The Role of Virtual Reality in Care Settings: Insights from People with Dementia, Care Staff, and Its Adoption

A Thesis Submitted to the University of Kent

for the degree of Doctor of Philosophy in Engineering

By

Hiba Jawharieh

January 2025

Canterbury – United Kingdom

This thesis is dedicated to the resilient and steadfast people of Palestine, especially the women and men with dementia, whose unwavering connection to their homeland stands as a testament to the enduring power of identity and belonging. May your strength and stories never be forgotten and may the deep bond you hold with your homeland live on in the memories, hearts, and voices of the generations that follow.

Acknowledgement

I would like to begin by expressing my deepest gratitude to my supervisor, Dr Chee Siang Ang, for his invaluable guidance and endless support throughout every aspect of this research. I also want to express my heartfelt gratitude to my co-supervisor, Dr Luma Tabbaa, for her constructive feedback and immense support. I consider myself very fortunate and am deeply appreciative of the mentorship I have received from both of you.

A very special thanks to Avante Care & Support for providing me with scholarship funding that enabled me to conduct this research. I particularly thank Jacqueline Morris for entrusting me with this project. I would also like to thank Stella Austin for her continuous support, rides and chats. I am deeply grateful to all the residents and care staff who participated in this research. Without your support, this work would have never seen the light.

I am deeply appreciative of my external examiner, Dr David Frohlich, and my internal examiner, Dr Rocio Von Jungenfeld, for their insightful feedback, rigorous questions, and generous engagement with my research.

I am grateful to Dr Andrew Sommerland for his insightful advice and support. I thank Heema Ajeet Gokani for being part of the focus groups and discussion rounds. I also thank Dr Panote Siriaraya and Dr Alexandra Covici for their support.

I am indebted to my colleagues, friends and neighbours who never failed to brighten my days. I extend my sincere gratitude to Ethan Cheung for providing the VR application used in this research. Your support and contribution were valuable to this study. I am thankful to Acarima Nanthanasit for her continuous support and for being there for me throughout this journey. Thank you, Rania Kolaghassi and Badea'a Al-Sukhni for the walks, coffee breaks and chats. Thank you, Lorrain Millard, for your friendship, the guided meditation sessions and continuous support in helping me build resilience during stressful times. Thank you, Age UK, Canterbury for allowing me to be part of your family. I am truly grateful to have met you all.

Above all, I would like to thank my family for their unconditional love and constant motivation. To my husband, Ghassan, I am eternally grateful for your unwavering support every step of the way. To my children, Adnan, Ghady and Sery, thank you for your patience, understanding and for being my biggest cheerleaders, I love you guys endlessly. To my mother, Janet, thank you for your sacrifices and limitless motivation. To my beloved father, Hani, and my dear brother, Fakhry, whose memories continue to guide me and inspire me at every turn. I hope I have made you proud. Finally, I would like to extend my gratitude to my dear aunties and cousins; your love and support mean the world to me.

Abstract

Given the increasing number of people with dementia in recent years, there is an emerging need to develop and implement non-pharmacological interventions to promote, support, and enhance the quality of life (QoL) of this population, particularly among those residing in care homes. Although Virtual Reality (VR) technology has emerged as a promising tool for providing meaningful and enjoyable experiences for people with dementia, its appropriate integration and adoption in dementia care settings are rarely discussed.

In this research thesis, a three-phase study was conducted to investigate how VR can be successfully deployed in multifaceted care settings to support dementia care. The first phase evaluated and identified key challenges and opportunities associated with VR in care settings via focus groups and discussion rounds with healthcare professionals and family members, laying the foundational framework for subsequent studies. The second phase investigated the complexities of VR design for dementia care settings, incorporating stakeholders' perspectives, including people with dementia, family members, care staff, and managers. The third phase investigated the comprehensive integration of VR to evaluate its efficacy in care settings and assess associated implications, with sessions led by care staff for practical deployment. Phases two and three are interrelated, so the findings were organised based on key stakeholders' categories. As such, the findings revealed that VR positively impacted people with dementia, enhancing interaction, emotional well-being, and communication with family members. For care staff, VR improved rapport with people with dementia, fostered a positive work environment and increased awareness of the capabilities of people with dementia. The findings highlighted key factors

influencing VR adoption, including technology acceptance, engagement and the role of managers and care staff in facilitating successful implementation.

The findings from this thesis extend our practical insights into the effective implementation of VR in dementia care settings, providing guidance for creating VR experiences tailored to the needs of people with dementia.

Table of Contents

List of Figures

List of Tables

List of Acronyms

3D	Three-Dimensional
360-VEs	360° Video-Based Virtual Environments
ASD	Autism Spectrum Disorder
AT	Assistive Technology
BPSD	Behavioural and Psychological Symptoms of Dementia
CS	Care Staff
DT	Digital Technology
DR	Discussion Round
EPWDS	Engagement of a Person with Dementia Scale
FG	Focus Group
FM	Family Member
F-2-F	Face-to-Face
HMD	Head-Mounted Displays
HS	Hybrid Session
GPS	Global Positioning System
HCI	Human-Computer Interaction
ICD-10	International Classification of Diseases, 10th Revision
ICT	Information and Communication Technology
MCA	Mental Capacity Act
MGR	Manager
MTR	Mobile Telepresence Robots
NHS	National Health Services
NPT	Non-Pharmacological Treatment
OERS	Observed Emotion Rating Scale
PC	Personal Computer
PwD	Person with Dementia
PTSD	Post-Traumatic Stress Disorder
QoL	Quality of Life
RS	Remote Session
SUS	System Usability Scale
TAM	Technology Acceptance Model
UCL	University College London
UTAUT	Unified Theory of Acceptance and Use of Technology
VE	Virtual Environment
VR	Virtual Reality
VW	Virtual World

Chapter 1: Introduction

1.1 Background and Problem Statement

According to Alzheimer's Disease International, as of 2020, over 55 million people are living with dementia worldwide, a number expected to almost double every 20 years, reaching 78 million in 2030 and 139 million in 2050. Dementia is a term that describes a variety of disorders that are progressive in nature and -currently- cannot be cured. As the condition progresses, people with dementia become forgetful, disoriented, and unable to communicate or retain new information (Jones et al., 2015) (see section 2.1.1), leading to compromised Quality of Life (QoL). Dementia is currently the seventh leading cause of death and one of the major causes of disability and dependency among older people, costing the global economy US$ 1.3 trillion in 2019 (World Health Organisation, 2024).

While pharmacological treatments are available (see section 2.1.4.3) they are unsuitable for everyone due to potential medication side effects, emphasising the need for alternative interventions. Research has been investigating non-pharmacological interventions to enhance the QoL for people with dementia (see section 2.1.4.4). Given the recent advances in digital technologies, research has gained momentum in developing innovative solutions to support this population (see section 2.2).

Virtual Reality (VR) creates immersive, computer-generated environments that users can interact with, providing a sense of presence and realism (Ehizogie et al., 2024) (see section 2.3). VR is a rapidly advancing technology platform that has gained considerable attention in healthcare research (see section 2.4). VR has been used as a tool to facilitate medical education (Keswani et al., 2020; Yanping et al., 2014), treatment interventions (Czech et al., 2023; Zhang et al., 2022), and screening and diagnosis (Ijaz et al., 2019; Pareek et al., 2018). Its deployment (see section 2.5.3) and acceptance (see section 2.4.4) encounter numerous hurdles impeding its full potential. However, few studies have looked at socio-technical issues around the deployment of VR in care facilities, considering the views, perspectives, and roles of key stakeholders, including people with dementia, their family members, care staff and care managers.

In the context of VR technology being used for dementia care, research has highlighted multiple VR applications to support individuals, such as early detection (Mendez et al., 2015), training activities for daily living (White & Moussavi, 2016; Zakzanis et al., 2009) and cognitive skills (Andringa et al., 2019) (see section 2.5.1). Several studies have proven the efficacy of the technology in enhancing the emotional (Appel, Ali, et al., 2021; L. N. Lee et al., 2019; Lin et al., 2018a) and social (D'Cunha et al., 2019; Gaspar et al., 2018; Lin et al., 2018a) well-being of people with dementia because it immerses users and boosts their sense of engagement (Hodge et al., 2018). Furthermore, VR promotes social connectedness (Deighan et al., 2023; Hughes et al., 2017) and mood-uplifting (Rose et al., 2021; Tabbaa et al., 2019) (see section 2.5.2). Nevertheless, limited research has highlighted the significance of tailoring the VR application, drawing on the feedback from people with dementia regarding their experience with wearing the VR headset and engaging in the immersive world.

To successfully implement VR in dementia care settings, it is essential to understand the factors impacting technology acceptance and adoption (see section 2.6) particularly stakeholders' perspectives (see section 2.6.2). Almost all studies involving family members have focused on understanding the perceived benefits of VR to their loved ones, with little consideration of the potential benefits to the family members themselves when sharing face-to-face or hybrid VR experiences with their loved ones and how it might affect their relationships (Afifi et al., 2022; C. S. Kruse et al., 2015). Furthermore, some studies have examined the role of care staff in technology acceptance and deployment with people with dementia (Hicks et al., 2022; Liu et al., 2018; Sas et al., 2020). Nonetheless, limited research has explored their role in independently deploying VR and the impact on them, mainly due to observing the reactions of people with dementia to VR experiences. Regarding the last key stakeholder, care managers, despite their primary role in the decision-making process of implementing activities and interventions, and thus their crucial role in VR deployment and adoption, no studies, to the knowledge of the author, have investigated their perceptions of the adoption and deployment of VR. Lastly, limited research has examined the organisational aspects and resource requirements associated with VR adoption in dementia care settings.

1.2 Aim and Research Questions

The present research aims to fill the aforementioned gap in the literature by exploring the opportunities, issues, and challenges associated with designing and deploying VR in dementia care settings. The focus is placed on technical and logistical requirements, stakeholder perceptions, and their impact through conducting a three-phase comprehensive study. Phase One laid the foundation for the subsequent phases by conducting focus groups and discussion sessions with healthcare professionals and family members. This phase aimed to examine, understand, and identify the main challenges and opportunities of implementing and integrating VR in complex care environments. Drawing on the vital findings from Phase One (Chapter 3), Phases Two and Three (Chapters 5, 6, and 7) were initiated to investigate the use of VR as a routine practice in dementia care settings and to allow its independent deployment. Since the study phases in this PhD were interdependent, the findings were organised around the perspectives and experiences of the stakeholders. Discussion pivots around the following research questions:

- *Considering key stakeholders' perspectives and organisational contexts, what are the multi-dimensional factors of VR technology acceptance before and during deployment in dementia care settings?*

The first research question investigates the technical (i.e. accessibility), social (i.e. social interaction) and organisational (i.e. institutional support) factors influencing acceptance and eventually adoption. Building on the perspectives and VR experiences of people with dementia, their family members, care staff and care home managers will provide valuable insights into approaches to improve technology acceptance.

- *How can VR impact the QoL of people with dementia and family members, and what are the potential opportunities and positive effects, particularly from their perspective?*

As the condition progresses, the QoL of people with dementia declines, which leads to reduced engagement and meaningful interactions. This research question explores the potential of VR to offer people with dementia new possibilities, providing a therapeutic dimension to the technology, particularly from the perspective of those living with the condition. By investigating how VR can improve emotional well-being and meaningful conversations, this research seeks to identify strategies in which VR can promote more person-centred care and improve QoL.

- *How does the use of VR impact the work environment of care staff in dementia care settings, based on their perspective?*

Dementia care settings present considerable challenges for those who work within, often leading to a stressful and demanding work environment. This research question attempts to understand whether and how VR deployment sessions can influence the work dynamics in dementia care settings.

- *What challenges are encountered when deploying VR technology and assessing the main issues and concerns of people with dementia, care staff, managers, and professionals working in dementia care settings?*

To optimise the outcomes of deploying VR in dementia care settings, it is crucial to identify and address the challenges associated with such deployment effectively and promptly. This research question seeks to investigate the technical and practical challenges, including concerns highlighted by key stakeholders, which reveal insights into properly integrating VR in these settings.

- *How should VR technology be used to deliver engaging and meaningful VR experiences to people with dementia in care settings, considering the contributions of care staff?*

It would be difficult to achieve optimal outcomes for deploying VR in these settings unless people with dementia were given engaging and meaningful VR experiences. This research question aims to explore how to deliver such captivating experiences, including what constitutes these experiences for people with dementia. It also aims to explore best practices and approaches to providing such experiences undertaken by care staff.

When the research questions were first developed, the focus was mainly on people with dementia and care staff, based on existing literature, initial planning, and Phase One key outcomes. At that early stage, family members were only formally included primarily to provide input on their loved ones' preferences and interests to curate personalised VR content. However, as the study unfolded, it became clear that family involvement had a meaningful influence on how VR was experienced and perceived, particularly by providing emotional support to people with dementia. This was specifically evident in the context of lingering effects of COVID-19 restrictions, during which people with dementia had experienced significant isolation. In light of these emerging insights, and in response to ongoing dialogue with professionals in the field, the research design was adjusted to involve family members more directly. This development also led to a refinement of the research questions, which were expanded to reflect the interconnected experiences of all three groups: people with dementia, care staff, and family members. These adjustments were part of a flexible, practice-based approach that allowed the study to evolve in real time, making space for voices that emerged as central throughout the process.

1.3 Contribution

The key contribution of this thesis is to provide insights into the design and deployment of VR experiences that are emotionally and therapeutically enriching, as well as meaningful that well-suit dementia applications in real-world situations. This thesis offers considerable practical contributions to the topic. The overall key contributions from this thesis could be summarised as follows:

- Extending the understanding of the concerns of professional healthcare workers and family members associated with delivering VR technology in a dementia care setting (Chapter 3)
- Extending the understanding of the impact of VR deployment on people with dementia, their family members and care staff (Chapters 5 and 6).
- Extending the understanding of delivering engaging and meaningful experiences while providing people with dementia personalised VR content (Chapter 5).

- Extending the understanding of the relationship between VR acceptance and adoption in dementia care settings, along with the factors that influence its adoption (Chapter 7).

Some of the findings derived from the present PhD thesis have already been published in 2 journals, aiming to extend the existing knowledge within the research community by contributing to the overall understanding of deploying VR in dementia care settings. Table **1.1** summarises the publications which have arisen directly from this thesis work.

Table 1.1 Publications list arising directly from this PhD thesis

Chapter	**Journal**	**Title**	**Status**	**Citation**
Five, Six and Seven	International Journal of Human-Computer Interaction	Care Beyond Borders: Investigating Virtual Reality Deployment Opportunities & Challenges Through the Lens of Dementia Care	Published	Jawharieh, H., Tabbaa, L., Ang, C. S., Cheung, E., Covaci, A. (2024)
Three	Dementia	Carers and professionals' views on using virtual reality in dementia care: A qualitative study	Published	Ajeet Gokani, H., Sommerland, A., Jawharieh, H., Ang, C. S., Huntley, J. (2024)

The table below includes work completed during the research period and used in this PhD thesis, although not directly associated with the phases conducted.

Chapter	Conference	Title	Status	Citation
Five, Six and Seven	Designing Interactive Systems (DIS) Companion	Meaningful Spaces, Meaningful Places, Co-Creating VR Experiences with People Living with Dementia	Published	Cheung, E., Ppali, S., Xygkou, A., Covaci, A., Jawharieh, H., Thomas, C., Ang, C. S. (2023)

1.4 Scope

This thesis focuses on deploying VR technology in dementia care settings, considering the views, perspectives and roles of key stakeholders, as well as investigating its acceptance and adoption to enhance the QoL of people with dementia.

Firstly, only low-cost, fully immersive VR systems are considered in this thesis. Affordable, fully immersive VR technologies can offer a feasible solution that can be deployed in real-world situations to enhance the QoL of people with dementia.

Secondly, all VR deployment sessions were conducted in small-scale care settings involving people with mild to moderate dementia. Given that one of the aims of this thesis is to investigate what constitutes engaging and meaningful VR experiences for people with dementia, this needed the provision of personalised VR content tailored to their individual needs. As a result, conducting the sessions in small-scale settings was essential for facilitating this level of tailored VR content while ensuring a more focused environment.

Thirdly, the phases of this thesis focused on technical, social and organisational factors influencing technology acceptance rather than its technical developments. This thesis centres on exploring technology acceptance based mainly on the feedback and views of key stakeholders in dementia care settings. Therefore, it investigates opportunities and challenges, prioritising meeting the needs of people with dementia and determining how best to integrate technology in these settings. Technical advances in VR technology relatively develop fast, sometimes exceeding the ability of care facilities to embrace them. By concentrating on technical, social and organisational aspects, this thesis considers fundamental issues that will persist despite technological developments.

Finally, the personalised VR content used in this thesis is context-specific and might not prove applicable to individuals with dementia in non-western contexts. This content reflects the preferences and interests of people with dementia living in the United Kingdom. This thesis emphasises the necessity of cultural adaptation when creating VR experiences since cultural and social diversity might impact engagement and effectiveness.

1.5 Structure

The structure of this thesis is as follows:

- Chapter 2 presents a comprehensive review of the literature related to this thesis. The chapter begins with an introduction to dementia, its impact, and current care approaches. Then, it investigates the use of digital technologies in dementia care and its applications for supporting people with dementia. Following an overview of VR technology, previous literature on the efficacy of VR in healthcare, particularly in dementia care, is reviewed, emphasising the challenges of its deployment. Finally, the chapter explores technology acceptance and adoption within care settings
- Chapter 3 outlines the methodology and the outcomes of Phase One, which evaluates and identifies the key challenges and opportunities associated with

deploying and adopting VR in complex care settings. The chapter details the design and procedure of this phase, including data collection methods. It provides an overview of the VR technology used, including the VR content and its selection criteria and presents the deployment plan developed for the subsequent phases.

- Chapter 4 outlines the methodology of Phases Two, the researcher-led VR deployment, and Three, the care staff-led VR deployment. The chapter describes the design and procedure of this phase, including recruiting participants, curating personalised VR content, data collection and analysis.
- Chapter 5 presents the findings on the impact of VR on people with dementia and their family members. It overviews the VR deployment sessions, technology acceptance, and the viewed content. The findings were organised into themes to discuss in depth the appeal of using VR for people with mild to moderate dementia and its potential to enhance their QoL. The chapter also highlights the role of VR in enriching conversations not only between family members and people with dementia but also among people with dementia themselves while alleviating feelings of guilt by family members.
- Chapter 6 presents the findings on the impact of VR on care staff. It provides an overview of the deployment sessions, investigating the factors leading to improved care staff's confidence and navigational proficiency with VR content. The findings were also organised into themes to highlight the role of care staff in facilitating VR deployment sessions. Furthermore, the themes underlined the potential of VR to strengthen the relationship between care staff and people with dementia, enhance care staff's understanding of the capabilities of people with dementia and improve their work environment.

- Chapter 7 examined adopting VR in dementia care settings. The findings were also organised into themes to investigate the challenges associated with VR integration in these settings and to evaluate the influence of VR acceptance on adoption, considering the stakeholders' perspectives. Additionally, the findings explored the role of engagement in promoting VR adoption and the key factors shaping the adoption to support a successful implementation.
- Finally, Chapter 8 discusses the overall findings, implications, recommendations, and limitations of the three phases that have been carried out. It is followed by potential future work opportunities derived from the work done in this thesis. The results from Chapters 5, 6 and 7 have been synthesised to provide an in-depth discussion on the impact of deploying VR in dementia care settings, considering the perspectives and experiences of people with dementia, family members and care staff, as well as the factors influencing VR acceptance and adoption.

Chapter 2: Literature Review

The literature review focuses on a range of topics related to the key research components of this thesis. First, the literature on dementia is reviewed in section 2.1, covering its implications on individuals, family members, and care staff, Quality of Life (QoL) of people with dementia, and care approaches. Then, digital technologies for dementia care are discussed in section 2.2, followed by an overview of the Virtual Reality (VR) technology (section 2.3) and its use in healthcare (section 2.4). The applications of VR and dementia care are then explored in section 2.5. Afterwards, the acceptance and adoption of technology in healthcare are examined in section 2.6.

2.1 Dementia

This section focuses on defining dementia and provides an overview of its common symptoms and clinical features, including cognitive impairments and behavioural and psychological symptoms. Afterwards, the impact of dementia on individuals is discussed, highlighting the challenges faced by family members and care staff, including distress and burden. A review of QoL and current approaches to dementia care follows.

2.1.1 Definition, Classification & Clinical Presentation

Dementia is an umbrella term caused by diseases that destroy nerve cells and damage the brain, leading to deterioration in cognitive function (i.e. the ability to process thought) beyond biological ageing (World Health Organisation, 2024). It manifests in progressive and uncurable disorders, affecting 55 million people worldwide, with numbers expected to rise to 78 million in 2030 and 139 million in 2050 (World Health Organisation, 2024). Common types include Alzheimer's disease, vascular dementia, Lewy body dementia and Frontotemporal dementia (Alzheimer's Society, 2024b).

Each type of dementia impairs a person's brain cell function in specific areas, affecting memory, thinking, and speech (Dementia UK, 2024b).

Symptoms include agnosia, apraxia, and impaired reasoning (Duong et al., 2017). Mood changes, such as irritability, withdrawal, sadness or aggressive behaviour, are common (Alzheimer's Society, 2024b). People with dementia could experience sleeping and eating fluctuations. With age, the incidence of dementia rises, making it increasingly common within the ageing population, where it leads to dependency and vulnerability, both socially and in terms of physical and mental health (Cunningham et al., 2015). Behavioural and Psychological Symptoms of Dementia (BPSD) affect up to 90% of patients with issues of apathy, depression, anxiety, psychosis, agitation, aggression, and other problematic behaviours such as wandering, sexually inappropriate behaviours, and care refusal (Bessey & Walaszek, 2019) considerably impacting their QoL.

2.1.2 Impact of Dementia on Individuals, Family Members & Care Staff

There are three stages of dementia: early, middle, and late. The onset of symptoms is gradual and often overlooked, advancing from occasional forgetfulness to disorientation and difficulty recognising relatives and friends. Subsequently, people with dementia would need assistance with self-care and mobility. Managing dementia is particularly challenging because of the complexity of the disorder and the limitations of current pharmacological options (Duong et al., 2017). Such options can only delay the progression of the symptoms but not prevent their advancement. As such, people with dementia progressively lose their sense of autonomy and become dependent on others for everyday activities of daily living (Chenoweth et al., 2009).

This often means they require care in long-term settings, especially at the later stages of the condition (Verbeek et al., 2010).

The condition places a considerable burden on family members caring for a person with dementia (Albinsson & Strang, 2002). Approximately 11% of family caregivers of people with dementia reported having depressive symptoms (Chi et al., 2019). As dementia progresses, family caregivers face growing emotional, psychological, physical, and social challenges as care needs increase (Thompson & Roger, 2014a). Family members often provide care at home, leading to stress and exhaustion that may result in relocating the person with dementia to a long-term care facility (Seiger Cronfalk et al., 2017), potentially causing feelings of guilt (Hennings et al., 2013).

Caring for people with dementia in care settings can be challenging and stressful for staff, who often work long hours, have limited training opportunities, received low pay, and face high expectations (Islam et al., 2017). Care staff offer people with dementia various support services, such as personal care, medication administration, mobility aid, social interaction and cognitive and emotional support. Research suggests that care staff in this environment may experience high physical and psychological workloads, such as stress (Fjelltun et al., 2009; Vondras et al., 2009) and fatigue (Costello, Walsh, et al., 2019), resulting in a high risk of burnout (Chamberlain et al., 2017). Stress and burnout among care staff may result in high staff turnover (Costello, Walsh, et al., 2019), potentially compromising care provided to home residents (Woodhead et al., 2016).

2.1.3 Quality Of Life of People with Dementia

QoL for dementia care is a multifaceted construct, including measures related to i) physical comfort, hygiene, and well-being, ii) safety, security, and order, iii) maintaining a sense of autonomy, dignity, and privacy, and iv) living a meaningful life, individuality, maintaining relationships, and enjoyment (Kane, 2001). Behavioural (i.e. apathy and sleeping and eating disturbances) and psychological (i.e. anxiety and depression) disturbances are more strongly associated with QoL than cognition or functional limitation (Banerjee et al., 2006). QoL is vital for people with dementia as it promotes feelings of safety, gives them control over daily life, fosters physical functioning (Malley & Fernández, 2010), meets their needs, respects their privacy, and treats them with respect (Towers et al., 2021).

Research has reported that measuring the QoL of people with dementia is challenging (Banerjee et al., 2006), especially as the condition progresses (Bowling et al., 2015). However, QoL is viewed and assessed as a concept encompassing different domains (emotional, physical, social, and environmental) of a person's well-being (Bökberg et al., 2017). The evaluation of QoL is possible in self-and/or proxy ratings, although self-rating scales are the best way to evaluate it due to the subjective aspect of the concept (Gräske et al., 2014). However, obtaining self-ratings becomes difficult when the individual has an advanced stage of dementia. Many measurements have been developed to assess the QoL of a person with dementia, such as QUALIDEM (Dichter et al., 2016), Quality of Life in Alzheimer's Disease (QoL-AD) (Logsdon et al., 1999), and Quality of Life Assessment Schedule (QOLAS) (Selai et al., 2001).

2.1.4 Current Approaches to Dementia Care

Nearly all (95%) people with dementia receive assistance, such as self-care, mobility, and healthcare system interaction (Chi et al., 2019). Early detection and management may prevent the overuse of costly healthcare resources and allow affected individuals and caregivers time to prepare for future medical, financial, and emotional challenges (Grand et al., 2011a). Given the lack of a cure for dementia and the complex challenges of caring for people with dementia, care approaches have developed to include a range of strategies and interventions targeted at improving their QoL and well-being. Some of the key approaches encompass the following:

2.1.4.1 Person-Centred Care

Person-centred care has been referred to as treating patients as unique individuals, which considers the patients' points of view and circumstances in decision-making (Paparelli, 2016), preserving their personhood (Hennelly et al., 2021; Vernooij-Dassen & Moniz-Cook, 2016). It offers a holistic alternative to conventional care practices that can moderate the effects of malignant social psychology and help personhood persist as dementia develops while addressing human needs, mitigating cognitive and functional deterioration (Chenoweth et al., 2009), and enabling people with dementia to engage in activities they enjoy (Alzheimer's Society, 2024c).

Studies have highlighted the significance of person-centred care in dementia care (Ballard et al., 2018; Edvardsson et al., 2010; Fossey et al., 2014), including person-centred activities (Jung et al., 2018; K.-U. Kim et al., 2017). It provides dignity, compassion, and respect (The Health Foundation, 2016). It ensures coordinated and personalised care, support, and treatment while fostering the recognition and development of a person’s strengths and abilities to live independently and fulfill their lives (The Health Foundation, 2016). However, implementing person-centred care poses challenges, such as economic constraints and a shortage of healthcare professionals (Paparella, 2016).

2.1.4.2 Multi-Disciplinary Care

An integrated multi-disciplinary approach to diagnosing and managing complex disorders such as dementia is generally recommended because no single medical or healthcare specialist has the expertise to deal with the range of mental, emotional, physical and social problems that accompany dementia (Wolfs et al., 2008). This approach relies less on standard pharmacological-based medical practice and more on the integration of therapies from a broader range of healthcare providers and community professionals, such as neurologists, geriatricians, neuropsychologists, nurse practitioners, nutritionists, social workers, and physical/occupational therapists (Grand et al., 2011a).

A multi-disciplinary approach improves the quality of care for people with dementia (Anantapong et al., 2022; Rolland et al., 2020; Wolfs et al., 2006), including reducing BPSD and caregiver burden, improving some cognitive domains and delayed institutionalisation (Zucchella et al., 2018). Nevertheless, to implement this approach effectively, clinicians must have an adequate understanding of the condition and the available resources available to meet the patient's medical, social, and emotional needs (Grand et al., 2011b) and a high level of organisation (Wolfs et al., 2008).

2.1.4.3 Pharmacological Treatments

Some dementia medications, such as donepezil[1] and rivastigmine[2], are most beneficial for people with early to middle-stage dementia and may help with anxiety, memory, and concentration (Dementia UK, 2024a). Other medications can control blood pressure and cholesterol, preventing additional damage to the brain (World Health Organisation, 2024). Selective serotonin reuptake inhibitors can help with severe symptoms of depression (World Health Organisation, 2024). Nevertheless, they appear to be less effective in people with dementia (Alzheimer's Society, 2023) and may sometimes further impair cognitive function (Kitching, 2015). Psychotropic drugs, such as Benzodiazepines[3], are often prescribed to manage challenging behaviour in dementia despite evidence indicating an increased risk of strokes and

[1] https://www.nhs.uk/medicines/donepezil/
[2] https://www.ema.europa.eu/en/medicines/human/EPAR/rivastigmine-sandoz
[3] https://www.england.nhs.uk/london/wp-content/uploads/sites/8/2022/10/Antipsychotic-Prescribing-Toolkit-for-Dementia.pdf

death (O'Donnell et al., 2022). These pharmacological treatments do not target the underlying pathogenesis of dementia but rather help improve or maintain function following neuronal damage (Grand et al., 2011a). They help relieve some symptoms and slow the condition's progression (Dementia UK, 2024a) but do not prevent its advancement (Duong et al., 2017). Eventually, the disease will damage enough of the brain that these medications have much less of an effect (Alzheimer's Society, 2024b). However, some people with dementia may find that the benefits of taking medication are not worth its side effects (Alzheimer's Society, 2024a). Common side effects include loss of appetite, nausea, diarrhea, and headaches, while more serious side effects include seizures, muscle weakness with high temperature, and severe stomach pain (Alzheimer's Society, 2024a).

2.1.4.4 Non-Pharmacological Interventions

Non-pharmacological interventions involve delivering therapeutic activities and psychological support to people with dementia to maintain or enhance cognitive functioning, promote independence, increase QoL, provide enjoyment and meaningful activities, and encourage interaction with others and the environment (Hoe & Thompson, 2010). Non-pharmacological interventions, believed to be a safe treatment option with fewer side effects and cost-effectiveness than pharmacological treatments, stem from various disciplines; each seeks to positively impact cognitive, mood, and other behavioural and psychological symptoms of dementia (Berg-Weger & Stewart, 2017). Non-Pharmacological Treatments (NPT) aim to reduce the BPSD of people with dementia without the use of medication. It encompasses interventions to improve patients' symptoms, reduce caregivers' stress, and better the environment (Zucchella et al., 2018). McDermott et al. (2019) explain that NPT is based on different methodologies, ranging from straightforward (e.g., environmental interventions) to complex approaches (e.g., virtual reality, home automation).

Reminiscence therapy, a popular psychosocial intervention, uses personal items like photos to stimulate memory and promote communication in people with dementia (Alarcão, 2017). It enables older adults to share meaningful experiences, fostering emotional connection, self-worth, and life satisfaction (Tsao et al., 2019). The sessions can be individual (Subramaniam & Woods, 2012) or group-based (Gil et al., 2017). A study with 24 veterans at a care home to investigate the impact of such therapy, Ching-Teng et al. (2020) found that it reduced depression and enhanced meaning of life. While it is easy to implement (Redulla, 2019), challenges include added burden on caregivers (Park et al., 2019) and difficulty engaging with participants (Woods et al., 2018).

Another common intervention is music therapy. Through singing and listening to music (Cho, 2018), this approach promotes non-verbal communication, relationships, learning, and expression, improving emotional, social, and cognitive functioning through increased QoL (Grand et al., 2011a). People with dementia find music therapy enjoyable and can still stimulate the less able ones; it raises their spirits and helps them concentrate (Harmer & Orrell, 2008). Chu et al. (2014) studied 104 persons with dementia randomly assigned to the experimental and control groups to assess music therapy's effectiveness. The experimental group received 12 sessions (two 30-minute sessions weekly for 6 weeks), and the control group received usual care. The findings showed that music therapy reduced depression and delayed cognitive decline, particularly in short-term recall (Chu et al., 2014). However, although music therapy requires a qualified therapist for beneficial outcomes (Gómez-Romero et al., 2017), the care staff leading the sessions are often untrained (Cho, 2018).

In addition to traditional therapies/interventions, digital technologies have been investigated as tools to support and deliver NPTs, which will be discussed in the next section.

2.2 Digital Technology for Dementia Care

Research on designing Digital Technology (DT) for people with dementia is increasing (Astell et al., 2019; Neves et al., 2019; Van der Roest et al., 2017). Previous research has investigated various technologies to promote the independence of people with dementia, increase their autonomy, boost self-confidence, help maintain specific skills and abilities, and improve their overall QoL (Alzheimer's Society, 2017; Nishiura et al., 2021). While most DTs are designed to support people with dementia (Houben et al., 2019; Kleinberger et al., 2019; Zamir et al., 2020), others are aimed at supporting informal (Boise et al., 2013) and formal carers (Lindauer et al., 2020). Notably, in early dementia stages, DTs focus on people with dementia, while later stages see increasing use by family members and healthcare professionals (Lorenz et al., 2019).

2.2.1 Roles and Applications of Digital Technology

According to Alzheimer's Society (2017), technology can improve confidence, help manage potential risks in and around the house, support people with dementia to maintain some abilities, reassure carers, and help them feel less stressed. As DTs are becoming pervasive in people's everyday lives, various technologies have been documented in the literature, leading to 6 primary functions: 'memory and support of self-care and activities of daily living', 'treatments and intervention delivery', 'safety, security, monitoring and reassurance', 'training', 'care delivery, management and support', and 'social interaction and networking' (Lorenz et al., 2019). Furthermore, technology can contribute to various areas, including reminders, stimulation, relaxation, behaviour management, safety, surveillance, control assistance for relatives, service coordination and communication (Riikonen et al., 2010). However, adoption rates of such technologies remain low, in part due to a lack of awareness (Astell et al., 2019; Lorenz et al., 2019; Neves et al., 2019) and challenges in accessibility (including financial) and support (Astell et al., 2019).

2.2.2 Digital Technology as an Assistive Technology

Assistive Technology (AT) refers to devices or systems that support people with dementia to maintain or improve their independence, safety, and well-being, assisting them with memory, cognitive, mobility, and physical challenges (Alzheimer's Society, 2015). However, AT can never eliminate risks (Alzheimer's Society, 2015). For AT to be effective for people with dementia and their families, it must be accessible at the right time, adaptable to the user's changing needs, easy to use, and low-cost (Lorenz et al., 2019). As such, here are examples of ATs that enhance the QoL of people with dementia.

2.2.2.1 Assistive Technology for Life Management

AT for life management allows people with dementia to maintain independence for longer periods, enhancing autonomy, QoL, and reducing caregiver burden and care cost (Nishiura et al., 2021). Such devices include the Global Positioning System (GPS), electronic medicine dispensers, electronic door locks (to secure access for healthcare workers) (Holthe et al., 2022), and telecare (Carretero, 2015).

Wandering and getting lost are common concerns for people with dementia. GPS technology, including wearable watches and pendants, modern phones (McKinstry & Sheikh, 2013), and wearable arm–wrist mobile safety alarms (Holthe et al., 2018), has been used to address this issue. Øderud et al. (2015) found that GPS can help persons with dementia maintain their independence, enjoy outdoor activities and enhance their safety even as the disease progresses (Øderud et al., 2015). Although such devices are relatively widespread among family carers and professionals, concerns persist about their impact on civil liberties, ethical implications (McKinstry & Sheikh, 2013; Zwijsen et al., 2011), practical limitations like battery life (Hadwen et al., 2017) and user acceptance (Sait et al., 2019).

People with dementia often experience disorientation with time, struggling to know the time, measure it or distinguish between day and night (Evans & Collier, 2019). Electronic calendars can support time management, reduce anxiety, and promote independence (Persson et al., 2023) by providing reminders for appointments, meals or tasks (Carretero, 2015). In a study with 27 older people to investigate the effectiveness of such calendars, Nishiura et al. (2021) found improvement in cognitive function and daily behaviours, though participants required care staff support to maintain the calendar. Another study with 6 pairs of people with dementia and their family members showed that calendars were used either intensively as external memory records or more casually and randomly for reassurance (Persson et al., 2023). However, such devices become harder to use as the condition advances (Astell et al., 2019; Rosenberg et al., 2009). Therefore, time-related interventions are recommended in the early stage of dementia to help maintain time management skills (Persson et al., 2023).

2.2.2.2 Digital Technology for Home Management

DTs aim to help vulnerable people live more safely, capably, and longer in their location of choice (Mahoney et al., 2007), especially as the condition progresses. These technologies support functional, activity, cognitive, intellectual, and sensory-related activities, such as providing alarms to detect dangerous situations and continuously monitoring their health and well-being through interactive and virtual services (Augusto et al., 2011). Related technologies include night movement detectors, such as bed occupancy sensor that triggers alarms for the carers if a user remains out of bed for longer than usual according to their habits; alerts for abnormal activities, which notify carers of unurgent situations such as the fridge door left open or running water; and medication management systems designed for dispensing, adherence, and tracking (Carretero, 2015).

Furthermore, smart home technology, designed to enhance QoL and "ageing in place", has gained popularity in monitoring the health of older people (Bourazeri & Stumpf, 2018; E. J. Lee & Park, 2020). To explore the experiences, needs and benefits of sensor-based technology (TECH@HOME) for safety and independence, Malmgren Fänge et al. (2020) installed home monitoring kits in the homes of people with dementia (n=9) and their family members (n=21). TECH@HOME kit included sensors for home-leaving, smoke and water leaks, door and window, motion-based bed and automatic lights designed to notify family members of adverse events (Malmgren Fänge et al., 2020). The findings highlighted that the technology was seen as a precaution and a safety measure, providing a sense of control over the everyday life of a person with dementia (Malmgren Fänge et al., 2020). In a more comprehensive study, (Lazarou et al., 2016) remotely monitored people with dementia and designed personalised interventions based on system feedback and clinical observations for improving cognitive function and health-related QoL (Lazarou et al., 2016). They found improvement in physical condition, sleep and neuropsychological assessment from the beginning to the end of the trial (Lazarou et al., 2016).

Nonetheless, such technologies are mostly cost-prohibitive (Collins, 2018) and raise ethical dilemmas about monitoring people with dementia in their homes (Mahoney et al., 2007; Malmgren Fänge et al., 2020). Also, they may not align with users' technical capabilities (Mahoney et al., 2007).

2.2.2.3 Digital Technology for Socialisation & Companionship

Socialising is vital for people with dementia as it promotes well-being and helps maintain cognitive function (Astell et al., 2019). Studies have investigated the potential of Mobile Telepresence Robots (MTR) to improve the social life of people with dementia (Liang et al., 2017; Moyle et al., 2020; Yamazaki et al., 2019). Robotic care intervention may be an effective non-pharmacological alternative for improving health outcomes, reducing negative emotions and behavioural symptoms, and enhancing engagement in people with dementia (Saragih et al., 2021). Different MTR serves various purposes. *Giraff*, for example, facilitates remote communication between people with dementia and their loved ones. Moyle et al. (2019) found that *Giraff's* mobility enhanced social connections while serving as a safety and monitoring device. Remote socialising via videoconferencing boosts positive emotions and reduces agitation (Astell et al., 2019). An investigation by Van Der Ploeg et al. (2016) using internet video calls (Skype) versus standard landline telephone calls as a treatment of agitated behaviour revealed improvement in participants' (n=9) behaviour. The findings suggested that combining visual with auditory sensory inputs captures attention and reduces agitated behaviours more effectively than auditory inputs alone (Van Der Ploeg et al., 2016). Other robots, like Bomy (see Figure **2.1**), act as companions and assist with daily activities such as medication reminders and cognitive stimulation games (Gasteiger, Ahn, et al., 2022). In general, people with dementia tend to accept robots, whether for socialisation (Khosla et al., 2017) or companionship (Zsiga et al., 2018).

Figure 2.1 The Companion Robot (Bomy)
Note. Adapted from "A Review of Companion Robots for Older Adults" by Gasteiger, Ahn, et al., 2022, Assistive Technology, 34(4), pp. 487-497. https://doi.org/10.1080/10400435.2021.1877210. Licensed under CC BY 4.0.

Furthermore, reminiscence using digital media tools is also increasingly being adopted in care settings to support the well-being of people with dementia (Edmeads & Metatla, 2019; Kleinberger et al., 2019; Lazar et al., 2014). Reminiscence therapy, a popular psychosocial intervention in dementia care, assumes that remote memory remains intact until later stages and can facilitate communication with people with dementia (Cotelli et al., 2012). Using DT for reminiscence therapy provides access to engaging multimedia materials, opportunities for social interactions, ownership of conversations, and reduced barriers from motor deficits during media use (Lazar et al., 2014). Examples include MOMENTO (West et al., 2007), a digital-physical scrapbook, and Memory Music Box (Kleinberger et al., 2019) (see Figure 2.2), a personalised music therapy device.

However, implementing these technologies requires ongoing technical support to avoid frustrating users (Gasteiger, Ahn, et al., 2022), demands more time and effort from care staff, increases budget allocations, and can confuse individuals with dementia, who may forget the technology between sessions (Zamir et al., 2020).

Figure 2.2 Memory Music Box

Note. Adapted from Note. Adapted from "Supporting Elder Connectedness through Cognitively Sustainable Design Interactions with the Memory Music Box," by Kleinberger et al., 2019, Proceedings of the 32nd Annual ACM Symposium on User Interface Software and Technology (UIST '19), pp. 355–369. https://doi.org/10.1145/3332165.3347877. Licensed under CC BY 4.0.

