CMC2009/Liberation.pdf [Accessed 25 May 2018].

Vasilakos, K. (2014). *Sculpting Sound in Real Time with SuperCollider*. [Online]. Leap Motion Blog. Available from: http://blog.leapmotion.com/sculpting-sound-real-time-supercollider/ [Accessed 17 May 2017].

Veague, H.B., Collins, C. and Levitt, P. (2010). *Autism [Psychological Disorders]*. New York (USA): Chelsea House (an imprint of Infobase Publishing).

Vicker, B. (2001). *Aiding Comprehension of Individuals with Autism Spectrum Disorders During One-on-One Interactions.* [Online]. IRCA Articles / Communication. Indiana (USA): Indiana Institute on Disability and Community (IRCA). Available from: https://scholarworks.iu.edu/dspace/bitstream/handle/2022/9133/05.pdf?sequence=1 [Accessed 18 April 2020].

Villafuerte, L., Jordà, S. and Markova, M.S. (2012). Acquisition of Social Abilities Through Musical Tangible User Interface: Children with Autism Spectrum Conditions and the Reactable. *Proceedings of the ACM SIGCHI Conference on Human Factors in Computer Systems,* Austin, Texas (USA), 5-10 May 2012. DOI: 10.1145/2212776.2212847.

Vink, A.C. (2013). *Music Therapy for Dementia: The Effect of Music Therapy in Reducing Behavioural Problems in Elderly People with Dementia*. [Online]. Groningen (Netherlands): University of Groningen / Uni. Medical Centre Groningen, PhD Dissertation. Available from: http://www.rug.nl/research/portal/files/14427178/volledigedissertatie.pdf [Accessed 18 April 2020].

Virues-Ortega, J., Julio, F.M. and Pastor-Barriuso, R. (2013). The TEACCH Program for Children and Adults in Autism: A Meta-Analysis of Intervention Studies. *Clinical Psychology Review*, 33(8), 940-953. DOI: 10.1016/j.cpr.2013.07.005.

Vismara, L.A. and Rogers, S.J. (2008). The Early Start Denver Model: A Case Study of an Innovative Practice. *Journal of Early Intervention*, 31(1), 91-108. DOI: 10.1177/1053815108325578.

Vivanti, G. and Hamilton, A. (2014). Imitation in Autism Spectrum Disorders. In: Volkmar, F.R., Rogers, S.J., Paul, R. and Pemphrey, K. eds. *Handbook of Autism and Pervasive Developmental Disorders - Volume One: Diagnosis, Development, and Brain Mechanisms*. 4th edn. London: Wiley, pp. 278-301.

Vivanti, G., Dissanayake, C., Zierhut, C., Rogers, S.J. and Victorian ASELCC Team (2013). Brief Report: Predictors of Outcomes in the Early Start Denver Model delivered in a Group Setting. *Journal of Autism and Developmental Disorders*, 43(7), 1717-24. DOI: 10.1007/s10803-012-1705-7.

Vivanti, G., Duncan, E., Dawson, G. and Rogers, S.J. (2016). *Implementing the Group-Based Early Start Denver Model for Preschoolers with Autism*. Cham, Switzerland: Springer.

Vogrig, A. (2016). *SuperCollider 3.7.0 OSX Standalone*. [Online]. Available from: https://github.com/Vogrig/sc_osx_standalone-3.7.0 [Accessed 10 May 2018].

Volkmar, F.R. and Wiesner L.A. (2009). *A Practical Guide to Autism: What Every Parent, Family Member, and Teacher Needs to Know*. Hoboken (New Jersey): John Wiley & Sons.

Volkmar, F.R., Koenig, K. and McCarthy, M. (2003). Autism: Diagnosis and Epidemiology. In: Hollander, E. ed. *Autism Spectrum Disorders*. USA: Marcel Dekker / Taylor & Francis, pp. 1-14.

Von dem Hagen, E.A.H., Stoyanova, R.S., Rowe, J.B., Baron-Cohen, S. and Calder, A.J. (2014). Direct Gaze Elicits Atypical Activation of the Theory-of-Mind Network in Autism Spectrum Conditions. *Cerebral Cortex*, 24, 1485-1492. DOI: 10.1093/cercor/bht003.

