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Introduction

Many autistic adults lack daily life skills, reducing their quality of life (QOL) (Bertelli *et al.*, 2011; Jacobson and Ackerman, 1990; Jonsson *et al.*, 2016). Barnard *et al.* (2001) found that only 3% of 450 autistic adults lived completely independently; 10% could complete a range of unaided daily tasks, and about one-third lacked social interaction outside their family homes. Underdeveloped skills may exacerbate these poor levels of engagement, as well as their sense of helplessness, vulnerability, and serious short-term and permanent health problems (Boutain *et al.*, 2020).

Applied Behaviour Analysis

Applied behaviour analysis is an evidence-based approach traditionally tied to behavioural skills training, such as teaching independent living skills and solving practical problems based on basic behavioural science (Hugh-Pennie *et al.*, 2018). It is effective in addressing the needs of autistic people. It entails applying behavioural principles to meaningfully change socially significant behaviours through careful observation and systematic experimentation (Baer *et al.*, 1968).

Much research has described difficulties in teaching self-care skills to autistic adults. For example, adequate oral hygiene involves tooth-brushing with fluoride toothpaste to prevent caries (Marinho *et al.*, 2003). Since many autistic adults experience multi-sensory sensitivity, achieving healthy oral

hygiene can be difficult. Unsurprisingly, poorer oral hygiene and enhanced periodontal disease are evident among autistic adults, making this a major challenge for carers (Martens *et al.*, 2000). Poor oral hygiene may have broader negative effects, such as discouraging carers from providing adequate support, potentially deteriorating into a vicious circle, that ultimately results in poorer quality of life (QOL) (Dawson *et al.*, 2007; Felce and Perry, 1996). One way, therefore, to enhance the lives of vulnerable individuals may be to train their carers in teaching skills to facilitate greater independence for their clients.

Many relevant staff training packages have been developed, often incorporating behavioural skill training programs (BSTs) (Homlitas *et al.,* 2014; LaBrot *et al.*, 2018; Sarakoff and Sturmey, 2004; Stewart *et al.,* 2007). In training staff to implement discrete trial teaching with autistic children, Sarakoff and Sturmey employed instructions, feedback, rehearsal, and modelling. Such approaches are generally effective, with trainee performances increasing substantially post-training. However, without component analysis, we cannot attribute these positive outcomes to specific training procedures. Apart from weak experimental control, this may result in unnecessarily costly interventions (Stolz, 1976).

Felce *et al.* (2015) illustrate the cost of intervention: they evaluated staff BST programs, employing similar training procedures to Sarakoff and

Sturmey (2004). Four staff members were trained, each member receiving three to four hours of one-on-one instruction over six months, while spending time preparing written material for the instruction and feedback phases. Service providers are not always willing to or financially capable of implementing lengthy BSTs (e.g., Boutain *et al.*, 2020; Clayton, 2019). Lengthy, complex, expensive staff training programs may then have counterproductive effects of delaying or preventing clients' learning and achievement.

Video-Modelling

Video-modelling is well-researched: many papers suggest its viability as an affordable and simple means to substantially improve staff teaching performance (Bandura, 1969; Haydon *et al.*, 2016; Nosik *et al.*, 2012; Prelock, 2017). Similarly, Digennaro-Reed *et al.* (2010) used individualized video-modelling to increase integrity when treating problematic behaviour, which is valuable because it tends to enhance intervention outcomes. Sigafoos *et al.* (2015) used individualized video feedback (IVF) to train parents, enhancing their interactions with their autistic children as part of a BST program. However, it was not possible to attribute the positive outcomes to IVF or any other single variable.