2.3 Virtual Reality Technology

VR is an advanced, human-computer interface that simulates a realistic environment where participants can move around in the Virtual World (VW) (Zheng et al., 1998). Girvan (2018) defined VW as a shared, simulated space where users, represented as avatars, interact in real-time, shaping the environment and constructing a shared understanding. The computer must generate new images fast enough to give the impression of real-time movement and responsiveness (Sisto et al., 2015). VR has many uses, from recreation to communication to scientific and medical research (Zheng et al., 1998).

This section will discuss an overview of VR technology, followed by user experience and perception.

2.3.1 Overview of Virtual Reality Technology

VR has existed in various forms since the late 1960s, known by names such as synthetic environment, cyberspace, artificial reality, and stimulator technology before VR was adopted (Onyesolu & Eze, 2011). The combination of interactivity and the ability to provide a high-fidelity three-dimensional (3D) visualisation of places and objects offers a unique experience for users that is difficult to achieve using traditional media (Siriaraya & Ang, 2014). To create immersive VR experiences, various critical components must be seamlessly integrated, including Head-Mounted Displays (HMD), sensors, input devices (e.g., controllers and gloves), and software.

Current commercial VR systems typically require the user to wear a HMD to fully immerse in the Virtual Environment (VE), where their view of the physical environment is completely obscured and replaced by a 3D VW (Baker et al., 2020). They contain two screens presented in front of the individual's eyes, where digital images are delivered to each screen, and they are rendered with appropriate perspective to account for the position of each eye (Bird, 2019). HMD enhances the stereoscopic view of the environment through the movement of the user's head and audio and haptic devices due to an embedded system to track its positions and rotation, improving the overall virtual experience (Cipresso et al., 2018).

HMDs have embedded sensors that track rotational motion, allowing users to explore the simulated environment by walking, crouching, and bending for the best view (Walters et al., 2022). VR HMDs deliver real-time updates in sensory perception, stereoscopic visuals, and broad fields of vision to ensure that individuals experience the Virtual Environment (VE) as their primary reality (Won et al., 2017). VE technology uses a 3D graphics program that relies on a spatially organised, objectorientated database in which people perceive the simulated environment as real-life objects and events (Sisto et al., 2015).

The handheld controllers, an input device, allow interaction and improve the overall VR experience (Cipresso et al., 2018). They permit the user to select items, access menus, and position the hand in the VE using a combination of hand tracking and pressing controller buttons (Baker et al., 2020). Another input device is the data gloves. Data gloves are fitted gloves with position and stretch sensors that track the movement of the user's hands to stimulate the user's movement (Sisto et al., 2015), facilitating the user's interaction with virtual objects and tactile and force feedback (Slater & Sanchez-Vives, 2016).

VR software helps generate immersive experiences by integrating multiple applications and tools. This software includes programming instruments such as Unity[4] and Unreal Engine[5], which enable developers to create complex 3D environments with interactive features. Technological advancements have led to the variation in VR software applications, such as OpenTracker, a VR software architecture (Reitmayr & Schmalstieg, 2001), VR-EAL, a VR neuropsychological battery (Kourtesis & Macpherson, 2021), and VRChat, a VR social connectedness application (Deighan et al., 2023).

2.3.2 User Experience & Perception

Regarding user experience and perception in VR experiences, two key concepts—presence and immersion—significantly influence how people engage with and perceive the VW.

[4] https://www.unity.com/
[5] https://www.unrealengine.com/en-US

2.3.2.1 Presence

To ensure the success of a VR experience, presence is a crucial element as it gives the users the feeling of "being there" and perceived realism. As such, it is a psychological state (Blackman, 2024). Slater & Wilbur (1997) explain that presence is a state of consciousness that may be concurrent with immersion and is related to a sense of being in a place; it governs aspects of autonomic responses and higher-level behaviours of a participant in a VE. The perception of presence occurs only in the present tense as it is only momentary, immediate and compact (Harth, 2018).

Modern HMDs enable users to block external stimuli and expose them to visual sensory input, whereas early HMDs have narrow field-of-views (Weber et al., 2021). Weber et al. (2021) explain that such a modern design of HMD inevitably fosters a high sense of presence even if a VE is not convincing (i.e. poor resolution) because there is no external sensory information from the world other than the visual and auditory inputs provided.

2.3.2.2 Immersion

Immersion is the extent to which high-fidelity physical inputs (e.g., light patterns, sound waves) are provided to the different sensory modalities (vision, audition, touch) to create strong illusions of reality in each (Mandal, 2013). There are three types of VR: non-immersive, semi-immersive, and fully immersive. The degree to which a system provides displays across all sensory modalities and tracking that faithfully preserves fidelity to their real-world equivalents defines how 'immersive' the system may be described. (Slater et al., 2009). Ma & Zheng (2011) use the following guidelines to distinguish between non-immersive, semi-immersive, and immersive VR systems: a non-immersive VR system employs a conventional graphics workstation with a monitor, a keyboard and a mouse; a semi-immersive system uses a relatively high-performance graphics computing system coupled with a large surface to display the visual scene; and an immersive VR system projects the visual scene into the HMD – or large projection surfaces "encasing" the user – filling the user's field of view. Immersion is supposedly technologically determined and, in turn, creates a sense of presence (Blackman, 2024).

2.4 Virtual Reality for Healthcare

VR is an innovative technology increasingly adopted in different healthcare settings (i.e. hospitals and rehabilitation clinics), offering benefits for patients with various health issues (i.e. exposure therapies for anxiety and trauma and eating and body image disorders) (Ehizogie et al., 2024; Halbig et al., 2022; Kouijzer et al., 2023). VR has garnered the attention of health professionals, hospitals, universities, technology developers, researchers, and educational institutions. VR interventions have been explored across various healthcare contexts, including improving cognitive function following a stroke (Wiley et al., 2022) and enhancing the mindful-based intervention to treat anxiety, depression, and emotional regulation difficulties (Navarro-Haro et al., 2019). Also, VR can stimulate addiction scenarios in the VW, providing a framework for treatment via counterconditioning procedures (Wang et al., 2019). Herein, the body of literature was explored, aiming to understand how VR is used to provide various forms of support within different healthcare settings.

2.4.1 Virtual Reality for Education & Training

VR has played a vital role in advancing various educational and training domains. VR delivers stimulation and education by creating scenarios replicating real life, letting learners act as they would in real life. It provides feedback and debriefing on performance, offering low-cost and repeatable, standardised clinical training (Pottle, 2019). This education and training approach enhances student engagement by promoting active, constructivist learning, increasing authentic learning experiences, fostering empathy, encouraging creativity, and concretely visualising abstract concepts (Hu-Au et al., 2017). For instance, a study on teaching the History of Civilisations to 25 first-year undergraduates used a VR experience with audio-visual elements to introduce the Kaaba (Yildirim et al., 2018). Participants found it effective in showcasing historical events and locations, increasing their course interest and enabling active learning, especially for those with disabilities or other limitations (i.e. financial and time) (Yildirim et al., 2018). They also underlined that VR environments could create more memorable learning environments than traditional learning methods (i.e. images and videos) (Yildirim et al., 2018).

Additionally, VR has been successfully implemented in the medical education field. Keswani et al. (2020) suggested that VR technology can provide a simulated workbench environment for doctors with a 3D image of the human body, enabling them to learn how to deal with the actual clinical procedure and practice surgery on a virtual human body. This process is beneficial not only for experienced surgeons in complicated procedures but also a new learning opportunity for new ones. Yanping et al. (2014) highlighted that surgical training simulators, with virtual and haptic feedback functions, can offer a safe, repeatable, and cost-effective alternative to traditional surgeries. Moreover, VR technology can enhance classroom training by providing an interactive process for exploring concepts like human anatomy, heart structure and disease mechanisms without requiring physical specimens (Hsieh & Lee, 2018; Keswani et al., 2020).

VR also has the potential to enhance surgical procedures. The use of VR to create virtual organs or tissues can assist physicians, improve doctor-patient communication, and enhance diagnosis and surgical progress information (Hsieh & Lee, 2018).

Moreover, VR applications can improve preplanning of surgery procedures. For example, an immersive VR application for preoperative 3D models in liver reconstruction is widely accepted as a process for preplanning surgeries (Boedecker et al., 2021). In a study assessing the efficacy of such an application, Boedecker et al. (2021) concluded that the five experienced surgeons deemed the application easy to use and more advantageous than 3D PDFs and 3D prints in preoperative liver surgery planning. They noted that the VR model calculation took under a minute and allowed for a show-and-hide structure, natural (using both hands), multi-user interaction (including remote collaboration and surgery simulation with resection mode (Boedecker et al., 2021). Figure 2.3 illustrates these functions, which enable interactive preoperative planning and team discussion within the VR application (Boedecker et al., 2021).

VR presents a new milieu for learning from experience in a risk-free setting where the process could be reversed and repeated, focusing on decision-making, critical thinking, and clinical reasoning, with scenarios designed to replicate human interaction in the real world (Pottle, 2019).

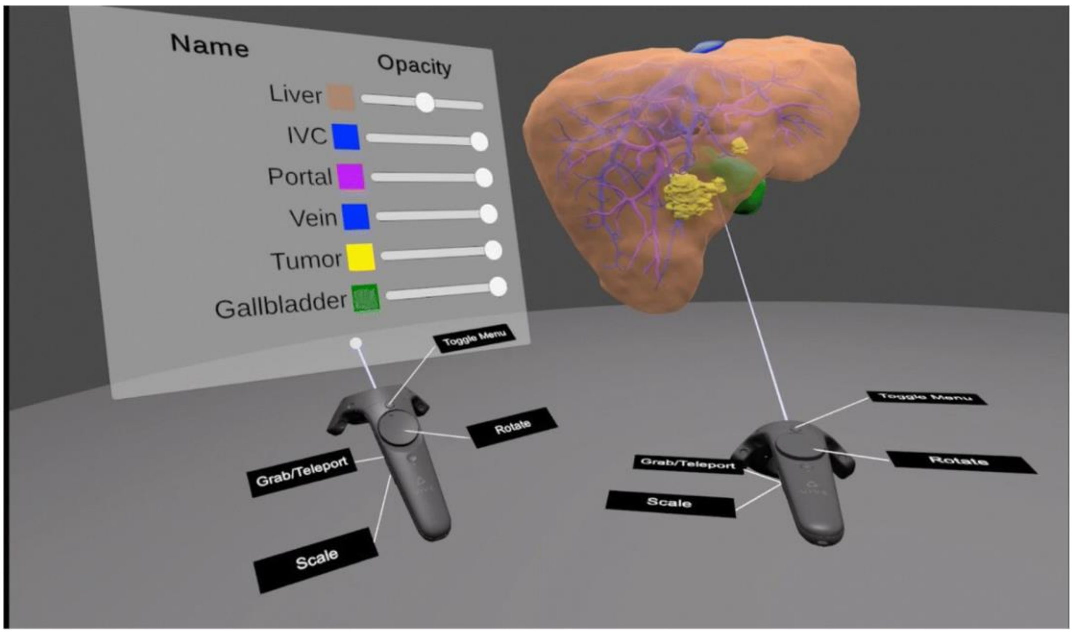


Figure 2.3 VR Application for the Preoperative Demonstration of 3D Liver Models

Note. Reprinted from "Using Virtual 3D-Models in Surgical Planning: Workflow of an Immersive Virtual Reality Application in Liver Surgery", by Boedecker et al., 2021, Langenbeck's Archives of Surgery, 406, pp. 911-915. https://doi.org/10.1007/s00423-021-02127-7. Licensed under CC BY 4.0.

2.4.2 Virtual Reality for Treatment Interventions

Research has identified VR as a potentially transformative tool for psychological interventions, improving the efficacy of psychiatric treatments, reducing costs, and increasing accessibility to a broader patient population (Geraets et al., 2021). By using VW in therapy, patients can relive typical real-life experiences to improve their behaviour and overcome their challenges. VR allows them to face anxious-inducing or difficult social situations, where the difficulty can be adjusted and rehearsed repeatedly with a therapist before applying new strategies in real life (Emmelkamp & Meyerbröker, 2021).

Additionally, VR has proven its efficacy as an intervention for pain management. Smith et al. (2018) state that pain carries a substantial global burden, with a prevalence of 20% and an incidence of 10%. They also said it negatively affects one's psychological and social functioning, impinging on the QoL. Usually, pain is managed with medication or psychological technique. In some cases, medication could have side effects, and psychological intervention is costly. According to Mallari et al. (2019), most acute pain studies show that VR is an effective tool in reducing pain experienced during medical procedures (i.e. labour contractions, episiotomy repair, periodontal procedures) or burn-related pain (including wound debridement or remobilisation joint range limited by burns).

Also, VR intervention can be deployed during chemotherapy treatments (Czech et al., 2023; Rutkowski et al., 2021). To assess the effectiveness of VR distraction technology in reducing pain and anxiety among female patients with breast cancer, Bani Mohammad & Ahmad (2019) used a randomised control trial design with a sample of 80 female patients with breast cancer. They discovered that virtual reality was a more effective and safer distraction approach to manage pain and anxiety in breast cancer patients than morphine alone (Bani Mohammad & Ahmad, 2019).

In addition, research has shown that VR is an effective tool for treating phobias, anxiety, and Post-Traumatic Stress Disorder (PTSD) (Carl et al., 2018; C. M. Coelho et al., 2009; Freitas et al., 2021). These mental health conditions can negatively impact an individual's day-to-day life, reducing their QoL. Exposure therapy, which assists patients in confronting their feared memories and situations, has long been a success in treating various disorders (Rothbaum & Schwartz, 2002). VR exposure therapy has been proven effective in helping individuals overcome their conditions and alleviate suffering (Gerardi et al., 2008), offering cost-effective solutions in a controlled environment, particularly when compared to In Vivo therapy (Boeldt et al., 2019). For PTSD patients, VR can increase accessibility to treatment and improve traumatic memory activation during exposure therapy (Neerincx et al., 2010). Studies have shown that VR exposure therapy can reduce anxiety and phobia symptoms (Parsons & Rizzo, 2008) and PTSD (Rothbaum & Schwartz, 2002).

Furthermore, several studies have highlighted VR efficacy as an intervention for people with Autism Spectrum Disorder (ASD) (De Luca et al., 2021; Ke et al., 2022; Zhang et al., 2022). ASD is a neurodevelopmental disorder characterised by deficits in social communication, restricted interests and repetitive behaviours (Hodges et al., 2020). Unusual fears (Mayes et al., 2013), including social anxiety (Shephard et al., 2019), are common in individuals with ASD. In a study by Maskey et al. (2014), results show that cognitive behavioural therapy techniques offered in VE were a highly effective treatment for specific phobias in some young people with ASD. They reported that eight out of 9 children showed improvement in addressing their target situation, and 4 ultimately overcame their phobia. Similarly, in a study by Suresh & George (2019) with 40 autistic children aged 8-15, VR intervention significantly reduced anxiety during dental procedures and improved dental behaviour.

2.4.3 Virtual Reality for Screening & Diagnosis

Many studies have used VR as a screening and diagnostic tool for specific conditions and diseases. For example, Nolin et al. (2012) tested the feasibility of VR to detect the subtle effects of sports concussions in 25 adolescents with special educational needs, concluding that VR offered several advantages, such as easy reproducibility, enabling concurrent studies in different locations, and requiring no specialised training to operate. In another study using VR-CogAssess to assess spatial navigation memory in older adults compared to a Personal Computer (PC) screening, Ijaz et al. (2019) found that participants in VR were significantly more engaged, had better landmark recall, made fewer navigational mistakes and reported a higher presence than those in PC setup, with no difference of stress level between the two groups. Figure 2.4 illustrates the VR-CogAssess platform that runs various cognitive assessment tasks using photorealistic imagery to assess topological cognitive impairment (i.e., spatial navigation memory) as a tool for predementia diagnosis (Ijaz et al., 2019).

Figure 2.4 To the left: Illustration of the Use of the Equipment. To the right: A Scene from the game

Note. Adapted from "An Immersive Virtual Reality Platform for Assessing Spatial Navigation Memory in Predementia Screening: Feasibility and Usability Study," by Ijaz et al., 2019, JMIR Serious Games, 6(9), e12345. https://doi.org/10.2196/13887. Licensed under CC BY 4.0.

Furthermore, VR has elevated breast cancer diagnosis and enhanced tumour visualisation. Research carried out by Pareek et al. (2018) has indicated that using VR in this context can permit doctors to carry out studies regarding the visualisation processes on a large scale, allowing them to see the tumour correctly, create better treatments, and develop improved pharmaceuticals. Additionally, such VR visualisation processes, including virtual colonoscopy, facilitate painless, less stressful, and quicker procedures (Pareek et al., 2018).

2.4.4 Obstacles of Virtual Reality Technology in Healthcare

In recent years, VR technology has advanced substantially and has shown great potential in healthcare settings (Saab et al., 2022). However, its acceptance and implementation face numerous obstacles hindering its full potential. One of the challenges facing VR technology is technical limitations (Blackman, 2024; Kouijzer et al., 2023). Research has highlighted the tracking issue within the system (Mandal, 2013). Chong et al. (2018) stated that tracking technologies presented a deficiency in accuracy when tracing users' movements, as not all gestures can be tracked by the device (i.e. translational movements). Such a challenge hinders patient progress (Sisto et al., 2015) and results in poor health outcomes (Bui & Alaei, 2022). Furthermore, most high-fidelity authoring tools, such as Unity3D[6], Unreal Engine[7], or A-frame[8], cater to experienced developers and designers, while easier-to-use tools like CoSpaces[9] limit users by restricting design capacities and experience control features (Halbig et al., 2022). Additionally, research underlines that users encounter technical difficulties navigating VR systems (Lakshminarayanan et al., 2023) primarily due to insufficient training (Saab et al., 2022).

When implementing VR in healthcare settings, it's essential to understand the user's condition to cater to their specific needs and consider the use of the technology, making VR application design crucial for a successful experience. For example, when assessing VR as a training tool for motor rehabilitation after a stroke, Sisto et al. (2015) underscored potential dangers and obstacles due to the limited understanding of neurological recovery of movement. They explained that the design of such applications had poor transference to the real world and lacked sufficient sensory information, which resulted in slow recovery (Sisto et al., 2015). Also, navigation within the system was cumbersome, which resulted in losing the benefits of directed movement goals (Sisto et al., 2015). Tabbaa et al. (2021) emphasised the design challenges in deploying VR as a psychological, cognitive and behavioural intervention, including autonomous experiences and translating specific therapies into VR formats.

[6] https://unity.com/
[7] https://www.unrealengine.com/en-US
[8] https://aframe.io/
[9] https://www.cospaces.io/

Moreover, the cost is an obstacle (Ehizogie et al., 2024; Lakshminarayanan et al., 2023). Several studies have reported that VR, a relatively new technology, is often costly and unaffordable for many small and medium-sized users (Altinay Ozdemir, 2021; Gandhi & Patel, 2018), hindering its accessibility. Also, the cost hinders its adoption in large-scale utilisation (Luo et al., 2021). Garrett et al. (2018) explain that quality VR environments still require high-end computer systems with advanced graphics processing, making clinical research with numerous participants expensive and challenging to conduct on large-scale trials. VR applications are also costly to develop (Farra et al., 2019).

Numerous studies have reported some undesirable symptoms and side effects related to the use of VR (see section 2.5.3) (Cherniack, 2011; Freeman et al., 2023; Regan, 1995). Cybersickness increased steadily over each exposure (Clifton & Palmisano, 2019; Risi & Palmisano, 2019; Teixeira & Palmisano, 2021). Simón-Vicente et al. (2022) indicated that the most frequent adverse events after a VR exposition were disorientation, nausea, and oculomotor disturbances. Maloca et al. (2022) disclosed that young users' most common side effects were fatigue, eye strain and 'head fullness'.

Finally, the literature identifies additional obstacles impacting VR implementation in healthcare settings, such as users' acceptability, ethical concerns (Lakshminarayanan et al., 2023), accessibility (Ehizogie et al., 2024), and organisational and technical support (Kouijzer et al., 2023).

2.5 Virtual Reality for Dementia Care

Dementia research has drawn significant interest in the Human-Computer Interaction (HCI) community due to the unique needs of its population arising from cognitive deterioration, which affects technology usability and adoption. Furthermore, as the condition progresses, the BPSD worsen, intensifying caregiver distress and leading to increased institutionalisation (Sultana et al., 2020). With no effective pharmacologic treatments for symptom relief, professionals and families need non-pharmacologic behavioural interventions to improve individuals' QoL and decrease the frequency and intensity of dementia-related behaviour (Berg-Weger & Stewart, 2017). As such, NPT is a suitable approach for reducing BPSD, alleviating caregiver stress and improving symptoms (see section 2.1.4.4).

Over the past decade, VR technology has developed considerably and gained research interest across multiple domains, including healthcare (Keswani et al., 2020) and well-being (Chaze et al., 2022). VR interventions have been applied to address phobias, stress, and anxiety in psychotherapy and behavioural therapy (Kim et al., 2019) and have proven effective as an NPT to enrich the restricted life of people with dementia (D'cunha et al., 2019; Yang et al., 2022; Zucchella et al., 2018). By simulating immersive and interactive real-life scenarios, VR creates a sensation of "being there" (García-Betances et al., 2015) and is valued for its cost-effectiveness, flexibility, comprehensiveness, and potential in person-centred care (Kim et al., 2019). As such, VR can serve as a tool for stimulation and enjoyment, which are essential for the well-being of people with dementia, particularly those living in long-term facilities.

2.5.1 Virtual Reality Applications for Dementia Care

Research suggests that VR is an innovative and effective tool for assessing specific cognitive skills and aiding early detection of dementia (Mendez et al., 2015). It supports training activities for daily living (i.e. spatial navigation (White & Moussavi, 2016; Zakzanis et al., 2009) and cognitive skills (i.e. mental stimulation) (Andringa et al., 2019)). For instance, one study examined VR as a training tool to address memory decline and found that the experimental group showed significant improvements in memory tests over six months (Optale et al., 2010). VR-based reminiscence therapy enhances engagement by stimulating autobiographical memory and familiarity with a given scene (Benoit et al., 2015; Saredakis et al., 2021). A study found this therapy more effective than traditional methods due to its extensive content range, enabling therapists to tailor the treatment better, while its immersive feature enhances engagement and can significantly reduce pharmaceutical costs (Hayhurst, 2018).

VR can also "serve as a point to talk about" (Hodge et al., 2018), enhancing the social interaction of people with dementia. A study exploring VR opportunities indicated that short, playful VR experiences can be shared on an ad-hoc basis with friends and family, and people can discuss what they are experiencing even while experiencing it (Hodge et al., 2018). In another study, A. Flynn et al. (2022) disclosed that VR can be a positive experience for people with dementia and provide meaningful interactions, positive expressions, and long-term impacts on everyday functioning.

VR creates VEs by surrounding people with images and sound, allowing them to feel physically present in the VW (Moyle et al., 2018). This feature potentially addresses the need for more self-engaging activities for persons with dementia (Moyle et al., 2018), as they need innovative and more appealing activities to encourage them on a different level. For instance, Baker et al. (2020) suggested that VR could provide stimulation and engagement to improve the QoL of some vulnerable older adults for whom traditional social programs lack appeal. Additionally, Manera et al. (2016) conducted a study comparing an attentional task performed in VR versus a paper-based version and found that participants showed enthusiasm and interest in the VR task. They reported feelings of safety, low discomfort, anxiety, and fatigue and preferred the VR format, even when the task was more difficult. Figure 2.5 represents the study's conditions where participants were asked to locate and choose targets surrounded by distractions.

Figure 2.5 Snapshots of Attention Task: VR vs Classical (Paper) Condition

Note. Adapted from "A Feasibility Study with Image-Based Rendered Virtual Reality in Patients with Mild Cognitive Impairment and Dementia," by Manera et al., 2016, PLOS ONE, 11(3), e0151487, https://doi.org/10.1371/journal.pone.0151487. Licensed under CC BY 4.0.

Other research has shown that VR can effectively reduce apathy and improve cognitive function for older adults (D'Cunha et al., 2019; Zhao et al., 2020). R. E. Brimelow et al. (2020) found that VR experiences considerably reduced apathy in residents who reported enjoying the experience with minimal discomfort. Additionally, reminiscence was observed in six of nine people with mild to moderate cognitive impairment who could verbally communicate.

Moreover, studies show that VR can enhance communication and relationships in care homes. For example, Siriaraya & Ang (2017) observed residents and caregivers collaborating and socialising while creating a virtual garden, fostering laughter and interaction. Such sessions can train care staff, helping them understand the needs of people with dementia and improve care quality (Hayhurst, 2018).

2.5.2 Therapeutic Effect of Virtual Reality on People with Dementia

Numerous studies have highlighted the role of VR in improving the emotional (Appel, Ali, et al., 2021; L. N. Lee et al., 2019; Lin et al., 2018a) and social (D'Cunha et al., 2019; Gaspar et al., 2018; Lin et al., 2018a) well-being of people with dementia due to its ability to make its users feel more engaged (Hodge et al., 2018). Lin et al. (2018a) investigated the VR impact on the emotional and social well-being of 63 people with dementia. They found that the participants were less socially isolated, showed fewer signs of depression, experienced positive effects more frequently, and reported improved overall well-being after using the system (Lin et al., 2018a).

Furthermore, research has underlined VR's potential to promote social connectedness (Deighan et al., 2023; Hughes et al., 2017) not only with care staff (Siriaraya & Ang, 2014) but also family members (Afifi et al., 2021), as VR help build natural conversations and socialisation (L. N. Lee et al., 2019). A study was carried out to assess the impact of VR on people with dementia during interactions with distant family members (Afifi et al., 2022). They disclosed that VR-supported social engagement improved psychological (i.e. anxiety, depressive symptoms and stress) and relational well-being (i.e. closeness, satisfaction and communal perspective) with older adults experiencing significant improvements in overall QoL (Afifi et al., 2022). In care homes, people with dementia may experience a sense of confinement, especially as leaving the facility becomes increasingly challenging. Approximately 70% of care home residents live with dementia and often have mental health needs due to cognitive, psychological, and behavioural symptoms of dementia (Thraves, 2016). The institutionalised care environment, along with factors like mobility, health, and external influences like location and weather, exacerbate this issue. Research suggested that VR offers an alternative through virtual travel, providing a sense of escapism linked to positive feelings while delivering high visual realism and immersion to evoke autobiographical memories (Munoz et al., 2021; Niki et al., 2019). This allows VR to stimulate the "outside" world when real experiences are inaccessible, promoting mood-uplifting, general well-being (Rose et al., 2021; Tabbaa et al., 2019) and positive therapeutic connection between people with dementia and care staff (Tabbaa et al., 2019).

2.5.3 Challenges of Deploying Virtual Reality for Dementia Care

Studies have investigated the acceptability and feasibility of deploying VR as a novel intervention for people with dementia (Asiain et al., 2022; Clay et al., 2024; Foloppe et al., 2018). However, several studies have explored the side effects of this technology. Several study participants reported symptoms such as dizziness, nausea and feelings of 'giddy' (Y. J. Kang & Ku, 2008; Nichols & Patel, 2002; Zhao et al., 2020), known as cybersickness (Benoit et al., 2015). Cybersickness is a motion sickness characterised by symptoms like nausea, vomiting, eyestrain, disorientation, ataxia, vertigo and drowsiness (Benoit et al., 2015).

In a study assessing memory by measuring presence, motivation, and cybersickness symptoms in a fully immersive VE, Lecavalier et al. (2018) reported that older adults were less prone to cybersickness than younger adults. They discovered that while symptoms slightly increased with immersion, they remained low and did not hinder participants from completing the VR activity (Lecavalier et al., 2018). Similarly, Benoit et al. (2015) reported that participants did not experience sickness across the VR conditions during the experiment.

Tools like the simulator sickness questionnaire are often used to measure such symptoms. They quantify the severity of 16 symptoms in categories such as nausea, oculomotor disturbance, and disorientation (Bimberg et al., 2020). Although most studies reported no or low levels of simulator sickness (Andringa et al., 2019), this remains a factor limiting the use of immersive VEs among older people (Costa et al., 2018).

Another challenge documented in studies is the use of the HMD. Participants expressed concerns about the HMD for various reasons. Zhao et al. (2020) reported concerns related to its weight, discomfort, and feelings of foolishness or intimidation. Despite limited research, understanding the side effects of VR in older adults remains crucial, particularly with increasing HMD-based therapy in older populations (Saredakis et al., 2020). In a study by Rose et al. (2021) to explore whether HMD-VR use was feasible with people with moderate to severe dementia, they suggest that HMD-VR use is feasible for people living with mild to moderately severe dementia, including those with periodic behavioural challenges in inpatient psychiatric care.

Furthermore, considering the meaningfulness of VR content to people with dementia when implementing the technology is essential. To ensure a better experience, VR scenarios should not adopt a "one size fits all" approach. The VR content should cater to the likes, preferences, and self-identities of people with dementia. As Cohen-Mansfield et al. (2010) explained, self-confidence refers to identifying roles people have assumed throughout their lifetimes, such as occupational, family, leisure time, and attributes. More user-centred design is required to provide relevant VE to people with dementia, which can lead to greater immersive experience and engagement (Hayhurst, 2018). To assess the applicability and feasibility of VR in this population, Lecavalier et al. (2018) indicated that well-developed VR content can be effectively applied to people with dementia and can result in positive outcomes. Siriaraya & Ang (2014) highlighted a similar issue with their VW, noting the importance of considering individual preferences and capabilities when designing a VW.

When deploying VR in care homes, an essential point to consider is the cooperation of care staff to make this experience successful. Their commitment to deploying VR plays a vital role in ensuring better outcomes. Adopting and integrating this system into care processes depends decisively on the willingness and motivation of relatives and professional caregivers (Unbehaun et al., 2020). Although it is self-evident that psychosocial interventions require the involvement of care staff, the synthesis underlines the absolute necessity of their commitment, knowledge and skills (Lawrence et al., 2012). To embrace it fully, care staff must perceive the technology as valuable and understand how it will contribute to people's care, health, and well-being (Unbehaun et al., 2020).

2.6 Technology Acceptance & Adoption in Healthcare

The success of new technology is not simply based on its measured outcomes but on how well it is implemented and integrated into healthcare settings (Shiells et al., 2020). Building on this foundation, it is essential to investigate the factors influencing technology acceptance in such settings and identify the primary aspects that promote or hinder novel technology adoption.

While technology acceptance is an attitude and an intention (Vogelsang et al., 2013), technology adoption is a process- starting with the user becoming aware of the technology and ending with the user embracing the technology and making full use of it (Renaud & Biljon, 2008). Technology adoption is driven by a decision taken by senior leaders in organisations (Almeida et al., 2017; Bernstein et al., 2007). Several studies have investigated the relationship between technology acceptance and adoption, concluding that acceptance leads to adoption and actual use of that technology (Renaud & Biljon, 2008; Rodić et al., 2023; Syed-Abdul et al., 2019).

2.6.1 Theoretical Framework

The Technology Acceptance Model (TAM) is the most frequently used user acceptance model (Alqudah et al., 2021; Sagnier et al., 2020; Vogelsang et al., 2013). Its goal is to explain the determinants of technology acceptance (Malhotra & Galletta, 1999). Davis (1989) suggests that the two essential factors influencing users' attitudes toward technology acceptance are perceived usefulness and perceived ease of use. Perceived usefulness is the degree to which a person believes using a particular system would enhance their job (Davis, 1989). Perceived ease of use is the degree to which a person believes using a specific system would be effort-free (Venkatesh et al., 2003). It has also been frequently applied to assess the acceptability of VR (Barsasella et al., 2019; Roberts et al., 2018; Sancho-Esper et al., 2022). While perceived benefits of technological innovations may be the most distinctive factor for healthcare professionals, ease of use is equally important for patients because perceived ease of use is influenced by personal norms and beliefs control (Öner Gücin & Berk, 2015). Other technology acceptance models, such as The Theory of Planned Behaviour, incorporate psychological principles to predict an individual's acceptance and adoption of a new technology. According to Ajzen (1991), this theory focuses on the influences of attitudes, subjective norms, and perceived behavioural control on individuals' intentions and behaviours. In contrast, other models integrate elements from various models, such as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). UTAUT identifies three direct determinants of intention to use (performance expectancy, effort expectancy, and social influence) and two direct determinants of usage behaviour (intention and facilitating conditions).

2.6.2 Perceptions of Key Stakeholders

Numerous studies have emphasised the necessity of understanding key stakeholders' perceptions of technology because they are essential in its optimal use and implementation (Hogan-Murphy et al., 2021; Stafford, 2020; Tousignant et al., 2011). Therefore, it is necessary to investigate their perceptions of technology use in general healthcare settings and specific elderly care settings. In the context of this thesis, key stakeholders include patients, their family members, care staff, and managers.

Within healthcare, the stakeholder issue is frequently an area of focus, with the patient often seen as an essential stakeholder as technological initiatives empower them (Nilsen et al., 2020). Sujan et al. (2022) revealed that trust in the organisation or institution impacts patients' perceptions of the technology used. In a study to assess patients' perception of telemedicine in managing chronic diseases, patients showed high acceptability of this technological service as it enabled people involved in their health management to monitor their conditions better. In another study to assess the feasibility of using VR as a therapy for older adults, Appel et al. (2020) noted that participants tolerated the HMD very well; most had positive feedback, feeling more relaxed and adventurous.

Campbell (1997) argues that if a stakeholder has any validity, the family should be included among the stakeholders. In a study to assess stakeholders, including family members, perceptions of health technology in palliative care, Brereton et al. (2017) described family members' feedback as valuable as they provide helpful insights, identifying key issues and highlighting factors influencing applicability and potentially contributing to decision-making. In a care setting where VR sessions were deployed for people with dementia and their family members who lived at a distance, family members reported high satisfaction levels, finding VR experiences fun, easy to use and recommendable (Afifi et al., 2021).

In exploring care staff's perception of technology acceptance and adoption, issues such as confidence towards its implementation and safety emerged. Hogan-Murphy et al. (2021) examined the perceptions of key stakeholders towards implementing electronic prescribing systems, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospital settings; they concluded that successful implementation requires a need for adequate training, organisational support and confidence in system use among staff. I. A. Scott et al. (2021) explored stakeholder (i.e. clinicians) attitudes towards artificial intelligence in clinical practice; they documented that stakeholders' positive attitudes towards accepting and adopting the technology were connected to ensuring certain safeguards, such as confidentiality. Additionally, research has underscored that if care staff perceived a technology beneficial, they would recommend it to others (Hicks et al., 2023; Shree Adhyaru & Kemp, 2022).

Healthcare service managers are generally responsible for technology implementation (Nilsen et al., 2020). As such, their perspective and attitudes towards a specific technology may be key to its successful integration into a healthcare system, especially managers who are responsible for care planning, quality management, operations, scheduling, and budgeting. In a study assessing clinical video visits, managers found the technology beneficial for various reasons, such as triaging patient needs and increasing scheduling capacity (including urgent care) and allowing for greater collaboration between providers (Franzosa et al., 2021). As a result, it was integrated into their care system. Similarly, in a study assessing managers' perspectives on the normalisation of eHomecare service to monitor elderly citizens in their homes, the service was perceived to improve the quality of everyday life for older people (Åkerlind et al., 2017). However, the decision was influenced by several factors: i) economic benefits and financial considerations, ii) family members' attitude towards the service, iii) service benefits and functionality, iv) strategies to promote the service to older people and their family members, and v) workload concerns (Åkerlind et al., 2017).

In conclusion, in the context of key stakeholders, research has suggested that 'who' is involved and 'when' during the technology innovation process matters as it impacts its adoption and successful implementation (Ahmad et al., 2012). It has also been suggested that healthcare projects should identify and involve these stakeholders early to ensure successful implementation (Nilsen et al., 2020).

2.6.3 Technology Adoption in Care Settings

For this research, issues related to technology adoption in care settings, specifically for people with dementia, will be explored in this section. There is a myriad of literature investigating the issues related to ICT adoption in various care settings. One study (Koru et al., 2016) outlined vital challenges that affect technology adoption in supported care (i.e. services delivered to homebound patients at their homes): i) the challenge of coordinating clinical and administrative workflows, ii) inadequate access to service users' medical records and difficulties with medication reconciliation, iii) hiring, training, scheduling, and retaining qualified care staff, and iv) educating service users and family members. Other studies looking into the adoption of Electronic Health Record (EHR) systems in long-term care settings (Cherry et al., 2008; C. S. Kruse et al., 2015) highlighted that the main barriers to adoption include: i) cost-effectiveness (i.e. does the benefits outweigh the costs), ii) evidence that the technology will improve care outcomes, iii) user perceptions (i.e. acceptance and complete understanding of the new system by care staff, family members, and other key stakeholders), iv) fear of changing the facility culture and v) lack of external support from governmental agencies.

This section investigates the barriers to adopting VR in dementia care settings particularly. In a recent study exploring the adoption of VR as a tool to diagnose dementia in primary care, healthcare professionals positively appraised the VR usefulness in clinical settings, considering it a relatively easy and approachable means of assessment (Yondjo & Siette, 2024). However, they expressed concerns about time constraints, the need to learn how to use VR tools, limited dementia-related funding and the validity of VR for diagnosis (Yondjo & Siette, 2024). Hung et al. (2023) identified barriers to deploying VR in dementia long-term care settings, including technological adaptability, video quality, and organisational culture. K. Thach et al. (2020) noted that sustaining a VR program was challenging within these settings due to the complexity of residents' conditions, the technology itself, and the challenges related to staff facilitating VR activities and providing training.

Conversely, several studies have explored successful means and approaches to VR implementation (García-Betances et al., 2015; Karaosmanoglu et al., 2021; Oosterveld-Vlug et al., 2019). In a study aiming to increase the successful implementation of the technology, K. Thach et al. (2021) suggested that more co-design efforts should be undertaken, organisations should invest more in technical infrastructure, and adequate staff training is essential, including providing a clear understanding of its benefits. Furthermore, research has underlined that adopting technology must be embedded in daily working routines (Åkerlind et al., 2017; Li et al., 2023). Finally, additional factors to consider are the degree of the managers' support for the implementation, management stability (Kelley et al., 2020), high staff turnover and other competing priorities (Oosterveld-Vlug et al., 2019).

2.7 Summary

The body of research presents a wide range of literature validating VR's efficacy in dementia care settings for delivering therapies, treatments, training, assessments and other forms of support. Nonetheless, practical implementation strategies and approaches in the real-world are limited. The knowledge of multi-dimensional issues related to VR design, incorporating key stakeholders' perspectives of VR deployment, including people with dementia, their family members, care staff and managers, is lacking. Furthermore, how care staff can independently deploy VR in this setting is unclear. Moreover, the knowledge of organisational aspects and resources related to VR adoption in dementia care settings is scarce. Finally, although VR benefits for people with dementia are well-documented, it is unclear what advantages family members and care staff might gain from engaging in VR deployment sessions.

Herein, this thesis aims to investigate practical VR implementation in dementia care settings, considering the perspectives of key stakeholders. Three interdependent study phases were carried out, which led to care staff deploying VR independently. Initially, Phase One laid the foundation for the subsequent phases by conducting focus groups and discussion rounds with healthcare professionals and family members. The phase focused on assessing, comprehending, and identifying the key challenges and opportunities of adopting and integrating VR in complex care situations. Based on the key outcomes from the focus groups and discussion sessions in Phase One, Phases Two and Three were initiated to investigate using VR as a routine practice in dementia care settings and allow for independent deployment.

Phase Two (Researcher-led VR deployment) was structured to prepare care staff to deploy VR independently. As such, the HCI researcher (the author of this thesis) facilitated the VR sessions collaboratively with 3 care staff in 1 care home and 1 adult day care centre with 6 people with dementia and 4 family members. This collaborative approach aimed to involve care staff in decision-making, troubleshooting and accommodating the needs of people with dementia.

Phase Three (Care staff-led VR deployment) explored best practice approaches to capacitate care staff to deploy VR independently. As such, 5 care staff conducted the

VR session autonomously with the HCI researcher's (the author of this thesis) remote support. The sessions were conducted in 2 care homes with 11 people with dementia. The findings of this thesis are organised according to stakeholder categories and their perceptions and experiences with VR. Chapter 5 explores the results relating to people with dementia and their family members. Chapter 6 outlines the findings relating to care staff. Chapter 7 addresses the adoption of VR in dementia care settings. Chapter 8 presents the discussion and conclusion.