Wager, K.M. (2000). The Effects of Music Therapy upon an Adult Male with Autism and Mental Retardation: A Four-Year Case Study. *Music Therapy Perspectives*, 18(2), 131-140. DOI: 10.1093/mtp.18.2.131.

Wall, K. (2007). *Education and Care for Adolescents and Adults with Autism: A Guide for Professionals and Carers.* London: Sage Publications.

Walther-Hansen, M. (2016). Balancing Audio: Towards a Cognitive Structure of Sound Interaction in Music Production. In: Kronland-Martinet, R., Aramaki, M. and Ystad, S. eds. *Music, Mind, and Embodiment*. Proceedings of the 11th International Symposium, CMMR 2015, Plymouth, UK, 16-19 June 2015. Switzerland: Springer International Publishing, pp. 228-242.

Walworth, D. (2012). Music Therapy Interventions for Social, Communication, and Emotional Development for Children and Adolescents with Autism Spectrum Disorders. In: Gallo-Lopez, L. and Rubin, L.C. eds. *Play-Based Interventions for Children and Adolescents with Autism Spectrum Disorders*. Hove, East Sussex: Routledge, pp. 317-332.

Walworth, D.D. (2007). The Use of Music Therapy within the SCERTS Model for Children with Autism Spectrum Disorder. *Journal of Music Therapy*, 44(1), 2-22. DOI: 10.1093/jmt/44.1.2.

Wan, C.Y. and Schlaug, G. (2010). Music Making as a Tool for Promoting Brain Plasticity across the Life Span. *The Neuroscientist*, 16(5), 566-577. DOI: 10.1177/1073858410377805.

Wan, C.Y., Bazen, L., Baars, R., Libenson, A., Zipse, L., Zuk, J., Norton, A. and Schlaug, G. (2011). Auditory-Motor Mapping Training as an Intervention to Facilitate Speech Output in Non-Verbal Children with Autism: A Proof of Concept Study. *Plos One Journal*, 6(9), 1-7. DOI: 10.1371/journal.pone.0025505.

Wan, C.Y., Demaine, K., Zipse, L., Norton, A. and Schlaug, G. (2010). From Music Making to Speaking: Engaging the Mirror Neuron System in Autism. *Brain Research Bulletin*, 82(3), 161-168. DOI: 10.1016/j.brainresbull.2010.04.010.

Wang, G.E. (2007). A History of Programming and Music. In: Collins, N., D'Escrivan Rincón, J. eds. *The Cambridge Companion to Electronic Music*. Cambridge: Cambridge University Press, pp. 55-71.

Waranusast, R., Bang-Ngoen, A. and Thipakorn, J. (2013). Interactive Tangible User Interface for Music Learning. *Proceedings of the 28th International of Image and Vision Computing New*

Zealand (IVCNZ), Wellington, New Zealand, 27-29 November 2013. New Zealand: IEEE, pp. 400-405. DOI: 10.1109/IVCNZ.2013.6727048.

Ward, W.D. and Burns, E.M. (1982). Absolute Pitch. In: Deutsch, D. ed. *Psychology of Music*. London: Academic Press, pp. 431-452.

Warwick, A. (2001). 'I Have A Song – Let Me Sing': Relating Part of a Journey through Music Therapy with an Autistic Boy. In: Richer, J. and Coates, S. eds. *Autism: The Search for Coherence*. London: Jessica Kingsley Publishers, pp. 199-204.

Watanabe, D., Savion-Lemieux, T., Penhune, V.B. (2007). The Effect of Early Musical Training on Adult Motor Performance: Evidence for a Sensitive Period in Motor Learning. *Experimental Brain Research*, 176, 332-340. DOI: 10.1007/s00221-006-0619-z.

Watson, L.R. and Marcus, L.M. (1988). *Diagnosis and Assessment of Preschool Children*. In: Schopler, E. and Mesibov, G.B. eds. *Diagnosis and Assessment in Autism*. London: Plenum Press, pp. 271-302.

Webster, A., Cumming, J. and Rowland, S. (2017). *Empowering Parents of Children with Autism Spectrum Disorder: Critical Decision-Making for Quality Outcomes*. Singapore: Springer Science + Business Media Singapore.