Single-component training procedures, therefore, have the advantages of reduced cost and enhanced evidence of specific effectiveness. They may, of

course, be less effective than BST, requiring additional resources, and this paper aims to develop and evaluate the efficacy of an innovative, low-cost, single-element training program to enable staff to teach socially significant behaviour. **Methodology**

Participants and Learners

Three untrained support workers with no experience in behaviour analysis procedures and no previous studies or degree in any subject served as participants. All participants were providing home-based support for an autistic adult (learner). Participant 1 (Eliah, female, 26 years, pseudonym) had supported vulnerable individuals for three years and had cared for her learner for one-and-a-half years. Participant 2 (Alfred, male, 39 years, pseudonym), with no previous experience, had supported his client for five years. Participant 3 (Srulik, male, 25 years, pseudonym), also with no experience, had supported his client for three months. English was the second language of all participants.

All learners were autistic adults. The first learner (supported by Eliah) was a 28-year-old female with severe communication difficulties and aggressive behaviour. The second learner (supported by Alfred) was a 34-year-old male with severe communication difficulties. The third learner (supported by Srulik) was a 29-year-old male with severe communication difficulties.

Settings and materials

A multiple-baseline experimental design across participants was used (Carr, 2005). Sessions occurred in the learners' houses in ordinary-sized bathrooms measuring 2.5–7 m^2, equipped with ordinary household fixtures. Most sessions involved participants and learners standing at the washbasin. Materials included a toothbrush, plastic cup, hand-towel, a 1-min Scrabble Electronic Timer® (timer), edible toothpaste, and a bin (where relevant). For maintenance and generalization purposes, the order and positioning of the materials resembled usual settings. Actual training involved participants watching an approximately 14-minute instructional DVD at their leisure.

Instructions for learners

All sessions began with the same instruction, 'X, please brush your teeth', accompanied by pointing at the task area. Next, learners were given five seconds to perform each step unaided before providing graded support as well as contingent and immediate reinforcement.

Additionally, the researcher followed an 11-step teeth-brushing task analysis, based on Horner and Keilitz (1975). The researcher demonstrated alternative ways to provide graded support and gestures, particularly when learners did not respond or made errors, ensuring learners completed each step successfully with minimal errors.

The data-recording systems (DRS) contained elements used in previous research (e.g., Lerman *et al.*, 2015; Yun *et al.*, 2017). Some elements were

linked with client characteristics: for example, measurement of prompts, gestures, and physical guidance (likely to be associated with better skill acquisition) and absence of speech and verbal demands (commonly associated with problem behaviour among autistic adults). Other elements encompassed several basic principles in behaviour analysis, such as the physical configuration of the material (Moore and Fisher, 2007). All sessions were video-taped and the elements were coded.

Ethics and risk-assessment

All participants provided informed consent. For ethical purposes, participants (and learners' families) were formally informed of the study procedure and potential outcomes. Bangor University Research Ethics Committee granted ethical approval for the research.

For health and safety reasons, risk assessment was conducted and appropriate responses were agreed upon with respect to termination of trials in the event of challenging behaviour.

Producing the video-model

Video footage was taken from all three carers supporting their individuals and of the researcher modelling similar skills. The researcher viewed the entire footage along with his own performance and added subtitles to the footage correcting participants' training skills. Three sections of 14-minute

footage were individually designed, each personalized and containing a range of behavioural teaching techniques that naturally complemented participants' behaviour respectively. Next, both subtitled video clips were digitally transferred onto a single DVD to provide a complete video-model for one participant. This was done to increase social validity as viewers could watch it at their leisure and on a range of devices.

Procedure

Pre-baseline

This phase involved a single session in which participants supported learners in tooth-brushing. The purpose was principally to ascertain participants' pre-training experience and the type and efficacy of reinforcement they used. It additionally enabled the researcher to practice the DRS 'live' to verify its suitability and assess the feasibility of using a GoPro-camera in the learners' bathrooms, where the sessions were conducted. All layouts were left as usual, and participants used ordinary materials.