Chapter 3: Investigating the contextual dynamics and requirements of deploying VR in dementia care facilities

Despite the plethora of literature that supports the efficacy of Virtual Reality (VR) in dementia care, such as facilitating reminiscence therapy and training activities for daily living, little is known about the realistic deployment of VR within long-term care facilities that would be essential to effective and well-integrated deployment. The existing studies on VR in dementia care are primarily experimental and lack a focus on the practical elements of implementing VR technology in real-world situations. Hence, this thesis comprised three phases of a comprehensive study. The three phases were conducted to explore achieving such a comprehensive VR-integrated deployment. Phase One, as presented in this chapter, primarily served as a Patient and Public Involvement (PPI) consultation to support the development of the broader study. It aimed to evaluate, understand, and identify key challenges and opportunities for deploying and adopting VR in complex care settings. In this chapter, only the agreed requirements that emerged from this consultation are presented, reflecting the outcome of this phase. The full qualitative analysis of the data gathered during this phase, through Focus Groups (FGs) and Discussion Rounds (DRs) involving healthcare professionals and family members, is reported in Chapter 7. This chapter also sets the foundation for the subsequent phases: Phase Two, which involved a researcher-led VR deployment, and Phase Three, which entailed a fully independent VR deployment. Together, these phases aim to increase our understanding of effective VR implementation in care settings.

This preliminary phase was conducted in collaboration with Avante Care & Support, University College London (UCL) Division of Psychiatry, joined with North London

Mental Health Partnership and Age UK Camden. The author of this thesis is the Human-Computer Interaction (HCI) researcher who conducted the three phases and collected and analysed the data.

3.1 Ethics

The study phase was reviewed and approved by the University College London's (UCL) ethics committee (Ref: 22575.001). All participants were given information sheets detailing the study's aims and methodology. They were also asked to sign consent forms to indicate their understanding and voluntary participation in the study. Multiple measures, such as secure storage in line with the Data Protection Act, to ensure the confidentiality and anonymity of the participants in the FGs and DRs and the data collected from these interactions. Furthermore, the interview audio was recorded using a University of Kent laptop and saved directly on the university iCloud (a secure server that can be accessed remotely using a two-factor authentication process). Names were replaced with pseudonyms to protect their identities.

3.2 Participants

Participants were recruited from the following entities:

3.2.1 Avante Care & Support[10]

This not-for-profit organisation cares for and supports over 1000 older people through registered nursing and dementia care homes, home care and well-being support services. They have 10 specialist dementia and nursing care homes in Kent, Bexley, and Greenwich, where they have been providing support and care for over 30 years.

[10] https://avantecare.org.uk/

3.2.2 University College London- Division of Psychiatry in collaboration with North London Mental Health Partnership[11]

This National Health Service (NHS) organisation provides services for people with dementia in various borough branches. Their services cover home treatment, memory assessment, and mental health services for older people.

3.2.3 Age UK Camden[12]

This independent community-based charity has supported older people in Camden for over 50 years. They give advice, help organise care, befriend people with dementia, and provide activities for them.

Participants from the above entities included directors (n=2), managers (n=5), practitioners (n=1), Information and Communication Technology (ICT) technicians (n=1), psychiatrists in old age (n=1), activities coordinators (n=4), healthcare assistants (n=4), caregivers (n=5), physicians (n=4), registered mental health nurses (n=1) and clinical psychologists (n=1), carers/family relatives (n=3), social workers (n=1), volunteers in an adult day care centre (n=1) and retired senior managers (n=1) and adult social care (n=1). Participants in FGs and DRs met once at their sites or UCL facilities due to geographical distance and logistics, where the number of participants ranged from 2 to 5. Most participants were females (88.0%) and of white ethnicity (96.0%). Half of the participants had more than 10 years of experience caring for/working with people with dementia (50%). Age ranged from 19 to 81(Mean=50.43 & standard deviation=16.60). Participants were recruited by email.

[11] https://www.northlondonmentalhealth.nhs.uk/
[12] https://www.ageuk.org.uk/camden/

3.3 Phase Design and Procedure

A kick-off brainstorming meeting with Avante Care & Support, the participating care provider, took place to assess the contextual dynamics and requirements for practically deploying VR in dementia care facilities. Attendees from Avante Care & Support (directors (n=2), managers (n=5), practitioners (n=1), and ICT technicians (n=1)) met with the HCI researchers (n=2) from the University of Kent, where the HCI researchers provided the attendees with insights into the VR technology, the potential benefits and side effects of VR, suitable strategies for its deployment in their care home environment. Then, they discussed navigating future steps and considerations of implementing the technology within their care facilities. At the end of the meeting, attendees proposed to carry out FGs and DRs with family members and healthcare professionals specialising in dementia care from other charitable organisations to obtain a broader understanding of issues related to their perspectives and the feasibility of integrating VR within this care environment.

3.3.1 Focus Groups

FGs (n=5) were conducted to explore the participants' perspectives and insights about opportunities and challenges regarding deploying VR technology for people with dementia in care settings. They focused on ethical considerations, facilitating VR sessions and VR experiences, suitable VR content, and ideas and recommendations for VR applications. The questions used to guide the Focus Group discussions are provided in Appendix A. Attendees included healthcare assistants (n=4), caregivers (n=2), physicians (n=4), registered mental health nurses (n=1) and clinical psychologists (n=1), carers/family relatives (n=3), social workers (n=1), volunteers in an adult day care centre (n=1), retired senior managers (n=1) and adult social care (n=1).

3.3.2 Discussion Rounds

DRs (n=13) were conducted not only to address the issues mentioned above but also to engage participants in making decisions related to the following issues, as most of them were recruited from Avante Care & Support, the care provider organisation: feasibility of integrating VR within the care facilities, including technical requirements, infrastructure needs, suitable VR headsets, care staff training needs and inclusion criteria of people with dementia and care staff. The questions used to guide the Focus Group discussions are provided in Appendix B. Attendees included directors (n=2), managers (n=5), practitioners (n=1), ICT technicians (n=1), psychiatrists in old age (n=1), activities coordinators (n=4) and caregivers (n=3).

The protocol for delivering the FGs and DRs commenced with a brief on the purpose of the study phase, followed by the latest literature on the use of VR in dementia care (Appel et al., 2020), including its benefits and applications in dementia care to provide the participants with a sense of familiarity with the technology. Participants were then invited to use and interact with the Meta Quest 2[13] VR headset to become acquainted with the technology. All participants experienced 360° Video-Based Virtual Environments (VEs) of landscapes (such as a beach or cathedral) for 4 to 7 minutes. This enjoyable and non-threatening VR exposure aligned it with a VR experience that would be presented to people with dementia, allowing attendees to provide feedback on how it could be practically implemented in dementia care. Table 3.1 below summarises the key details of the FGs and DRs conducted in Phase One.

[13] https://store.facebook.com/gb/quest/products/quest-2/

Table 3.1 A Summary of Focus Groups and Discussion Rounds

Session Type	No. of Sessions	Participants	Main Topics Discussed	Purpose/ Outcome
Focus Groups	5	Healthcare assistants (4), caregivers (2), physicians (4), mental health nurse (1), psychologist (1), family carers (3), social worker (1), day care volunteer (1), retired senior managers (1), adult social care (1)	Ethical considerations, VR facilitation, suitable content, VR experience feedback, recommendations	To gather broad perspectives on VR opportunities and challenges in dementia care
Discussion Rounds	13	Directors (2), managers (5), practitioners (1), ICT technicians (1), psychiatrists (1), activity coordinators (4), caregivers (3)	Feasibility of integration, infrastructure needs, training requirements, inclusion criteria, headset selection	To collaboratively agree on implementation requirements within care settings

3.4 Data Collection

A set of FGs (n=5) and DRs (n=13) were conducted. During DRs, participants were solely neutrally divided across the sessions according to availability. Meanwhile, FG participants were divided according to the following categories: care home staff, family carers, and clinicians. Following the VR experiences, participants engaged in semi-structured interviews and discussions. DRs focused on the practicality of deploying VR technology, such as choosing an eligible care home from the participating care provider and care staff training content. FGs centred on the suitability of deploying VR in a care home setting, such as the health and safety measures of integrating the technology into the existing care infrastructure and appropriate VR content.

All sessions were led by the HCI researcher, who documented the minutes and collected any written materials (e.g., flipcharts, sticky notes, etc.). The notes were corroborated with attendees via email afterwards to ensure their fitness. The sessions were audio-recorded to capture noteworthy remarks that might have been overlooked during documentation.

3.5 Data Analysis & Key Outcomes

The analysed data consisted of verbatim transcriptions of audio recordings and the HCI researcher's notes. Thematic analysis was conducted using the structured, inductive approach outlined by Guest et al. (2012), in which codes and themes were derived from the data itself rather than pre-established categories. This method was particularly suitable given the study's aim to produce actionable insights for dementia care. Its transparent and replicable process for identifying recurring themes along with its team-based coding strategies and applied orientation, aligned well with the study's practical focus and the involvement of numerous stakeholders.

Three HCI researchers, including the lead researcher, author of this thesis, were involved in the data analysis. Each transcript in the initial subset was coded independently by all three researchers to develop a preliminary coding framework. Through collaborative discussions, this coding framework was iteratively refined. In instances where full team coding was not feasible, coding decisions were reviewed and validated with one or both other HCI researchers to maintain credibility and minimise potential bias. Drawing on Guest et al. (2012) approach, the research team worked to identify guidelines and key outcomes that informed the final recommendations to progress the research. An overview of the inductive thematic analysis applied throughout this three-phase study is presented in Figure 3.1.

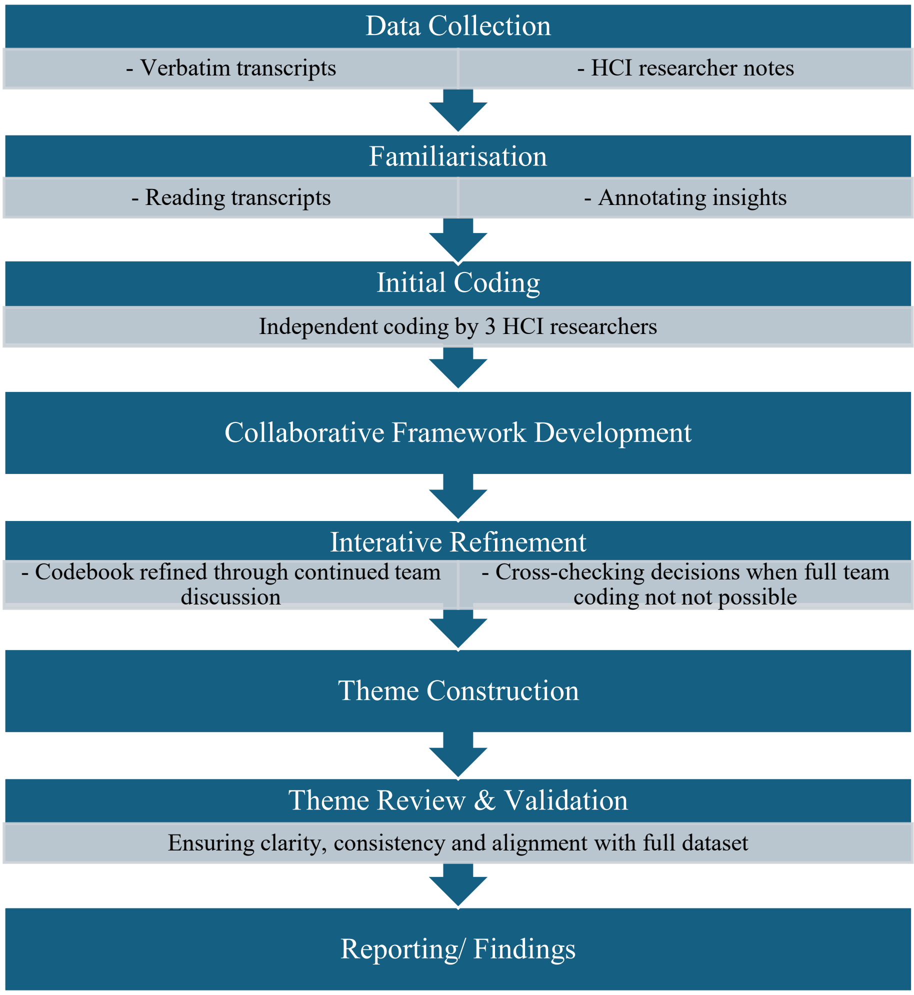


Figure 3.1: Thematic Analysis Process Based on Guest et al. (2012)

The following outcomes were derived from the FGs and DRs:

3.5.1 Care Facility Selection

It was agreed that vulnerable care facilities must be excluded from experimentation. Participants defined vulnerability as COVID-19-related visitation restrictions (i.e., those hosting residents classified as "at risk" due to underlying medical conditions) and severe staff shortages. Furthermore, care facilities should include people with early to moderate dementia as an inclusion criterion.

3.5.2 Exclusion and Inclusion Criteria of People with Dementia

The exclusion criteria of people with dementia who would participate in forthcoming phases from the participating care provider (see section 3.2.1) included the following: i) individuals with pacemakers and defibrillators (as per headset manufacturer safety guidelines[14]), ii) individuals with substantial visual impairment, history of motion sickness, history of psychosis features of dementia, history or active experiences of hallucinations or delusions to minimise potential risks, and iii) individuals who were deemed unsuitable based on multi-disciplinary team clinical judgment. The inclusion criteria included the following: i) residents with early to mid-stage dementia, based on a previous diagnosis made by a hospital or a memory clinic professional in line with the standardised dementia diagnosis criteria (e.g. International Classification of Diseases, 10th Revision (ICD-10) (Zaudig et al., 1991)), ii) Residents who express an interest in participating in the study phase after receiving an explanation from care staff about the VR technology and the nature of the study phase, and iii) residents who have the capacity to consent (in cases where a person with dementia required the consent form to be read out loud, the care home manager will be present at the time in the room and co-sign the form as a measure of witnessing the process). As for assessing the consent process, it was decided that selecting potential residents to engage with forthcoming phases would be done by the participating care provider (see section 3.2.1), staff led by the Senior Care Lead and the manager of the involved care home in line with the Mental Capacity Act (MCA) 2005[15]. Furthermore, the HCI researcher leading the forthcoming phases was required to undertake the MCA course

[14] https://www.meta.com/legal/quest/health-and-safety-warnings/
[15] https://www.legislation.gov.uk/ukpga/2005/9/contents

from Healthcare - NHS England[16] (see Appendix C) to ensure legal compliance, ethical considerations, participants' protection, and quality assurance.

3.5.3 Care Staff

On the one hand, people with dementia desire comfort and familiarity, generally preferring the company of individuals they know. At the same time, care staff may be unfamiliar with VR technology, which includes setting up procedures and ensuring safe "entering" and "exiting" of VR experiences. Simply completing the research study by the researcher was deemed insufficient and inappropriate to achieve a completely autonomous VR deployment. As such, there was a need to train care staff, enabling them to become independent in implementing VR sessions in the future.

3.5.3.1 Training Care Staff

A decision was reached that staff, encompassing activities coordinators and caregivers close to the participants with dementia, were considered the most suitable staff members to lead or co-lead the VR sessions to reassure people with dementia. As such, the selected care staff were to receive one or multiple training sessions, depending on their needs and preferences, at their care facility at a pre-scheduled convenient date and time.

Furthermore, the training sessions were deemed to be face-to-face to allow care staff to engage in hands-on learning experiences, ensure competence, and build confidence in using the technology. The HCI researcher would deliver the face-to-face sessions, and at the end of the training, the care staff would carry out a mock session in which they would independently set up the VR system. Figure 3.2 represents an example of the training content provided to care staff indicating the protocol for delivering VR for people with dementia.

[16] https://www.e-lfh.org.uk/

Moreover, to ensure that all the training content delivered by the HCI researcher would be integrated seamlessly with dementia practices, a collective effort was carried out. A multi-disciplinary team collaborated to co-design and approve the training, including HCI researchers (n=2), psychiatrists in old age (n=1), care organisation directors (n=2), managers (n=5), practitioners (n=1), and technicians (n=1). Initially, the training content considered the manufacturer's VR health and safety guidelines and previously published best practices for VR in healthcare[17]. Afterwards, discussions were conducted with the multi-disciplinary team to capitalise upon their expertise and practical knowledge to create a thorough care staff training content. Upon that, initial training material was assembled. Additional meetings were held to refine the training materials before final approval.

The training content was required to address the following issues: i) The technicality of VR (i.e. how to set up and interact with the technology), ii) The physical safety considerations (i.e. how to manage risk), iii) Pre- and post- VR considerations (i.e. how to prepare participants with dementia to "enter" and "exit" VR experiences safely and comfortably), iv) VR-induced distress management; although care staff were well equipped to manage distress, participants highlighted that care staff might not be fully aware of the adverse effects of VR and how to manage distress (see Appendix D) caused by these effects, including the management of the equipment, and ensuring the safety of the person of dementia, v) Instructions regarding administering the quantitative measures were to use in forthcoming phases.

[17] https://painstudieslab.com/vr-guidelines/

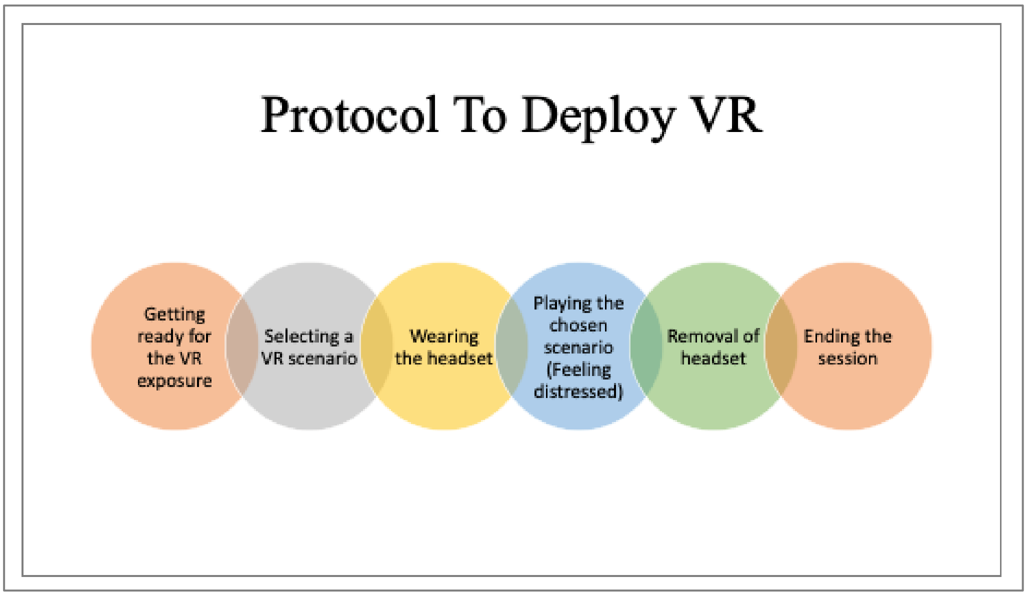
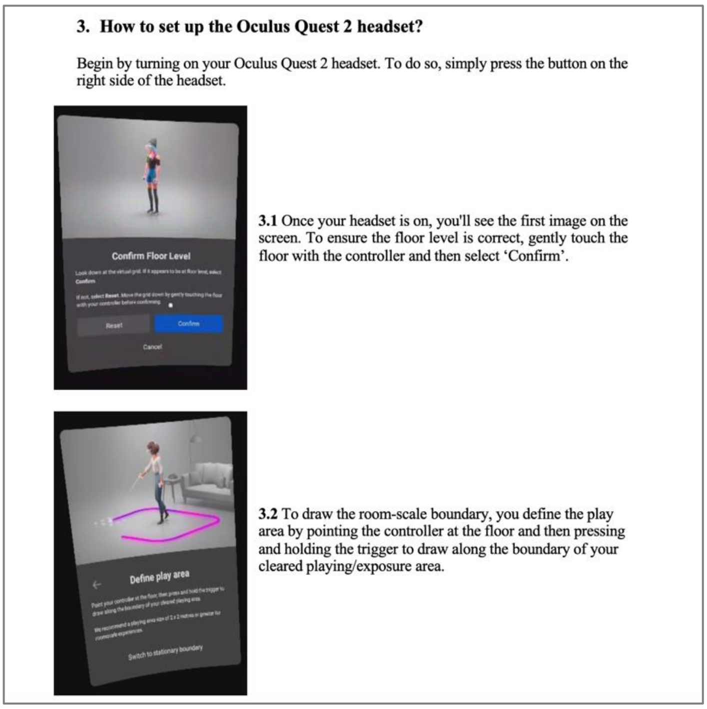


Figure 3.2: Snapshot of the Care Staff Training Content

3.5.3.2 Toolkit

A toolkit was deemed imperative to give care staff at the end of the training sessions (see Appendix E). The comprehensive VR toolkit (see Figure 3.3) ought to encompass the following components highlighting the material covered in the training session: i) details regarding the VR technology, including benefits and factors to consider before its deploying, ii) instructions accompanied by visual aids for setting up the VR system, managing the VR web app, and configuring the VR headset, iii) key do's and don'ts, iv) instructions regarding facilitating the utilisation of VR among the people with dementia, v) health and safety protocols, including a protocol for managing distress, and vi) troubleshooting procedures.


3. **How to set up the Oculus Quest 2 headset?**

Begin by turning on your Oculus Quest 2 headset. To do so, simply press the button on the right side of the headset.

3.1 Once your headset is on, you'll see the first image on the screen. To ensure the floor level is correct, gently touch the floor with the controller and then select 'Confirm'.

3.2 To draw the room-scale boundary, you define the play area by pointing the controller at the floor and then pressing and holding the trigger to draw along the boundary of your cleared playing/exposure area.

Figure 3.3: Example of the Toolkit

3.5.4 The VR Technology

To develop a prototype of a 360°-video-based VR system with content designed to promote the well-being of people with dementia, the HCI researcher provided continuous feedback from the FGs and DRs to the HCI design team at the University of Kent. As such, and following discussions with the design team, the prototype was created and improved, incorporating features suitable for use by care staff in social settings with people with dementia.

Given the participants' favourable inclination towards the final iteration, it was deemed necessary to persist with the developed system to ensure the safety and comfort of people with dementia. As such, and to avoid repetition, the hardware and software equipment presented below were used in Phases Two and Three. Furthermore, an audio recorder was used to capture the VR deployment sessions and the semi-structured interviews.

3.5.4.1 The VR Headset

The Meta Quest 2 headset was chosen due to the following reasons: i) lightweight (503g), ii) its wireless nature facilitated administration and mitigated risk compared to a wired headset, iii) it featured a 3-point safety harness that could be easily adjusted to accommodate the user's preference, therefore ensuring clear imagery and reducing motion sickness risk when appropriately fitted, iv) designed to be used by those who wear glasses which was particularly common in elderly users, and v) ease of hygiene maintenance.

3.5.4.2 The VR App

The VR App was created using Unity[18] and Firebase[19] by the HCI design team at the University of Kent. It was modified based on the feedback from FGs and DRs, which the HCI researcher presented to the team. To minimise the amount of learning required from the person with dementia using VR, the entire experience management (select, play, pause, change VR experiences) was done via a web app, VR Passport, and using any smart device (phone, tablet, personal computer, etc.). This also ensured that people with dementia could use VR without taking the headset on and off whenever they wanted to change an experience. The management web app (see Figure 3.4) (connected to the VR app via Wi-Fi) allowed care staff to fully manage VR experiences and view the perspective of participants with dementia in real-time.

[18] https://unity.com

[19] https://firebase.google.com

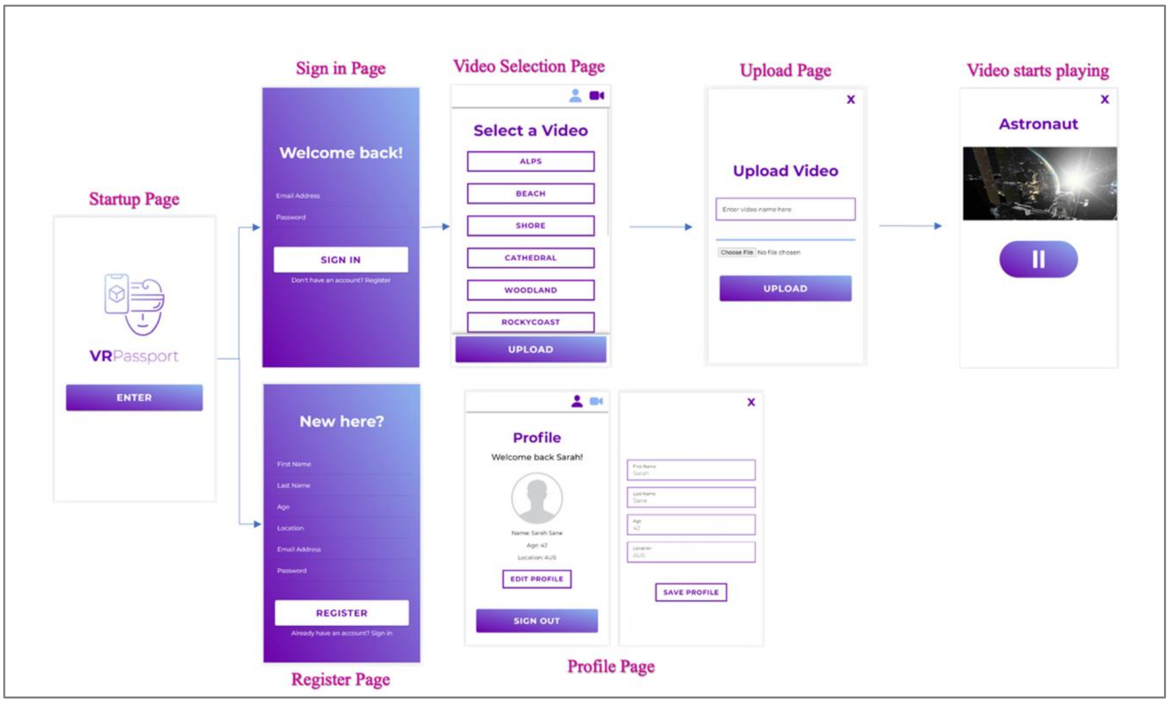


Figure 3.4: Snapshots of The Facilitator's App (VR Passport)

3.5.4.3 The VR Content

When exploring suitable VR content for people with dementia, it was necessary to choose positive content as it should not cause participants with dementia to be startled or scared and should not cause motion sickness (i.e. moving camera) or dizziness (i.e. low-quality content). It was also necessary to curate personalised VR content throughout future phases to maximise benefits and engagement for people with dementia. To curate such VR content, it was deemed imperative to collect feedback from people with dementia, and their family members and care staff, who would retain closeness to the potential participating person with dementia.

When considering the type of VR content, previous research work highlighted the advantages of using 360° VEs over computer-generated (i.e. 3D) experiences due to the time and cost to design, develop, and personalise the content (Niki et al., 2019; Tabbaa et al., 2019). As such, 360° video-based experiences were deployed, mainly because many studies have used this content modality with older populations, reporting little to no adverse effects (Moyle et al., 2017; Rose et al., 2021).

The 360° VEs were selected based on selection criteria set by experts in old age, dementia, and HCI designers (Tabbaa et al., 2019) to ensure minimal risk and maximised benefits in forthcoming phases. All environments available on the developed prototype abided by the following criteria for content:

- A resolution of less than 2K (2048×1080) was avoided as it compromised the resolution quality of the content.
- Sudden transitions between scenes were not utilised to prevent people with dementia from being startled or confused.
- Moving, shaking, and unstable camera recording was disregarded to avoid inducing motion sickness.
- Having animals or people close to the camera was bypassed as it might be perceived as startling or scary.
- Negative high-arousal content was sidestepped as it might be perceived as startling or scary.
- Audial content inconsistent with the visual content was eluded as it contributed to coherent audio-visual feedback and introduced a distractive element.
- Audial content perceived as loud, low, or noisy was avoided as it might be distracting.
- Explicit audio narration was not prioritised, as it was important for people with dementia to be able to hear the care staff's directions and prompts whilst using VR.

3.6 Deployment Plan

Based on the key outcomes (see section 3.5) derived from this phase, a comprehensive deployment plan was crafted outlining the methodical procedures and logistical considerations required to empower care staff to implement VR independently in the end. Accordingly, Phase Two aimed to facilitate VR sessions led by the HCI researcher and co-led by care staff, whereas Phase Three would transition the sessions to be led solely by care staff. As such, a preliminary phase was initiated to build the framework for the future phases.

The initial stages of Phases Two and Three included visiting the selected facilities to evaluate and confirm whether the VR system was functioning efficiently on the premises. There was a particular emphasis on troubleshooting issues with Wi-Fi connection reliability. Multiple sites within the facilities were assessed to identify appropriate locations for sufficient Wi-Fi coverage. As such, a private meeting room was selected, with the cafeteria supplementing the former as needed during its occupancy.

Furthermore, appropriate care staff close to the participating people with dementia were recruited to attend training sessions (see section 3.5.3.1). Training sessions were scheduled before the VR deployment sessions began. As deemed necessary in the key outcomes from Phase One, training sessions were designed to cover aspects related to VR technicalities, physical safety and pre- and post-VR considerations, VR-induced distress management, and guidelines for using the quantitative measures. Training sessions (see section 3.5.3.1) were approved by health professionals (n=10) and HCI researchers (n=2) in line with dementia practices.

Two-hour in-person training sessions took place at the participating care staff's care facility at a convenient time and were scheduled beforehand. Based on recommendations from FGs and DRs, care staff were provided with a toolkit (see section 3.5.3.2) to refer to when needed. The toolkit consisted of all the material covered in the training session, including guidance on best practices, cautionary measures, and troubleshooting procedures for addressing potential issues.

3.7 Summary

This chapter describes the investigation that laid the groundwork for the subsequent study phases, reaching a point where care staff can conduct VR sessions autonomously. This investigation was conducted through FGs and DRs with healthcare professionals in dementia care and carers/family members of people with dementia. The key outcomes derived from the investigation included inclusion criteria for care facilities, people with dementia, and care staff. Furthermore, they emphasised the content to include in the care staff training and toolkit. They also highlighted essential characteristics of the VR technology intended to be used in Phases Two and Three of the study.

The next chapter will present the methodology of Phase Two, where the HCI researcher led the VR sessions, and Phase Three, where the VR sessions were led by care staff. It will highlight the design and procedures of Phases Two and Three and the data collection and analysis, including recruitment, VR content, and measures used in both phases.

Chapter 4: Methodology

The previous chapter (Chapter 3) reported the findings derived from Focus Groups (FGs) and Discussion Rounds (DRs), which investigated how to best prepare for realistic VR deployment in care settings. Specifically, the chapter explored key outcomes from these forums concerning selecting suitable care homes and the criteria for excluding and including people with dementia to generate recommendations for future phases. It also indicated key outcomes regarding care staff training, highlighting essential issues to incorporate into these sessions. Furthermore, the chapter described the Virtual Reality (VR) technology used, encompassing the VR headset, facilitator's App, and VR content.

Building on the key outcomes from FGs and DRs in Phase One, Phases Two and Three were established to investigate further integrating VR as a regular practice in care settings to support dementia care. Phase Two was structured to prepare care staff to deploy VR independently so that the Human-Computer Interaction HCI researcher would facilitate VR sessions with collaborative facilitation by care staff. This collaborative approach sought to involve care staff in decision-making, troubleshooting, and accommodating the needs of people with dementia.

4.1 Phase Two: Researcher-Led VR Deployment

Phase Two aimed to explore the multi-dimensional issues of VR technology design to facilitate its deployment in dementia care settings, considering the perspectives of people with dementia, family members, care staff, and managers within long-term care facilities whilst situating people with dementia at the heart and centre of this research work. As such, this phase aimed to investigate the following objectives:

- How should VR technology be used to deliver engaging VR experiences to people with dementia in dementia care settings?
- How can VR support family members in participating in experiences with their loved ones through hybrid formats?
- What are the main issues and concerns of care staff and managers within dementia care settings when considering adopting VR?
- Considering the perspectives of all key stakeholders, how can VR be better designed, addressing challenges and opportunities for achieving effectiveness in its adoption in dementia care settings?

Consequently, this phase was carried out through a researcher-led VR deployment while care staff shadowed and supported the researcher. Qualitative data was gathered through face-to-face and virtual semi-structured interviews with people with dementia, care staff, and family members. Furthermore, quantitative measures were collected pre-, during and post-VR exposure.

4.1.1 Ethics

Participants were recruited from an elderly care provider in the United Kingdom, Avante Care & Support (see section 3.2.1). The care provider is a not-for-profit organisation that cares for over one thousand older people through registered well-being support services, daycare centres, home care services, and nursing and dementia care homes. Ethical approval was obtained from the University of Kent (Ref: CREAG085-08-2021). Where concerns were expressed regarding the capacity of people with dementia to consent, capacity assessments were completed using the MCA 2005 Assessment Checklist[20]. Only people with dementia with the capacity to

[20] https://www.advancedassessments.co.uk/resources/Mental-Capacity-Checklist.pdf

consent were invited to participate. Care staff and family members were also recruited based on their relationships with the selected people with dementia. All participants (people with dementia (see Appendix F), family members (see Appendix G) and care staff (see Appendix H)) received an Information Sheet regarding the purpose of the study phase, its benefits and risks, procedure, and confidentiality. They were then given a consent form to sign. Several safeguards were implemented to ensure the confidentiality and anonymity of interview participants and the data they provided. Participants' identities were protected by replacing real names with pseudonyms. Furthermore, care staff anonymised quantitative data acquired from people with dementia, assigning each participant a unique identity number rather than personal identifiers.

4.1.2 Phase Design & Procedure

According to the key outcomes (see section 3.5.1) derived from the FGs and DRs concerning selecting suitable care homes to be included in the study phase, excluding vulnerable facilities with COVID-19-related visitation restrictions and severe staff shortages was deemed necessary. As such, one care home and one day care centre were selected from the participating care provider (see section 3.2.1). A mixed-methods design was used to collect data over two months from 13 participants: people with dementia (n=6), care staff (n=3) and family members (n=4).

Eight care staff (activities coordinators (n=6) and caregivers (n=2)) received in-person training (see section 3.5.3.1) and a toolkit (see section 3.5.3.2) to refer to when needed. Two to three care staff attended the session at a time. Then, the trained care staff approached suitable people with dementia (see section 3.5.2) who had the capacity to give consent to participate in the study phase. They presented the study and the VR technology to them, assessing their willingness to join while showing them the Meta

Quest 2 headset. Consequently, family members were contacted by the HCI researcher via email, using contact information provided by the care home manager with the family members' consent.

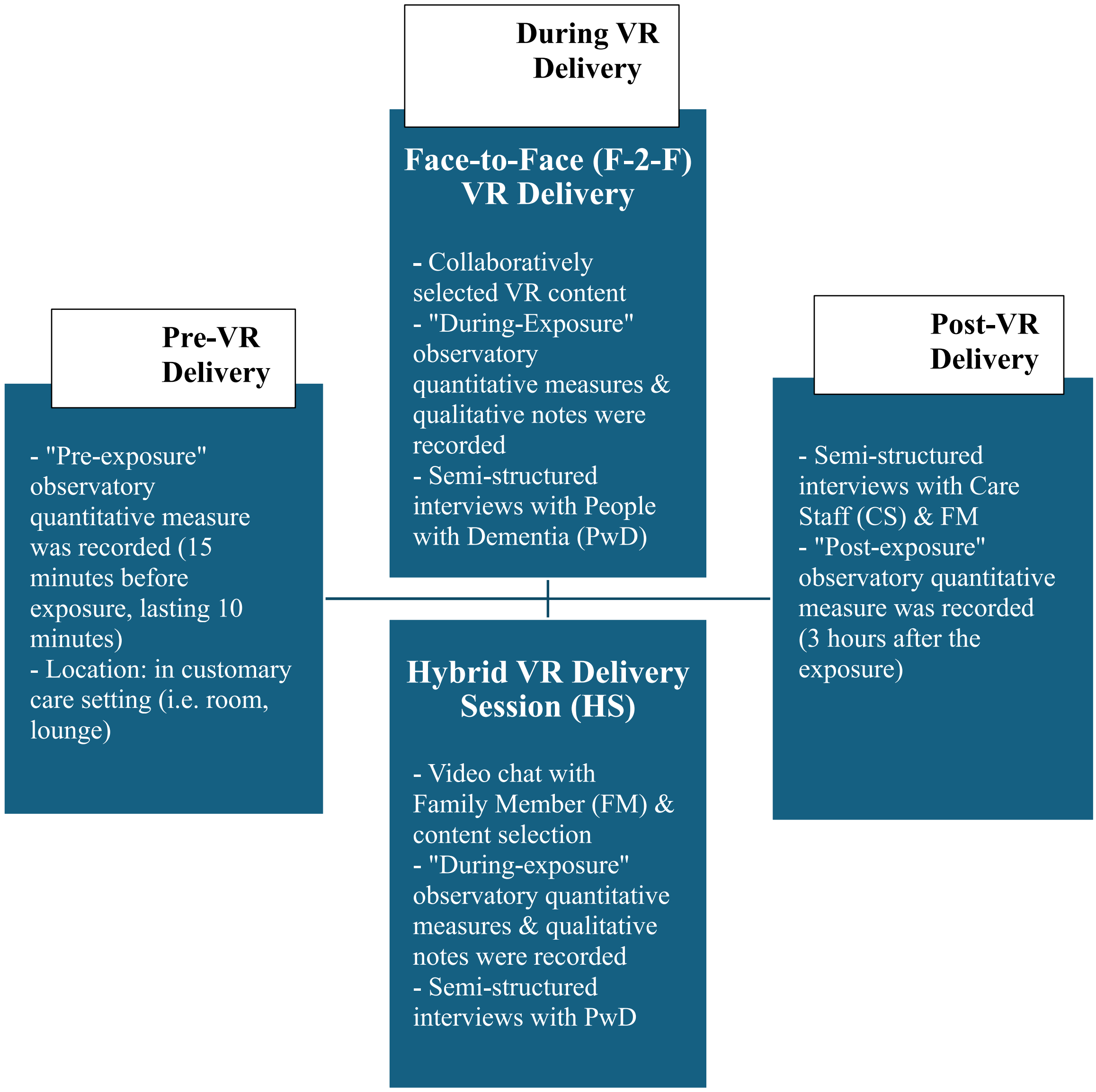


Figure 4.1: Phase Procedure per Visit

4.1.2.1 Modality of VR Delivery Sessions

As part of preparing for the VR deployment sessions and 15 minutes before the start of the session, the care staff filled out the "pre-VR delivery" quantitative measure, the Observed Emotion Rating Scale (OERS) (Lawton et al., 1999). Then, depending on availability, one to two care staff escorted the person with dementia to the VR session location, either a private meeting room or the care home cafeteria. Figure 4.1 summarises the procedure followed for each visit in this phase. The audio-recorded VR sessions were delivered in two modalities, as follows:

A. Face-to-Face Delivery Sessions

As depicted in Figure 4.2, the participants with dementia and care staff engaged in a conversation about where they would like to "go" in VR. Finally, the care staff assisted the participants with dementia in wearing and adjusting the headset and its straps until they felt comfortable. Participants were assured they could choose not to use VR or quit at any point.

During exposure to VR, the care staff prompted a conversation with participants with verbal prompts and provided support and reassurance whenever needed. In facilitating the dialogue, care staff were able to see what people with dementia were viewing on the VR headset (on their smart device). Participants with dementia were offered to view one or multiple VR experiences depending on what they fancied at the time. Meanwhile, trained care staff recorded the "during-VR delivery" quantitative measure, the OERS and The Engagement of a Person with Dementia Scale (EPWDS) (Jones et al., 2018a). In contrast, the HCI researcher recorded qualitative observation notes.

After the exposure to VR, people with dementia and care staff engaged in semi-structured interviews separately. Furthermore, three hours after the end of the VR session, trained care staff captured "post-VR delivery" quantitative measurements, the OERS.

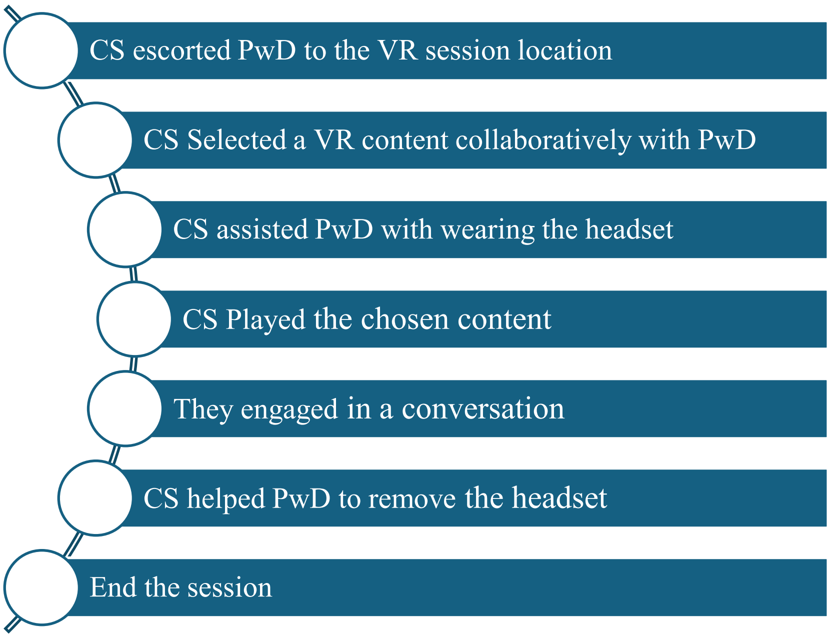


Figure 4.2: Summary of F-2-F VR Delivery Session

B. Hybrid Sessions

The hybrid sessions involved a family member joining from a remote location via a video conferencing platform (i.e. Zoom[21]) after obtaining their consent through email correspondence. The family member was given a web link that allowed them to see (on their smart device) the perspective the participant with dementia is viewing while using VR in real time.