Wechsler, R. (2012). Applications of Motion Tracking in Making Music for Persons with Disabilities. [Online]. In: Reiterer, H. and Deussen, O. eds. *Workshopband Mensch & Computer 2012* [Workshop Volume Person & Computer 2012, translated from German]. Munich (Germany): Oldenbourgh Verlag, pp. 313-318. Available from: https://dl.gi.de/bitstream/handle/20.500.12116/7710/Wechsler_2012.pdf [Accessed 14 April 2020].

Weinberg, S.L. and Abramowitz, S.K. (2015). *Statistics Using IBM SPSS: An Integrative Approach*. New York: Cambridge University Press.

Weiss, K.J. and Westphal, A.R.N. (2015). *Autism Spectrum Disorder and Criminal Justice*. In: Weiss, K.J. and Watson, C. eds. *Psychiatric Expert Testimony: Emerging Applications.* Oxford: Oxford University Press, pp. 67-83.

Weiten, W. (2016). *Psychology: Themes and Variations.* 10th edn. Boston, Massachusetts (USA): Cengage Learning.

Westerkamp, H. (1993). Interview by Andra McCartney in Toronto: Ontario, April 20, 1993. Cited in: McCartney, A. (1997). *Creating Worlds for my Music to Exist: How Women Composers of Electroacoustic Music Make Place for their Videos.* [Online]. North York, Ontario, Canada: York University (not to be confused with the University of York, UK), Master's Thesis. Available from: http://www.alejandrocasales.com/teoria/teoria/creating_worlds_for_my.pdf [Accessed 28 December 2017]. *N.B.: The original interview is not available online; it has probably been conducted by McCartney herself as part of her thesis*

Wheeler, B.L. (2015). *Music Therapy as a Profession*. In: Wheeler, B.L. ed. *Music Therapy Handbook*. New York: The Guilford Press, pp. 5-16.

Whipple, J. (2004). Music in Intervention for Children and Adolescents with Autism: A Meta-Analysis. *Journal of Music Therapy*, 41(2), 90-106. DOI: 10.1093/jmt/41.2.90.

Whipple, J., Gfeller, K., Driscoll, V., Oleson, J. and McGregor, K. (2015). Do Communication Disorders Extend to Musical Messages? An Answer from Children with Hearing Loss or Autism Spectrum Disorders. *Journal of Music Therapy*, 52(1), 78-116. DOI: 10.1093/jmt/thu039.

White, B. (2019). Group Clinical Improvisation as a Practice of Ritual and Connection for Young People with Autistic Spectrum Conditions. In: Dunn, H., Coombes, E., Maclean, E., Mottram, H. and Nugent, J. eds. *Music Therapy and Autism Across the Lifespan*. London: Jessica Kingsley Publishers, pp. 137-154.

Whitehouse, A.J.O., Maybery, M.T. and Durkin, K. (2006). Inner Speech Impairments in Autism. *The Journal of Child Psychology and Psychiatry* 47(8), 857-865. DOI: 10.1111/j.1469-7610.2006.01624.x.

Whiteley, P., Earnden, M. and Robinson, E. (2014). *Autism: Exploring the Benefits of a Gluten and Casein Free Diet: A Practical Guide for Families and Professionals*. Abingdon, Oxon: Routledge.

Wigram, T. (1999). Contact in Music: The Analysis of Musical Behaviour in Children with Communication Disorder and Pervasive Developmental Disability for Differential Diagnosis. In: Wigram, T. and De Backer, J. eds. *Clinical Applications of Music Therapy in Developmental Disability*. London: Jessica Kingsley Publishers, pp. 69-92.

Wigram, T. (2000). A Method of Music Therapy Assessment for the Diagnosis of Autism and Communication Disorders in Children. *Music Therapy Perspectives*, 18(1), 13-22. DOI: 10.1093/mtp/18.1.13.

Wigram, T. (2004). *Improvisation: Methods and Techniques for Music Therapy Clinicians, Educators, and Students*. London: Jessica Kingsley Publishers.

Wigram, T. and De Backer, J. (1999). *Clinical Applications of Music Therapy in Psychiatry*. London: Jessica Kingsley Publishers.