Baseline

Several days of baseline performance were recorded for all participants on the same dates. Layouts were left as usual. Participants were allowed ten minutes to read an instruction sheet before the first baseline session explaining how to conduct the tooth-brushing session, listing an 11-step task-

analysis. To enhance understanding (as English was not the participants' first language) the researcher read the information sheets aloud and answered questions. Baseline sessions began following a short request: 'Support your learner to brush their teeth, please'. No further interaction occurred during sessions, which ended once participants said so, waved, or when learners' behaviour criteria for ending the session were met. Each session lasted two to four minutes. The researcher video-recorded all 37 sessions, and conducted observations subsequently.

Intervention

During this phase, participants received their video-model, an instructional DVD, 14-minutes long on average, integrating two video clips: one from the baseline phase and one depicting a researcher supporting the same activity with the same learner. Participants were asked to watch the DVD six times, and then return it to the researcher. The clip of the participant was carefully chosen to ensure that it contained ample learning opportunities. The researcher footage aimed to aid learning by demonstrating how to rearrange the layout, introduce new materials, and employ basic behavioural teaching techniques. Each clip was accompanied by subtitles to draw attention to key messages.

Digital footage was examined and participants' behaviour was evaluated in each step of the 11-step task-analysis using the DRS. This

enabled the researcher to identify weak areas in participants' performances. Further frame-by-frame analysis enabled the researcher to hypothesize about weak areas requiring attention and add subtitles at specific points in the footage, directing participants to amend these areas of their behaviour. That is, integrating frame-by-frame analysis within an accurate digital editing program enabled the researcher to determine the onset/offset of the subtitles, a feature specific to video-modelling.

Recording sessions recommenced once DVDs were returned. Participants were given time to arrange the physical environment. Similar initial instructions were provided to those given during the baseline phase. The researcher did not interact with the participant or the learner during sessions. All sessions were video-taped, and observations made subsequently.

Criterion for success

The success criterion was set as correctly enacting a minimum of 70% of the 11-element DRS over two consecutive sessions (Conine *et al.*, 2020; Horner and Keilitz, 1975; Lerman *et al.*, 2015). The decision to set a relatively low criterion for success was taken by relevant parties at a multidisciplinary meeting discussing this intervention and its potential outcome. All agreed that to promote the experience of success for both learners and participants, it was crucial to set relatively low criteria.

Procedural fidelity and inter-observer agreement

These were conducted by a secondary observer who remained oblivious to the study purpose. Assessment of procedural fidelity was conducted for 100% of video-models, ensuring that each included five key characteristics: (i) DVDs were personalized; (ii) the researcher modelled desired behaviour; (iii) subtitles accompanied DVD footage; (vi) DVD footage systematically followed elements of the DRS; (v) the researcher did not interact with either participants or learners during sessions. Fidelity was 100%. Inter-observer agreement on correct responses was assessed for 37% and 28% of the intervention and baseline sessions, respectively. Researcher and secondary-observer data were compared on an interval-by-interval basis, lasting two to four minutes each and including the 11 steps of task analysis. Agreements/disagreements were determined by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. The mean inter-observer agreement was 90% and 88% for the baseline and intervention sessions, respectively. Overall, inter-observer agreement averaged 88% for the 20 observed sessions, ranging between 82% and 94%. This suggests that the data were sufficiently reliable.

Results

An element-by-element correct-performance-percentage was calculated for all three participants. Figure 1 depicts participants' overall use of

behavioural teaching techniques during baseline and intervention sessions, calculated as described above. Each datapoint represents one session.

Place Figure 1 here

A detailed analysis of pre-post percentage averages of participants' behavioural teaching techniques, which were measured for each of the 11 steps of task analysis, is illustrated in Table 1. Following video-modelling (i.e. during the Intervention Phase), all three participants increased their behavioural teaching techniques by 41.53% on average, ranging from 1.4% to 100%.