As in the face-to-face sessions, the person with dementia was escorted to the VR session location by one or two care staff. The HCI researcher facilitated the communication between the family members and the person with dementia by arranging the Zoom link on a laptop where they jointly chose VR content to see. The family member and the participant with dementia engaged in a video chat before and after the exposure to VR, as shown in Figure 4.3. During the hybrid session, trained

[21] https://zoom.us/

care staff captured "during-exposure" quantitative measurements, such as the OERS and EPWDS, while the HCI researcher took qualitative observational notes.

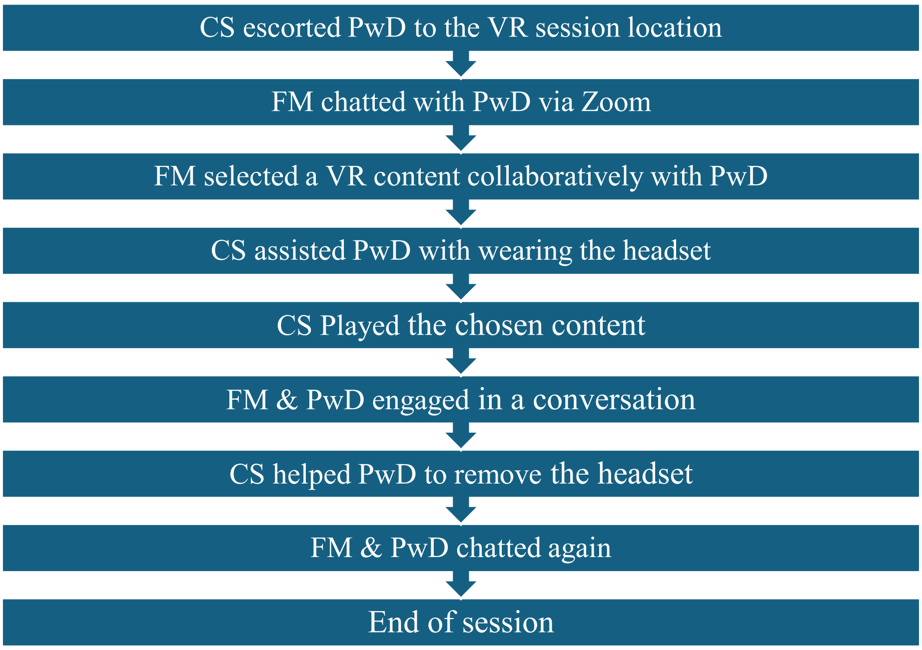


Figure 4.3: Summary of Hybrid Session

4.1.3 Recruitment

People with dementia and care staff were recruited from one care home and one day centre from Avante Care & Support (see section 3.2.1). They were selected based on the key outcomes in Phase One (see section 3.5) which emphasised excluding vulnerable facilities affected by COVID-19. In regard to family members, they were recruited based on their ties to the participating people with dementia.

- **People with Dementia**

Six people with dementia were selected from Avante Care & Support (see section 3.2.1). In Phase One, the outcomes of the FGs and DRs delineated the inclusion and exclusion criteria for people with dementia (see section 3.5.2). As such, people with mild to moderate dementia who had the capacity to consent were recruited to participate in the VR sessions. The assessment of the consent process was undertaken under the guidance of the Senior Care Lead and the manager of the facility, along with the HCI researcher who completed the MCA course from Healthcare- NHS England (see Appendix C). The capacity assessments used the MCA 2005 Assessment Checklist. Table 4.1 below describes the key demographic information of the participants.

Table 4.1: Demographics of Participants with Dementia

Participants with Dementia	Care Setting	Age	Gender	Dementia Diagnosis	Other Considerations	VR Sessions
PwD-1	Care Home	94	Female	Signs of Early-Stage Dementia	Hearing Impairment, Wears glasses	F-2-F (x2) Hybrid (x1)
PwD-2	Care Home	85	Female	Vascular Dementia	-	F-2-F (x2) Hybrid (x1)
PwD-3	Care Home	83	Male	Vascular Dementia	-	F-2-F (x2) Hybrid (x1)
PwD-4	Day Care Centre	86	Male	Vascular Dementia	Aphasia	F-2-F (x2)
PwD-5	Day Care Centre	87	Male	Vascular Dementia	-	F-2-F (x2)
PwD-6	Day Care Centre	82	Female	Alzheimer's- Vascular Mixed Dementia		F-2-F (x2) Hybrid (x1)

**Note: It was not possible to conduct a third VR (hybrid) session with PwD-4 and PwD-5. Participant PwD-4's family member was elderly and did not have access to any internet-enabled devices. Participant PwD-5's family members were not responsive.*

- **Family Members**

Family members were recruited based on their relationship with the participating people with dementia. Six family members were approached to take part in the study phase. Still, only 4 out of the potential family members were recruited, as one family member was elderly and lacked access to any internet-enabled devices, and the other was unresponsive. All family members were first contacted via email, where they received the information sheet regarding the study phase (see Appendix G). Then, a meeting was scheduled via Zoom to discuss their participation, specifically if they had any inquiries regarding the study phase and collect feedback regarding loved ones with dementia to provide them with suitable VR content.

- **Care Staff**

As derived from Phase One (see section 3.5.3), it was considered essential to select care staff who had close relationships with the potential participants with dementia to facilitate a sense of comfort among them. Although 8 care staff undertook the training, only three participated in this phase due to withdrawal caused by a COVID-19 breakout in their care home, forcing their replacement.

4.1.4 Curating Personalised VR Experiences

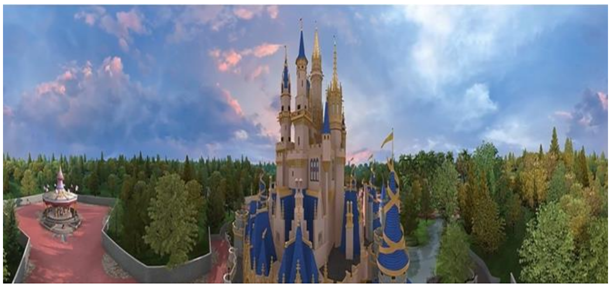
The facilitator's App developed in Phase One (see section 3.5.4.2) had some VR content. However, per recommendations from Phase One (see section 3.5.4.3) and given the potential benefits of personalised VR experiences for people with dementia, as demonstrated by research (Hodge et al., 2018; Munoz et al., 2021; Siriaraya & Ang, 2014), such as maintaining attention for as long as possible, and motivating reminiscence, interviews were deemed necessary to gather insights about the interests, past and present hobbies, and life stories of people with dementia.

Thirteen interviews, each lasting 20 to 30 minutes, were conducted with people with dementia (n=6), their family members (n=4), and care staff (n=3) to gain an understanding of suitable VR content to upload to the facilitator's App, VR Passport. The care staff members (caregivers specialising in dementia care (n=1) and activity coordinators (n=2)) were regular carers for the people with dementia participating in this phase and, therefore, were able to provide insights into participants' personal interests. The HCI researcher asked interviewees about places participants with dementia grew up in, places they travelled to in the past, and places they wanted to visit but never got the chance to. They also inquired about previous hobbies participants with dementia enjoyed but can no longer do for any reason, as well as things and activities that interested them in the past and the present. Interviews with people with dementia and care staff were in-person, while interviews with family members were done virtually due to geographical constraints. Interviews were audio recorded. Key findings regarding relevant VR content were noted during the interview. Afterwards, the HCI researcher shared the results with the HCI design team at the University of Kent, who then curated and uploaded the sensibly curated content content to the facilitator's App.

Figure 4.4 illustrates examples of 360° VEs using royalty-free online platforms. Twenty-four VR experiences were identified under the following themes: Religion (n=1), Tourism, History & Heritage (n=7), Films or Series (n=5), Bird Watching (n=2), Water Spaces (n=6), and Greenery (n=3).

In addition, in response to the preferences and specific requests expressed by people with dementia, the range of the VR experience continued to be broadened throughout the VR deployment sessions. For example, during the first VR session, a person with dementia requested a Disneyland-related VR experience, while another reported a desire to visit Italy. In response to their desires, suitable VR content that corresponded to their requests was secured.

Bird Resort 360°-VE



Disney 50 360°-VE

Venice 360°-VE

Rochester Castle 360°-VE

Figure 4.4: Snapshots of 360°- Virtual Environments

4.1.5 Data Collection

Trained care staff, who had prior experience in supporting people with dementia, were responsible for recording the observational measures. Before the data collection, they received a training session on how to adequately use the scales, including definitions and examples to guide their ratings. Each session was observed by two care staff members who completed the measures independently, then compared their observations and reached a consensus. This collaborative approach helped to ensure the reliability of the data, as their responses consistently supported one another's evaluations.

- **The Observed Emotional Rating Scale (OERS)**

The scale facilitates continuous, direct observation of the time spent expressing each of the 5 affect types. It assesses the time spent in the following emotions: pleasure, anger, anxiety/fear, sadness, and general alertness. Ratings are measured on a Likert scale (1= never; 2= <16 seconds; 3= 16-59 seconds; 4= 1-5 minutes; 5= >5 minutes; and 7= not in view) (Lawton et al., 1999). The OERS was employed pre-, during- and post-exposure to VR. The OERS was utilised to measure the emotional well-being of people with dementia pre-, during, and post-exposure.

- **The Engagement of a Person with Dementia Scale (EPWDS)**

This emotional and behavioural scale addresses affective, visual, verbal, behavioural and social engagement. Ratings are measured on a 5-point Likert scale ranging from 1 (indicating strong disagreement) to 5 (indicating strong agreement) (Jones et al., 2018b). The EPWDS was used during the VR exposure. The EPWDS was used during the VR sessions to measure the engagement of people with dementia while employing the VR technology.

Semi-structured interviews were conducted as follows:

- **Interviews with People with dementia**

Semi-structured interviews with participants with dementia (see Appendix I) aimed to reflect on their general thoughts over the audio-visual aspects of the VR experiences, emotional affect, presence, and technology acceptance. Some questions were constructed using the System Usability Scale (SUS) (Brooke, 1996) and the Presence Questionnaire (Witmer & Singer, 1998). In the case where participants with dementia could express their answers elaborately, questions were asked in an open-ended nature to allow discussions. On the other hand, a simplified version of the questions (see Appendix J) was adopted for participants with dementia, who best respond to simple and close-ended questions. Finally, to ensure the reliability of the answers, the same questions were asked more than once and sometimes in a different format. The semi-structured interviews were conducted face-to-face at the end of each VR session.

- **Interviews with Care Staff**

Semi-structured interviews with care staff (see Appendix I) aimed to evaluate their experience in delivering the VR intervention and sought their opinion on VR's usability and feasibility problems in their respective care settings. The usability questions were based on the SUS (Brooke, 1996). The semi-structured interviews were conducted face-to-face at the end of the first and the last VR session.

- **Interviews with Family Members**

Semi-structured interviews with family members (see Appendix K) aimed to reflect on their general thoughts over the hybrid VR experience, their experience regarding the technical aspects of joining and setting up the necessary links, and the perceived benefits/problems of the hybrid VR session. The semi-structured interviews were conducted virtually via Zoom.

4.1.6 Data Analysis

Altogether, the data consisted of the following:

- Interview notes with care staff and family members to curate personalised VR content.
- Interview notes with people with dementia, care staff, and family members after engaging in VR sessions.
- Qualitative observation notes of the VR sessions.
- Quantitative measures (OERS & EPWDS)

To analyse the interview data, the primary phase was transcribing the audio recordings from 18 interviews verbatim. Afterwards, the interview and observation notes were thematically analysed using the structured, inductive approach described by Guest et al. (2012). This approach involved cooperatively identifying and refining main patterns in the data, with codes and themes derived directly from the content itself

(Guest et al., 2012). Three HCI researchers coded the data. The coders reviewed and critically discussed the themes and the underlying codes together until they reached an agreement on the final themes, then refined the codes and themes. Figure 3.1 provides additional details on this process.

As for the quantitative data, the statistical analyses carried out in this phase were performed using Microsoft Excel[22] software.

4.2 Phase Three: Care Staff-Led VR Deployment

The primary aim of this phase was to investigate suitable means and approaches to enable care staff to effectively implement VR in dementia care settings independently while assessing the potential implications and considerations associated with such an implementation. In particular, it aimed to:

- Investigate the feasibility, opportunities, and challenges connected with care staff independently implementing VR in their work environment.
- Understand the impact of VR on the emotional engagement of people with dementia and care staff.
- Understand whether VR can promote well-being and elevate mood in the longer short term.

Accordingly, VR deployment sessions in Phase Three were led by care staff to explore the feasibility of autonomous care staff implementation overseen by the HCI researcher remotely. In contrast, a limitation of Phase Two was that two face-to-face VR sessions were conducted, and both were led by the HCI researcher. This limited the ability to assess whether the care staff could deploy the VR technology on their own. As a result, Phase Three aimed to investigate whether VR could be implemented

[22] https://www.microsoft.com/en-us/microsoft-365/excel

and sustained over an extended short-term duration (at least two months) without the researcher's presence. Qualitative data was gathered by the HCI researcher through weekly follow-up virtual meetings and monthly in-person semi-structured interviews with care staff, while the quantitative measures were collected by care staff.

4.2.1 Ethics

The study phase was reviewed and approved by the University of Kent's Central Research Ethics Advisory Group (Ref: CREAG054-03-23). Participants were recruited from Avante Care & Support (see section 3.2.1). All care staff who participated in the study phase received information sheets (see Appendix L) about the study's purpose and procedure. Furthermore, they were asked to sign consent forms. Various steps were taken to ensure the confidentiality and anonymity of the participants in the interviews and the data collected from them. Names were replaced with pseudonyms to protect their identities. Quantitative measures of people with dementia collected by the care staff were anonymised; identification numbers were assigned to them instead.

4.2.2 Phase Design & Procedure

The phase design emerged to enable a seamless transition from VR deployment led by the HCI researcher to deployment led by care staff. As such, a mixed-methods design was used to collect data over 6 months, including weekly virtual meetings, monthly in-person semi-structured interviews, and quantitative measures.

Initially, care staff chose residents for the first month of the study phase in line with the exclusion and inclusion criteria set in Phase One (see section 3.5.2). The selection of participating care homes was made by Avante Care & Support directors based on their need to add innovative activities to certain facilities.

Before the start of the VR sessions at the care homes, similar to Phase Two, a deployment plan (see section 3.6) was put in place to prepare an appropriate environment to facilitate the VR sessions, such as the Wi-Fi connection reliability and care staff training. As care staff were to conduct the VR deployment independently, they demanded another training session at the end of the first to boost their confidence and enable them to carry out the sessions independently.

4.2.3 Recruitment

Nine care staff were recruited to attend the training session to familiarise themselves with the VR system and achieve proficiency in using it independently, including the physical and emotional safety of people with dementia per key outcomes from Phase One (see section 3.5.3). Alongside the original training and the toolkit, the following additions were incorporated to be aligned with the independent deployment sessions: i) care staff were given instructions regarding completing the quantitative measures, which they would use during the VR sessions with people with dementia and ii) they were also provided with a Care Staff Checklist (see Appendix M) and a Resident VR Session Log (see Appendix N) to assist them in maintaining a systematic session recording and tracking documenting the quantitative measures.

After receiving the training, care staff became familiar with the exclusion and inclusion criteria of people with dementia (see section 3.5.2) who were suitable to participate in the study phase. As such, the care staff chose three residents to take part in the VR sessions in the first month.

Even though 9 care staff attended the training session, only 5 participated in the study phase. Two care staff withdrew for personal reasons approximately a week after the beginning of the VR deployment sessions, and the other two withdrew due to an overwhelming volume of different responsibilities.

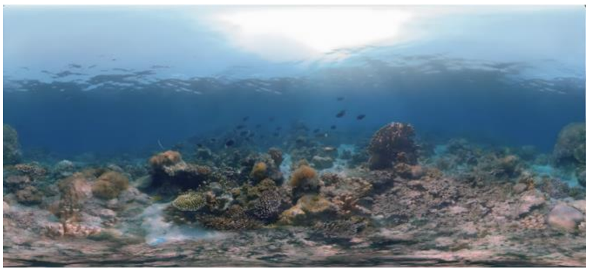
4.2.4 Curating Personalised VR Content

The VR content previously uploaded to the facilitator's App from Phases One and Two was kept providing a diverse library for people with dementia. However, since the care staff were to lead the VR deployment sessions, they discussed VR content preferences with the people with dementia they selected and reported to the HCI researcher. Through these discussions, care staff sought insights regarding favourite places and activities, past experiences, and hobbies of people with dementia. Consequently, the HCI researcher uploaded further suitable VR content to the VR App according to the criteria mentioned in section 3.5.4.3.

Figure 4.5 illustrates examples of 360° VEs in Phase Three using a royalty-free online platform. Twenty VR experiences were identified under the following themes: Religion (n=1), Tourism, History & Heritage (n=10), Films or Series (n=1), Pet Watching (n=3), Water Spaces (n=4), and Greenery (n=1). During this phase, care staff reported that people with dementia showed particular interest in VR content featuring human subjects, incorporating dynamic stimuli, active events, and hometowns. Appropriate VR content was added according to the requests of people with dementia in response to their preferences.

Vatican City 360°-VE

Harbour Street, Jamaica 360°-VE



Great Barrier Reef 360°-VE

Puppies 360°-VE

Figure 4.5: Snapshots of 360°- Virtual Environments

4.2.5 Data Collection

The care staff recorded the following quantitative measures after receiving the appropriate training prior to data collection:

4.2.5.1 QUALIDEM-Carer

This scale is a QoL observation instrument rated by professional caregivers of persons with mild to severe dementia living in residential settings (Bouman et al., 2011). It includes 9 subscales: care relationships, positive affect, negative affect, restless tense behaviour, positive self-image, social relations, social isolation, feeling at home and having something to do, where a higher score indicates a higher quality of life (Gräske et al., 2014). Ratings are measured on a 4-point Likert scale (0=almost always; 1=often; 2=occasionally; and 3-hardly ever). The QUALIDEM-Carer was administered in the morning before the initial VR deployment session started and then at the end of the week after completing the three sessions.

Qualitative data was audio recorded and collected as follows:

4.2.5.2 Weekly Follow-up Meetings

Weekly follow-up online meetings (see Appendix O) were conducted with care staff to provide technical support if needed, ensure the sessions' progression, and investigate the practicality of the VR deployment. Furthermore, the follow-up meetings aimed to discuss any concerns or issues the care staff faced during that week, collaborate with the HCI researcher to consider strategies for improving the following week's sessions, and explore ideas for adding new VR content according to the preferences of people with dementia. The virtual meetings were held through instant messaging platforms, such as WhatsApp[23] and Telegram[24], depending on the care staff's choice and convenience. These platforms were utilised as they are renowned for their end-to-end encryption system to safeguard the confidentiality and security of the exchanged and saved messages or conversations. Weekly follow-up meetings ranged from 15 to 40 minutes.

4.2.5.3 Semi-Structured Monthly interviews

The semi-structured monthly interviews (see Appendix P) took place in person at the care facility to explore further the care staff's perspective regarding their VR encounter. The interview questions focused on eliciting their reflections on the VR's perceived benefits for them and people with dementia. They aimed to re-evaluate the usability and acceptability of VR and delve into ways to improve the use of VR in this setting. Some questions were constructed based on the SUS (Brooke, 1996). Questions

[23] https://www.whatsapp.com/
[24] https://telegram.org/

were modified every month to capture emerging aspects. Semi-structured monthly interviews ranged from 25 to 130 minutes when interviews were conducted in a group setting.

4.2.6 Data Analysis

Altogether, the data consisted of the following:

- Interview notes with care staff to curate personalised VR content.
- Interview and follow-up notes with care staff.
- Quantitative measure (QUALIDEM-Carer)

All follow-up meetings (n=56) and interviews (n=17) were transcribed verbatim by one HCI researcher and then corroborated by two HCI researchers to ensure the quality of transcripts. Then, the notes were analysed using thematic analysis, a useful method for capturing the complexities of meaning within a textual data base through developing codes and themes (Guest et al., 2012). An inductive approach to thematic analysis was used, with the codes and themes emerging directly from the data content (Guest et al., 2012). Three HCI researchers coded the data. Through collaborative review and critical debate, consensus was gained on the final themes, which were refined. Figure 3.1 provides additional details on this process. Regarding the quantitative data, statistical analyses were conducted using Microsoft Excel software.

4.2.7 Summary

This thesis aims to investigate facilitating independent VR implementation among care staff in dementia care settings. Therefore, Phases Two and Three were constructed upon laying the foundation in Phase One to attain this aim.

This chapter describes the study design and procedure for Phases Two and Three, highlighting recruitment, tailoring the VR content to meet the needs of people with dementia, and data collection and analysis.

While analysing the data collected from all phases, organising the findings according to key stakeholders (people with dementia, their family members, and care staff) was deemed most appropriate, considering VR adoption in dementia care settings. As such, Chapter 5 will present the findings related to people with dementia and their family members. Chapter 6 will present the findings related to care staff, while Chapter 7 will focus on VR adoption in care settings.

Chapter 5: The Impact of Virtual Reality on People with Dementia and Their Family Members

The previous chapter (Chapter 4) described the two-phase methodology used to conduct this research. It discussed Phase Two, researcher-led Virtual Reality (VR) deployment, Phase Three, care staff-led VR deployment, ethical considerations, designs and procedures, and data collection and analysis methods. This comprehensive methodology serves as the foundation for the findings presented in the following three chapters: 5, 6, and 7. Table 5.1 summarises the key elements of the phases' design and methodology.

Table 5.1: Summary of Phases Two & Three

Aspect	Phase Two	Phase Three
Session Leadership	Led by Human-Computer Interaction (HCI) researcher (author of the thesis), with the support of care staff (n=3)	Led by fully trained care staff members (n=5) with the remote support of the HCI researcher
Main Aim	To explore the multi-dimensional issues of VR technology design for dementia care settings, considering key stakeholders' perspectives	To investigate methods and approaches for enabling care staff to independently deploy VR in dementia care settings, while evaluating potential implications and considerations
Participants	People with dementia (n=6), their family members (n=4), care staff (n=3) & care home managers (n=2)	People with dementia (n=11), care staff (n=5) & care home managers (n=2)
Data Collection	Interview notes (n=18), qualitative observation notes, and quantitative measures (OERS & EPWDS)	Interview (n=17) & follow-up (n=56) notes and quantitative measure (QUALIDEM-Carer)
Data Analysis	• Inductive thematic analysis • Quantitative Data Analysis: Microsoft Excel	

This chapter presents an overview and explores the findings related to people with dementia and their family members. Some of the quotes in this chapter reflect on the impact of VR sessions as reported by care staff. Although more direct quotes from people with dementia across various themes were desired, logistical obstacles, the need to retain anonymity, and concerns regarding the accuracy and integrity of recordings posed substantial hurdles. Furthermore, as the main aim of Phase Three was to investigate suitable means and approaches to enable care staff to independently and effectively deploy VR in their care settings, it was deemed necessary to allow them to conduct the sessions autonomously to adequately assess their ability and confidence in using the technology. Moreover, since the VR sessions in Phase Three were solely carried out by care staff with the support of the HCI researcher, it was impractical for them to collect and document responses and reactions simultaneously. As a result, the care staff's observations were the core data used for evaluating the impact of the VR sessions.

5.1 Overview of the VR Sessions

5.1.1 People with Dementia

Overall, the research included 17 people with dementia and 4 family members in Phases Two and Three. Table 5.2 presents the number of participants in each session modality, including the phase. VR sessions were conducted in either a private room, the cafeteria, or the lounge, depending on availability, the preference of people with dementia, and Wi-Fi connectivity.

Table 5.2: Overview of VR Deployment Sessions by Participant Group and Format

Participant Group	Phase	Total Participants	Face-to-Face	Hybrid Session	One-to-One	Group Session
People with Dementia	2	6	6 (2)	4 (1)	-	-
Family Members	2	4	-	4 (1)	-	-
People with Dementia	3	11	-	-	3 (12)	8 (12)

Note: Values in brackets represent the number of sessions per person (format: sessions/person).

Overall, all people with dementia reported enjoying the experiences they chose together with care staff and family members (e.g. *"That was very interesting and lovely… It takes you back to the past… Oh, extraordinary!"* [PwD-10, 1:1 Session #9, Conversation during VR Session, P3][25]. Except for one participant who was not enthusiastic about the technology; nevertheless, they continued attending the VR sessions whenever invited. They explained (*PwD-1: I like reality, not virtual reality. I like real things!*) [PwD-1, F-2-F Session #1, Interview, P2]. Her family member clarified (*FM-1: She gets very little conversation from the rest of the residents… she doesn't really have any apart from the care home staff. She has very few visitors... She has been very, very lonely... I think you (HCI researcher) coming is… nice for just some extra visitors, attention and conversation.* [FM-1, Hybrid Session, Interview, P2].

In the first instance, all participants accepted trying on the headset as the care staff had no trouble fitting and adjusting the headset for the participants with dementia. Participants with dementia commented that the headset felt comfortable and that the exploration of VR experiences was similar to how one would explore real

[25] [Participants with Dementia (PwD), Family Members (FM), CS (Care Staff), MGR (Manager), Session Mode & Number, Quote Resource, Phase]

surroundings (e.g. *"It was easy wearing the headset… When I had that thing on, the effect I got was that I was there"* [PwD-3, F-2-F Session #2, Interview, P2].

5.1.2 Family Members

Six family members were invited to participate in the hybrid session. However, 4 ultimately participated. Due to specific challenges, hybrid sessions could not be conducted with two family members. For the first participant, this was because the family member (spouse) being very old and lacking access to any web-enabled device. For the second participant, the family member (grandchild) stopped responding to our correspondence. Efforts were made to ascertain their lack of interest, but no response was received.

All family members who participated in the VR remote sessions found the web-enabled application easy to access and manage. They appreciated the session with their loved ones as they witnessed how the latter enjoyed the technology (e.g. "*The links were fine… The instructions were clear…Mum still talks about the VR sessions, and I could see how the sessions gave her happiness and joy… They gave Mum a chance to escape... I enjoyed the pleasure that they gave Mum, and I thank you for that*." [FM-2, Remote Session, Interview, P2].) They also expressed their interest in engaging in more VR sessions in the future (e.g. "*I don't mind doing it again*" [FM-1, Remote Session, Interview, P2]).

Unsurprisingly, family members in Phase Two, the researcher-led VR deployment phase, found it an exciting opportunity to engage in an activity with their loved ones and share an experience. This was particularly valued by a family member who lived far from the care setting and could only see their loved one face-to-face once every two to three months as it allowed them to connect (e.g. "*The session gave us the* *opportunity to connect whilst being physically apart."* [FM-2, Remote Session, Interview, P2].

5.1.3 Overview of Technology Acceptance

All people with dementia who were approached to participate in VR sessions accepted using the technology. In general, most people with dementia in Phases Two and Three (researcher-led and care staff-led VR deployment) showed high receptiveness to VR technology (e.g. "*What an amazing experience… This is fantastic!"* [PwD-8, 1:1 Session #8, Conversation during VR Session, P3]. During interviews, all participants with dementia showed an interest in and willingness to use VR again (e.g. *"Thank you so much for coming in today. When are you (HCI researcher) coming back, and how many times do we get to use the VR?"* [PwD-5, F-2-F Session #1, Conversation at the end of the VR Session, P2]. However, among 16 sessions in Phase Two and 48 sessions in Phase Three, three incidents took place where people with dementia reported feeling uneasy during the VR session. Two participants reported feeling acrophobic due to one VR experience filmed from a considerable height (e.g. "don't *like being up here"*) [PwD-6, F-2-F Session #2, Conversation during VR Session, P2]. Another participant experienced mild dizziness (e.g. "*feeling a bit dizzy"* [PwD-3, F-2-F Session #2, Conversation during VR Session, P2]. In response to this, the distress management protocol was followed by the care staff successfully (i.e. remove the headset, ensure the participant does not stand up or risk their physical well-being in any way and then comfort the participant), and the participants with dementia reported feeling better afterwards. They continued to use VR by choosing a different experience. Consequently, the VR content involved in these incidents was removed from the library VR application.

5.1.4 Overview of Viewed Content

Previous studies highlighted the importance of having a personalised approach when delivering VR experiences to people with dementia (Hodge et al., 2018; Matsangidou et al., 2020). Personalised Virtual Environments (VE) relevant to the interests and/or past memories of people with dementia are more likely to improve their immersion and engagement (Matsangidou et al., 2020; Siriaraya & Ang, 2014). Section 4.1.5 highlighted the procedure of choosing suitable VR content, including collecting more related data through interviewing key stakeholders. As such, a list of relevant VR content was created. As the VR sessions were initiated, the following observations were made regarding the selected VR content:

- People with dementia devoted considerable attention to the narration. Although, in the initial phase, the VR content was designed without prioritising an explicit audio content, as it was considered important for people with dementia to be able to clearly hear the care staff's live prompts and guidance during VR use. However, during the sessions, people with dementia frequently asked questions or requested additional historical or contextual information about the places they were viewing. As care staff were not always able to answer these inquiries, it was decided to incorporate relevant and accessible narration into the content to bridge this gap. This adaptation enabled an examination of the potential for incorporating such information to improve user engagement and satisfaction.

This change positively impacted the VR experience. People with dementia clearly preferred VR content with a narrator over content without. They enjoyed acquiring new knowledge or being walked through the content as per care staff (e.g. "*(Name of resident) said the commentary was really good on the reef video… They (people with dementia) pay a lot of attention to the narrator. They actually do enjoy the narration,* *especially the ones with mild to moderate dementia… because it can tell them what they're looking at and is very informative for them. They always like to learn about new things.*) [CS-4, 1:1 Session #3, Interview, P3]. People with dementia were curious about what they were viewing. However, when the narrator did not provide enough information, they kept asking questions throughout the VR exposure (e.g. "*I wonder how deep the water is?... How deep is the river?... You feel as if you could jump in! Ha ha ha... That's why I wondered how deep it was... 5 meters... good for a swim?*" [PwD-2, F-2-F Session #2, Conversation during VR Session, P2].

While overlapping audio was anticipated to increase cognitive load, explicit audio narration initially avoided to make sure that people with dementia could clearly hear the facilitator's prompts and guidance during VR use. However, subsequent investigation showed that participants frequently found narration useful, especially when it provided contextual information or descriptive guidance, indicating that carefully designed narration may actually improve comprehension and engagement.

- People with dementia were entertained by VR content involving liveliness and movement (e.g. "*I think the ones (VR videos) when they (people with dementia) moving around like kind of walking forward, or if it keeps changing, I think that one's better because it keeps them interactive, keeps them more interested in")* [CS-7, 1:1 Session #4, Interview, P3]. They enjoyed the content, which included dynamic and captivating scenes. They preferred VEs with social interactions, which they found more engaging than passive scenes, such as beaches or forests (e.g. "We've *got one (video) where it's like in a forest with water… They (people with dementia) quickly lose interest in it because there's nothing happening in it. I thought that it might transfer them to the peaceful tranquillity of sitting beside a river, but it didn't really. They kept saying, "Nothing is happening"… They expect something more stimulating,* *such as a cityscape with people walking around.")* [CS-6, Virtual Session, Weekly Follow-up, P3]. Also, people with dementia preferred viewing content that featured people as they enjoyed observing and discussing them (e.g. *"There are no people around."* [PwD-3, F-2-F Session #2, Conversation during VR Session, P2] and *"Look at the lady with the red dress; she looks lovely!"* [PwD-2, F-2-F Session #1, Conversation during VR Session, P2]).

- People with mild to moderate dementia made multiple remarks about the technicalities of VR content, including its quality and camera angles (e.g. "*(Name of resident) likes to give me (care staff member) quite a lot of feedback about the position of the camera, the colours of the pictures and whether they enjoyed it or they didn't enjoy it."* [CS-4, Virtual Session, Weekly Follow-up, P3]).

5.2 Findings

The findings in this chapter aimed to explore the impact of VR on people with dementia and their family members and what opportunities it offers from their perspective. For this to be achieved, an inductive approach to thematic analysis was used where data from the audio recordings was transcribed verbatim, and then codes and themes emerged forthrightly from the data content. The data analysed included interview notes with people with dementia, family members, and care staff, as well as qualitative observation notes and quantitative measures. The quantitative data were embedded in the findings as appropriate to provide further insight regarding the themes and support the qualitative observations with measurable evidence. As a result, the following themes have emerged:

i) Improving Emotional Well-Being

ii) Alleviating Apathy

iii) Preserving Individuality and personhood

iv) An Innovative Tool for Enhancing Interactions between People with Dementia

v) Enriching Conversations through Upgrading Family's "Phone Call"

vi) Family Members as Partners in Care

Table 5.3 provides a brief explanation of each theme.

Table 5.3: A Brief Explanation of the Themes

Theme	Key Focus of the Themes
i) Improving Emotional Well-Being	The role of VR in improving emotional well-being and mood, with increased happiness during and after VR sessions.
ii) Alleviating Apathy	Using emotionally engaging VR content to counteract apathy and revive curiosity and enthusiasm.
iii) Preserving Individuality and personhood	Supporting Quality of Life (QoL) for people with dementia by providing comprehensive person-centred care and promoting the preservation and continuation of their personhood.
iv) An Innovative Tool for Enhancing Interactions between People with Dementia	Using group VR sessions to promote social connectedness and engagement among people with dementia and.
v) Enriching Conversations through Upgrading Family's "Phone Call"	Enabling shared and interactive VR experiences that deepen communication between people with dementia and their family members.
vi) Family Members as Partners in Care	Providing virtual space for ongoing family involvement, alleviating feelings of guilt and reinforcing emotional bonds.

5.2.1 Improving Emotional Well-being

This theme drew attention to the role of VR in uplifting the emotional well-being of people with dementia, specifically their mood. Throughout the findings, it was clear that VR has the potential to positively impact the emotional health of people with dementia. The documented observations and care staff feedback showed that people with dementia seemed happier during and after the VR deployment sessions. Care staff disclosed that by providing people with dementia with enjoyable and stimulating VR experiences, the technology "enriches the lives of their residents and that there are goosebumps moments in the sessions and happy tears" [CS-8, F-2-F Session #4, Interview, P3]. It was clear that people with dementia seemed happier during the sessions through their body language, comments, and reactions. Their body language signs included smiling, laughing, tapping on their leg, nodding, and gesturing with their hands at the video being shown to them. Figure 5.1 depicts a participant with dementia engaging with VR, pointing to specific elements within the virtual content. People with dementia expressed their reactions to the experience in various manners. In an instance where words failed a participant with dementia to express their feelings at the end of a VR exposure, they reacted as such.

> *"PwD-4 stood up and hugged the HCI researcher, excitedly saying: I forgot the words I needed to use, so I'm hugging you to show you how happy I am!" [Researcher's Note, F-2-F Session #1, Data Collection, P2]*

Figure 5.1: To the Left: A participant with Dementia Immediately After Donning the Headset. To the Right: The Participant Being Engaging with The VR Content

Furthermore, when bedridden people with dementia were given the opportunity to use VR technology, they experienced a positive impact. VR allowed them to gain a sense of freedom despite their physical limitations. They appreciated being included in meaningful activities like VR sessions, which offered a respite from their usual routine.

> *"When I did a session with (name of the resident), who's bedridden, they were so thankful. They quite liked it (VR). They enjoyed it because it offered them the freedom to have a walk where they're unable to walk and see stuff that normally they can't and see, the animals and dogs or whatever… something different rather than say hello-bye, hello-bye, hello-bye*." [CS-6, F-2-F Session #8, Interview, P3]

The quantitative measure (QUALIDEM-Carer) results corroborated these findings where the ratings are measured on a 4-point Likert scale (0=almost always; 1=often; 2=occasionally; and 3-hardly ever). This subscale ranges from 0 to 18, with 0 representing the least attainable score and 18 representing the maximum attainable score (Dichter et al., 2016). Figure 5.2 presents the mean for the first and last sessions.

Two observations were recorded regarding the positive effect of the VR experience on people with dementia. Firstly, in general, the positive effect of engaging in VR was observed in all sessions. Secondly, the last session (M=17.69; Mdn=18; SD=0.82; MIN= 16; MAX=18) was slightly higher in comparison to the first (M=15.83; Mdn=15.5; SD=1.94; MIN=11; MAX=18). A paired-sample t-test was applied to explore whether there was a positive change between the first and last VR sessions. Although the result did not reach the conventional level of statistical significance ($p < .05$), it did reveal a p-value of .069, which indicates a potential improvement. While the data hints at a positive effect, the evidence is not strong enough to make a definite claim.

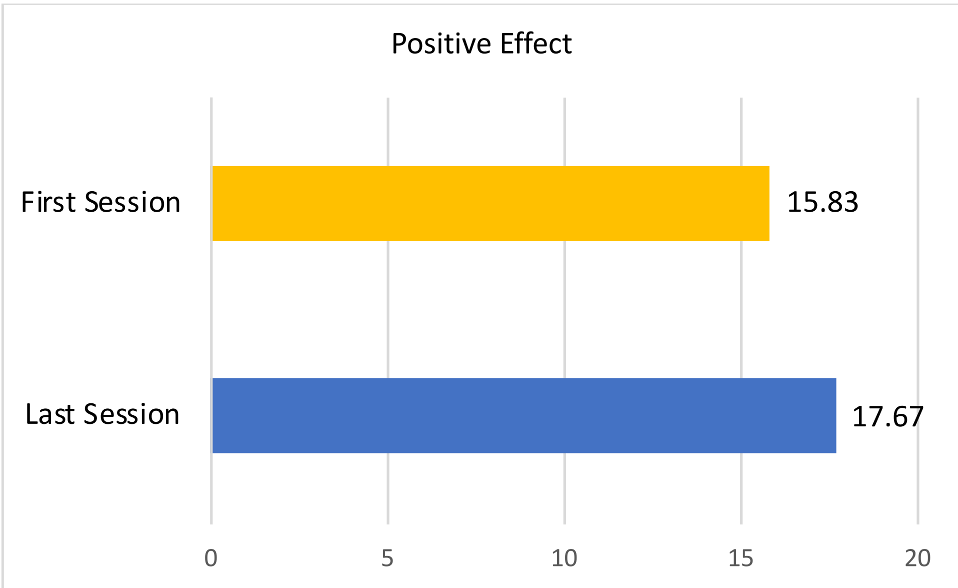


Figure 5.2: Mean of QUALIDEM-Carer over Positive Effect

Furthermore, people with dementia exhibited a sudden shift in mood while engaging in VR experiences, highlighting the effectiveness of enhancing their experiences in these care settings. This was outlined by their enthusiastic and positive verbal reactions to the VR content, such as "*This is fantastic!*" [PwD-3, F-2-F Session #1, Conversation during VR Session, P2]. Care staff reported that they had observed a remarkable transformation in the mood of people with dementia once they wore the VR headset, improving their emotional well-being. For example, a care staff member stated that they had noticed that people with dementia became happy and excited while engaging with the technology, a dramatic contrast to their regular demeanour, even in those who are often unresponsive or withdrawn. Additionally, care staff indicated that sometimes people with dementia used VR for an extended period of time, which they allowed while complying with their physical and emotional safety measures. This suggested that VR was found not only to improve their emotional well-being but also to be captivating and help maintain their attention.

> "I'd *say for (name of resident), they're very much "miserable-ish" usually and never smile, but then when they put the VR on, they're kind of happy and smiling and excited… The way it (VR) can make them feel, it can bring them up so quickly. Their mood changes dramatically. I've never heard them saying those words before. They're really enjoying that. They just sit with the headset on for ages!"* [CS-4, 1:1 Session #8, Interview, P3].

The results from the quantitative measure Observed Emotion Rating Scale (OERS) supported these findings. Figure 5.3 represents the emotional responses of people with dementia as measured by the OERS pre-, during and post-the VR sessions. Ratings are measured on a Likert scale (1= never; 2= <16 seconds; 3= 16-59 seconds; 4= 1-5 minutes; 5= >5 minutes; and 7= not in view (Lawton et al., 1999)). Results indicated a noticeable increase in pleasure from pre-VR exposure (M=2.56; Mdn=2.0; SD=0.73; MIN= 2; MAX= 4) to during (M=4.75; Mdn=5.0; SD=0.53; MIN=3; MAX=5) to after (M=4.65; Mdn=5.0; SD=0.63; MAX=3; MAX=50).

Furthermore, OERS general alertness ratings slightly increased from pre-VR exposure (M=4.5; Mdn=4.0; SD=0.52, MIN= 4; MAX= 5) to during (M=4.94; Mdn=5.0;

SD=0.25; MIN= 4; MAX= 5) to after (M=4.69; Mdn=5.0; SD=0.48; MIN= 4; MAX= 5) (see Figure 5.3).