Wigram, T. and Elefant, E. (2009). Therapeutic Dialogues in Music: Nurturing Musicality of Communication in Children with Autistic Spectrum Disorder and Rett Syndrome. In: Malloch, S. and Trevarthen, C. eds. *Communicative Musicality: Exploring the Basis of Human Companionship*. Oxford: Oxford University Press, pp. 423-445.

Wilkinson, K. and Twist, L. (2010). *Autism and Educational Assessment: UK Policy and Practice*. Slough, Berkshire: National Foundation for Educational Research.

Willemin, T., Litchke, L.G., Liu, T. and Carrie, E. (2018). Social Emotional Effects of Drumtastic®: A Dyadic Within-Group Drumming Pilot Program for Children with Autism Spectrum Disorder. *International Journal of Special Education*, 33(1), 94-103. Available from: https://files.eric.ed.gov/fulltext/EJ1184084.pdf [Accessed 19 March 2020].

Willey, L.H. (2015). *Pretending to Be Normal: Living with Asperger's Syndrome (Autism Spectrum Disorder)*. 2nd (Expanded) edn. London: Jessica Kingsley Publishers.

Williams, C. (2011). Unintentional Intrusive Participation in Multimedia Interactive Environments. *International Journal on Disability and Human Development*, 10(1), 81-85. DOI: 10.1515/ijdhd.2011.005.

Williams, C., Wright, B. and Young, O. (2004). *How to Live with Autism and Asperger Syndrome: Practical Strategies for Parents and Professionals*. London: Jessica Kingsley Publishers.

Williams, D. (1996). *Autism – An Inside-Out Approach: An Innovative Look at the Mechanics of 'Autism' and its Developmental 'Cousins'*. London: Jessica Kingsley Publishers.

Williams, E. (2007). *Edward Williams: Oral History Transcription*. [Online]. Interview of Edward Williams (Soundbeam creator), conducted by Martin Kiszko. Bristol: Wild Film History Website. Available from: http://www.wildfilmhistory.org/helpers/force-download.php?file=pdf/Edward_Williams.pdf [Accessed 15 May 2015].

Williams, J.H.G., Whiten, A., Suddendorf, T. and Perrett, D.I. (2001). Imitation, Mirror Neurons and Autism. *Neuroscience and Biobehavioural Reviews*, 25, 287-295. DOI: 10.1016/S0149-7364(01)00014-8.

Willis, C. (2006). *Teaching Young Children with Autism Spectrum Disorder*. Reprinted in 2009. Beltsville, Maryland (USA): Gryphon House Inc.

Wilmshurst, L. (2011). *Child and Adolescent Psychopathology: A Casebook*. London: Sage Publications.

Wilson, A. (2018). *Mastering Apple iPad – iOS 12*. Antioch, Tennessee (USA):

Wilson, B.L. (2002). *Models of Music Therapy Interventions in School Settings*. Silver Spring, Maryland (USA): American Music Therapy Association.

Wilson, S., Cottle, D. and Collins, N. eds. (2011). *The SuperCollider Book.* Cambridge, Massachusetts (USA): The MIT Press.

Wimpory, D.C. and Nash, S. (1999). Musical Interaction Therapy – Therapeutic Play for Children with Autism. *Child Language Teaching and Therapy*, 15(1), 17-28. DOI: 10.1177/026565909901500103.

Wing, L. (1976). Assessment: The Role of the Teacher. In: Everard, M.P. ed. *An Approach to Teaching Autistic Children*. Oxford: Pergamon Press, pp. 15-30.

Wing, L. (1980). *Childhood Autism and Social Class: A Question of Selection?* The British Journal of Psychiatry 137(5) [November 1980], pp. 410-417.

Wing, L. (1981). Language, Social, and Cognitive Impairments in Autism and Severe Mental Retardation. *Journal of Autism and Developmental Disorders*, 11(1), 31-44. DOI: 10.1007/BF01531339.

Wing, L. (1988). *The Continuum of Autistic Characteristics.* In: Schopler, E. and Mesibov, G.B. eds. *Diagnosis and Assessment in Autism*. New York: Springer Science and Business Media, pp. 91-110.

Wing, L. (1991). The Relationship Between Asperger's Syndrome and Kanner's Autism. In: Frith, U. ed. *Autism and Asperger's Syndrome*. Cambridge: Cambridge University Press, pp. 93-121.