Place Table 1 here

Social validity

To promote a stable, low-cost, sustainable program, and to secure commitment from those involved, all sessions occurred during participants' typical working hours and at times (e.g. late evening) when toothbrushing routines occurred naturally. A 9-item Feedback Questionnaire (FQ), previously developed by Reimers *et al*. (1992), was modified to score participants' and learners' parents' satisfaction with the procedures. The FQ used a 1–5 rating scale, where higher values indicated greater satisfaction. Questionnaires were completed anonymously; the return rate was 100%. The results delineated an overall encouraging evaluation of the training method,

that is, of its favourability, affordability, and general social validity. Their responses indicated that the intervention procedure was acceptable and likable, with minimal risks to both learners and participants. The overall satisfaction score achieved across the six forms completed by all participants and learners' parents was 92.5%.

Discussion

Observations

This study's main goal was to evaluate use of individualized video-modelling technology in training carers to teach self-help skills to autistic adults. The results suggest, both experimentally and clinically, that the single-element video-modelling BST used was reasonably successful, affordable, and socially valid. Participant 1 achieved the performance criterion in intervention sessions 8 and 9 of 11 (79% in both cases). Though they did not achieve the criterion for any sessions, the remaining two participants did achieve a relatively high performance: participant 2 gained 72% on session 5 and 73% on session 8 of 8; participant 3 achieved 73% on session 2 and 69% on session 4 of 5. The results are unlikely to be attributable to practice or time factors because the multiple baseline design quite effectively demonstrated that behaviour change occurred only once training was applied. Furthermore, in the present study, baseline performance averaged 17%, and the subsequent performance increase averaged 46%. In related studies wherein

multi-element training programs were used, baseline performances were typically higher than in the current study, and average performance increases lower. For example, using a non-concurrent multiple-baseline across eight participants, LaBrot *et al*. (2018) evaluated the effectiveness of a range of multi-component behavioural skills training programs: instructions, rehearsal, modelling, and feedback. Baseline performance averaged 52-59% with a subsequent average performance increase of 34.5%. Furthermore, participants in the current study had less prior training and experience than participants in most comparable studies; hence, it was affordable.

Given its impact on participant performance, video-modelling may represent a low-cost and relatively simple single-element training program with several advantages. First, video-modelling produced positive outcomes with participants who had no previous training, limited experience, and for whom English was their second language. This is potentially significant because many service providers rely on untrained and inexperienced personnel to provide adequate support for vulnerable individuals. In contrast, much previous research on staff training has used more experienced and qualified participants, at a much higher cost. For example, Clair *et al*. (2018) examined the coupling of behaviour-specific praise, teacher performance feedback, and contingency-specifying stimuli as primary strategies taught in the staff skill training package. Researchers hired two highly skilled consultants who delivered classroom intervention programs aiming to

increase teaching skills. This intervention was a relatively costly, complex multi-element training program requiring approximately 31 days and 6.5 hours per day. Their study resulted in an average increase of 18% from baseline to intervention.

The video-modelling presented in this study required participants to view 14-minute DVDs six times at their leisure, promoting the study's social validity. The training method had high social validity, being willingly accepted by participants and learners' parents. For example, two of the families requested that participants watch the DVD footage together with their son/daughter twice daily. In fact, in many instances, viewing became a group event, gathering family, participant, and learner together in front of the TV, making the training procedure both fun and educational. Moreover, video-modelling is individualized and can, therefore, be designed to complement participant strengths and weaknesses. For example, footage subtitles were set to 'run' long enough to give the participants, for whom English was their second language, extra time to read and understand.

Limitations

The current study has several limitations. First, video-modelling is described as a single element training program in contrast to the multi-element programs found in the literature (e.g., Clair *et al*, 2018; Ward-Horner and Sturmey, 2012). Video-modelling itself comprises several sub-

components that could have separate effects on participants' behaviour. These include use (or absence) of subtitles, extent of individualization, DVD length, and possibly time spent viewing. In the absence of suitable controls, it might be argued, for example, that similar results could have been achieved without personalizing the footage or providing subtitles, potentially reducing costs and making the training program more viable. Similarly, in a multi-component BST investigation, Ward-Horner and Sturmey (2012) found that both modelling and feedback are effective components of BST; therefore, neither modelling nor feedback can be considered the sole necessary effective component of BST. Moreover, because both components are effective for some participants, it cannot be surmised that either was insufficient to produce behavioural change.