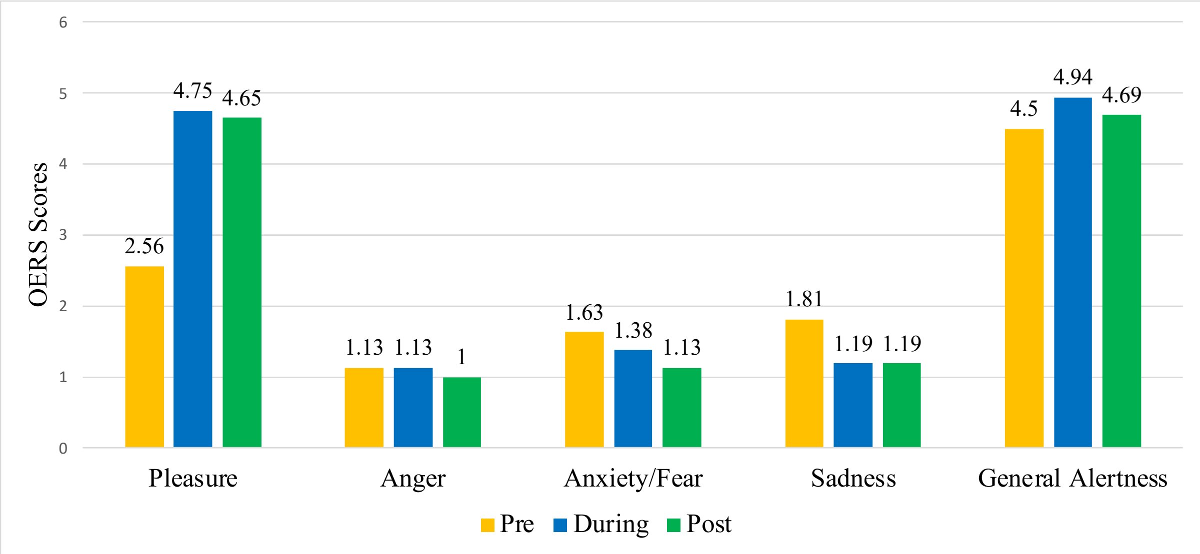


Figure 5.3: Mean of Observed Emotion Rating Scale Pre-, During and Post-VR

Moreover, care staff disclosed that VR promoted emotional regulation for people with dementia through distraction and relaxation. VR experiences contributed to managing feelings of anxiety and temporarily transported people with dementia away from such emotional distress. Being immersed in a VE, such as watching fish swimming around and admiring the vibrant colours, the person with dementia relaxed and calmed down. VR also supported a sense of tranquillity for people with dementia, providing a sense of relief. As such, VR has a therapeutic potential in reducing anxiety among people with dementia.

> "We've *got someone here who's anxious all the time; VR takes that away. It (VR) takes them away from the anxiety and the worry for a while. They feel relaxed while using the headset and after it... However, having a session on the VR, watching fish swimming around and pointing out the beautiful colours, they became a lot calmer and thanked the staff member."* [CS-8, F-2-F Session #4, Interview, P3]

The quantitative measure OERS results supported the abovementioned observations (see Figure 5.3). A slight decrease in anger, anxiety/fear and sadness components of OERS was recorded. Ratings of anger exhibited a modest reduction from pre-VR exposure (M=1.13; Mdn=1; SD=0.50; MIN=1; MAX=3) to during (M=1.13; Mdn=1; SD=0.34; MIN=1; MAX=2) to after (M=1; Mdn=1.00; SD=0.00; MIN=1; MAX=1). Ratings of anxiety/fear also showed a minor reduction from pre-VR exposure (M=1.63; Mdn=2; SD=0.50; MIN=1; MAX=2) to during (M=1.38; Mdn=1; SD=0.62; MIN=1; MAX=3) to after (M=1.13; Mdn=1; SD=0.50; MIN=1; MAX=3). Also, ratings of sadness recorded a minor drop from pre-VR exposure (M=1.81; Mdn=1; SD=1.28; MIN=1; MAX=5) to during (M=1.19; Mdn=1; SD=0.40; MIN=1; MAX=2) to after (M=1.19; Mdn=1; SD=0.75; MIN=1; MAX=4).

Research reports that people with dementia often experience a wide range of discouraging changes and impairments due to the progressive and degenerative nature of dementia, which significantly contributes to reduced QoL and emotional well-being (Cho, 2018). Consistent with previous literature, it was feasible to deploy VR to improve the emotional well-being of people with dementia (Appel, Ali, et al., 2021; Lin et al., 2018b), including positive verbal responses (Chaze et al., 2022), shaped by the perceived usefulness of the technology (Roberts et al., 2018). Furthermore, the findings are in line with previous studies that have demonstrated that VR can be a helpful tool for creating immersive experiences that distract people with dementia from their anxieties and promote relaxation (Reynolds et al., 2018; Rose et al., 2018; Sánchez-Nieto et al., 2023). Manera et al. (2016) stated that when performing an attentional task through VR condition, people with dementia reported feeling less anxious than those performing the task with the paper condition.

5.2.2 Alleviating Apathy

This theme underscored the potential of VR to alleviate apathy by offering novel content for engagement and emotional connection, which would reignite feelings of enthusiasm and curiosity. Various definitions of apathy are found throughout the literature (Marin, 1990; Radakovic et al., 2014; Sommerlad et al., 2022). In the context of this thesis, apathy was characterised as a lack of interest, difficulty sustaining interest, enthusiasm, or willingness to engage in an activity. Apathy was only observed in Phase Three, care staff-led VR deployment, because the VR sessions were conducted by care staff who were more familiar with the nature of people with dementia who participated in the VR sessions. Additionally, Phase Three aimed to explore the impact of VR in the longer short term, making it suitable to investigate the effects of VR on apathy.

Care staff reported that VR activities motivated people with dementia to participate in the sessions as they broke the monotony and added diversity, reducing the apathy associated with repetitive activities offered at the care facility. This was demonstrated by the enthusiastic response of people with dementia when they saw the VR headset before the second session, indicating joy and willingness to participate in VR sessions. Unlike conventional recreational activities offered at care facilities, VR appeared to stimulate curiosity and active participation, implying that it could be an effective tool for encouraging people with dementia to participate. They also reported noticing positive changes in behaviour associated with engaging in activities. This observation highlights VR's potential to increase engagement and improve the entire experience for people with dementia.

> *"I think VR was more appealing to them (the residents) than our usual activities. When I called (name of resident) for their second session, they said: "Oh, are we doing the VR today?" with a big smile and*

enthusiasm... VR definitely stimulates the involvement of residents in an activity... VR is making people curious and wanting to take part, which doesn't happen with other activities." [CS-4, F-2-F Session #4, Interview, P3]

Moreover, VR created experiences that surpassed traditional activities and interventions by bringing visual stimuli directly to the eyes of people with dementia. As such, the immersive nature of VR facilitated greater participation among people with dementia, as it provided them with a heightened sense of engagement compared to ordinary television viewing. VR made people with dementia feel like they were actively participating in the experience rather than passively watching television, which was more captivating. VR appears as a more successful means for attracting and retaining resident attention, providing a more engaging and interactive alternative to traditional television.

> *"You've got a television set that is far away (from residents) ... Whereas this VR system is literally 360 that is so close to their eyes ... They feel like they're immersed in it... It attracts their attention way more than a TV... They are more involved with the VR than the TV because it's as if you're going through the experience of what you're watching; you're sort of walking through it."* [CS-5, F-2-F Session #8, Interview, P3]

Moreover, people with dementia displayed a high level of energy and engagement in the VR experiences, a response rarely observed in other activities in their care setting. VR offered people with dementia content that aligned with their interests, resulting in greater participation throughout the sessions.

> *"VR helps the situation in the (care) home. It encourages the residents to do something distinct... Their energy level with VR is completely different than with other activities. It becomes a bit higher... I've seen them getting more engaged and involved in the session than in other activities. I suppose because the topic we've touched is what they're*

> *into. They become very active."* [CS-7, F-2-F Session #4, Interview, P3]

Interestingly, the care staff saw connections between the VR sessions and interactions with family members. This connection illustrated a unique phenomenon in which people with dementia use the VR headset with the same level of engagement as they would with their family members. This parallel emphasised the potential of VR to create experiences that elicit similar sensations of engagement and liveliness as those encountered with family members.

> "I've *noticed that when residents wear the headset, it's like they are in the presence of their families. You sometimes see them all completely lost in their own thoughts, but they come alive when they're with their own families. I draw a parallel with that. You definitely see a more active side to them when they use the headset."*
> [CS 6, Virtual Session, Weekly Follow-up, P3]

Apathy is a crucial behavioural syndrome of several neuropsychiatric diseases, including depression and dementia, and is associated with reduced daily functioning, caregiver distress and poor functioning outcomes (Groeneweg-Koolhoven et al., 2014). Nearly half of people with dementia in care homes were reported as having clinically significant apathy at least once, while scores worsened with time (Sommerlad et al., 2022). Although there are currently no definitive standard therapies for the treatment of apathy, non-pharmacological treatment is often considered to be at the frontline of clinical management (Manera et al., 2020). As such, consistent with another research (R. E. Brimelow et al., 2020), it is proposed that the flexibility of tailored VR and the impact it has on personal autonomy was tempting for people with dementia to participate in the session, in addition to its novelty and stimulation element in the care setting.

5.2.3 Preserving the Individuality & Personhood of People with Dementia

This theme highlighted the potential of VR technology to enhance the QoL of people with dementia by facilitating all-encompassing person-centred care and catering to the preservation and continuation of their personhood. It was found that VR can be used to explore the past and present of individuals living with dementia to help care staff gain greater insight into their unique personalities and interests. Consequently, VR can be leveraged to continue fostering the growth of these traits following a dementia diagnosis. It is important to note that person-centred care would mean care staff must learn about the history of the person with dementia, as well as their interests and hobbies (past and new). Throughout the observations, it was evident in many instances that VR experiences triggered old interests. For example, PwD-4 was part of a local church's choir as a child. When choosing the VR experiences, they decided to "go" to the cathedral three times, saying it would make them "*happy and calm and bring pleasant memories"* [PwD-4, F-2-F Session #1, Observation Notes, P2]. Such interaction enabled care staff to learn more about the past memories of the participants with dementia. For instance, at the end of the session, a person with dementia noted:

> *"PwD-10: The video is lovely… VR brings back lovely memories of when I used to go to Camden Town Market… I used to go on Saturdays with my sister and a friend… Sometimes, Mum joined as well… I grew up near that area… Lovely walks."* [PwD-10, 1:1 Session #7, Conversation during VR Session, P3]

In addition to triggering old memories, it was found that the VR content provided a space for more meaningful and personally relevant conversations between people with dementia and family members, ensuring a way to preserve and maintain personhood by re-living past experiences. For example, it was observed that the participants with dementia and their family members co-created their experience in VR as they recalled memories and added verbal details to their experience, transforming a "generic" beach (the VR experience they were engaging in) into a past shared memory space (a past holiday) they were re-living together:

> *"PwD-4: Oh, that's a lovely one [referring to the VR content]. FM-4: We've been to a lot of beaches like that, haven't we? PwD-4: Yes, we did. FM-4: You used to dig a big sandcastle for the kids, didn't you? PwD-4: I used to make a lot of things for them. The birds used to come to me. FM-4: Remember the little Robin at the beach? You fed it out of your hands, didn't you? PwD-4: yeah… Different colours, remember?"* [PwD-4 & FM-4, Remote Session, Conversation during VR Session, P2]

The results of the qualitative measure, The Engagement of a Person with Dementia Scale (EPWDS), validated the findings. EPWDS is measured on a 5-point Likert scale ranging from 1 (indicating strong disagreement) to 5 (indicating strong agreement), where the total score will range from 10 to 50 (Jones et al., 2018b). Observations indicated that when people with dementia engaged in VR sessions with their family members, engagement increased slightly (see Figure 5.4). There was a noticeable increase in engagement in remote sessions (M=48.5; Mdn=49; SD=1.91; MIN=46; Max=50) compared to face-to-face (M=43.75; Mdn=46.5; SD=7.11; MIN=28; Max=49). This suggests that by recalling old memories, VR enhanced conversations with family members and increased overall engagement. However, a paired-sample t-test revealed that this difference in engagement between the two formats was not statistically significant, $p = .15$, suggesting that the observed variation may not be solely attributable attributed to session type.

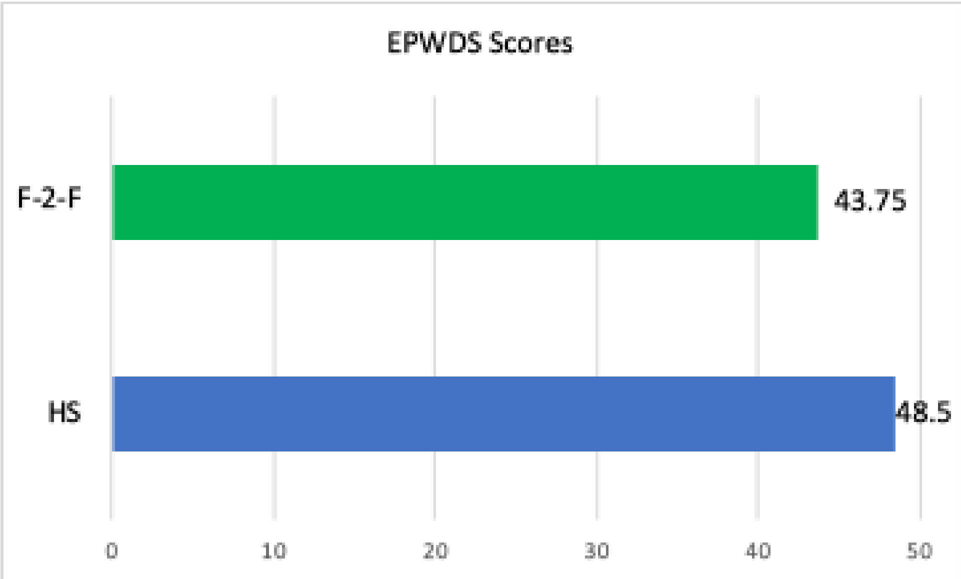


Figure 5.4: Mean of EPWDS

Reminiscence work has been seen to have a cognitive rationale. People with dementia often recall events from childhood, yet memories from the person's earlier life will not all be sources of pleasure and happiness; indeed, some may be distressing or traumatic (Woods et al., 2018). For instance, PwD-4 experienced negative reminiscence due to "being" in a cathedral. As part of a church choir, the VR content reminded them of losing their mother in a tragic accident and how they had split apart as siblings. CS-3 was aware of this traumatic incident, so they managed the situation accordingly and redirected the attention of PwD-4 to a positive aspect of the experience. The selected VR content was a triggering stimulus in this case.

Equally and perhaps more importantly, the identity of people with dementia is not only defined by their past experiences; their identity transforms throughout the progression of the condition (Beard, 2004). As such, based on the collected data and observations, VR experiences helped people with dementia create positive narratives and outlooks that can enrich their lives post-diagnosis. These experiences can also assist in fostering their personalities and interests, allowing them to stay connected with the world around them. The importance of such a notion has been mentioned during interviews:

> *"CS-4: VR brings the outside in for them (Residents)... Instead of them being in a care home, they are like transformed to a different place… I feel like they've almost had a trip out when they haven't... They really liked seeing all the monuments in the videos especially around where they grew up."* [CS-4, 1:1 Session #8, Interview, P3]

Through VR, people with dementia may be able to exercise (to some extent) their continued interests, which may not be feasible to achieve by means other than VR. In one interview from Phase Two, researcher-led VR deployment, it was mentioned that PwD-5 used to have an aviary in their garden where they looked after many birds. However, such a hobby could not be maintained due to old age and the lack of mobility required to care for birds. As such, a VR experience was chosen to allow them to "visit" a park full of flying seagulls and another one inside a resort with various birds. As a result, PwD-5 was ultimately (pleasantly) surprised to discover that these experiences were curated specifically for them.

> *"A big smile appeared on their face during the initial PwD-5 experience (Seagulls in the Park). They repeatedly exclaimed, "Dear our Lord, what have we got here?". I (HCI researcher) asked them to move their head to see the surroundings. They repeatedly laughed out loud."* [PwD-5, F-2-F Session #2, Observation Notes, P2]

Based on observations, it was established that through VR, people with dementia can also "go" somewhere new, try an exciting experience or fulfil an otherwise inaccessible experience. For instance, PwD-2 had some European cities on their "bucket list" but never got the chance to visit them. As such, PwD-2 chose two European city tours in VR, which they certainly enjoyed:

> *"PwD-2: ... it's really amazing what you see [in the headset]. That was exciting! It's beautiful... It's so nice to hear the talk [the tour's voice-over]. I'd like to see more things. I'd like to see Switzerland 'cause I've always wanted to go to Switzerland."* [PwD-2, Remote Session, Interview, P2]

Furthermore, many people with dementia residing in care facilities are originally from outside the United Kingdom, making it challenging for them to visit their home countries. As such, care staff requested the upload of VR content tailored to meet the interests of this population. For example, one person with dementia who was natively from Jamaica constantly expressed longing and nostalgia for their homeland.

> *"I showed the person from Jamaica the car journey in downtown Kingston. They recognised all of it. Oh, they were so pleased. They were really happy with it. They were as if they were in the car with the commentator. They kept saying yes, yes, yes, that's right, that's right. They remembered the market and kept talking to the commentator."* [CS 6, Virtual Session, Weekly Follow-up, P3]

Digital Technologies, including VR, can be utilised to provide therapies to meet the social and emotional needs of people with dementia; one example is reminiscence therapy, which often involves using artefacts such as old photographs or music for therapeutic benefit (Lazar et al., 2014). In line with the findings, a literature review found that VR is an effective and feasible technology for supporting reminiscence therapy (Tominari et al., 2021; Tsao et al., 2019). Reminiscence is a helpful communication approach in a care home setting (Redulla, 2019), where staff can learn more about the past of people with dementia. It is suggested that if such information from VR sessions were systematically captured and extracted, it might be embedded into the care plan, thus improving QoL for people with dementia.

5.2.4 An Innovative Tool for Enhancing Interactions between People with Dementia

This theme investigated the potential of VR technology as a tool to enhance interactions, leading to social connectedness among people with dementia, by conducting VR sessions in a group setting. This theme only emerged in Phase Three, where the sessions were led by care staff and conducted in a group setting, allowing individuals with dementia to interact with one another. It was unexpected that they would converse during and after the sessions to the extent observed. During Phase Two, where the sessions were led by the HCI researcher and conducted privately, interactions were not observed, preventing a full understanding of participants' responses.

Initially, the VR sessions involved one person with dementia and one to two care staff members, covering three people with dementia per week. However, during interviews at the end of the first month of VR deployment, it became evident that many people with dementia expressed a desire to participate, having observed others using VR in the lounge. This prompted a suggestion to include more people with dementia in each session to accommodate their interest, notably since care staff reported feeling guilty not offering it to others.

> *"I felt awkward singling out one person in the lounge to have this experience but not being able to do it to everybody. Sometimes I've done it (VR session) where... I walk into a lounge, do it with one person, and then walk out again, which I didn't like… not having time to let everybody else have a go in order to enjoy it."* [CS-6, F-2-F Session #4, Interview, P3]

Furthermore, when the sessions were initiated in a group modality, people with dementia were motivated to participate as they observed others using the headset. This group modality enabled the inclusion of several people with dementia simultaneously, fostering a social engagement event that lasted around two hours. The sessions were structured to begin with a social component, such as tea and biscuits, followed by the implementation of the VR experience. This was concluded in a chat, which enhanced their overall participation and interaction.

> *"This felt more of a sort of activity for everybody. Even if not everybody took part, they're still part of a lively group... They did get excited, and they chatted about it. They saw each other's reaction and saw each other's involvement in it, which sparked a lot of conversation between them."* [CS 6, Virtual Session, Weekly Follow-up, P3]

VR extended the prospect for people with dementia to engage together in social interaction using their VR experiences as prompts for shared socialisation immediately following the VR exposure session while remaining in the group setting. The VR environment encouraged people with dementia to converse about the VR content and or share memories related to the content, fostering social connectedness among them.

> *"The residents shared some experiences with each other. (Name of resident) started sharing their past experience of diving, and then (name of another resident) took part in the discussion and then another person joined in... VR triggers off more memory stuff due to what they're looking at... What they're looking at is improving their conversation with each other."* [CS 4, Virtual Session, Weekly Follow-up, P3]

The results of the quantitative measure QUALIDEM-Carer over social relations support these observations (see Figure 5.5). This subscale ranges from 0 to 18, with 0 representing the least attainable score and 18 representing the maximum attainable score (Dichter et al., 2016). The social relations component slightly increased in the last session (M=16.17; Mdn=16; SD=2.28; MIN=12; MAX=18) compared to the first session (M=15; Mdn=15; SD=1.83; MIN=13; MAX=18). A paired-sample t-test was applied to assess changes in social changes between the first and the last session. The results revealed a statistically significant improvement, $p = .034$, suggesting a positive effect of repeated VR exposure on social connectedness.

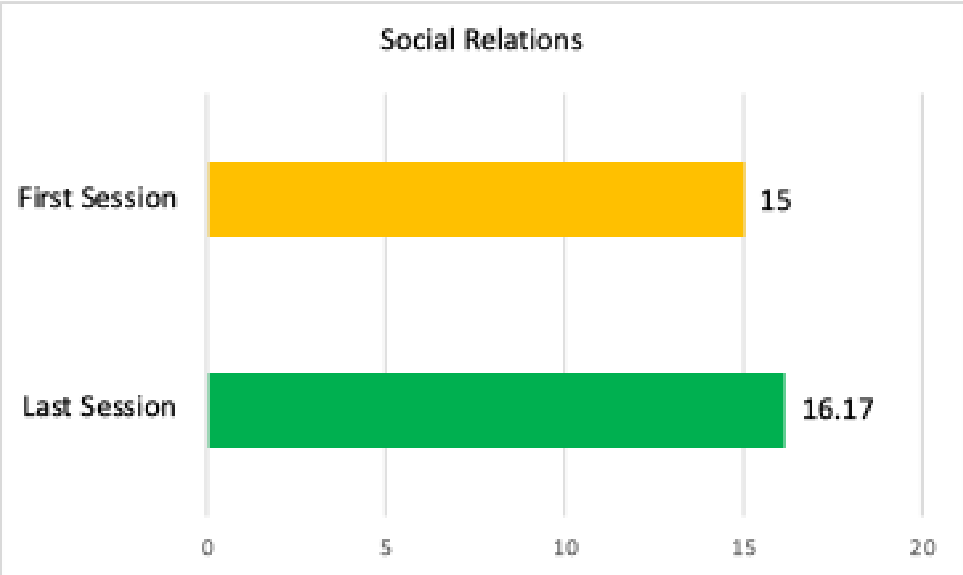


Figure 5.5: Mean of QUALIDEM-Carer over Social Relations

Unexpectedly, these interactions extended beyond the group sessions, indicating that VR experiences have become focal points of conversation among people with dementia in the lounge, offering new and engaging topics for discussion. This observation is particularly valuable in care settings where conversational topics might be limited. The VR sessions served as a stimulant for social interaction and engagement beyond the sessions themselves.

> *"(Name of resident X) has definitely been talking to their friend (Name of another resident) about the VR... So (Name of resident Y) has been talking to the rest about it just because, you know, they don't really have a lot to talk about… Residents were definitely talking*

about VR among themselves about it." [CS-5, Virtual Session, Weekly Follow-up, P3]

Research has shown that technology can create opportunities for social connectedness, helping alleviate social isolation and loneliness (Neves et al., 2019). The virtual experience helps build conversation and socialisation naturally (L. N. Lee et al., 2019). Emanating from the results, this thesis proposes that VR being conducted in a group modality created an atmosphere that supported social connectedness for people with dementia in care settings. Scott & Clare (2003) stated that offering interventions on a group basis allowed people with dementia to meet in a supportive context where each member could personally relate to what others were experiencing (Scott & Clare, 2003). Consistent with the findings of a study conducted by (Gaspar et al., 2018), older adults reported overwhelming positive effects of the VR group experienced sparkling connectedness among them. As such, conducting activities for people with dementia in a group setting maintains QoL (Tanaka et al., 2021).

5.2.5 Enriching Conversations through Upgrading Family's "Phone Call"

Maintaining connections and relationships between people with dementia residing in long-term care and their family members has substantial benefits for both parties. As such, this theme explored the quality of conversation between people with dementia and family members through the VR system.

As discussed in section 4.1.3, 6 family members were invited to participate in Phase Two, researcher-led VR deployment. However, 4 family members ultimately participated. Recruiting family members necessitated considerable preparation and organisation, posing substantial obstacles to securing their participants. In contrast, Phase Three focused on investigating optimal ways to conduct VR sessions independently by care staff, making it unfeasible to include family members due to logistical and resource constraints. Therefore, the current and subsequent themes are based on the data collected during Phase Two.

Not only did VR help shorten the geographical distance between people with dementia and their family members, but it also served as an upgrade from the conventional phone (or video) family calls in two unique ways. Firstly, family members often struggle to find appropriate conversation topics when visiting or speaking to people with dementia. A worth-noting observation was that VR facilitated a new level of engagement for people with dementia with their loved ones, allowing them to explore a broader range of topics in an interactive manner without the limitations or restrictions of the physical environment. The VR content enabled people with dementia in care facilities to experience locations outside their care home's natural environment, thus providing them with additional stimulation to stimulate conversation and create new threads. The VR content served as communication support, offering a stimulus to elicit conversation. During the remote VR sessions, it was evident that VR could provide a new context for conversations through the VR experiences.

> *"FM-4: What are you seeing now? PwD-1: I'm seeing a door, stairs, lights… You've got all the lights, 1, 2, 3… 7, loads of that. FM-4: Do you know what cathedral it is? PwD-4 It's what you said… It's…, FM-4: It's in England somewhere… PwD-4: I can see the writing on the floor; FM-4: I can't read it. It's Italian."* [PwD-4 & FM-4, Remote Session, Conversation during VR Session, P2]

Furthermore, VR experiences could provide a viable solution to family members who encounter challenges in identifying suitable conversation topics beyond mundane day-to-day updates when interacting with their loved ones. Through the use of VR, family members were presented with an engaging environment that provided them with opportunities to stimulate conversation topics. As such, FM-1 shared an experience about a personal event.

> *"FM-1: Can you see lots of people walking around the Colosseum? PwD-1: Yeah, I can, and I see the Colosseum. FM-1: Yes, it is very impressive, isn't it? PwD-1: Yes, it is! FM-1: I went there with [husband] and [daughter] and [son] for my 40th birthday… You must have been there before that, a long time ago, I expect. PwD-1: Are these old pictures or new? FM-1: It looks like people have got face masks on, so they must be quite new."* [PwD-1 & FM-1, Remote Session, Conversation during VR Session, P2]

Secondly, VR experiences provided a new opportunity to strengthen the bond between family members and people with dementia further. Interestingly, family members and participants with dementia viewed VR as an activity that they can "do together" rather than just a conversation:

> *"FM-1: ... to do something with me… yes, it's beneficial ... it's nice to find an activity that we can do together." [FM-1, Remote Session, Interview, P2]*
>
> *"PwD-1: It was nice… It was also nice to know that they (family members) could see the same thing… thank you, thank you very much… It was like we were travelling together."* [PwD-1, Remote Session, Interview, P2]

Previous research has indeed shown that the lack of conversation topics erodes the quality of communication between people with dementia and their family members and that providing conversation resources and activities can increase their connectedness and intimacy (M. Kang et al., 2015). However, barriers such as distance, commute cost, work, and life responsibilities or restrictions (i.e. COVID-19 lockdown) can restrict people with dementia from interacting and engaging with family members frequently (Verbeek et al., 2020; Yamamoto-Mitani et al., 2002).

Research in the HCI community has previously focused on designing interventions to create "better visits" for family members visiting people with dementia in their care setting. These interventions aim to enrich visits by making them enjoyable and engaging. For instance, studies have explored the use of social media applications to collate content (i.e. pictures, videos, articles, etc.) and then use them during visits as discussion prompts (Welsh et al., 2018) and tablet-based games for people with dementia and family members to engage with during visitation (Munoz et al., 2021). The findings of this study align with previous work (Afifi et al., 2021), which reported that people with dementia were more conversationally and behaviourally engaged with their family members when using VR compared to regular video conferencing calls. The use of VR facilitated joint activities, improving their interaction and conversation (Afifi et al., 2021).

5.2.6 Family Members as Partners in Care

This theme emerged from the interviews and observations on how VR experiences extended their benefits to family members of people with dementia. In two instances, VR technology supported the family members by taking the connection with their loved ones a step further. Precisely, when it provided a virtual space where family members continued caring and giving emotional care to their loved ones, it helped them alleviate their guilt due to not contributing enough to care for their loved ones in care homes. By involving family members in what is perceived as a beneficial activity for people with dementia, family members may feel better about their involvement in the care process.

> *"I could see how much my mum enjoyed them (the VR sessions) and made her happy and content… At the end of the day, I want her to have a positive and pleasant experience… VR gave her a new experience, which I thought was really good… The VR session was*

totally about her… It generated more memories that we both had together… I enjoyed the pleasure that they gave (PwD-2)." [FM-2, Remote Session, Interview, P2]

Unexpectedly, the results showed that VR could help nurture family members' trust in the care staff and, by extension, the care system overall. VR was seen as a tool to help build trust between family members and their care staff. Trust is "this safe feeling" (Waite et al., 2019), which is built through dialogue (Barnes & Brannelly, 2008). Trust within the dementia healthcare setting indicates best practices and adaptation to the needs of people with dementia (Karlsson et al., 2014). It is a caring partnership between the involved parties (Ter Meulen & Wright, 2012). The shared experience between family members, care staff, and people with dementia allowed the family members to observe the care staff in action. It also allowed the family members to interact with care staff. During the VR sessions, family members observed how participants with dementia are being treated and cared for:

"FM-1: During the remote VR session when we were on Zoom, I saw the activities coordinators were helping (PwD-1), and they were looking after them very well. It gave me a little insight into (PwD-1) 's life; it is difficult to know how they are getting on in the care home when I am so far away." [FM-1, Remote Session, Interview, P2]

Family members often feel guilty when they transfer their care responsibility to care professionals by placing their loved ones (persons with dementia) in a long-term care setting (Thompson & Roger, 2014b). Research suggests that increasing the contact between family members and care staff wherever possible is essential for building a trusting relationship (Sävenstedt et al., 2003). Not unsurprisingly, early research found that video conference calls not only helped family members feel more connected to people with dementia but also highlighted the idea that "to see makes me part of the caring"; the study reported that "seeing" people with dementia helped family members alleviate negative feelings of guilt (Sävenstedt et al., 2003). It is argued that VR extends this idea, enabling the sentiments of "visiting together makes me part of the caring". The findings are consistent with previous research that has stated that VR potentially improves the QoL of family members and people with dementia and reduces the family members' feelings of guilt and burden (Afifi et al., 2022).

5.3 Summary

This chapter describes the impact of VR experiences on people with dementia and their family members, focusing on novel findings. It included the observations and feedback from care staff, who indicated specific improvements in residents' interactions, emotional well-being, and communication skills facilitated by VR technology. Notably, the findings showed that VR could considerably enhance engagement and motivation among people with dementia, encouraging more active participation in care settings. These findings suggest that VR could hold substantial promise as an innovative tool in dementia care, offering new means for enhancing the QoL and social interaction for this population.

The next chapter will present the findings related to care staff, highlighting the feasibility of care staff administering VR independently. It will illustrate the impact of VR on this demographic while ensuring the safety and well-being of people with dementia, particularly in enhancing rapport with people with dementia, facilitating a profound comprehension of their capabilities among care staff, and fostering a positive work environment.

Chapter 6: The Impact of VR on Care Staff

The previous chapter (Chapter 5) explored the findings related to the impact of Virtual Reality (VR) on people with dementia and their family members. The chapter highlighted the reflections of people with dementia regarding the VR content they experienced, including their feedback on narrations and aspects they found enjoyable. The chapter further explored several key themes related to people with dementia and their family members. These themes include improving emotional well-being, alleviating apathy, and preserving individuality and personhood. Additionally, it highlighted the innovative use of VR as a tool for enhancing interactions between people with dementia, enriching conversations by upgrading the traditional family "phone call," and recognising family members as essential partners in care.

This chapter will present the results from Phases Two and Three, focusing on the perspective of the care staff who worked with people with dementia and their family members. In Phase Two, the sessions were conducted by the Human-Computer Interaction (HCI) researcher, while three care staff shadowed and supported the researcher. In Phase Three, the sessions were entirely facilitated by 5 care staff. In both phases, care staff were selected based on their close relationship with the participating people with dementia to instil a sense of comfort and reassurance.

Throughout the Preliminary Phase (see section 3.5.3), it was clear that care staff training was necessary to ensure a successful deployment, increase the acceptability of VR technology, and empower care staff with the confidence to deploy the technology both dependently and independently. Of the 17-care staff who attended the training sessions, only 8 participated in the two phases for various reasons, such as personal and work overload. For convenience, the training sessions were conducted at the care facility of participating staff.

The training content addressed the following areas: i) technical aspects of VR, including setup procedures and user interactions with the technology; ii) considerations for physical safety, including risk management measures; iii) pre- and post-VR protocols, describing the preparations required for people with dementia before participating in "entering" VR experiences and the processes for completing their engagement "exiting"; iv) management of VR-induced distress, highlighting to care, staff, the adverse effect that VR might have on people with dementia including equipment management and safeguarding the safety of participants; and v) guidelines for administering quantitative measures to be used in the studies. The training sessions included mock sessions where care staff delivered VR sessions to their peers, followed by feedback from the HCI researcher on how they could enhance their delivery.

In both phases, at the end of the training sessions, care staff were given a comprehensive toolkit (see section 3.5.3.2) containing essential elements supporting adequate deployment and use of VR technology in care settings. The kit also contained information on VR technology and its benefits, thorough instructions with visual aids for setup and maintenance, relevant guidelines, facilitation instructions for people with dementia, health and safety protocols, and troubleshooting procedures. In Phase Three, as the sessions were entirely led by care staff, in addition to the toolkit, they received a Care Staff Checklist (see Appendix M) and a Resident VR Session Log (see Appendix N) to help them maintain a systematic session recording and tracking of the quantitative measures.

6.1 Overview of Findings

6.1.1 Deployment Settings

Like other research-based studies, the researcher-led sessions in Phase Two were typically held in a private room. Nonetheless, sessions were conducted in the cafeteria when the private room was unavailable. However, in practical implementations where sessions were led by care staff in Phase Three, most care staff held their sessions in communal rooms (lounges). This practice is likely derived from the fact that residents usually sit in these areas, making the setting more comfortable for both residents and care staff. Figure 6.4 illustrates the spatial and social configurations across the different phases, session formats, and locations.

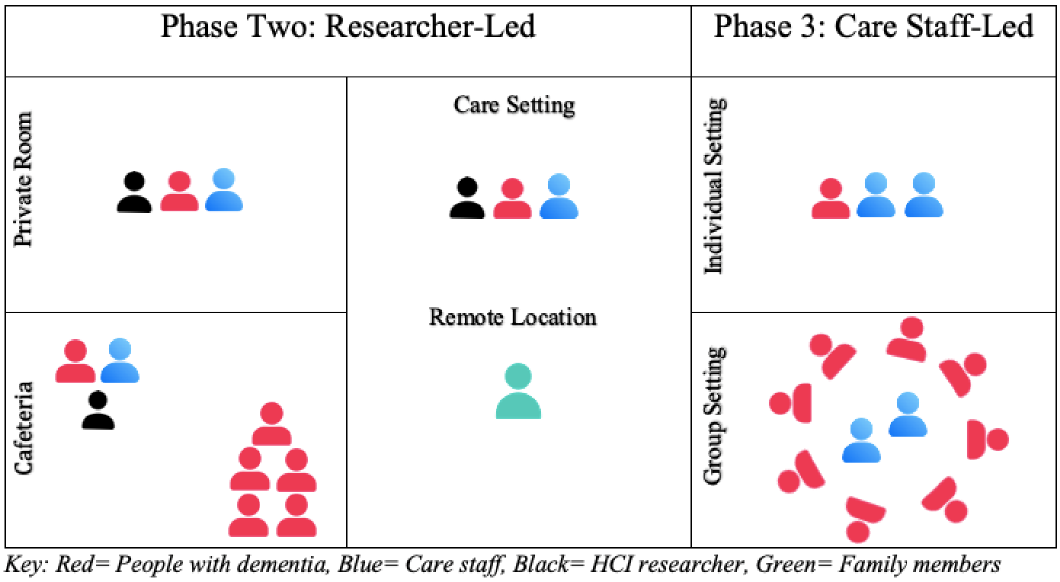


Figure 6.1: Social Configurations in VR Sessions

In the second month of Phase Three, the HCI researcher opted to adapt the methodology to accommodate the care staff's demands and aspirations. As mentioned earlier, the primary aim of the VR sessions in Phase Three was to enable care staff to autonomously conduct deployment and assess its effectiveness as a regular practice in their care facilities. When they started conducting the sessions in the lounge, they reported feeling uncomfortable inviting particular people with dementia while the rest watched and showed interest in participating. (CS-6) conveyed, *"I felt awkward singling out one person in the lounge to have this experience but not being able to do it to everybody… and let everybody else have a go."* [CS-6, Virtual Session, Weekly Follow-up, P3]. Following participatory research values, the methodology was modified according to the care staff's suggestions, and in turn, the participant pool was expanded to include more people with dementia.

Ensued this adaptation, quantitative measures were excluded in the second month of the care staff-led sessions, granting care staff more time to conduct VR sessions, as (CS-5) disclosed, *"It's time-consuming… it is a burden for me… I prefer to do more VR sessions instead of filling the forms*." [CS-5, Virtual Session, Weekly Follow-up, P3]. Instead of employing quantitative measures to collect data, care staff provided more feedback verbally following the sessions every week, using instant messaging platforms at their discretion. This modification allowed care staff to engage more residents in VR experiences, *"That sounds really good! We can invite more residents, so more residents can benefit from it (VR)."* [CS-7, F-2-F Session #4, Interview, P3]

6.1.2 Confidence to Administer VR

In the HCI researcher-led sessions in Phase Two, where care staff co-led the sessions, (CS-3) didn't feel confident enough to administer the first VR session. Their lack of confidence could be attributed to their older age and unfamiliarity with advanced technologies such as VR, noting that they were only accustomed to utilising everyday technology (i.e., mobile, basic PC skills, etc.). The HCI researcher noted, *"This morning, I conducted a training session with three care staff to demonstrate how to set up the VR system. The two younger staff members (in their early twenties) found it* *easier to learn how to set up the system due to their greater familiarity with technology*" [Researcher's Note, Training session #1, Data Collection, P2]. Nonetheless, as (CS-3) carried more VR sessions (with the support of the HCI researcher), the former built up their confidence. The other two care staff members (CS-1 and CS-2) felt reasonably confident administering VR immediately after the training. Their self-assurance with using the technology could be credited to their technology proficiency in everyday tasks. CS-1 disclosed that *"It was easy being raised in the technology era. I'm used to using apps, controllers, connecting to the internet and so on"* [CS-1, F-2-F Session #1, Interview, P2].

In the care staff-led sessions in Phase Three, one care staff member (CS-8) felt confident enough to lead and administer the VR technology after one training session. However, as (CS-4), (CS-5), (CS-6), and (CS-7) didn't feel confident enough to conduct sessions on their own during the first week, (CS-7) requested another training session to boost their confidence in carrying out the sessions independently, *"Whenever you (the HCI researcher) have time to come in and just go through everything again with everyone because a lot of people still aren't confident, comfortable on the activity team to do it."* [CS-4, Virtual Session, Weekly Follow-up, P3]. Care staff were also encouraged to use VR to familiarise themselves with the technology and gain confidence in its implementation to use the technology. They were also advised to contact the HCI researcher for assistance if needed. Figure 6.2 shows a care staff member using VR during a break to get acquainted with the system.

Figure 6.2: Care Staff Member Engaging with VR

6.1.3 Navigational Proficiency in VR content

The observations showed that the care staff's ability to switch between VR content increased as the phase progressed. In the first two weeks of Phase Three, some care staff downloaded one VR content and used it with all people with dementia. They were unsure of how to navigate between contents while conducting the sessions. In particular, one care staff (CS-6) noted their navigational experience throughout the phase, expressing their concern regarding potential errors during the video-switching process.

> *"I've limited myself to one video because I haven't been too familiar with changing the video on the headset. I choose one video per day… I'm always afraid that if I change the video, something will happen, and I'll lose the link or something like that."* [CS-6, Virtual Session, Weekly Follow-up, P3]

At the end of the second month's interview, when the same care staff was asked about the VR content preferences of people with dementia, they disclosed that they had experienced navigational progression since the beginning of the sessions, where they could smoothly switch between contents.

"(Name of resident) choose a combination of different videos. It was first the diving one... then they visited the cathedral and Barcelona... I can change the videos fairly easily now... I'm more confident than before because I can use it better. Everything is much easier now: setting it up, pairing it and changing the videos." [CS-6, F-2-F Session #8, Interview, P3]

6.2 Findings

The findings in this chapter aimed to investigate the perspectives of care staff on the deployment and engagement of VR in their care settings. For this to be achieved, an inductive approach to thematic analysis was used. The data from audio recordings were transcribed verbatim, allowing codes and themes to emerge directly from the content. The data analysed included interview notes from people with dementia and care staff, weekly follow-ups with care staff, qualitative observation notes, and quantitative measures. The quantitative data were incorporated in the findings where applicable to provide additional insight into the themes and to support the qualitative observations with measurable evidence. As a result, 4 themes were identified:

i) Emotional, Physical, and Contextual Safeguarding

ii) Enhancing Rapport: Creating Deeper Connections with People Living with Dementia

iii) Educational Tool: Understanding the Capabilities of People with Dementia

iv) Fostering a Positive Work Environment

Table 6.1 provides a brief explanation of each theme.