Wing, L. (1993). The Definition and Prevalence of Autism: A Review. *European Child and Adolescent Psychiatry*, 2(2), 61-74. DOI: 10.1007/BF02098832.

Wing, L. (1994). The Autistic Continuum. In: Bouras, N. ed. *Mental Health in Mental Retardation: Recent Advances and Practices*. Cambridge: Cambridge University Press, pp. 108-125.

Wing, L. (2011). *The Use and Misuse of Diagnostic Labels*. [Online]. London: The National Autistic Society. Available from: http://www.autism.org.uk/labels [Accessed 25 January 2016].

Wing, L. and Gould, J. (1979). Severe Impairments of Social Interaction and Associated Abnormalities in Children: Epidemiology and Classification. *Journal of Autism and Developmental Disorders*, 9(1), 11-29. DOI: 10.1007/BF01531288.

Wing, L. and Potter, D. (2002). The Epidemiology of Autistic Spectrum Disorders: Is the Prevalence Rising? *Mental Retardation and Developmental Disabilities Research Review*, 8(3), 151-61. DOI: 10.1002/mrdd.10029.

Wolf, J.M., Tanaka, J.W., Klaiman, C., Cockburn, J., Herlihy, L., Brown, C., South, M., McPartland, J., Kaiser, M.D., Phillips, R. and Schultz, R.T. (2008). Specific Impairment of Face-Processing Abilities in Children with Autism Spectrum Disorder Using the 'Let's Face It!' Skills Battery. *Autism Research*, 1, 329-340. DOI: 10.1002/aur.56.

Wong, C., Odom, S.L., Hume, K., Cox, A.W., Fettig, A., Kucharczyk, S., Brock, M.E., Plavnick, J.B., Fleury, V.P. and Schulz, T.R. (2014). *Evidence-Based Practices for Children, Youth, and Young Adults with Autism Spectrum Disorder*. [Online]. North Carolina (USA): FPG Development Institute, The University of North Carolina at Chapel Hill. Project Report. Available from: http://autismpdc.fpg.unc.edu/sites/autismpdc.fpg.unc.edu/files/2014-EBP-Report.pdf [Accessed 20 April 2020].

Wong, E.L., Yuen, W.Y.F. and Choy, C. (2008). Designing Wii Controller: A Powerful Musical Instrument in an Interactive Music Performance System. *Proceedings of the MoMM'2008 – The*

6th International Conference on Advances in Mobile Computing and Multimedia, Linz, Austria, 24-26 November 2008. DOI: 10.1145/1497185.1497205.

Wong, P.C.M. and Perrachione, T.K. (2006). Learning Pitch Patterns in Lexical Identification by Native English-Speaking Adults. *Applied Psycholinguistics*, 28, 565-585. DOI: 10.1017/S0142716407070312.

Wood, M.M., Davis, K.R., Swindle, F.L. and Quirk, C. (1996). *Developmental Therapy – Developmental Teaching: Fostering Social-Emotional Competence in Troubled Children and Youth*. Australia: Pro-Ed.

Woods, A. (2003). *The Healing Touch of Music: An Exploration*. [Kindle]. Albuquerque, New Mexico (USA): Sound Vistas. Available from: https://www.amazon.co.uk/Healing-Touch-Music-Alana-Woods-ebook/dp/B004NNVCV6 [Accessed 10 March 2018].

Wuang, Y-P., Chiang, C-S., Su, C-Y. and Wang, C-C., (2011). Effectiveness of Virtual Reality Using Wii Gaming Technology in Children with Down Syndrome. *Research in Developmental Disabilities*, 32(1), 312-321. DOI: 10.1016/j.ridd.2010.10.002.

Xambó, A., Hornecker, E., Marshall, P., Jordà, S., Dobbyn, C. and Laney, R. (2016). Exploring Social Interaction with a Tangible Music Interface. *Interacting with Computers*, 29(2), 248-270. DOI: 10.1093/iwc/iww019.

Xiong, C.Q. (2019). A Low-Cost Music-Interactive Accompanying Robot for Children with Autism. *Proceedings of the 2nd International Conference on Mechanical, Electronic and Engineering Technology (MEET 2019)*, Xi'an, China, 19-20 January 2019. China: CSP, pp. 204-209. DOI: 10.23977/meet.2019.93731.