Second, the 70% mastery criterion was lower than in previous ABA studies, considering that modern research recommends 100%. Nonetheless, two studies (Conine *et al.*, 2019; Rapp *et al.*, 2019) used a 70% criterion for success, and there is a paucity of data around the personnel-skills acquisition of untrained and inexperienced carers aiming to teach independent living skills to autistic adults with co-occurring intellectual disabilities via video-modelling (e.g., Lerman *et al.*, 2015). Owing to the paucity of data relating to simple, affordable single-element video modelling intervention programs, we chose to adopt the lower percentage criterion used in previous studies.

Future research should seek to replicate the efficacy of video-modelling and related programs and investigate effects of their sub-components and variations in these such as voice-overs vs. subtitles. It would also be useful to explore the potential for using video-modelling across a range of learner settings (e.g. work, education, family, respite). A study conducted with a specific learner might be aimed at enhancing the consistency of approach or generalization and maintenance of skills. Video-modelling or related approaches may be particularly adaptable training tools; subtitles can be translated to other languages and voice-overs can be added. Video-modelling may focus on a particular learner or might be designed to develop more generalized training skills in a particular activity.

Practical implications

This study's findings have potentially important implications for social care providers who use BST to train caregivers and parents to implement interventions. First, where possible, it may be more affordable and efficient to begin with video-modelling in isolation before introducing other training components such as instruction and rehearsal. Of course, it may be impossible to completely remove other training components, particularly if the interventionist is unfamiliar with video-modelling; although video-modelling does not necessarily require preliminary training, it does require familiarity with the technology and relevant computer software. In such cases, it might

be more beneficial to implement a multi-component conventional package, reserving video-modelling training programs for situations in which the trainer has the necessary knowledge.

Notwithstanding, the availability of mobile Apps may make producing video-models more accessible than before. Additionally, the ease of video viewing allows for flexibility and spontaneity in terms of place and time; subsequently, treatment integrity has rapidly improved. Intervention procedures that are implemented over long periods (e.g., Clair *et al.*, 2018) may not facilitate cost reduction, hence decreasing the feasibility and efficiency of such methods compared to a simple, affordable video-modelling training procedure.

In summary, this study's overall aim was to enhance the lives of vulnerable individuals and improve their autonomy by training those supporting them in behavioural teaching skills. It was shown that a simple, affordable video-modelling intervention could substantially improve the performance of three previously untrained support workers. Many service providers require continuous training programs for their staff and carers to ensure high-quality support to clients. The type of staff training program presented herein might appeal to these service providers. Speaking loosely, if untrained staff or carers with limited experience could develop relevant behavioural teaching skills relatively quickly after watching a 14-minute

personalized DVD, such training programs could be disseminated extensively, potentially influencing many autistic individuals and ultimately enhancing their QOL.