Table 6.1 A Brief Explanation of the Themes

Theme	Key Focus of the Themes
i) Emotional, Physical, and Contextual Safeguarding	The essential role of care staff in ensuring secure and successful VR use, including supporting the transition between the real and the virtual environments.
ii) Enhancing Rapport: Creating Deeper Connections with People Living with Dementia	VR's potential to strengthen the relationship between care staff and people with dementia by fostering conversations and understanding.
iii) Educational Tool: Understanding the capabilities of People with dementia	The use of VR to reveal hidden abilities and characteristics of people with dementia to care staff, such as recognising landmarks in VR, which may not be observed otherwise.
iv) Fostering a Positive Work Environment	The contribution of shared VR experiences to improving care staff well-being and enhancing job satisfaction in the care environment.

6.2.1 Emotional, Physical, and Contextual Safeguarding

The findings showed that the deployment of VR primarily relies on the care staff administering the equipment, delivering the session, and supporting the participants with dementia. Perhaps the first critical step in using VR with people with dementia is to help them understand the technology, what it does, and why the care staff want them to try it.

> *"CS-1: It's just explaining it to them; that's the most difficult part. When you say VR or virtual reality, there's no context that they can grasp. So, I Think… that's the only thing is explaining before it happens, getting it through what's going to happen."* [CS-1, F-2-F Session #1, Interview, P2]

Consistent with the criteria laid out in the Preliminary Phase (see section 3.4) it was found that the care staff's familiarity and built trust with people with dementia influenced the latter's acceptability and willingness to undertake VR sessions as they would trust the care staff with trying something completely new. Such support to maximise the acceptability and meaningfulness of VR sessions did not stop at the beginning of the session (i.e. introduce VR at the beginning). It was also carried over throughout the session as care staff facilitated the interaction and directed the attention of the participants with dementia to the various elements of the VR experience (Siriaraya & Ang, 2014).

> *"CS-7: If you look up, you can see the sky? PwD-8: Certainly can! CS-7: Is it nice? PwD-8: Yes, lovely! The colour of the sky alters! Little Robin Guide! CS-7: When you look sideways, you'll see the road where the people walk in the woods. PwD-8: Yes, yes, you're so near this bird."* [CS-7 & PwD-8, F-2-F Session #11, Conversation during VR Session, P3]

Moreover, it was found that care staff play a crucial role in safeguarding the physical and emotional well-being of people with dementia. Consequently, multiple measurements were incorporated to ensure the safety and well-being of participants with dementia, which care staff could implement. Firstly, during the Preliminary Phase (see section 3.5.2), the exclusion criteria for people with dementia who may experience adverse effects of VR due to their underlying health conditions were discussed. Secondly, in the Preliminary Phase, while designing the VR experiences, the HCI researcher considered technical aspects of the content (i.e. low resolution or shaking cameras), content type (i.e. pleasant experiences), and interaction style (i.e. simple navigation) to support the physical well-being of participants with dementia (see section 3.5.4.3). Thirdly, the HCI researcher underscored the need for appropriate staffing, delivery modality, and training in the deployment plan for maintaining the safety of people with dementia. Fourth, care staff ensured that people with dementia were seated on a sturdy armchair and instructed not to stand up. Figure 6.3 depicts a care staff member preparing a person with dementia for a VR experience while seated in a sturdy armchair. However, two participants with dementia reported feeling acrophobic due to one VR experience filmed from a considerable height. Therefore, the headset was immediately removed, and the distress management protocol was followed by the care staff successfully (which was covered as part of the training) and gave them the appropriate time and support to recover fully:

> *"PwD-3: I'm feeling a bit dizzy [CS-1 took off the VR HMD as soon as she heard them complain]. CS-1: A bit dizzy [while holding their hand]? PwD-3: Yeah, CS-1: Would you like me to get you a drink? PwD-3: Yes, please, a cold one. [CS-1 brought them their favourite juice and helped them drink it.] CS-1: You are safe, and you will feel better soon".* [PwD-3, F-2-F Session #2, Conversation during VR Session, P2]

Figure 6.3: Preparing for a VR Experience

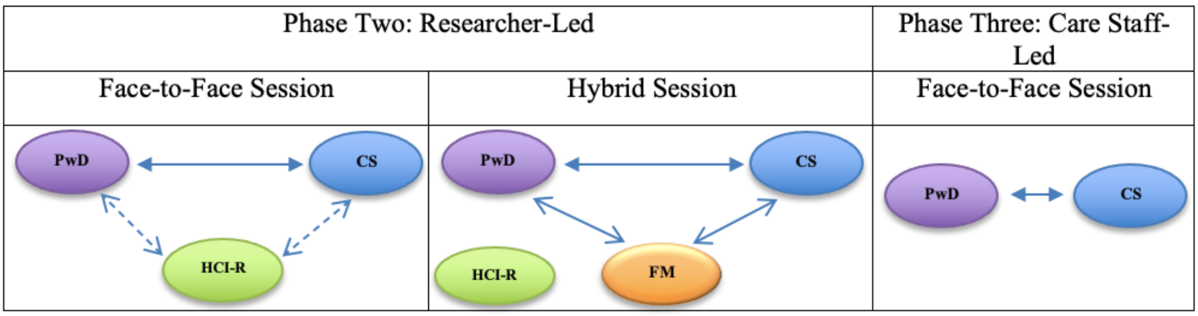
Facilitating the transition between the physical and digital space was another substantial role of the care staff involved in deploying VR. For instance, care staff facilitated the transition from the real world to the VR experience using phrases such as "*It will play now, and you're going to see the Opera House in Vienna*" [CS-8, F-2-F Session #12, Conversation during the session, P3] and the transition back to the real world by using phrases such as "*There you go, hello again!*" [CS-1, F-2-F Session #2, Conversation during session, P2]. Within the scope of this research, the gentle transition was sustained using verbal prompts to support the participants with dementia while they fell in and out of the two spaces.

Care staff play an essential role in successfully integrating and implementing VR technology in care facilities (Hicks et al., 2022), where safeguarding people with dementia is central to the process. Several studies highlighted the importance of delivering VR sessions with care staff being present with people with dementia (Appel et al., 2020; Moyle et al., 2018) to ensure a safe and effective deployment for the latter (Ijaz et al., 2022). In line with the findings, Hung et al. (2023) stated that the involvement of care staff is pivotal to improving the engagement of people with dementia during implementation, where such an active involvement is the key factor that enables residents to access personally meaningful experiences (Waycott et al., 2022), including safeguarding their needs (Chandra et al., 2021).

6.2.2 Enhancing Rapport: Creating Deeper Connections with People Living with Dementia

Throughout the findings, it was clear that care staff saw VR technology as a means to cultivate and reinforce their relationships with people with dementia. This theme emerged as care staff perceived that VR enabled a deeper understanding of the past experiences of people with dementia as it prompted them to share. By providing a platform for greater engagement and awareness, VR allowed care staff to connect with people with dementia more personally, improving the Quality of Life (QoL) for people with dementia. As such, the sessions fostered stronger bonds and enriched the caregiving experience by creating new channels for communication.

Figure 6.4 visualises the social interactions that surface across the two phases and types of VR sessions. It draws attention to the focus and level of interaction among people with dementia, family members, care staff and the HCI researcher, demonstrating how proximity, trust, and shared experiences influenced the changing dynamics between them. Solid arrows show active participation and engagement, while dashed ones depict weaker connection among agents.



Key: PwD= Person with Dementia; CS= Care Staff; HCI-R=HCI Researcher; FM= Family Member

Figure 6.4 Social Interactions and Engagement Flows in VR Sessions

As people with dementia started sharing more about their past experiences, valuable insights into their interests and life stories were uncovered, enhancing the quality of care provided. The VR sessions not only facilitated increased interaction and conversation but also furthered a more person-centred approach to care.

> *"I think it (VR) is really good; I think it's a valuable tool really because it's going to get conversations going…conversation that we wouldn't normally talk about… It's really good to do one-to-ones…*

More personal stuff… It's interesting to find out new things about our residents this way." [CS-3, F-2-F Session #2, Interview, P2]

Furthermore, care staff expressed that the VR sessions nurtured a sense of closeness with the people with dementia as they fostered increased conversations and permitted people with dementia to share more about their previous experiences. The VR sessions promoted mutual relationship-building between care staff and people with dementia, allowing both parties to understand one another better, leading to enhanced interpersonal relationships.

> *"I'd say they've (people with dementia) obviously got to know me more, and I've got to know them more, so it's kind of brought us closer together… So we could kind of talk to them about a lot more than you would have been able to before... it's definitely made us learn a lot about more about the resident, their interests and their life history. "* [CS-7, F-2-F Session #8, Interview, P3]

Similarly, people with dementia felt that VR facilitated a closer connection with care staff by allowing them to learn more about their personal history.

> *"She (CS-3) knows now exactly what I've done before… been through… What happened to my mum and my brothers… She helped me… She understands just how I have had to do just to get better*." [PwD-4, F-2-F Session #2, Interview, P2]

Additionally, the care staff noted that establishing rapport during VR sessions facilitated the cultivation of a deeper level of trust, owing to enhanced communication with people with dementia.

> *"It (VR) helped us build a new kind of trust between us and the residents because they're trusting you with something new… we could kind of talk to them about a lot more than you would have been able to before because what they're watching makes them want to talk and share... because they're trusting you with something new as well."* [CS-4, F-2-F Session #8, Interview, P3]

Also, care staff disclosed that they used the insights from VR sessions to initiate conversations with people with dementia during subsequent encounters, enabling continued engagement and communication.

> *"When I want a resident to talk a bit more about their travels or something of that sort, I base my approach to start a conversation referring to what they enjoyed in the VR session... I make mental notes of what they like in the video so I can use them later."* [CS-6, Virtual Session, Weekly Follow-up, P3]

The care relationship results of the quantitative measure (QUALIDEM-Carer) confirmed these observations (see Figure 6.5). Results indicated a notable rise in care relationships from the first session (M=13.83; Mdn=13.5; SD=2.86; MIN=11; MAX=16) compared to the last session (M=18.33; Mdn=18.5; SD=1.63; MIN=17; MAX=20), highlighting the positive impact of VR on the care relationship between people with dementia and care staff. This finding was further supported by a paired-sample t-test, which showed a statistically significant improvement in care relationships between the first and last sessions ($p < .001$), indicating that repeated VR exposure may help people with dementia and their care staff feel more connected.

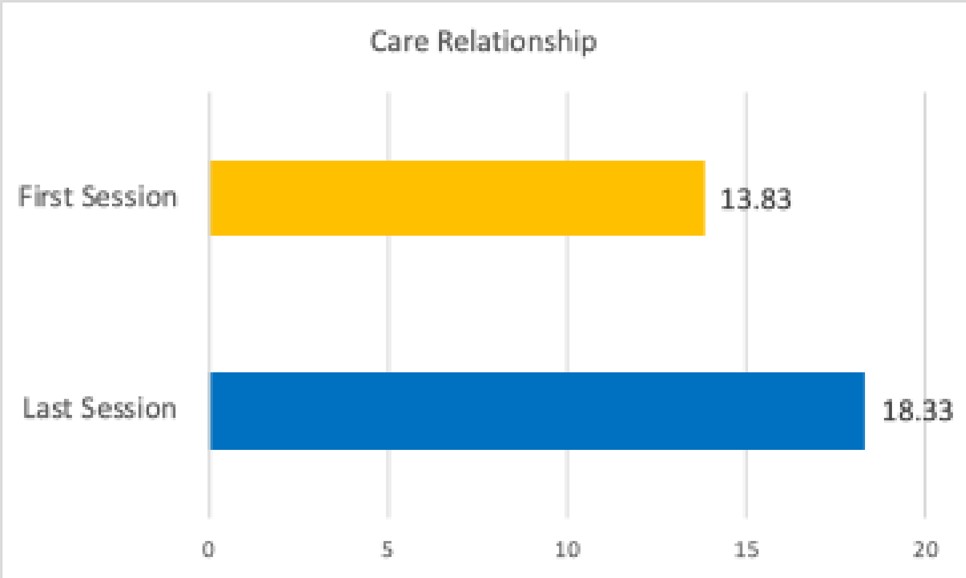


Figure 6.5: Care Relationship Scores from QUALIDEM-Carer

Frequently cited aspects of quality of care include staff attitudes and behaviour and staff trustworthiness (Malley & Fernández, 2010). While the QoL is subjective and is often related to residents' satisfaction with life, it includes interactions (Towers et al., 2021). As such, the quality of care and QoL for people with dementia can be profoundly shaped by the caregiving experience provided by staff. Consistent with the findings, a study conducted by (Adra et al., 2015) to construct the meaning of QoL in care homes stated that one of the domains that impact QoL included maintaining and developing relationships with care staff. Adra et al. (2015) highlighted that resident valued close bonds with care staff, while care staff viewed the significance of relationships based on the degree of reciprocity they experienced with their residents and the emotional connection they established with them.

6.2.3 Educational Tool: Understanding the Capabilities of People with Dementia

This theme explored the prospective benefits of VR in facilitating care staff's understanding of the capabilities of people with dementia. According to the care staff, the VR sessions revealed unknown competencies and attributes of people with dementia. The VR experience served as a prompt to reassess the capabilities of people with dementia in ways that differ from traditional assessments, such as passive observation or verbal reporting. Initially, care staff were astonished at how people with dementia were able to embrace the technology and enjoy it, as highlighted in section 5.2.2. There was a shift in their perception as they observed people with dementia exceeding expectations and adopting the technology. The care staff's reflections highlighted the transformative potential of VR experiences for people with dementia, challenging stereotypes and fostering surprise in enjoyment and engagement.

> *"I was quite shocked actually at how much they (residents) were engaged in it (VR), and they really did enjoy the session. They were transformed, and they were showing really positive behaviour to it. VR changed how we perceive the residents. Sometimes, we don't fully realise what they're capable of."* [CS-2, F-2-F Session #1, Interview, P2]

Furthermore, care staff noted that VR technology has given them a new dimension to their caretaking, as it broadens their understanding of people with dementia and how they evolve throughout the progression of the condition. VR was seen as a new tool to improve the care staff's ability to connect with and understand people with dementia on a deeper level.

> *"Through VR, I've learned more about some residents and their experiences and about their limitations and capabilities than other activities... It showed me that some residents have, not just from the point of view of the experience of their life but also their experience of dementia or their experience of getting older and how it has limited that sort of inquisitiveness and acceptance of what things are."* [CS-4, F-2-F Session #8, Interview, P3]

Moreover, care staff reported that people with dementia could recognise and interact with familiar landmarks presented in the virtual world. Surprisingly, care staff noted that these recognitions were not possible when previously presented in static images. This unexpected finding highlighted the potential of VR sessions to disclose previously unknown capacities among people with dementia, providing a window into their cognitive capability and expanding our comprehension of these capabilities.

> *"There was one resident who actually was saying: "Oh, that's Buckingham Palace". They actually recognised, which doesn't happen very often, quite a few of the London landmarks in the VR. Usually, if we showed them a picture of Buckingham Palace, most residents don't recognise it... The VR sessions illuminated a little bit of an insight into residents' capacity. They've got more capacity than I realised."* [CS-6, Virtual Session, Weekly Follow-up, P3]

Understanding dementia can enable care staff to deliver high-quality care that can diminish communication problems and improve relationship quality between the care staff and people with dementia (Jütten et al., 2018). Consistent with the findings, several studies underscored the feasibility of using VR interventions to educate care staff about dementia (Hicks et al., 2023; Jones et al., 2021; Wijma et al., 2018). The findings indicate that VR experiences can advance this experience to become an educational tool for care staff. The VR experiences provided a new insight into the capabilities of people with dementia, which could significantly impact the development of tailored care approaches and interventions, allowing care staff to perceive individuals with dementia from a different perspective.

6.2.4 Fostering a Positive Work Environment

It was evident through the findings that VR had the potential to promote a conducive and constructive work environment among the care staff at their job site. Through follow-ups and interviews, care staff highlighted the uplifting nature of the VR sessions. They reported enhanced job satisfaction and improved emotional well-being, attributing these benefits to observing the enjoyment and engagement that VR facilitated among people with dementia. Care staff used words such as "*heart-warming*", "*very positive*", "*lovely*", and "*good experience*" to describe the VR session and their accompanying emotional states while overseeing the residents' responses. They also reported feelings of appreciation when people with dementia showed signs of satisfaction, enjoyment and gratitude toward them during or after their VR experiences, such as “*Oh, that’s lovely!”* and “*It’s really amazing what you see!*”. At times, care staff received direct expressions of appreciation and gratitude, which enhanced their emotional connection. Such incidents promoted a positive work atmosphere among the care staff, leaving them feeling recognised and valued for their efforts.

> *"HCI researcher: Did you like (CS-1) being here with you? PwD-1: Oh yes, CS-1: That’s good (laughing), PwD-1: I wouldn’t do it without you, CS-1: Thank you, HCI researcher: How did [CS-1] help you? PwD-1: Just being with me, held my hand, I think (laughing), thank you, and thank you very much for doing it."* [PwD-1, F-2-F Session #1, Conversation during VR Session, P2]

Some care staff stated that the VR sessions made them feel fulfilled at work and happy because they shared meaningful experiences with people with dementia, especially while observing their reactions. Seeing the joy and contentment on the faces of people with dementia during the VR sessions can elicit similar sentiments in care staff.

> *"It (VR session) makes me feel really happy to see them (the residents) happy... heart-warming! I was quite happy with their responses*." [CS-1, F-2-F Session #2, Interview, P2]

Care staff revealed that they not only experienced an enhanced sense of wellness but also observed carryover effects outside the workplace, noting increased happiness at home after the deployment sessions.

> *"I feel happier when I go home after doing them (VR sessions) … I enjoy doing them with our residents… seeing them happy is really nice... It's lovely" [*CS-2, F-2-F Session #2, Interview, P2]

Furthermore, care staff reported that they have been sharing their positive feelings stemming from the sessions with their family members, extending the impact and significance of these sessions beyond the immediate caregiving setting.

> *"It is very interesting to see just how the VR can, at times, take a resident's anxiety away and see how they become so passionate about sharing past experiences. It has been really very pleasing to see our residents like that. I've been talking to my husband about the sessions and how they make me feel."* [CS-8, Virtual Session, Weekly Follow-up, P3]

Additionally, care staff disclosed that the VR sessions held a therapeutic significance for both them and people with dementia. As people with dementia enjoyed the VR experiences and shared stories about their past, the care staff felt grateful for being part of these unfolding memories, knowing they were contributing to improving the QoL for the people they cared for.

> *"These VR sessions became therapeutic for both parties, which made them friendly and comfortable in conversation with me. It feels like you became a close friend to them, which makes me so grateful I could give them comfort and joy... It feels so good to be able to share these moments together with them. The VR sessions gave me satisfaction."* [CS-5, F-2-F Session #8, Interview, P3]

Care staff in care facilities face high physical and psychological demands, leading to burnout (Costello, Cooper, et al., 2019; Fjelltun et al., 2009). These demands cause symptoms of depression and diminished mood as well, where interventions are needed to help decrease care staff stress and lessen the burden on healthcare resources (Donaldson et al., 1998). If not addressed, care staff stress can lead to high sickness, high absenteeism, high turnover, low productivity, and low job satisfaction (Islam et al., 2017). As such, the implementation of VR, based on the feedback from the care staff in this research, is a potential intervention to enhance the working environment of care staff to improve their overall well-being and job satisfaction. The findings align with a recent study by Shree Adhyaru & Kemp (2022), which demonstrated that VR could promote well-being and increase feelings of happiness among National Health Services clinicians. They also align with several studies, which showed that when care staff feel appreciated, they feel empowered, highlighting that their job is worth doing, making up for any difficulties and stressors encountered on the job (Foà et al., 2020; Moyle et al., 2003; Zimmerman et al., 2005).

6.3 Summary

This chapter describes the findings of the two phases, researcher-led and care staff-led VR deployment, of a comprehensive study investigating the deployment and engagement of care staff in co-leading and independently leading VR sessions in care facilities. The findings highlighted the crucial role of care staff in the physical and emotional safeguarding of people with dementia to ensure effective and secure VR sessions, starting with explaining what VR is to the latter. Furthermore, it was evident through the findings that VR has the potential to enhance the rapport between care staff and people with dementia by fostering broader and extensive conversation, providing a milieu for a deeper understanding of the latter's experiences. Moreover, the VR sessions allowed care staff to uncover the capabilities and attributes of people with dementia, changing their perception of this population. In addition, it was also clear that those sessions created a positive work environment for care staff, extending beyond their work facilities.

The next chapter will address findings related to the adoption of VR in organisations, emphasising the challenges hindering technology integration. Moreover, it will provide insights into technology acceptability, adoption, and the facilitation of adoption in dementia care settings.

Chapter 7: Adopting VR in Dementia Care Settings

The previous chapter (Chapter 6) explored the findings related to Virtual Reality (VR) deployment and the care staff's engagement with the technology. The chapter provided an overview of the care staff's implementation of VR in their care facility. It described the role of care staff in safeguarding the physical and emotional well-being of people with dementia. It also explained the potential of VR to improve rapport between care staff and people with dementia. Moreover, the chapter demonstrated the potential of VR as a tool to enable care staff to understand the capabilities of people with dementia and to enhance the work environment for the former.

To understand the processes involved in accepting and adopting novel technology in a multidimensional care setting, it is necessary to investigate organisational barriers and cultural dynamics. Merely acceptance of the technology may not guarantee its adoption and efficient deployment. Hence, this chapter will present the results from Phases Two and Three, research-led and care staff-led deployment, respectively, focusing on factors crucial for adopting VR technology in dementia care settings.

Although 6 care settings were identified as suitable for deploying VR during Focus Groups (FGs) and Discussion Rounds (DRs) in the Preliminary Phase (see section 3.5.1), two care setting managers withdrew from the trial, claiming increased staff workloads and burdens caused by COVID-19-related demands. Their primary challenges were scheduling care staff for VR session delivery and securing logistical and space requirements.

7.1 Findings

The findings discussed in this chapter aims to investigate the factors influencing the acceptance and adoption of VR technology in care settings, focusing on identifying barriers and facilitators. This was achieved by an inductive theme analysis. As described earlier, the audio recordings were transcribed verbatim, which allowed codes and themes to emerge naturally from the data. The data analysed included interview notes from people with dementia and care staff, including managers, weekly follow-ups with care staff, qualitative observation notes and quantitative measures. Where applicable, quantitative data were included in the findings to provide more insight into the themes and to substantiate the qualitative observations with measurable evidence. Consequently, the following 4 themes were identified:

i) Barriers to Technology Integration
ii) Acceptance as a Factor of Adoption: Insights through Technology Acceptance Model (TAM)
iii) Engagement as a Factor for Adoption
iv) Facilitating VR Adoption in dementia Care Settings

Table 7.1 provides a brief explanation of each theme.

Table 7.1: A Brief Explanation of the Themes

Theme	Key Focus of the Themes
i) Barriers to Technology Integration	Challenges such as institutional culture and logistical constraints affected the integration of VR.
ii) Acceptance as a Factor of Adoption: Insights through TAM	Stakeholders' perceptions of usefulness and ease of use influenced VR adoption, aligning with the TAM framework.
iii) Engagement as a Factor for Adoption	Active engagement of care staff and people with dementia supported the potential for VR adoption.
iv) Facilitating VR Adoption in Dementia Care Settings	Effective implementation of VR depended on support from managers and care staff, highlighting their key role.

7.1.1 Barriers to Technology Integration

This theme describes the findings related to the obstacles encountered in integrating VR at a managerial level. During the Preliminary Phase, where the foundation for this comprehensive study was laid through FGs and DRs (see section 3.5) care managers and the administration team of the care providers showed great interest in utilising VR in their care settings. However, integrating VR into the day-to-day practices of the care settings was a different matter. Challenges arose from the institutional culture of the settings, including staff and managers' perceptions of the suitability and benefits of VR for people with dementia. Despite participating in the kick-off meeting, FGs, and DRs in the Preliminary Phase, some remained sceptical about the rationale behind considering VR. Nevertheless, the testimonials and word of mouth from peer care managers who had overseen VR sessions and encountered comparable concerns, expectations, and challenges ultimately changed their opinion.

> *"Last week, CS-3 asked why I had not approached care home (X) to participate, given that many residents fulfilled the criteria. I explained that management had stated otherwise. Today, CS-3 informed me that after sharing their VR reactions, care home (X) agreed to permit VR deployment despite initially doubting its suitability despite having eligible residents." [Human-Computer Interaction (HCI) researcher's Notes, Data Collection, P2]*

Furthermore, it was anticipated that the care staff training would be challenging due to time constraints. For this reason, the aim was for it to be concise. Care staff commented they were happy about it and did not feel it took them away from their jobs for too long. Only 8 of the 17 trained care staff members could conduct VR sessions. Six care staff members withdrew due to a staff shortage at their care facility.

"CS-2: There should be a person responsible for the VR deployment other than caregivers… It's sad to say, but they don't have the time to sit down with them (people with dementia) for a long time… I don't think it's in their kind of day-to-day routine to kind of have time for activities as much as that." [CS-2, F-2-F Session #1, Interview, P2]

In addition, the other three care staff members withdrew because they could not manage the additional paperwork required for the study alongside their existing responsibilities and workload.

"I am finding it difficult to find time…I hated the paperwork. On top of our documentation, it was kind of an added pressure that I didn't need." [CS-9, Virtual Session, Weekly Follow-up, P3]

Unsurprisingly, securing the logistics for the VR deployment was a challenge. In the deployment plan set in the Preliminary Phase (see section 3.6) it was agreed that a private room was required within the care facility to conduct the VR sessions, with the cafeteria supplementing the former as needed during its occupancy. However, in such a busy and highly demanding environment, the care managers struggled to secure another location for conducting the sessions if the private room and the cafeteria were unavailable. Sometimes, they were unable to do so.

"When I arrived at the care home, I was surprised to find out that the designated private room was unavailable, requiring the VR session to be relocated. The alternative location lacked a reliable internet connection, resulting in rescheduling all the sessions for that day." [HCI researcher's Notes, Data Collection, P3]

An additional logistical issue pertained to scheduling conflicts with pre-existing activities for people with dementia. In care home settings, activities are typically planned a month in advance, making it impractical to arrange occasional VR sessions. Challenges arose during the VR sessions because the study commenced after the monthly activity schedule was established. These schedule conflicts impacted the consistency of VR sessions during the first month, as care staff had to balance pre-existing commitments with the new VR activities. To address this issue, the HCI researcher collaborated with care home staff to find feasible time slots that would cause minimal disruption to the established routine. Additionally, attempts were made to incorporate VR sessions into the regular activity programme for the following months, assuring a smoother implementation.

> *"We put it (the VR activity) on our June monthly activity list, so we had time to fit it in weekly...I think the sessions went well because we've been putting them into our activities list. So we're making sure that we get quite a few of them in every week... Planning ahead of time works really well to make sure that we get the sessions done... It's best to schedule them before." [CS-4, Virtual Session, Weekly Follow-up, P3]*

Figure 7.1 illustrates the impact of barriers on the progression of the research presented in this thesis.

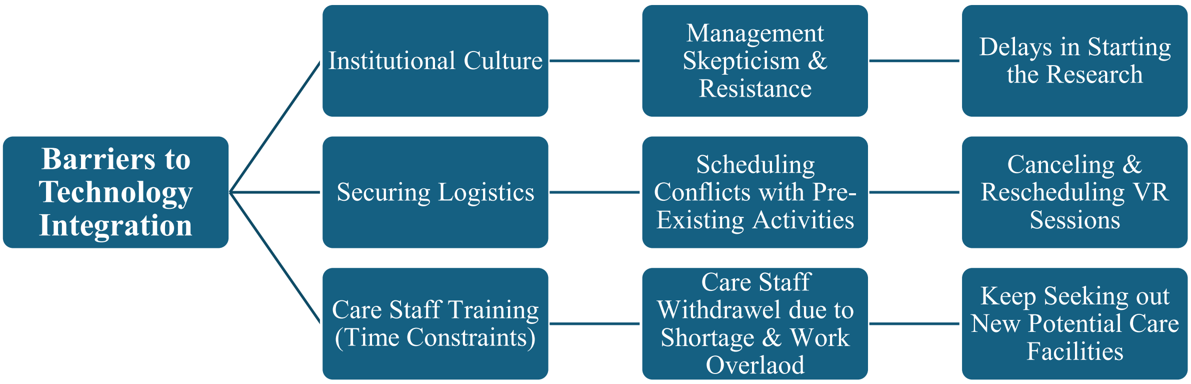


Figure 7.1: Impact of Barriers to Technology Integration on the Research Progression

Moreover, the technology integration by the care managers of 4 care settings was believed to be severely affected by the burden of logistics (i.e. location, staffing, etc.) required to arrange VR sessions. As such, it was found that the success of VR in being realistically deployed in dementia care settings relies on how well VR becomes embedded as part of the existing care plan for people with dementia, aiming to minimise the amount of preparation and logistics planning required to deploy VR. In an interview with CS-1, they proposed an idea of how VR could be harmonised within a fixed activity in their care setting for a better deployment consideration:

> *"CS-1: You can do sort of an activity based on one scenario, so for example, if we're having a theme about Mexico, we can have scenarios [referring to VR content]. I suppose it would become an activity that we are able to implement into our planners… It would be just another thing that we can add to our repertoire rather than the same things over and over again." [CS-1, F-2-F Session #1, Interview, P2]*

Despite the many potential benefits VR can offer people with dementia in long-term care, deploying such technology requires substantial organisational resources at various levels. This includes organising training sessions for care staff and managers to familiarise them with the technology's impact on people with dementia, thereby increasing acceptability and ensuring successful deployment. However, research reported that care staff in these settings experienced burnout due to excessive workload (Chamberlain et al., 2017). This issue greatly affects the feasibility of successfully delivering interventions in these facilities. Furthermore, long-term behaviour change improvement is another challenge at individual and organisational levels. The degree to which an intervention program or technology is integrated and maintained refers to whether it becomes part of routine practice or institutional culture (Glasgow et al., 1999). Given the limited resources in most care homes, primarily focused on delivering care and managing daily operations, effective planning and proper oversight are crucial. The findings align with previous literature recommending that introducing technology into care settings requires careful consideration of staff time and availability (Waycott et al., 2022). This is particularly important in dementia care settings where care staff are subject to substantial workload pressure and burden (Yamamoto-Mitani et al., 2002). Because of this, facilitating the successful deployment of VR technology in these settings involves addressing these challenges and seamlessly incorporating the technology into everyday practice.

7.1.2 Acceptance as a Factor of Adoption: Insights through TAM

Technology acceptance is the attitude toward technology (Renaud & Biljon, 2008). It could be considered a pre-adoption stage and is valuable for assessing the adoption possibility (Jia et al., 2015). As such, this theme explored key stakeholders' acceptance of technology based on TAM. TAM suggests two essential factors influencing users' attitudes toward acceptance of technology: Perceived usefulness and perceived ease of use (Davis, 1989). Perceived usefulness is the degree to which a person believes using a particular system would enhance their job (Davis, 1989). TAM has been successfully applied in qualitative research (Abbas Borhani et al., 2021; Sánchez-Prieto et al., 2014; Singh & Srivastava, 2019). Accordingly, organisations' motivation to adopt VR may be influenced by the positive outcomes of deploying the technology and its impact. Firstly, an essential aspect of the perceived usefulness of this technology, which motivates organisations to adopt it, is its impact on individuals with dementia. Positive experiences of people with dementia can influence organisational decisions since they demonstrate that VR technology is compelling and engaging. When people with dementia express enthusiasm and pleasure with VR, it provides persuasive proof that the technology can improve their Quality of Life (QoL).

This, consequently, can justify the investment in VR technology because the benefits go beyond functionality and include better emotional and psychological well-being. In this context, the findings in Chapter 5 (The Impact of VR on People with Dementia and Their Family Members) revealed that people with dementia found VR beneficial and enjoyable. Specifically, all people with dementia (n=17) expressed willingness to engage in additional VR sessions. They reported experiencing nostalgic recollections, resulting in a sense of joy. When PwD-6 was asked about their "castle" VR experience as per their request from a previous visit, they replied:

> *"PwD-6: It was a good experience, exciting experience. It is a nice feeling. I lived in a castle for five years during the war. It was a proper castle… This (the VR content) looks lovely, lots of trees … Nostalgic, yes, nostalgic… I feel contented. I would like to be there." [PwD-6, F-2-F Session #2, Interview, P2]*

When asked if they would participate in another session the following week, PwD-2 said, "*Yes, I would. Yes, indeed!"* expressing enjoyment and engagement in the VR sessions.

Secondly, another aspect of the VR's perceived usefulness that encourages organisational adoption is its impact on family members. Involving family members in caring poses considerable organisational challenges, mainly when geographical and time constraints limit their participation despite their willingness. However, family members' positive feedback regarding VR's potential to reduce burden and guilt (see section 5.2.6), particularly in facilitating virtual experiences, such as holidays with frail loved ones, highlights a compelling organisational motive to adopt this technology. This perceived usefulness underscores practical solutions and emphasises VR's emotional impact on improving the QoL and connectedness for both family members and people with dementia. Such adoption can correlate with organisations' goal of enhancing caring services and fostering a satisfying care experience, increasing organisational responsiveness to these demographics' emotional and practical requirements.

> *"FM-5: It (VR) could alleviate some guilt when you can't go on holiday, and you can't take your mother because they're too fragile… (You can) do some visits using virtual reality." [FM-5, Focus Group #2, P1]*

Thirdly, the care staff's perceived usefulness of VR can motivate organisations to adopt the technology. Chapter 6 (The Impact of VR on Care Staff) presented various ways in which VR has improved the well-being of care staff. Care staff reported VR increased their job satisfaction and contentment during the VR sessions and allowed them to gain deeper insights into the past and present experiences of people with dementia. Consequently, these encounters enhanced their emotional well-being and empathy towards people with dementia. Therefore, the positive perspectives and experiences of care staff can help to promote adopting VR technology in organisations. A more satisfied and well-supported staff will likely have lower turnover rates, resulting in stability and continuity of care within the organisation.

> *"It (VR session) makes me feel really happy to see them (people with dementia) happy... heartwarming! I learned a lot about the residents through VR. I learned about their past, travelling and their history, the expeditions they have been on, and even about who they went on holiday with." [CS-4, Virtual Session, Weekly Follow-up, P3]*

Also, care staff suggested that VR could benefit both themselves and people with dementia in their care setting. Care staff noted that VR provided novel and engaging experiences for people with dementia, indicating that such technology could stimulate cognitive function and elicit positive memories through immersive environments. Also, they disclosed that VR could potentially improve the QoL of people with dementia by allowing them to explore new experiences virtually. This can also serve as a driving force to encourage organisations to adopt the technology as it provides them with new care pathways.

> *"I think it's good for them to… try new things and see new things just like what happened with PwD-2; not only it (VR) took them somewhere but helped them to think back like reminiscing and stuff like that. I think people will enjoy it (VR) to make them feel like they've got more life. They can go places; they can see things that they don't always get to see." [CS-1, F-2-F Session #2, Interview, P2]*

Moreover, care staff reported that using VR can improve the services they provide for people with dementia, redirecting the latter's focus when they are distressed. This insight emphasises that deploying VR can improve care approaches for people with dementia. As a result, it can encourage organisations to adopt VR as it can potentially enhance their care interventions and quality.

> *"CS-10: Some of the behaviours that are difficult to manage when people are distressed… as using it (VR) as a kind… of refocusing people with dementia and kind of distracting them from what's going on." [CS-10, Focus Group #2, P3]*

Perceived ease of use is the degree to which a person believes that using a particular system would be free of effort (Davis, 1989).Throughout this comprehensive study, people with dementia were not responsible for setting up the system. Therefore, perceived ease of use might not be relevant in this context. After completing their training, most care staff reported that both operating and setting up the VR equipment were straightforward, indicating ease of use of the VR technology. When technology is regarded as easy to use, it suggests that limited training and support are needed, which can contribute to reducing costs and barriers to implementation and increase the probability of technology acceptance and effective integration into existing workflows in the organisation. Hence, these elements combine to make adopting such technology more appealing for organisations, as they expect a good return on investment and service without much interruption to their workflow.

> *"HCI researcher: Did you find the system complicated to use? CS-1: No, it was easy to set up; I know how to do it. CS-3: No, not once I get the hang of it… HCI researcher: Was it easy to use? CS-3: Yes, it was…Once you know your way of setting it up… using the App is easy." [HCI researcher, CS-1 & CS-3, F-2-F Session #2, Interview, P2]*

Family members' perspectives on the perceived ease of use of VR were favourable. They were provided two links to join the session remotely: one for a video conferencing platform and one for connecting to the Application. They reported that connecting to the links was smooth and straightforward, suggesting the technology's user-friendliness, especially since there was no need for additional learning or technical support. Remote VR sessions can be considered an extension of organisations' services, particularly since they improve accessibility between family members and their loved ones in care settings without requiring substantial technical knowledge or further training. This enhances operational efficacy, motivating organisational adoption.

> *"HCI researcher: How did you experience simultaneously setting up the video chat and VR links? FM-1: It was easy. HCI researcher: Were the instructions clear? FM-1: yes. HCI researcher: Did you face any problems using this? FM-1: No. HCI researcher: Did you have to learn anything to use it? FM-1: No. HCI researcher: Did you need technical support at some point? FM-1: I didn't." [HCI researcher & FM-1, Remote Session, Interview, P2]*

The relationship between technology acceptance and adoption in organisations is well documented in the literature (Rodić et al., 2023; Syed-Abdul et al., 2019), mainly through frameworks like TAM (Davis, 1989). This acceptance is critical because it is a prerequisite to actual adoption (Renaud & Biljon, 2008). When stakeholders within an organisation regard technology as beneficial and straightforward, their positive attitudes towards it grow, increasing adoption levels. Notably, implementing VR in a dementia care setting adds a new dimension to the caregiving experiences of people with dementia (Appel, Ali, et al., 2021), including their family members (Afifi et al., 2022) and care staff (Siriaraya & Ang, 2017). These benefits, highlighted in the findings, emphasise VR's transformative potential, which can encourage organisations to adopt this technology to improve their caring practices and overall operational efficiency.

7.1.3 Engagement as a Factor for Adoption

Engagement refers to the act of being occupied or involved with an external stimulus (Cohen-Mansfield et al., 2011). In the context of this comprehensive study, engagement with technology manifested in broader participation in VR as an activity and social interaction. It encouraged not only the participants with dementia but also other individuals with dementia around them to partake in VR sessions, where their emotional well-being was enhanced due to the VR experiences (see section 5.2.1). This theme examined the interaction of people with dementia with VR technology from various angles, drawing on the premise that engagement promotes organisational adoption. It investigated several aspects of engagement, interest, and participation in VR experiences to explore their potential impact on technology adoption on a managerial level in care settings. People with dementia showed enthusiasm in participating in the VR sessions. Through the observations and the feedback of care staff and people with dementia, it was found that people with dementia strongly desired to participate in the VR activity. The results of the quantitative measure, The

Engagement of a Person with Dementia Scale (EPWDS)- Behavioural Engagement, confirmed these observations (see Figure 7.2). EPWDS is measured on a 5-point Likert scale ranging from 1 (indicating strong disagreement) to 5 (indicating strong agreement), where the total score will range from 10 to 50 (Jones et al., 2018b). The positive behavioural engagement, including approaching, reaching out and handling the activity and the person/s involved (M=4.50; Mdn=5.00; SD=0.63; MIN=3; Max=5), was notably higher compared to avoiding, shoving away, or pulling back from the activity or the person/s involved (M=1.13; Mdn=1.00; SD=0.50; MIN=1; Max=3). However, a paired-samples t-test showed no statistically significant difference between positive and avoidant behavioural responses ($p = .054$); nonetheless, the result suggests a possible trend toward increased approach behaviour over avoidance.