Yapko, D. (2003). *Understanding Autism Spectrum Disorders: Frequently Asked Questions*. London: Jessica Kingsley Publishers.

Yau, S.H., McArthur, G., Badcock, N.A. and Brock, J. (2015). Case Study: Auditory Brain Responses in a Mininally Verbal Child with Autism and Cerebral Palsy. *Frontiers in Neuroscience*, 9, 208. DOI: 10.3389/fnins.2015.00208.

Young, R.L. and Nettelbeck, T. (1995). The Abilities of a Musical Savant and his Family. *Journal of Autism and Developmental Disorders*, 25(3), 231-248. DOI: 10.1007/BF02179286.

Zager, D. and Dreyfus, F.L. (2017). Promoting Integrated Employment Options. In: Zager, D., Cihak, D.F. and Stone-McDonald, eds. *Autism Spectrum Disorders: Identification, Education, and Treatment*. 4th edn. Abingdon, Oxon: Routledge.

Zager, D. and Wehmeyer, M.L. (2020). *Teaching Adolescents and Young Adults with Autism Spectrum Disorder*. Abingdon, Oxon: Routledge.

Zakari, H.M., Poyade, M. and Simmons, D. (2017). Sinbad and the Magic Cure: A Serious Game for Children with ASD and Auditory Hypersensitivity. In: Dias, J., Santos, P.A. and Veltkamp, R.C. eds. *Games and Learning Alliance: Proceedings of the 6th International Conference, GALA 2017,* Lisbon, Portugal, 5-7 December 2017. Berlin / Heidelberg (Germany): Springer, 54-63. DOI: 10.1007/978-3-319-71940-5_5.

Zatorre, R.J. and Belin, P. (2001). Spectral and Temporal Processing in Human Auditory Cortex. *Cerebral Cortex*, 11(10), 946-953. DOI: 10.1093/cercor/11.10.946.

Zatorre, R.J., Belin, P. and Penhune, V.B. (2002). Structure and Function of Auditory Cortex: Music and Speech. *Trends in Cognitive Sciences*, 6(1), 37-46. DOI: 10.1016/s1364-6613(00)01816-7.

Zatorre, R.J., Chen, J.L. and Penhune, V.B. (2007). When the Brain Plays Music: Auditory-Motor Interactions in Music Perception and Production. *Nature Reviews Neuroscience*, 8, 547-558. DOI: 10.1038/nrn2152.

Zatorre, R.J., Meyer, E., Gjedde, A. and Evans, A.C. (1996). PET Studies of Phonetic Processes in Speech Perception: Review, Replication, and Re-Analysis. *Cerebral Cortex*, 6, 21-30. DOI: 10.1093/cercor/6.1.21.

Zeedyk, M.S. (2012). Wired for Communication: How the Neuroscience of Infancy Helps the Understanding the Effectiveness of Intensive Interaction. In: Hewett, D. ed. *Intensive Interaction: Theoretical Perspectives*. London: Sage Publications, pp. 55-71.

Zhang, Y., Kuhl, P.K., Imada, T., Kotani, M. and Tohkura, Y. (2005). *Effects of Language Experience: Neural Commitment to Language-Specific Auditory Patterns*. [Online]. Available from: http://ilabs.washington.edu/kuhl/pdf/Zhang_Kuhl_2005.pdf [Accessed 28 August 2016].

Zheng, H., Zhang, L., Li, L., Liu, P., Gao, J., Liu, X., Zou, J., Zhang, Y., Liu, J., Zhang, Z., Li, Z. and Men, W. (2010). High-Frequency rTMS Treatment Increases Left Prefrontal Myo-Inositol in Young Parents with Treatment-Resistant Depression. *Progress in Neuro-*

Psychopharmacology & Biological Psychiatry, 34, 1189-1195. DOI: 10.1016/j.pnpbp.2010.06.009.

Ziv, N. and Radin, S. (2014). Absolute and Relative Pitch: Global Versus Local Processing of Chords. *Advances in Cognitive Psychology*, 10(1), 15-25. DOI: 10.2478/v10053-008-0152-7.