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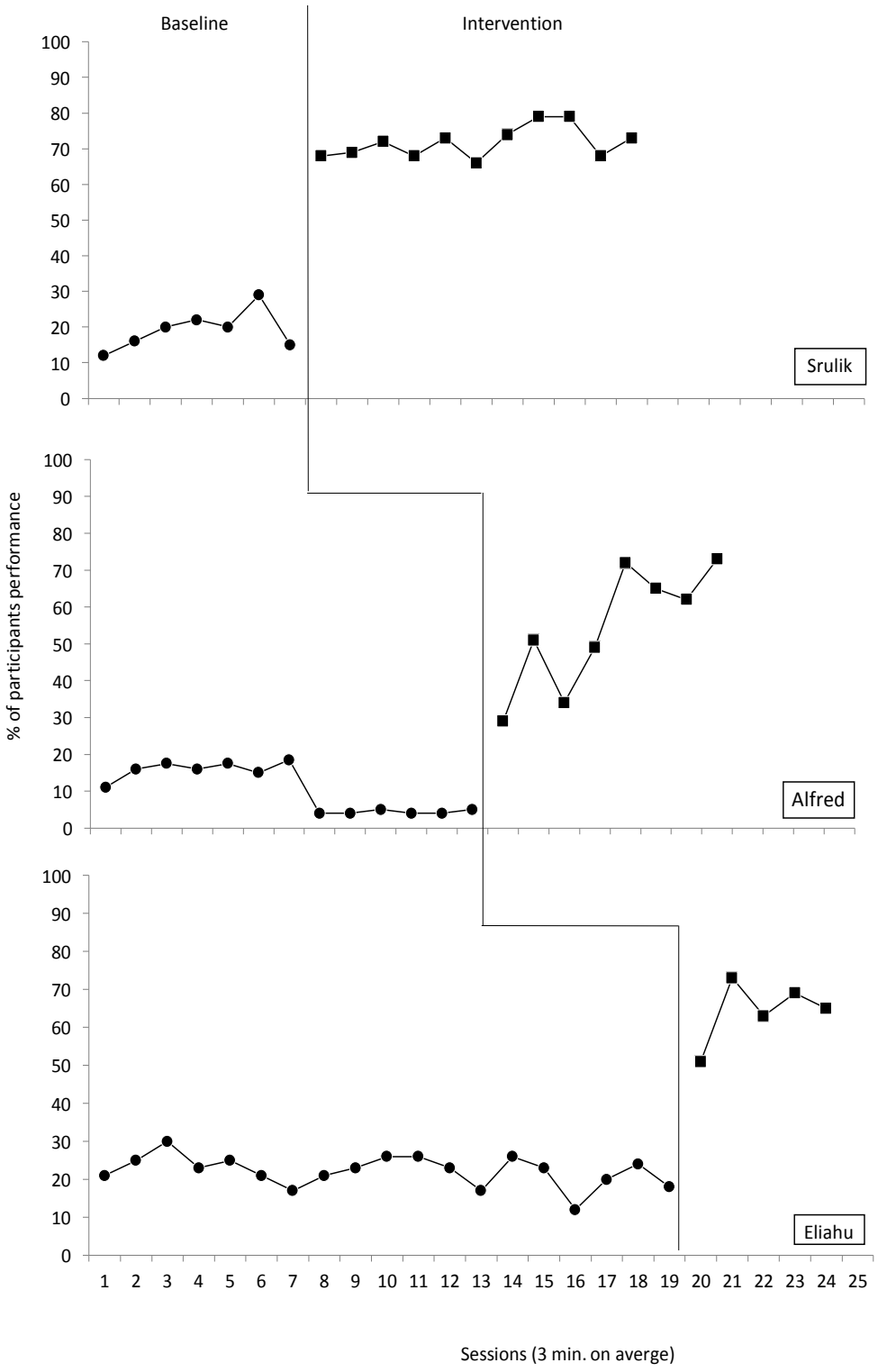
Figure 1. Session-by-session percentages of the correctly attained 11-element



behavioural teaching techniques during baseline and intervention phases.

Table I. Pre-post percentage averages of participants' element behavioural teaching techniques, measured for each of the 11 steps of the task analysis.

Task analysis Items	Srulik		Alfred		Eliah	
	Pre	Post	Pre	Post	Pre	Post
Physical Environment	9.4	100	22.8	100	12.1	100
No. of steps completed	63.8	96.7	51	77	72.9	92.2
5 seconds given to learners before Sd presented	14.1	42.54	0	57.3	8	82
Use of speech	82	5	87	23	69	7.8
Use of gestures	20.5	60.8	0	6.7	18	10
Use of physical guidance	2.5	66.6	0	48	1.4	58
Use of contingent reinforcement	5.1	47.5	0	26	10.4	27
Use of immediate reinforcement	5.1	46.7	0	25.8	10.4	27