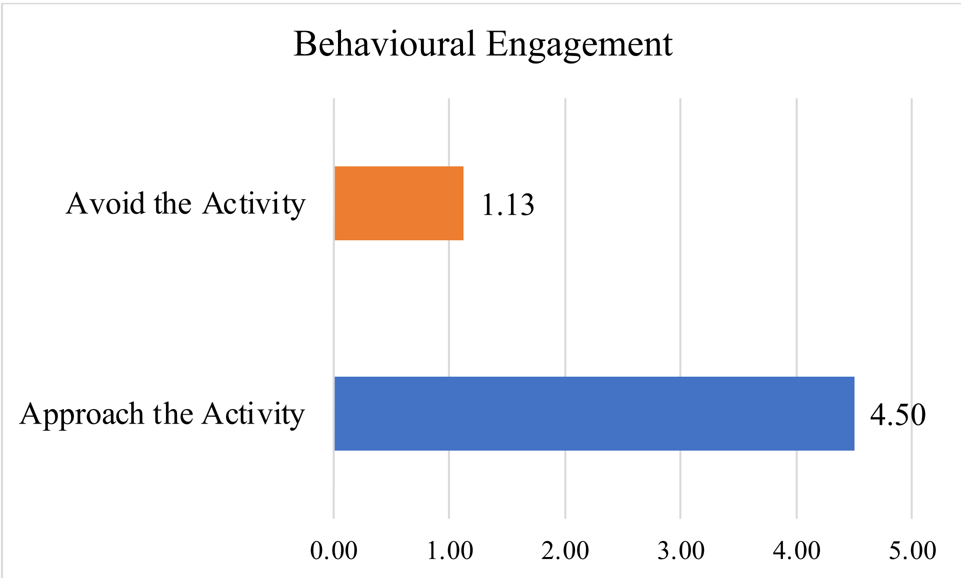


Figure 7.2: Means of EPWDS - Behavioural Engagement

In addition, after people with dementia had positive experiences with VR technology, they became advocates of the technology. They started promoting it to others. Care staff reported instances where people with dementia enthusiastically encouraged others to participate in a VR experience, highlighting the enjoyment derived from the experience. Therefore, deploying VR technology in dementia care settings can result in better resident outcomes and a more innovative and interactive care environment. As one care staff reported in a weekly follow-up meeting:

> *"I finished doing (name of resident X) session, then (name of resident X) started telling the (name of resident Y) that:" Oh, you need to try this, you really need to try this". So (name of resident Y) decided to try it and asked me to put the headset on for them. They were all, "Wow, wow! I like the sound of the rain and all that's very relaxing". They really enjoyed it." [CS-5, Virtual Session, Weekly Follow-up, P3]*

The findings from the quantitative assessment of the EPWDS focusing on Social Engagement corroborated these observations (see Figure 7.3). The VR sessions promoted social engagement among people with dementia. The ratings for using the VR experience as a communication channel to interact with staff and other residents were notably higher (M=4.56; Mdn=5.00; SD=0.63; MIN=3.00; MAX=5.00) than the ratings for distracting other residents and staff during the VR session (M=1.31; Mdn=1.00; SD=0.60; MIN=1.00; MAX=3.00). However, a paired-samples t-test showed no statistically significant difference in how people with dementia used VR to communicate with others compared to using it as a form of distraction (p = .191). Although not statistically significant, the result indicates that both social facets were present, without a definite dominance of one over the other.

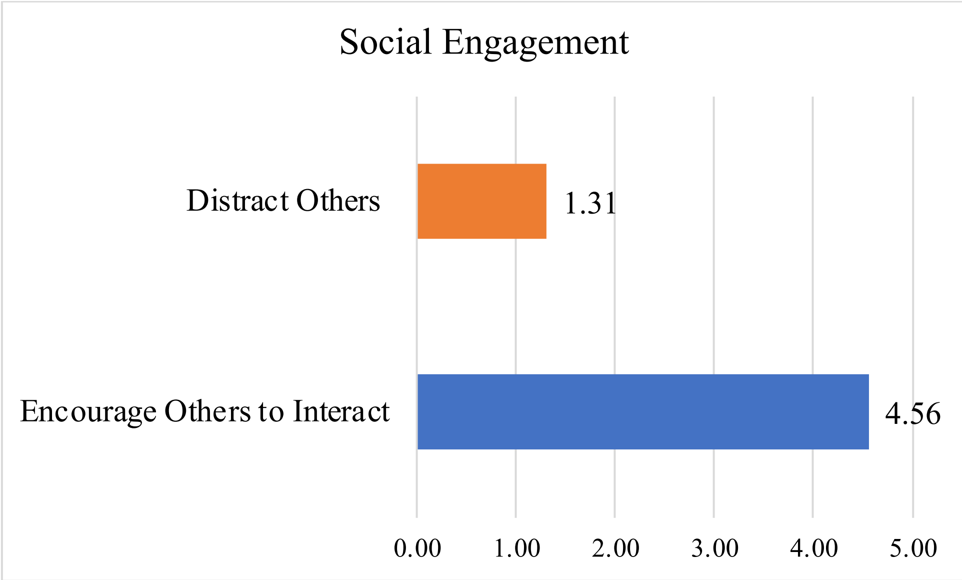


Figure 7.3: Mean of EPWDS - Social Engagement

Furthermore, people with dementia often asked when their next session would occur at the end of the VR experience, indicating a desire to maintain the interaction and continue the VR sessions. Their continuous interest and enthusiasm are indicators of the technology's appeal and effectiveness. This persistent demand underscores the potential for VR to foster long-term engagement and positive user experience, highlighting the technology's perceived value and making a compelling case for its use in dementia care settings. As a result, organisations can confidently adopt VR technology, knowing that it will be widely embraced and used. During the deployment sessions, some people with dementia began referring to the HCI researcher as the "VR lady" and consistently greeted her with joy whenever they encountered her in the care home surroundings, even if there was no scheduled VR session.

> *"HCI researcher: Thank you so much for your time this morning. PwD-4: That's alright, I had a good time. When are you coming back again? HCI researcher: Would you like to do this (VR session) again? PwD-4: Yes, I would love to do it again. When are you coming again? HCI researcher: I'm coming back in two weeks because you are going*

away to Scotland next week." [HCI researcher & PwD-4, F-2-F Session #2, Interview, P2]

Furthermore, as discussed in section 5.2.4, the VR experiences improved the social interaction of people with dementia, not only with the care staff but also among themselves. The VR content and experience gave people with dementia the opportunity to improve their dialogue with each other, fostering further engagement in the activity and social cohesion. Such improvements in social interaction and engagement contribute to better resident outcomes, greater pleasure among themselves and a more harmonious and positive care environment. Ultimately, these advancements can make adopting VR appealing to organisations, providing high-quality care. As one care staff noted:

> *"After watching the "cats" video, (Name of resident) said: "I used to have a cat. I had a black and white cat." They (a group of residents) started a whole conversation about pets which was carried on to describing their whole life... That situation opened the door to involve the rest of the residents in the conversation. They all carried on a conversation related to pets and to growing up around pets." [CS-5, f-2-f Session #8, Interview, P3]*

The quantitative measure EPWDS focusing on Verbal Engagement results confirmed these observations (see Figure 7.4). During the VR sessions, it was clear that VR enhanced the communication of people with dementia with each other through the high ratings for initiating, participating or maintaining verbal conversation (M=4.63; Mdn=5.00; SD=0.50; MIN=4.00; MAX=5.00) compared to refusing to engage in a conversation or verbalising negative comments related to the VR activity or the person/s involved (M=1.44; Mdn=1.00; SD=1.21; MIN=1.00; MAX=2.00). However, a paired-samples *t*-test revealed no significant difference in verbal engagement between active participation and refusal to engage (p = .596). Throughout the VR sessions, these behaviours manifested at similar levels.

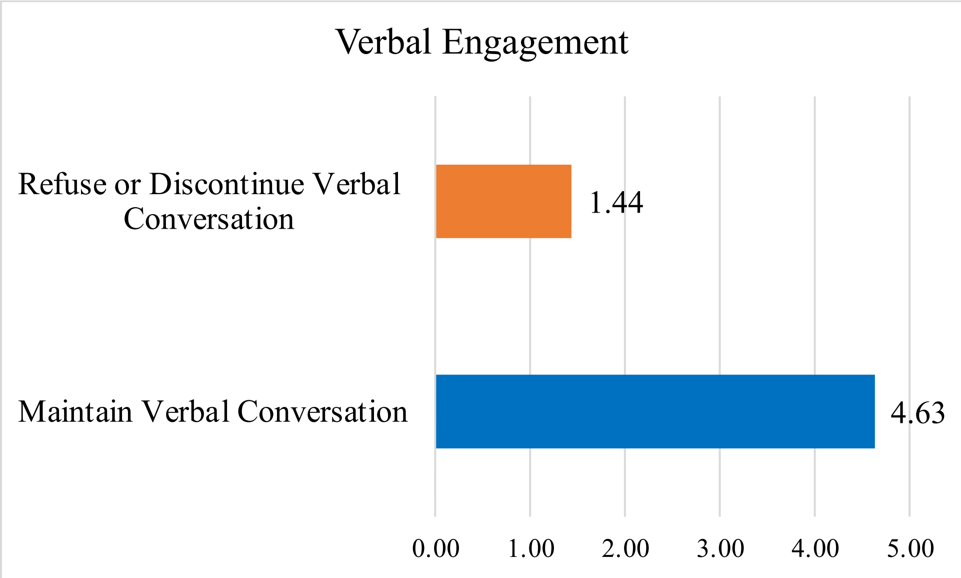


Figure 7.4: Mean of EPWDS - Verbal Engagement

Moreover, people with dementia experienced pleasure and satisfaction from participating in VR sessions. They enjoyed not only the experience itself but also the VR content. They also enjoyed chatting with care staff and other residents before and after the exposure, particularly during group sessions. All people with dementia reported "*having fun"* during the session and found the experience relaxing. Care staff noted that people with dementia seemed happier after the VR exposure. Participating in the VR experience elicited positive feelings and enhanced the mood of people with dementia by providing them with personalised content, contributing to reminiscence. These findings suggest that engaging in VR sessions can improve residents' overall well-being, foster social interactions, and create a positive environment within the care facility. Hence, VR technology can be valuable for organisations seeking to increase resident satisfaction and care quality. As one person with dementia noted in an interview, highlighting their experience:

> *"Well, you could see, you know, things you wouldn't see like a walkway, so it's very amazing… It was nice to see the walkway. Well, I don't watch much TV now, but that (VR) was exciting… It was fun. It brought nice memories, the woods especially. It reminded me of the walks we had during the war. I had a lovely time." [PwD-2, F-2-F Session #1, Interview, P2]*

The quantitative measure EPWDS focusing on Affective Engagement results confirmed these observations (see Figure 7.5). During the VR sessions, people with dementia displayed high positive affect rates, such as pleasure, contentment or excitement (M=4.38; Mdn=4.5; SD=0.81; MIN=2.00; MAX=5.00) compared to those displaying negative affect, such as apathy, anxiety or sadness (M=1.50; Mdn=1.00; SD=0.82; MIN=1.00; MAX=4.00). Despite the difference between positive and negative affective engagement was not statistically significant ($p = 1.000$), the continuously increased positive affect levels imply that VR sessions may contribute to more uplifting emotional experience. The lack of statistical significance is likely because of the small sample size or consistency in responses. This result suggests that participants generally displayed both emotional response types at similar levels.

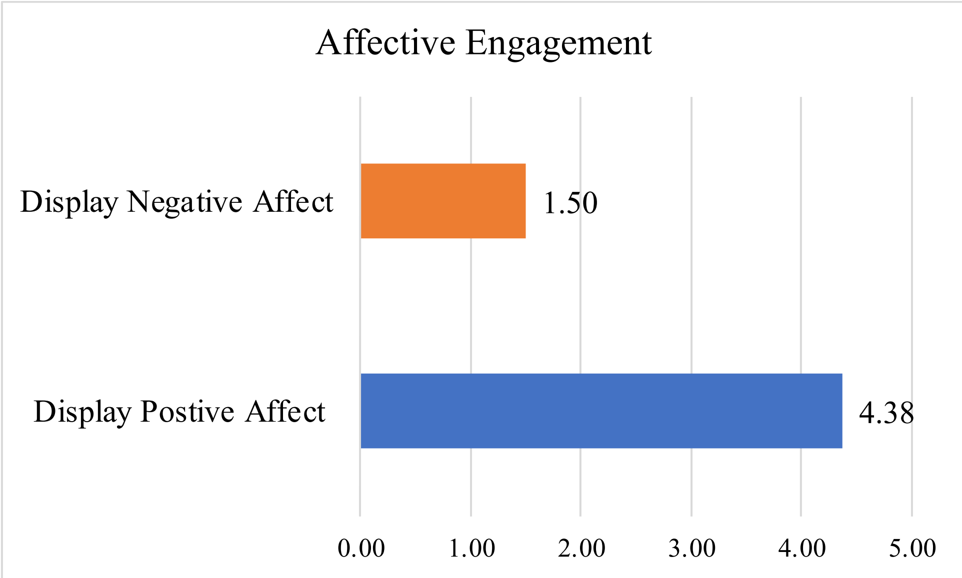


Figure 7.5: Mean of EPWDS - Affective Engagement

Adopting new technology depends solely on behavioural, psychological, and emotional engagement with the product (Hussain et al., 2019). People with dementia living in care homes tend to have a low rate of engagement in activities and sleeping (Smith et al., 2018); thus, increasing engagement is essential. Engagement supports well-being by encouraging individuals to feel good about themselves, brings meaning to their lives, helps them feel a sense of belonging and provides opportunities for using their skills (Jones et al., 2018b). Engagement in VR is unique in dementia settings because it offers immersive, enjoyable experiences, providing people with dementia with customised, interactive experiences tailored to their preferences. It is also important to note that, unlike traditional activities, the distinctively performative (i.e. virtual gardening (Siriaraya & Ang, 2014)) and social (i.e. use of avatars in social VR (Baker et al., 2019)) nature of VR permits people with dementia to participate in virtual worlds that imitate real-world situations, travel experiences, and social interactions, resulting in a sense of fulfilment and pleasure. The findings indicate that not only people with dementia but also care staff demonstrated considerable engagement with the VR technology, suggesting the potential for beneficial adoption of VR in these care settings. As such, the observed engagement ought to motivate organisations to adopt the technology as part of the activities they provide their residents as they improve outcomes and satisfaction for both people with dementia and care staff.

7.1.4 Facilitating VR Adoption in Dementia Care Settings

For a dementia care facility to adopt VR technology, it is essential to consider key factors influencing the adoption within this specialised environment. As such, this theme explored the optimal deployment variable of such adoption to ensure its successful implementation. It was found that a key factor that can impact VR adoption in dementia care facilities is keeping managers informed and involved in the process, which can give valuable support to their staff members, monitor progress, and handle any concerns that develop promptly. Management involvement not only makes implementation go more smoothly but also confirms the organisation's commitment to new technologies and supports their staff members. This proactive strategy can increase care staff involvement and confidence in adopting the technology, resulting in its long-term integration into care routines. Plus, continual management support can develop a culture of innovation and receptiveness to the new technology, which is critical for improving care practices and staff satisfaction and retention in care homes. During the first week of the VR deployment sessions, a care staff member requested to add their manager to the WhatsApp group created to provide technical support, discuss concerns and collect weekly data (see section 4.2.5.3) after a miscommunication incident regarding scheduling VR sessions. This request emphasised the importance of communication and managerial engagement in effectively implementing new technology and supporting staff members throughout the process.

> *"Thank you for adding me to the group and for clearing this matter (name of the HCI researcher). We have a very hardworking team at (name of the care home) who dedicate themselves to all challenges." [MGR-1, Virtual Session, Weekly Follow-up, P3]*

Another key factor impacting VR adoption in these care settings is the cost-effectiveness of the technology. When considering adopting technologies, solutions, or interventions within dementia care, it is crucial to ensure that these solutions are cost-effective and do not add to the existing financial burdens of caring for people with dementia (Sayma et al., 2020). The financial challenges are already substantial, given the rapid increase in the number of people with dementia (J. H. Kim et al., 2021) and the extensive care requirements for individuals who often lose sensory, cognitive, and motor skills (Appel et al., 2020). Therefore, to convince decision-makers in dementia care settings of the value of VR technologies, the benefits of VR must be quantified in such a way that they clearly outweigh the costs (Sayma et al., 2020).

During the Preliminary Phase, the directors and managers highlighted that the main motive behind joining this research was to enhance the QoL of people with dementia. As such, when the VR technology was introduced at the kick-off meeting (see section 3.3) the HCI researcher presented the various studies which have identified the multiple benefits of VR that could be linked to an improved QoL such as improving mood and promoting positive well-being (Afifi et al., 2021, 2022; Rose et al., 2021; Tabbaa et al., 2019; K. Thach et al., 2020), reducing social isolation (Eghtesadi M, 2020), increasing social connectedness and social interaction (Siriaraya & Ang, 2019) and offering a stimulus for the cognition of people with dementia (Caggianese et al., 2018; Garcia et al., 2012; Preston & Padala, 2022). However, one aspect that might have yet to be previously considered is the difference between measures of success in research and the measures of success in the eyes of care management. Predictors of success are assessed by care managers who focus on identifying a multifaceted contribution of an intervention within their setting (Kelley et al., 2020). In that case, it is vital to map the benefits of VR found in the body of literature onto the same measures care managers use in evaluating other activities and interventions in the care plans of people with dementia.

It was also found that care staff naturally developed peer system support when they encountered technical challenges during the sessions. This system allowed them to pair up to conduct the VR sessions jointly. By working in pairs, care staff provided mutual assistance and support to overcome these challenges, resulting in smoother and more practical sessions. This teamwork approach to conducting the VR session also provided care staff with enjoyment. As such, conducting the sessions in pairs led to better outcomes. This finding highlights the necessity for training sessions to be group-based rather than individually based, enabling care staff to identify who has received training and thus promote collaboration.

> *"It still takes me about half an hour to set it (the system) up, but when (name of care staff member) is here, they help me out, and we do it faster together... Last Friday, they were here, and it was easier when we did it together and fun. This week, it was much, much easier with two care staff members doing the sessions... we sort of subdivided the tasks a little bit between us." [CS-6, f-2-f Session #8, Interview, P3]*

Their collaboration not only enabled more manageable and more efficient session execution but also increased their confidence in dealing with any possible issues.

> *"(Name of care staff member) and I prepared for the VR session together and did them together... much easier and quicker. We feel more confident when we do that... because we worked as a team on*

this session, no challenges before, during or after." [CS-5, Virtual Session, Weekly Follow-up, P3]

VR is now increasingly recognised as a technology that has the potential to support people with dementia (Riaz et al., 2021). To enrich their VR experiences, it is recommended that care staff and managers be considered significant collaborators in implementing these experiences and that their recommendations be considered when implementing VR sessions in dementia care facilities. For a practical implementation of the technology within such facilities, it is essential to understand the organisation's structure and views of care staff on the new technology (Cavenett et al., 2018). For example, Hicks et al. (2023) stated that the care staff's feedback regarding evaluating VR was sought to provide Alzheimer's Research UK with more insights into improving or extending the virtual scenarios, funding permitted, as well as a greater understanding of the feasibility and acceptability of using the technology. In line with the findings, several studies have highlighted the essential role managers (Juul et al., 2019; Miller et al., 2023; Nilsen et al., 2020) and care staff (Chaze et al., 2022; Hung et al., 2023; Tabbaa et al., 2021) play in technology adoption in such care settings.

7.2 Summary

This chapter illustrated the findings on VR adoption considerations when implementing the technology in dementia care settings. It defined the obstacles to technology integration, such as institutional culture and securing logistics. Furthermore, it discussed key stakeholders' perceptions of technology acceptance using the TAM, focusing mainly on the perceived usefulness and ease of use. Moreover, it investigated the role of engagement as a factor in technology adoption within dementia care facilities. Also, it highlighted key factors to facilitating VR adoption in these settings to ensure a successful implementation, such as the active and direct involvement of managers and care staff and the cost-effectiveness of the technology.

In the next chapter, the overall findings from chapters 5, 6, and 7 will be discussed, demonstrating their significance in the context of existing research. Recommendations for future research endeavours will also be presented at the end of the chapter.

Chapter 8: Discussion and Conclusion

Around 55 million people worldwide live with dementia, a progressive and incurable condition marked by cognitive decline, memory loss, and behavioural changes (see section 2.1.2). While pharmacological treatments exist (see section 2.1.4.3) their side effects make them unsuitable for everyone, highlighting the need for alternative interventions. Virtual Reality (VR), a promising non-pharmacological approach (see section 2.1.4.4) has shown benefits for people with dementia, particularly in long-term care settings (see section 2.5.1, 2.5.2). However, deploying VR requires meticulous preparation, proper infrastructure, staff training, and evaluation of residents' needs and safety.

This thesis investigates the opportunities, issues, and challenges of designing and deploying VR in dementia care, focusing on technical and logistical requirements, stakeholder perceptions, and their impact. Considering the scope of a single PhD thesis, the research addressed specific gaps in the literature, presenting a three-phase comprehensive study exploring VR independent implementation in dementia care. The Preliminary Phase gathered the perspectives of healthcare professionals and family members on ethical considerations, session facilitation, suitable content, and feasibility. Phase Two examined multi-dimensional design issues of VR deployment where sessions were led by a Human-Computer Interaction (HCI) researcher (author of this thesis). Phase Three explored care staff-led VR implementation and its implications. Findings were structured to address stakeholder perspectives (Chapters 5 and 6) and VR adoption in dementia care settings (Chapter 7).

This chapter summarises and discusses the findings from the three-phase study conducted in the framework of this PhD and attempts to illustrate how VR can be independently deployed in dementia care settings, taking into consideration key stakeholders' perspectives. Afterwards, the implications of the work done in this thesis are presented, including limitations and potential directions of future research. Table 8.1 summarises the main characteristics of the three phases carried out in this thesis.

Table 8.1: Details of the Studies Carried out in this Thesis

Study Phase	Investigating the contextual dynamics & requirements of deploying VR in dementia care settings (The Preliminary Phase)	Researcher-led VR deployment (Phase Two)	Care staff-led VR deployment (Phase Three)
Objectives	1) Evaluate the status and methods of deploying VR in dementia care settings. 2) Investigate key challenges and opportunities in deploying VR in such settings. 3) Explore factors influencing VR acceptance and adoption.	1) Investigate how to deliver engaging VR experiences to people with dementia. 2) Explore how VR can support family members remotely. 3) Identify care staff and managers' VR adoption concerns. 4) Investigate how VR can be better designed, considering key stakeholders' perspectives.	1) Investigate the feasibility, opportunities, and challenges of care staff implementing VR independently. 2) Explore how VR impacts the emotional engagement of people with dementia and care staff. 3) Explore whether VR can promote well-being and elevate mood in the longer short term.
Method/s	Qualitative Study	Mixed methods design study	Mixed methods design study
Approach	Analysis of data collected in focus groups, discussion rounds and HCI researcher's notes	Analysis of semi-structured interviews, observation notes and quantitative measures	Analysis of semi-structured interviews, weekly follow-ups and quantitative measures
Analysis	Thematic analysis	Thematic analysis and Excel-based quantitative analysis	Thematic analysis and Excel-based quantitative analysis

<table>
<tr><td>Sample Size</td><td>- Kick-off brainstorming meeting with 9 participants from Avante Care & Support
- 5 focus groups with 19 participants
- 13 discussion rounds with 17 participants</td><td colspan="2">- 6 people with dementia
- 4 family members
- 3 care staff</td><td>- 11 people with dementia
- 5 care staff</td></tr>
<tr><td>Order of Findings</td><td>Chapter 3- Key outcomes and deployment plan</td><td colspan="3">- Chapter 5: The Impact of VR on People with Dementia and their Family Members
- Chapter 6: The Impact of VR on Care staff
- Chapter 7: Adopting VR in Dementia Care Settings</td></tr>
<tr><td>Main Findings</td><td>- The selection of care facilities.
- The exclusion and inclusion of people with dementia.
- The training of care staff and the toolkit.
- The selection of the VR equipment, App and content.
- The crafting of the deployment plan.</td><td>Chapter 5
- VR can improve the emotional well-being and mood of people with dementia.
- VR can alleviate apathy.
- VR can enhance the Quality of Life (QoL) for people with dementia by supporting person-centred care and preserving their personhood.
- VR can promote social connectedness among people with dementia.
- VR can offer a shared and interactive experience for people with dementia and their family members, enriching conversations.
- VR can allow family members to care for their loved ones virtually, reducing feelings of guilt.</td><td>Chapter 6
- Care staff are crucial in safeguarding the emotional, physical and contextual well-being of people with dementia while implementing VR.
- VR can enhance the relationship between care staff and people with dementia.
- VR can enable care staff to understand the capabilities of people with dementia better.
- VR sessions can contribute to fostering a positive work environment for care staff.</td><td>Chapter 7
- Institutional culture and securing logistics are the main barriers to integrating VR in dementia care settings.
- Key stakeholders' acceptance of VR technology can be a factor in adopting the technology.
- Engagement with the technology can be another factor of adoption.
- Managers and care staff within a care facility play a crucial role in successfully implementing the VR technology.</td></tr>
</table>

8.1 Research Questions Addressed

Overall, this thesis has addressed four research questions:

- *Considering key stakeholders' perspectives and organisational contexts, what are the multi-dimensional factors of VR technology acceptance in dementia care settings?*

The first research question was addressed in Chapters 3, 5, 6, and 7. It was found that the following 7 key factors impacted technology acceptance: a) Streamline Technology, b) Appealing and Suitable VR Content, c) Family Members' Involvement, d) Training Content, e) Care Staff Confidence, f) Guarding Serene VR Experiences, g) The Ripple Effect and h) Quality Enhancement in Dementia Care.

a) Streamline Technology

Designing intuitive and straightforward VR solutions facilitated technology acceptance, as detailed in Chapter 3. This result is consistent with the literature, highlighting the importance of selecting the right kind of simple VR system for staff (Miller et al., 2023) and the value of an easy-to-set-up VR system (Tabbaa et al., 2019). The simple VR design includes a system that is easy to install, use, and maintain, requiring minimal technological knowledge and limited training. These features minimise the complexity of operating the system, encouraging the care staff not only to use the technology but also to integrate it into their everyday activities.

Furthermore, stakeholders' positive experiences with VR, including their awareness of VR's potential to improve facilities' service and care outcomes, played a role in technology acceptance, as detailed in Chapters 4, 5 and 6. Also, family members and care staff noted that the technology was user-friendly. These findings are consistent with the Technology Acceptance Model (TAM) principles, which indicate that perceived usefulness and ease of use are critical factors in an individual's acceptance of new technologies (Davis, 1989). The user-friendly system in this context primarily encompasses the pre-configured hardware (i.e. setting up in advance VR headset to ensure easy use with necessary settings like display calibration, Wi-Fi connectivity, and application installation already carried out, reducing the need for extra user setup.) and preloaded software (i.e., installing the VR application in advance on the VR headset to ensure that the system is ready for immediate use, including access to preloaded VR content requiring no additional effort from users), and clear, straightforward instructions to follow. These elements can not only promote a smooth user experience but also lessen the need for further learning and continuous external technical support.

b) Appealing and Suitable VR Content

The design of VR content is crucial for its acceptance by people with dementia. Chapter 5 findings indicate they were likelier to enjoy motion-based, virtual interaction and narration material. Other studies have investigated designing engaging VR content, particularly for people with dementia, as it improves the experience outcomes (Morrissey et al., 2017; Moyle et al., 2018). For example, Siriaraya & Ang (2014) reported that people with dementia were more engaged with ludic experiences that employed bright and contrasting colours and experiences with stimulating visual and sound effects that involved numerous sensory modalities. However, this finding broadens the understanding of designing engaging VR content for people with dementia. It provides novel insights, demonstrating that people with dementia showed an increased acceptance when the content included motion-based components, which boosted liveliness and led to a sense of reality and authenticity. Interaction with virtual humans created a sense of connection with the content and social presence, while narration provided meaningful context to the experience. These elements jointly improved engagement, enjoyment and satisfaction by offering sensory stimulation.

c) Family Members' Involvement

Family members' involvement in VR deployment could boost technology acceptance among participants with dementia. VR experiences have contributed to alleviating family members' feelings of guilt and facilitating positive interactions, nurturing trust between them and care staff. These insights could improve family members' technology acceptance by increasing transparency, communication, and reliability between them and the care staff.

These results align with previous research, which noted that increased family involvement was essential to residents and directly linked to improved QoL; such involvement could also enhance the quality of staff-family relationships and preserve their loved one's identity (Gaugler, 2010; Gaugler & Mitchell, 2022). Good relationships and positive interactions increase residents' QoL and the Quality of Care (QoC) as they allow information-sharing, open communication, better collaboration, and person-centred care. Such an enriching environment helps avoid misunderstanding and staff-family conflict, which could lead to dissatisfaction with care services and emotional support for all parties.

The results also align with previous studies, which demonstrated the impact and influence of family members on their older loved ones' technology acceptance (Arntzen et al., 2014; Luijkx et al., 2015; Peek et al., 2016). Dementia often leads to overwhelming emotional encounters for those living with the condition, particularly when faced with new experiences such as engaging with an unfamiliar technology. The acceptance of such technology by a family member can ease these overwhelming feelings and reduce anxiety, encouraging the individual with dementia not only to accept the technology but also to feel safe using it.

d) Training Content

Care staff training sessions, supplemented with a toolkit, contributed to increased technology acceptance, as detailed in Chapter 6. The training addressed VR deployment aspects, such as VR's technicality and physical safety considerations. Furthermore, it was essential to make the care staff aware of VR's benefits for people with dementia in these sessions. Educating staff on these benefits could reduce misconceptions about the technology deployment in dementia care settings and allow them to understand the added value this technology could bring to these settings. When care staff realise that VR could contribute to their residents' emotional, cognitive, and social well-being, they would be more inclined to accept it, promote its use, and include it in their care routines. The findings align with several previous studies, emphasising the crucial impact of training sessions on care staff (Hung et al., 2023; Miller et al., 2023; K. S. Thach et al., 2020). A study by (K. Thach et al., 2021) aimed at developing VR guidelines in residential aged care highlighted that training care staff to facilitate VR experience and raising awareness of the technology's benefits were essential for enhancing their acceptance.

e) Care Staff Confidence

Care staff confidence in deploying VR technology was essential to the sessions' success and technology acceptance, as detailed in Chapter 6. Effective technology management, engaging session delivery, and participant assistance increased acceptability among care staff and residents, emphasising the need for training and continuous support to build confidence. Hogan-Murphy et al. (2021) stated that the key barriers to a system implementation included inadequate training, organisational support and the need for ease and confidence in system use. In the context of training care staff in dementia care, confidence is an essential outcome, as it provides them with strategies and practical tools that can be directly applied in their settings (Palmer et al., 2014). The findings, supported by earlier research (Gong et al., 2004), indicated that confidence in using a new technology enhanced its acceptance, as it impacted users' perceptions of ease of use and usefulness, which were crucial factors in accepting such a technology. However, a distinctive aspect of this finding was implementing various strategies to enhance care staff confidence. The process started with rigorous training, where additional sessions were offered to them as needed based on their technical proficiency. This was followed by a mock session where care staff delivered VR sessions to their peers, after which they received feedback from the HCI researcher on improving their delivery. Before delivering the sessions to people with dementia, they were encouraged to familiarise themselves further with the system and equipment. Finally, care staff were offered continuous remote support when needed, allowing them to resolve any concerns or technical difficulties in real-time and making them feel more prepared and secure in handling technology. This support system reassured them in the face of problems and instilled a sense of mastery and competence, resulting in smoother and more successful VR experiences for persons with dementia.

f) Guarding Serene VR Experiences

The findings in Chapter 6 underscored that safeguarding the physical and emotional well-being of people with dementia is vital for technology acceptance. Familiar care staff, wireless VR headset and tailored VR content were crucial for ensuring stress-free sessions and reducing distress. Consistent with prior studies, it is essential to address safeguarding issues when working with people with dementia (Ajeet Gokani et al., 2024; D. Flynn et al., 2003; Lawrence & Banerjee, 2010). Coldham & Cook (2017) noted that adapting the VR system to meet the needs and preferences of elderly users increased its likelihood of acceptance. Similarly, Ijaz et al. (2019) emphasised that creating a stress-free VR experience improved the acceptability of this technology. For this to be achieved, it was uniquely found that several measures needed to be implemented across the three phases of this research. Firstly, establishing the appropriate selection of care settings, people with dementia, and care staff. Secondly, confirming the suitability of technical aspects of VR content and its variation. Thirdly, considering mindfully the history of a person with dementia when designing or selecting the VR content. Fourth, including a protocol to manage the distress of people with dementia. Fifth, ensuring that participants with dementia were seated during the VR sessions on a sturdy chair.

g) The Ripple Effect

People with dementia's engagement and positive experiences with the VR system were key factors in its acceptance and adoption in care settings. During sessions, word of mouth involved people with dementia, recommending others to try it based on their positive experiences. The system incidentally enriched their dialogue and social interactions with residents, care staff and family members. It acted as a conversation medium, encouraging them to share their experiences and promoting it to others. Technology acceptance is the cornerstone of any technology implementation. Some HCI communities investigated how engagement influenced acceptance (Djabelkhir et al., 2017; Eppes et al., 2023; Khosla et al., 2017), while others investigated the reverse relationship (Gulliver et al., 2021; Perski & Short, 2021). Additionally, social dynamics in acceptance within the ageing population highlight the importance of support (Peek et al., 2016).

Nevertheless, the relational dimension of technology acceptance among people with dementia is often overlooked. Limited research has explored the impact of people with dementia on each other to promote VR technology inside care settings. An unexpected insight revealed by the findings of this research was that word of mouth, driven by the social dynamics among people with dementia after a meaningful engagement with VR technology, improved technology acceptance in these care settings. The spontaneous communication among residents caused a ripple effect that boosted their interest and participation in VR sessions. In this context, the residents acted as motivating agents within their social group, where informal peer recommendations played a vital role. Unlike conventional top-down approaches to technology implementation, this peer-driven social assurance fostered trust and acceptance of VR technology.

Moreover, this acceptance factor involved a second aspect. As the care staff noticed the positive reactions, enthusiasm, and social dynamics among people with dementia, they became motivated to conduct additional sessions. Witnessing firsthand how VR could enhance the social and overall well-being of people with dementia, care staff realised the value and benefits of VR in their care setting, encouraging them to accept the technology and also to deploy it.

h) Quality Enhancement in Dementia Care

Integrating VR technology in dementia care facilities improved the QoC and services for residents, family members, and care staff. VR promoted meaningful engagement for people with dementia, reduced family members' guilt while building trust with care staff, and improved care staff's emotional well-being and job satisfaction, as described in Chapters 5 and 6. Collectively, these outcomes demonstrated VR's potential as a valuable tool in dementia care, enabling greater technology acceptance within organisations.

Several studies have examined the QoC issues in care settings, focusing on factors that impact QoC (Bökberg et al., 2017; Geletta, 2013; Harrington et al., 2001). The findings encompassed ward characteristics (i.e. type and size), staffing ratio (Kirkevold & Engedal, 2006), outcome indicators (i.e. hours per resident per day) and process indicators (i.e. accessibility and content of protocols on care delivery) (De Boer et al., 2017). Job satisfaction (Moyle et al., 2003) and ongoing care staff training (Trinkoff et al., 2017) were also highlighted as influencing QoC. However, to the knowledge of the author, no other studies have explored the impact of VR on QoC in dementia care. This research uniquely showed VR's potential to advance QoC, improve services, and contribute to the organisation's acceptance of technology due to its tangible benefits. Capturing and communicating these QoC improvements would be critical to ensure widespread acceptance of VR. For example, enhancements in residents' emotional well-being or social connectedness with others should be recorded frequently using validated measures, such as questionnaires or observational checklists. These records should be reported to managers to guide future care plans and activities, to family members to facilitate comfort and to people with dementia to promote engagement.

- *How can VR impact the QoL of people with dementia, and what are the potential opportunities and positive effects, particularly from their perspective?*

The second research question was addressed in Chapters 5 & 6. This research showed that VR positively impacted the QoL of people with dementia through the following mechanisms: a) Fostering Emotional Elevation, b) Creating Interactive and Meaningful Conversation, c) Promoting Interpersonal Connections, d) Enhancing Person-Centred Care, and e) Stimulating Interest.

a) Fostering Emotional Elevation

The findings indicated that VR experiences could lead to positive outcomes in the overall emotional well-being of people with dementia, including those who were bedridden. VR experiences could shift their mood, reduce anxiety and help maintain the attention of this population. Their positive reactions were observed through their body language and verbal and non-verbal expressions.

Several studies have demonstrated the positive impact of VR on the overall emotional well-being of people with dementia (Cheung et al., 2023; Cho, 2018; Lin et al., 2018b), including positive verbal responses (Chaze et al., 2022). For example, in a study to explore the beneficial influence of VR, Appel et al. (2020) stated that people with dementia experienced increased levels of positive emotions (such as feeling relaxed and content) and decreased levels of negative emotions (such as feeling sad or anxious) after VR exposure. However, to the knowledge of the author, no one examined the context of how people with dementia who were not enthusiastic about VR technology would react. Would they still enjoy the overall experience? Would the experience be beneficial for them? Uniquely, the findings revealed that even if a person with dementia were not enthusiastic about the technology, they would still attend the VR session to benefit from the attention received and the conversations that occurred before, during and after the sessions, as described in Chapter 5. In this case, the experience provided an escape from routine and created social bonding by allowing them to chat and share their emotions with care staff. This social encounter promoted a sense of being valued and offered emotional reassurance, contributing to an improvement in the emotional well-being of those individuals.

b) Crafting Interactive and Meaningful Conversations

VR experiences could enrich conversations between people with dementia and their family members before, during, and after the VR sessions, particularly when accompanied by video calls, as detailed in Chapter 5. VR served as a tool to maintain connections by stimulating discussion beyond mundane day-to-day updates, offering engaging topics that strengthened bonds between them, with video calls adding a new dimension to the experience.

Limited research has investigated facilitating remote VR sessions, where an experience involves a person with dementia and their family members, creating a space for engaging and interactive dialogues before, during and after the sessions. In a recent study, Afifi et al. (2021) tested the feasibility of VR with people with dementia and their family members who lived at a distance, where the pairs engaged in a baseline telephone call followed by 3 weekly VR sessions. Results demonstrated the efficacy of remote sessions and the high satisfaction of the involved partakers. In their subsequent study, Afifi et al. (2022) explored how this remote experience could impact this population's QoL. They stated that the dyad who experienced VR as socially engaging reported better psychological and relational well-being, with older adults also experiencing more remarkable improvement in overall QoL. However, in this research, people with dementia and family members were provided opportunities to converse before, during and after the VR exposure via a video conferencing platform (i.e. Zoom), thereby increasing the potential benefits of the experience and offering more chances for meaningful connection and virtual" "face-to-face" conversation. These opportunities could enhance emotional well-being, reinforce bonds and promote cognitive stimulation, improving the QoL of people with dementia.

c) Promoting Interpersonal Connections

Conducting VR sessions within a group setting might be a means to enhance social connectedness among people with dementia, improving social interactions, as described in Chapter 5. The above-mentioned spontaneous communication among residents about VR experiences facilitated conversations, leading to social connectedness.

Many studies have demonstrated positive outcomes of VR experiences among people with dementia (Jawharieh et al., 2024; Matsangidou et al., 2022; Moyle et al., 2018), yet the formal evaluation of VR group experiences is limited (Gaspar et al., 2018). In a first assessment to explore the feasibility of group-setting VR to reduce behavioural and psychological symptoms in a residential care facility, R. Brimelow & Thangavelu (2022) reported that this setting reduced depressive symptoms and apathy and induced a positive emotional response in most residents. However, they did not investigate the impact of such a setting on social connectedness among people with dementia during and after the VR sessions. Building on this gap, the present research explored the effect of implementing VR within group settings as recommended by care staff. This setting created an environment for meaningful conversations among people with dementia during and beyond the sessions, ultimately strengthening social connectedness and enhancing their interpersonal interactions. VR-shared experiences generated conversation stimuli, resulting in a sense of belonging among the participants.

d) Enhancing Person-Centred Care

VR technology could preserve the individuality and personhood of people with dementia, serving as a foundation of person-centred care. VR experiences allowed people with dementia to flourish beyond their dementia diagnosis by engaging in their past and ongoing interests, enhancing their sense of agency and participation.

Previous research has highlighted the role of reminiscence therapy for people with dementia (Alarcão, 2017). This therapy primarily improves QoL, with secondary benefits including enhancing cognitive function, mood, communication, and interaction (Woods et al., 2018). As such, several studies have investigated promoting reminiscence therapy with VR and found positive outcomes (T. Coelho et al., 2020;

Tominari et al., 2021; Tsao et al., 2019). The outcomes from these investigations align with the findings of this research. For example, T. Coelho et al. (2020) reported that promoting reminiscence with VR headsets was safe and engaging, with care staff in this study stating that these experiences could benefit people with dementia. Additionally, Tominari et al. (2021) disclosed that VR-based reminiscence might positively impact the QoL of this group. Further supporting these outcomes, Tsao et al. (2019) highlighted that VR-based reminiscence improved satisfaction in social interactions.

e) Stimulating Interest

VR technology has the potential to alleviate apathy by stimulating the interest of people with dementia. The technology encouraged people with dementia to participate in activities through engaging and emotionally stimulating content that fostered curiosity and enthusiasm. Its immersive nature enhanced engagement, surpassing other activities and traditional television by actively involving participants and retaining their attention.

Research has shown that the use of VR can help reduce apathy (Appel et al., 2020; Manera et al., 2020; Saredakis et al., 2020; Zhao et al., 2020). D'cunha et al. (2019) stated that virtual experiences improved apathy and were preferred to nonvirtual experiences. The findings of this research align with a recent study involving 75 people with dementia across three care homes, where Abdalrahim et al. (2024) reported that a VR intervention led to a significant reduction in apathy. This was evidenced by a substantial decrease in the Person-Environment Apathy Rating Scale (PEARS) scores, with the Arabic version declining from 17.20 to 11.15 (Abdalrahim et al., 2024). However, a worth-noting observation made by care staff in this research was that people with dementia exhibited similar levels of engagement and liveliness when participating in VR sessions as when being visited by their family members. This suggests that the positive impact of the immersive nature of VR was similar to the emotional warmth and personal connectedness related to visitation with the family.

- *How does the use of VR impact the work environment of care staff in dementia care settings, based on their perspective?*

The third research question was addressed in Chapter 6. The findings highlighted the benefits of deploying VR in dementia care settings for care staff. They revealed how VR sessions positively impacted care staff work experiences. These sessions enhanced care staff work environments in two main ways: a) Shared Joy and Gratitude, and b) Increased Job Satisfaction.

a) Shared Joy and Gratitude

VR sessions allowed care staff to share meaningful moments with people with dementia, eliciting happiness. Observing the positive emotions of people with dementia during VR sessions brought similar joy to care staff, improving their emotional well-being. These positive emotions extended beyond the care facility, with care staff sharing these experiences with their family members.

Previous studies have investigated the applications of VR on care staff (Chiang et al., 2022; Farra et al., 2019; Williams et al., 2024). Still, they have mainly focused on its impact when the care staff utilised the technology personally rather than the experience of using it for those with dementia and how that affected the care staff. For instance, Beverly et al. (2022) examined the impact of VR on care staff subjective stress reduction in COVID-19 units, while Gasteiger, van der Veer, et al. (2022) investigated the use of VR to improve their skills, increase learning outcomes, knowledge and overall learner satisfaction. In contrast to previous research, the findings of this thesis uniquely demonstrated the feelings of happiness and gratitude experienced by care staff during and after the VR sessions as a result of witnessing people with dementia enjoying and engaging with the technology. This encounter had a therapeutic impact on care staff. They felt thankful for their role in improving the quality of life for those in their care since technology allowed for shared moments of joy and connection that would not have been possible otherwise. This sense of gratitude came from their recognition of their efforts' tangible benefits, contributing to their emotional well-being. This observation highlights the twofold benefits of VR in care settings, as it not only improves residents' lived experiences but also supports the professional fulfilment of care staff. Their efforts' immediate, tangible outcomes gave them a new perspective of the relational and emotional aspects of their involvement in a technology-enhanced environment.

b) Increase Job Satisfaction

VR strengthened the care staff's relationships with people with dementia through increased communication and provided a platform for greater engagement through sharing meaningful VR experiences. This interaction, along with a deeper understanding of the past experiences of people with dementia, contributed to the care staff's sense of fulfilment in their roles and boosted their job satisfaction.

Previous research has explored factors influencing care staff job satisfaction when working in dementia care facilities (Foà et al., 2020; Moyle et al., 2003; Nowaskie et al., 2020). Studies have examined situational aspects such as teamwork (Nowaskie et al., 2020) and practical factors such as training opportunities (Foà et al., 2020)). Additionally, the sense of gratification and joy derived from interactions with people with dementia has been highlighted as a contributing factor. However, to the knowledge of the author, no research has been conducted to investigate the impact of VR deployment on care staff job satisfaction in dementia care settings. This finding offers a new perspective on the potential of VR to increase care staff job satisfaction. For example, when people with dementia express appreciation to the care staff, satisfaction or enjoyment or straightforwardly acknowledge the care staff's efforts, such as constantly thanking them. Such expressions promoted a positive work environment among carers, boosting their sense of achievement and improving their professional experience and job satisfaction.

- *What challenges are encountered when deploying VR technology and assessing the main issues and concerns of people with dementia, care staff, managers, and professionals working in dementia care settings?*

The fourth research question was addressed in Chapters 3 and 7, where the findings highlighted several challenges and concerns related to VR deployment in dementia care settings. Some challenges emerged before the implementation of the technology, while others arose during its deployment. Accordingly, the discussion for this question will take a temporal approach, beginning with pre-implementation concerns and progressing to issues that arose during deployment.

a) Concerns and Preconceived Notions of Healthcare Professionals and Family Members Before Deployment

Healthcare professionals and family members raised concerns about the suitability of the selected care facility, notably given that the study commenced immediately after the COVID-19 lockdown due to heightened regulatory restrictions, which varied depending on the facility's infection status. In addition, the following concerns were identified: i) the exclusion and inclusion criteria for individuals with dementia; ii) the selection of care staff and the provision of comprehensive training; and iii) VR technology and content.

Existing literature has noted the previous concerns of healthcare professionals and family members (Hung et al., 2023; K. Thach et al., 2020; Unbehaun et al., 2020). For instance, care facilities implemented restrictive measures to prevent and control COVID-19 infections, including a visitor ban (Verbeek et al., 2020). Consistent with the findings, Abeele et al. (2021) addressed VR safety regulations by implementing inclusion and exclusion criteria, such as excluding participants with a medical implant, being visually impaired and unable to provide informed consent. Furthermore, challenges in training care staff and the complexity of the VR technology have been widely noted (K. Thach et al., 2020), particularly the barrier of care staff's familiarity with people with dementia (Hicks et al., 2022). Also, in agreement with the findings, the importance of delivering suitable personalised content has been highlighted across studies (Baker et al., 2020; Hodge et al., 2018; Matsangidou et al., 2020).

b) Challenges Encountered During Deployment

During phases Two and Three, the researcher-led and care staff-led VR deployment sessions, the findings identified the following challenges: i) ensuring sufficient care staff; ii) securing logistical requirements; and iii) institutional culture.

Research has consistently highlighted challenges in deploying VR in care facilities (Koru et al., 2016; K. Thach et al., 2020; Unbehaun et al., 2020) including care staff work overload (Åkerlind et al., 2017; Islam et al., 2017; Y. Kang et al., 2021) and logistical barriers that disrupt daily routine, limiting time for training and technical support (Baker et al., 2020; Cavenett et al., 2018). Consistent with the findings, Hung et al. (2023) reported that barriers to VR implementation in aged care settings include organisational culture influenced by values, assumptions and beliefs about using VR with older people, especially those with dementia. Similarly, Sampson & Goldberg

(2022) emphasised how organisational culture impacts care staff responses, further demonstrating the need to address internal dynamics in care environments.

- *How should VR technology be used to deliver engaging and meaningful VR experiences to people with dementia in care settings, considering the contributions of care staff?*

The fifth research question was addressed in Chapters 3, 5 and 6. The findings emphasised the necessity of providing engaging and meaningful VR experiences, which could enhance the outcomes of such interventions. As such, it was found that the following strategies and approaches are crucial in ensuring the delivery of such experiences: a) Encourage Effective Communication, b) Delivering Personalised VR Content, c) Facilitating VR in Small Groups, d) Features to Incorporate in VR Content and e) Outlining Care Staff Contribution.

a) Encourage Effective Communication

VR plays a key role in fostering effective and meaningful communication between people with dementia, their family members and care staff, which is essential for creating a supportive and empathetic care environment. Deploying a VR App with mirroring capabilities enabled family members and care staff to view the perspective of people with dementia in real-time, as described in Chapter 3. During the deployment phases of this research, family members and care staff used this capability to initiate conversations with participants through verbal prompts. This approach enhanced engagement, created meaningful experiences and facilitated improved conversations during VR exposure.

Several studies have applied the mirroring approach when implementing VR in dementia care settings (L. Kruse et al., 2021; Matsangidou et al., 2023; Tabbaa et al., 2019). The findings from this thesis are consistent with previous research. For instance, Rose et al. (2021) found this approach to allow care staff to better support and interact with the person in real-time (Rose et al., 2021), while Appel, Appel, et al. (2021) demonstrated its effectiveness in helping a second person (i.e. family members) provide prompts as conversation aids and enhance engagement.

b) Delivering Personalised VR Content

The findings indicated that offering people with dementia personalised VR content was an essential strategy for increasing engagement, creating meaningful experiences and enhancing communication, as specified in Chapter 5. Such content contributed to reminiscence, elicited positive experiences and improved their mood and overall well-being. Furthermore, tailored experiences helped sustain their identities, interests, and connections to the world around them. To effectively curate this content, insights should be gathered from people with dementia themselves, their family members, and care staff who are familiar with their preferences.

The findings agree with the existing literature, which emphasises the necessity of a personalised approach to VR experiences for people with dementia to increase positive outcomes (Ajeet Gokani et al., 2024; Hodge et al., 2018; Jawharieh et al., 2024). Previous research has shown that Virtual Environments (VEs) containing objects of personal relevance to residents were much more successful in stimulating conversation (Siriaraya & Ang, 2014) and engagement (Matsangidou et al., 2023; Siriaraya & Ang, 2014). In a study by Waycott et al. (2014), such personalised experiences were associated with enrichment, joy, and reminiscence, which links this approach to person-centred care. However, the findings revealed two novel insights on tailoring personalised VR content for people with dementia. First, VR provides people with dementia the opportunity to visit not only familiar places but also destinations from their "bucket list"- places they have always desired to experience.

Second, regularly updating the VR content to align with their evolving preferences and interests would considerably improve their sustained engagement and enthusiasm for the activity.

c) Facilitating VR in Small Groups

Conducting VR sessions in a small group setting motivated people with dementia to participate and interact with each other, with VR experiences inspiring social conversation, as described in Chapter 5. This setting promoted engagement and social connectedness among people with dementia.

Previous research has underlined the effectiveness of group interventions for people with dementia to maintain social activity and QoL (Tanaka et al., 2021). Studies on VR group sessions have highlighted multiple benefits. For instance, R. Brimelow & Thangavelu (2022) found that group-based VR reduced depressive symptoms and apathy while inducing a positive emotional response. Similarly, D'Cunha et al. (2021) revealed that a virtual cycling experience in a group setting encouraged meaningful discussion and promoted long-term connections. Furthermore, Gaspar et al. (2018) found that the group environment provided people with dementia with overwhelmingly positive social and emotional. However, none of these studies reported anything related to the impact of group-based VR beyond the actual VR session. A notable insight of this finding is that conducting VR sessions in a group setting not only promoted interaction and interpersonal connection among people with dementia but also extended these interactions beyond sessions. When VR was experienced in this setting, it created collective moments in which people with dementia connected and discussed. The stimulant content sparked a captivating topic of conversation, enabling people with dementia to reminisce, exchange viewpoints and connect over shared interests.

d) Features to Incorporate in VR Content

The narration in VR content improved engagement and enjoyment, as people with dementia appreciated the "story" behind it, whether acquiring new knowledge or navigating through it. The narration attracted and sustained their attention, while the lively scenes enhanced their engagement and enjoyment. People with dementia, despite their diagnosis, continued to admire visual components, emphasising the potential of VR to stimulate cognitive engagement.

Multiple studies have investigated different aspects of suitable and engaging VR content for people with dementia (Ijaz et al., 2022; Lecavalier et al., 2018; Siriaraya & Ang, 2014). For instance, Tabbaa et al. (2019) suggested types of appropriate VR content for people with dementia, such as travel, art experiences, and pets, to create " "personal space" for people with dementia. Conversely, Appel et al. (2020) used nature-based, live-action content (i.e. a dense forest with tall pine trees swaying in the wind) to explore its feasibility as a therapy for people with dementia with reduced sensory and mobility capacity. Participants found the content slow-paced and lacking elements like animals, people, city life, and adventure, highlighting the need for greater variability in VR options. In contrast, the findings from this thesis utilised diverse VR content that featured movement, liveliness, and virtual people, with dynamic and captivating scenes that encouraged social interaction within the VE, compared to passive scenes. These findings expand the range of suitable VR content to increase engagement and satisfaction. However, in agreement with Appel et al. (2020), the current findings also indicated the potential benefits of integrating more narrative-driven VR content to enhance the experience of this population. This emphasises how VR design must be adapted in order to reflect the preferences and engagement patterns of people with dementia.

e) Outlining Care Staff Contribution

Care staff were essential in successfully implementing VR technology in dementia care settings, taking on key responsibilities before, during, and after the VR sessions. This research highlighted their role as follows: i) assisting in selecting residents; ii) preparing them for the VR experience; iii) ensuring their physical and emotional safety during the session; iv) engaging with them in conversation; and v) supporting them to transition back to the physical world.

Existing literature has drawn attention to the fundamental role of care staff in delivering successful VR experiences (Hung et al., 2023; Waycott et al., 2022). The findings from this thesis are supported by previous research. For instance, Tabbaa et al. (2019) emphasised their role in facilitating open-ended discussions with people with dementia during VR exposure. In a study by Chaze et al. (2022) exploring VR's potential to support the well-being of people with dementia living in long-term care, care staff played vital roles, including selecting meaningful VR content, identifying suitable participants and engaging them in conversation. Engaging care staff in VR activities is imperative as they know their residents' likes and dislikes, capabilities, and needs, allowing them to create VR experiences successfully. Their relationships with the residents would foster trust and reassurance, ensuring comfort and increasing positive outcomes.

8.2 Implications for Dementia Care Practice

A key motivation for this thesis was to investigate how VR can be independently deployed in complex and diverse care environments to support dementia care. A series of study phases were conducted to assess the potential of care staff to deploy VR independently, considering the perspectives of key stakeholders, organisational challenges, care staff training, and the physical and emotional needs of people with dementia. Positive outcomes of VR were detected throughout chapters 5, 6 & 7.

8.2.1 Care Staff Training and Protocol

This thesis implies that the successful implementation of VR technology in dementia care settings strongly depends on comprehensive training and clear, easy-to-follow protocols. Through this PhD, a training protocol was developed, including a comprehensive toolkit provided to the care staff at the end of the training session to reinforce the training objectives. To ensure accessibility, the toolkit contained all the material covered during the training session for easy reference. The toolkit (see Appendix E) includes vital information in key areas: i) VR technology, its benefits for people with dementia and criteria of suitable VR content; ii) exclusion criteria of people with dementia; iii) do's and don'ts; iv) instructions for setting up the VR system accompanied by visual aids; v) protocols of deploying VR and managing distress; vi) guidelines of modes of VR delivery including conducting sessions with loved ones from a distance, and vii) basic troubleshooting.

The training and distress management protocol, combined with the information and instructions in the toolkit, can help managers improve the quality of care provided to people with dementia and advance the services offered by care facilities. This content might help managers distribute responsibilities more efficiently depending on the competencies of care staff. Staff who are unable to conduct VR sessions, for example, may be responsible for equipment maintenance. Furthermore, such content could help with budget planning, such as allocating funds for buying VR equipment and arranging maintenance services. It could also offer guidelines for planning VR sessions, such as recommendations for session location, duration and frequency to avoid overstimulation or tiredness with a focus on shorter but more frequent visits.

Lastly, managers could use this knowledge to develop a sustainable protocol for implementing VR interventions tailored to their care facility's needs and resources.

8.2.2 Personalised VR Content

This thesis further implies that delivering personalised VR content or content on the "bucket list" of people with dementia can improve engagement and communication. A diverse content library featuring VR experiences tailored to different interests, preferences, and cognitive abilities is crucial. Content should include relaxation, reminiscence, travel, nature, music, art, games, and social interaction. This variety enables care staff to personalise, to a great extent, the VR experiences, boosting the overall therapeutic impact.

Furthermore, to sustain interest and engagement, it is essential to update the VR content list with captivating material regularly. Continuous addition addresses the evolving needs of people with dementia, preserves the novelty of VR experiences, and aligns with their changing cognitive and emotional demands. Regular updates promote long-term engagement and prevent familiarity, which can diminish people's engagement with VR and diminish its therapeutic benefit. To enable such updates as needed, the care staff training programme could be extended to include VR content curation. Once care staff are well-versed in using the equipment and facilitating successful VR sessions, they could undertake advanced training focused on curating VR content to address the evolving interests and preferences of people with dementia. The training would encompass the following steps: i) engage in conversation with residents to identify changes in their needs; ii) search for suitable VR content on a royalty-free online platform guided by content selection criteria outlined in the toolkit; iii) upload the selected VR content onto the website application. This advanced training could enable care staff to more efficiently address the changing needs of their residents, avoiding the need to depend on a design team to make these updates on their behalf and enabling them to gain time in providing personalised care. Care staff might initially face challenges such as technological limitations and time constraints. However, these barriers can be effectively resolved with sufficient organisational and technical support.

8.2.3 Addressing Barriers to VR Integration

The findings of this PhD identify key implications for overcoming barriers to successful VR integration in care facilities. This strategy would considerably increase acceptability, leading to better outcomes for key stakeholders. Several factors must be considered in implementing this approach, as detailed below. Additionally, the language utilized to define the intervention is equally important. Although the technology is referred to in this thesis as "VR," a more approachable and experience-focused phrase, like "virtual travel," may resonate better when engaging with stakeholders who are not academics. By focusing on the experiential value rather than the technical aspects, this framing of VR could foster greater understanding, reduce perceived barriers, and promote broader acceptance among families, care staff, and decision-makers.

i) Organisational Support

Leadership buy-in is imperative for implementing VR in care settings because it ensures commitment and resource allocation from the decision-makers. It secures support and dedication from top management to create a culture that embraces innovation and technology adoption among care staff members. Leadership support should include logistical resources and requirements such as budget allocation for VR equipment, software, training, and maintenance, designated spaces for VR sessions, and transparent equipment storage, upkeep, and cleaning procedures.

To sustain care staff's continuous engagement with VR technology, organisations should conduct workshops and training sessions to raise awareness about VR benefits for both people with dementia and care staff while addressing misconceptions. These sessions could include mock VR demonstration sessions and create a peer support system through mentorship to share best practices, provide feedback, and address challenges. This peer-to-peer approach would enhance individual skills and foster a collaborative learning environment among care staff. Adequate staffing levels must also be ensured to integrate VR sessions into daily routines without disrupting other care activities.

ii) Outcome Evaluation and Success Indicators

A further implication is that the acceptance of technology by key stakeholders and the high level of engagement of people with dementia could be factors in successful VR adoption. Such acceptance and engagement can lead to more frequent and meaningful VR experiences, ultimately improving therapeutic outcomes. Additionally, these factors can encourage key stakeholders to sustain technology use and integrate VR into everyday routines. This, in turn, adds tangible value to care and services, increasing satisfaction, lowering care staff burden, and creating a more stimulating atmosphere in care settings.

Furthermore, quantifying the perceived usefulness of VR technology is essential to demonstrating its value in care settings. Measuring this outcome helps illustrate its benefits to care staff, encouraging increased VR use. For example, collecting data on residents' outcomes (i.e., mood, engagement, communication) can showcase VR's positive impact and support its continued implementation. Additionally, sharing success stories and testimonials from residents, families, and staff can further highlight the value of VR and encourage broader adoption.

iii) Collaborative Practices and Communication

To address the challenges that arise when implementing VR technology, the management team must encourage collaboration and effective communication. Collaboration between different departments in care facilities (i.e. nursing, activities, therapy) ensures seamless integration of VR into care plans. The involvement of such interdisciplinary teams enhances the engagement of people with dementia and encourages sustained implementation. This approach promotes holistic care as it brings the expertise of diverse skills and perspectives to improve the QoL of people with dementia. Effective and open communication channels among care staff, management, and families to address concerns and share feedback lead to continuous improvement in VR implementation and supported a positive experience for the residents.

8.3 Design Recommendations

8.3.1 VR Content

When delivering tailored VR content to people with dementia, consider the following strategies to enhance engagement and optimise therapeutic outcomes:

i) Tailor VR content to align with the cognitive and sensory abilities of people with dementia (i.e. simpler visuals and audio for those with advanced dementia) to minimise possible overstimulation while fostering comfort.

ii) Design VR content with varying levels of complexity to address the needs of individuals at different stages of dementia, incorporating features that promote active participation, such as interactive objects, games, and role-playing scenarios.

iii) Actively involve people with dementia, family members and care staff in the design process of VR experiences and incorporate their feedback to enhance the content's relevance and efficacy.

iv) Develop an extensive VR content library that includes diverse topics, such as scenarios with engaging narration, reflections on cultural identity, native languages of residents, and solutions to specific challenges (i.e. insomnia and anxiety associated with medical procedures).

v) Include VR content that facilitates music, art, or dance, which could resonate with people with dementia and support meaningful engagement without relying on verbal communication.

vi) Integrate prompts and questions within VR experiences to encourage conversation and self-expression to improve sustained engagement over an extended period.

vii) Enhance the sensory richness by incorporating elements, such as scents (i.e. flowers) or tactical sensation (i.e. the feeling of grass underfoot) to create more immersive and holistic VR experiences, evoking memories and emotions.

8.3.2 Family Involvement and Ongoing Engagement in VR Experiences

To foster enriching conversations and strengthen connections between people with dementia and their family members, a VR system could be developed that enables family members to share an activity or event with their loved ones with dementia via a 360◦ camera, either in real-time (synchronously) or through recorded sessions (asynchronously). Such flexibility could overcome issues such as time-zone differences, work schedules, and life responsibilities come into place. Hence, VR-dementia-care integration goes beyond integrating technology within the physical boundaries of the care setting and considers family members' lives.

Furthermore, family members can upgrade VR personalisation by actively contributing to creating VR experiences and providing biographical material, such as photos, videos, and music, that hold personal significance for people with dementia. They could also join VEs remotely through secure applications designed for shared experiences. Such platforms could enable family members to observe VR sessions, view recordings remotely and engage in meaningful interactions with conversation prompts tailored to the VR experience.

To further advance personalisation, larger-scale efforts are needed to produce a 360-video-based archive, like earlier research with photographs tailored for reminiscence (Blythe et al., 2010). Integrating such a library with an intelligent recommendation system that captures the likes and dislikes of people with dementia to recommend appropriate VR content, expanding their horizons by continuing to develop their identity and personhood. Also, by generating intelligent prompts, the system could facilitate meaningful conversations based on the recorded preferences of people with dementia.

Lastly, a challenge in dementia care is the lack of continuous updates and communications about people with dementia and how it affects family members negatively (i.e. feeling anxious, untrusting, and impacted) (Lopez et al., 2013; Zmora et al., 2019). To address this, the VR system could deploy a mechanism to report on the VR experiences of people with dementia. For example, the VR system can send a notification to family members when a person with dementia is visiting a virtual place (i.e. "Your mum is virtually visiting Stonehenge today"). Such notification could even be in the form of social media engagement, where the VR system posts messages and screenshots of the virtual places visited by the person with dementia. The design of this type of interaction could take inspiration from virtual photography or in-game photography, which is a new form of media art where users take screenshots of video game worlds and share them on social media (Gerling, 2018). Such notifications could also be enhanced by drawing on the wealth of literature in affective computing, where emotion detection systems can automatically detect the happy moments experienced by them.

8.3.3 Improving Personhood Preservation in Dementia Care

When people with dementia transition to institutional care, often at a moderate or severe stage, care staff often face challenges due to limited opportunities to build rapport with them or understand their socio-cultural background and life history, as individuals tend to stay at home as long as possible. For instance, it could be more challenging to understand why people with dementia are agitated without this in-depth understanding. Perhaps Artificial Intelligence (AI) within VR can help address this issue through human-AI collaboration. AI (supported by smart sensors) can collect data about their lives during the early stages of dementia to form an in-depth understanding of their socio-cultural background, preferences, hobbies, social roles, etc. This data can be used to support care staff in institutional settings by providing contextual insights and recommendations for personalised care. In this scenario, the AI can rapidly process the wealth of personal data of the people with dementia to allow human care staff to understand better why the person with dementia is behaving in a certain way, and the human care staff can help by providing sensory feedback (i.e. holding their hand, reassuring them). Nevertheless, before being put into practice, such an approach must properly address significant ethical issues, especially those pertaining to consent, data privacy, and autonomy.

Furthermore, the results showed that people with dementia responded positively to visual or auditory elements. As such, VR experiences incorporating music, art, or dance would likely resonate with them and support meaningful engagement without relying on verbal communication. Similarly, as the condition progresses and verbal communication of people with dementia declines, it is vital to consider VR experiences that facilitate non-verbal communication, such as music or art, to enhance engagement and enjoyment.

Moreover, given that people with dementia seemed more engaged when guided by caregivers or family members, combining prompts and questions within VR experiences to facilitate conversation and self-expression would improve sustained engagement over an extended period.

8.4 Organisational Recommendations

8.4.1 VR Implementation and Long-Term Integration

To ensure successful VR implementation for dementia care, several key milestones should be achieved. Facilities should be technically (i.e. Wi-Fi infrastructure) and logistically (i.e. securing suitable location) prepared for VR while fostering a culture of innovation to create a supportive environment for its implementation.

1) VR training should be integrated within the standard training curriculum for new staff members, enabling them to become familiar with the equipment, understand its benefits and recognise its alignment with the organisation's vision and care objectives.
2) Establishing a collaborative support network among care staff can foster a sense of community and commitment, ensuring that VR is recognised as an essential tool to enhance engagement and acceptability in dementia care settings.
3) Remote technical support is necessary to facilitate smooth implementation as it reinforces care staff confidence and reduces possible technical issues and disruptions.

4) VR sessions should be integrated into the care plans developed by the multi-disciplinary team as they are best positioned to comprehend residents' emotional needs and physical abilities.

5) VR sessions should be incorporated into the monthly activities planner to guarantee time slots without disrupting other scheduled activities or overloading care staff with additional tasks.

6) Avoid scheduling VR sessions during pleasant weather, as people with dementia might prefer outdoor activities. VR sessions may be better suited to colder months when alternative activities are harder to find.

8.4.2 Evaluation and Continuous Improvement

Collecting data on user experiences and outcomes is crucial for evaluating the success and impact of VR deployment in dementia care settings, as it helps determine what works, what doesn't, and areas for improvement. Analysing this data proves beneficial for improving future experiences on multiple levels. Aspects of VR experiences that should be evaluated regularly include i) the evolving needs of people with dementia; ii) engagement of people with dementia with the technology and its therapeutic impact on their QoL; iii) feedback from people with dementia, family members and care staff regarding VR experience; iv) change in mood, cognitive function and behaviour between residents who attend VR sessions and those who don't; v) VR training components; vi) VR equipment and content; vii) family members involvement, and vii) deployment strategies.

8.5 Limitations and Future Work

The work carried out in this thesis had a few limitations that are important to consider. This work primarily underscores technology acceptance and engagement as key factors in successful VR adoption in dementia care settings. While these are imperative, other factors, such as cost, sustainability, long-term maintenance, and integration with existing care practices, might also be crucial but have been explored less. Therefore, future research should investigate these extra factors to present a deeper understanding of VR deployment in these care settings.

Another limitation of this study is the absence of a control group (i.e., residents or care staff who did not receive the VR intervention). With a control group, it is easier to definitively attribute the observed benefits solely to the VR intervention, as other factors within the care environment may have also contributed to the outcomes. As such, future research should further include a control group to isolate VR's impacts on participant outcomes. This would allow for a more accurate comparison between individuals who participate in the VR intervention and those who do not, assisting with confirming if the observed benefits can be directly linked to VR rather than other variables in the care setting.

The three phases of this comprehensive study explored VR deployment in dementia care settings with a relatively small number of participants, particularly family members (Phase One n=45; Phase Two n=13; Phase Three n=17). Consequently, a more extensive study is required to examine the generalizability of the findings and further explore the role that family members may play in VR experiences. However, to recruit additional participants, substantial effort, time, and resources are needed. Also, part of the study was conducted during COVID-19 restrictions, which presented further challenges.

Furthermore, the study investigated the use of VR in two care settings (a long-term care setting and an adult day centre). As such, one direction of future research could involve exploring the use of VR in diverse dementia care settings. This includes investigating VR applications for people with dementia who reside in community settings, social housing, or hospitals. Exploring VR use in these diverse environments could offer insights into its adaptability, accessibility, and potential beneficial effects for a larger community of persons with dementia and reveal context-specific obstacles and needs for efficient deployment.

Finally, the study was limited by the short deployment period. Hence, a longitudinal study is required to assess the longer-term impact of VR on all key stakeholders, including people with dementia, their family members, care staff, and care managers. Such an approach to conducting a study might reveal valuable insight into sustained engagement with the technology and its potential impact on QoL and the care environment.

8.6 Final Summary

This thesis examined the role of VR in dementia care settings, investigating its implementation, adoption, and effects on important stakeholders, such as people with dementia and care staff. The findings demonstrated that relational, organisational, and emotional aspects influenced VR adoption and that joyous moments and shared social experiences frequently lead to meaningful engagement for people with dementia. The study revealed that care staff actively benefit from VR sessions in addition to serving as facilitators, with positive emotional outcomes noted.

The work done in this thesis provides a basis for future research related to deploying VR technology in dementia care settings. More importantly, it provides insights into its impact on key stakeholders, including design and organisational recommendations for successful implementation. Hopefully, this thesis will encourage more research to explore VR deployment across varied dementia care settings and to investigate additional factors influencing adoption. Prospectively, future work could involve longitudinal investigations of VR integration in real-world contexts, further family member co-design initiatives, and ethical investigation of AI technology to promote cultural sensitivity and personalisation in care. When combined, these approaches can support the growth and sustainability of VR's beneficial effects in dementia care.

References

Abbas Borhani, S., Babajani, J., Raeesi Vanani, I., Sheri Anaqiz, S., & Jamaliyanpour, M. (2021). Adopting Block chain Technology to Improve Financial Reporting by Using the Technology Acceptance Model (TAM). *International Journal of Finance and Managerial Accounting*, *6*(22). www.ijfma.ir/article_17481.html

Abdalrahim, A., Suliman, M., ALBashtawy, M., Alkhawaldeh, A., & Ta'an, W. (2024). Enhancing Apathy Treatment in Jordanian People Living with Dementia Residing in Care Homes Using Virtual Reality Reminiscence Therapy. *Working with Older People*, *28*(3), 293–304. https://doi.org/https://doi.org/10.1108/WWOP-07-2023-0031

Abeele, V. Vanden, Schraepen, B., Huygelier, H., Gillebert, C., Gerling, K., & Van Ee, R. (2021). Immersive Virtual Reality for Older Adults: Empirically Grounded Design Guidelines. *ACM Transactions on Accessible Computing*, *14*(3), 1–30. https://doi.org/https://doi.org/10.1145/3470743

Adra, M. G., Hopton, J., & Keady, J. (2015). Constructing the Meaning of Quality of Life for Residents in Care Homes in Lebanon: Perspectives of Residents, Staff and Family. *International Journal of Older People Nursing*, *10*(4), 306–318. https://doi.org/https://doi.org/10.1111/opn.12094

Afifi, T., Collins, N. L., Rand, K., Fujiwara, K., Mazur, A., Otmar, C., Dunbar, N. E., Harrison, K., & Logsdon, R. (2021). Testing the Feasibility of Virtual Reality with Older Adults with Cognitive Impairments and their Family

Members who Live at a Distance. *Innovation in Aging*, *5*(2). https://doi.org/https://doi.org/10.1093/geroni/igab014

Afifi, T., Collins, N., Rand, K., Otmar, C., Mazur, A., Dunbar, N. E., Fujiwara, K., Harrison, K., & Logsdon, R. (2022). Using Virtual Reality to Improve the Quality of Life of Older Adults with Cognitive Impairments and their Family Members who Live at a Distance. *Health Communication*, 1–12. https://doi.org/https://doi.org/10.1080/10410236.2022.2040170

Ahmad, R., Kyratsis, Y., & Holmes, A. (2012). When the User is not the Chooser: Learning from Stakeholder Involvement in Technology Adoption Decisions in Infection Control. *Journal of Hospital Infection*, *81*(3), 163–168. https://doi.org/https://doi.org/10.1016/J.JHIN.2012.04.014

Ajeet Gokani, H., Sommerlad, A., Jawharieh, H., Ang, C. S., & Huntley, J. (2024). Carers and professionals' views on using virtual reality in dementia care: A qualitative study. *Dementia*, *0*(0), 1–20. https://doi.org/https://doi.org/10.1177/14713012241272786/FORMAT/EPUB

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211. https://doi.org/https://doi.org/10.1002/hbe2.195

Åkerlind, C., Martin, L., & Gustafsson, C. (2017). Care Managers' Perceptions of eHomecare: A Qualitative Interview Study. *European Journal of Social Work*, *22*(4), 634–646. https://doi.org/https://doi.org/10.1080/13691457.2017.1366893

Alarcão, S. M. (2017). Reminiscence Therapy Improvement Using Emotional Information. *In the Proceeding of the International Conference on Affective*

Computing and Intelligent Interaction, *2018-January*, 561–565. https://doi.org/https://doi.org/10.1109/ACII.2017.8273655

Albinsson, L., & Strang, P. (2002). A Palliative Approach to Existential Issues and Death in End-Stage Dementia Care. *Journal of Palliative Care*, *18*(3), 168–174. https://doi.org/https://doi.org/10.1177/082585970201800305

Almeida, J. P. L. de, Farias, J. S., & Carvalho, H. S. (2017). Drivers of the Technology Adoption In Healthcare. *BBR. Brazilian Business Review*, *14*(3), 336–351. https://doi.org/https://doi.org/10.15728/BBR.2017.14.3.5

Alqudah, A. A., Al-Emran, M., & Shaalan, K. (2021). Technology Acceptance in Healthcare: A Systematic Review. In *Applied Sciences (Switzerland)* (Vol. 11, Issue 22). MDPI. https://doi.org/http://doi.org/10.3390/app112210537

Altinay Ozdemir, M. (2021). Virtual Reality (VR) and Augmented Reality (AR) Technologies for Accessibility and Marketing in the Tourism Industry. In *ICT Tools and Applications for Accessible Tourism* (pp. 277–301). IGI Global. https://doi.org/https://doi.org/10.4018/978-1-7998-6428-8.CH013

Alzheimer's Disease International. (2024). *Dementia statistics*. ADI. https://www.alzint.org/about/dementia-facts-figures/dementia-statistics/

Alzheimer's Society. (2015). *Assistive Technology Devices to Help with Everyday Living*. https://www.alzheimers.org.uk/sites/default/files/migrate/downloads/factsheet_assistive_technology_%25E2%2580%2593_devices_to_help_with_everyday_living.pdf

Alzheimer's Society. (2017). *Assistive Technology-Devices to Help with Everyday Living*. https://www.alzheimers.org.uk/sites/default/files/migrate/downloads/factsheet_assistive_technology_%25E2%2580%2593_devices_to_help_with_everyday_living.pdf

Alzheimer's Society. (2023). *Depression and Dementia*. https://www.alzheimers.org.uk/about-dementia/symptoms-and-diagnosis/depression-dementia

Alzheimer's Society. (2024a). *Dementia Medication Side Effects*. Alzheimer's Society. https://www.alzheimers.org.uk/about-dementia/treatments/dementia-medication/dementia-medication-side-effects

Alzheimer's Society. (2024b). *Medication for Dementia Symptoms*. Alzheimer's Society. https://www.alzheimers.org.uk/about-dementia/treatments/dementia-medication/medication-dementia-symptoms

Alzheimer's Society. (2024c, May 7). *Types of Dementia*. Alzheimer's Society. https://www.alzheimers.org.uk/about-dementia/types-dementia

Alzheimer's Society. (2024d, May 8). *What is Dementia?* Alzheimer's Society. https://www.alzheimers.org.uk/about-dementia/types-dementia/what-is-dementia

Anantapong, K., Davies, N., & Sampson, E. L. (2022). Communication between the Multidisciplinary Team and Families Regarding Nutrition and Hydration for People with Severe Dementia in Acute Hospitals: A Qualitative Study. *Age and Ageing*, *51*, 1–10. https://doi.org/https://doi.org/10.1093/ageing/afac230

Andringa, G., Nuijten, P. L., Macville, M. M., Mertens, E. G. A., Kaptein, J. J., Bauer, A. C. M., van den Doel, L. R., & Roos, A. G. (2019). Feasibility of Virtual Reality in Elderly with Dementia. *Communications in Computer and Information Science*, *1117*, 146–149. https://doi.org/https://doi.org/10.1007/978-3-030-33540-3_14/COVER

Appel, L., Ali, S., Narag, T., Mozeson, K., Pasat, Z., Orchanian-Cheff, A., & Campos, J. L. (2021). Virtual Reality to Promote Wellbeing in Persons with Dementia: A Scoping Review. *Journal of Rehabilitation and Assistive Technologies Engineering*, *8*, 1–16. https://doi.org/https://doi.org/10.1177/20556683211053952

Appel, L., Appel, E., Bogler, O., Wiseman, M., Cohen, L., Ein, N., Abrams, H. B., & Campos, J. L. (2020). Older Adults with Cognitive and/or Physical Impairments Can Benefit from Immersive Virtual Reality Experiences: A Feasibility Study. *Frontiers in Medicine*, *6*, 1–13. https://doi.org/https://doi.org/10.3389/fmed.2019.00329

Appel, L., Appel, E., Kisonas, E., Pasat, Z., Mozeson, K., Vemulakonda, J., & Sheng, L. (2021). Virtual Reality for Veteran Relaxation (VR2) – Introducing VR-Therapy for Veterans With Dementia – Challenges and Rewards of the Therapists Behind the Scenes. *Frontiers in Virtual Reality*, *2*, 720523. https://doi.org/https://doi.org/10.3389/FRVIR.2021.720523/BIBTEX

Arntzen, C., Holthe, T., & Jentoft, R. (2014). Tracing the successful incorporation of assistive technology into everyday life for younger people with dementia and family carers. *Dementia*, *15*(4), 646–662. https://doi.org/https://doi.org/10.1177/1471301214532263

Asiain, J., Braun, M., & Roussos, A. J. (2022). Virtual Reality as a Psychotherapeutic Tool: Current Uses and Limitations. *British Journal of Guidance & Counselling*, *50*(1), 1–28. https://doi.org/https://doi.org/10.1080/03069885.2021.1885008

Astell, A. J., Bouranis, N., Hoey, J., Lindauer, A., Mihailidis, A., Nugent, C., & Robillard, J. M. (2019). Technology and Dementia: The Future is Now. *Dementia and Geriatric Cognitive Disorders*, *47*(3), 131–139. https://doi.org/https://doi.org/10.1159/000497800

Augusto, J. C., Zheng, H., Mulvenna, M., Wang, H., Carswell, W., & Jeffers, P. (2011). Design and Modelling of the Nocturnal AAL Care System. *In Proceedings of the Second International Symposium on Ambient Intelligence*, *92*, 109–116. https://doi.org/https://doi.org/10.1007/978-3-642-19937-0

Baker, S., Kelly, R. M., Waycott, J., Batchelor, F., Warburton, J., Vetere, F., Ozanne, E., Dow, B., Carrasco, R., Hoang, T., & Ozanne, E. (2019). Interrogating Social Virtual Reality as a Communication Medium for Older Adults. *In Proceedings of the ACM on Human-Computer Interaction*, *3*, 1–24. https://doi.org/https://doi.org/10.1145/3359251

Baker, S., Waycott, J., Robertson, E., Carrasco, R., Neves, B. B., Hampson, R., & Vetere, F. (2020). Evaluating the Use of Interactive Virtual Reality Technology with Older Adults Living in Residential Aged Care. *Information Processing and Management*, *57*(3). https://doi.org/http://doi.org/10.1016/j.ipm.2019.102105

Ballard, C., Corbett, A., Orrell, M., Williams, G., Moniz-Cook, E., Romeo, R., Woods, B., Garrod, L., Testad, I., Woodward-Carlton, B., Wenborn, J., Knapp, M., & Fossey, J. (2018). Impact of Person-Centred Care Training and Person-Centred Activities on Quality of Life, Agitation, and Antipsychotic Use in People with Dementia Living in Nursing Homes: A Cluster-Randomised Controlled Trial. *PLOS Medicine*, *15*(2), e1002500. https://doi.org/https"//doi.org/10.1371/JOURNAL.PMED.1002500

Banerjee, S., Smith, S. C., Lamping, D. L., Harwood, R. H., Foley, B., Smith, P., Murray, J., Prince, M., Levin, E., Mann, A., & Knapp, M. (2006). Quality of Life in Dementia: More than Just Cognition. An Analysis of Associations with Quality of Life in Dementia. *Journal of Neurology, Neurosurgery, and Psychiatry*, *77*(2), 146. https://doi.org/https://doi.org/10.1136/JNNP.2005.072983

Bani Mohammad, E., & Ahmad, M. (2019). Virtual Reality as a Distraction Technique for Pain and Anxiety among Patients with Breast Cancer: A Randomized Control Trial. *Palliative and Supportive Care*, *17*(1), 29–34. https://doi.org/https://doi.org/10.1017/S1478951518000639

Barnes, M., & Brannelly, T. (2008). Achieving Care and Social Justice for People with Dementia. *Nursing Ethics*, *15*(3), 384–395. https://doi.org/https://doi.org/10.1177/0969733007088363

Barsasella, D., Chakkaravarthi, S. P., Chung, H. J., Hur, M., Abdul, S. S., Malwade, S., Chang, C. C., Liu, M. F., & Li, Y. C. (2019). Acceptability of Virtual Reality Among Older People: Ordinal Logistic Regression Study from Taiwan. *In Proceedings of the 2019 6th International Conference on Bioinformatics Research and Applications*, *172*, 145–151. https://doi.org/https://doi.org/10.1145/3383783.3383804

Beard, R. L. (2004). In their Voices: Identity Preservation and Experiences of Alzheimer's Disease. *Journal of Aging Studies*, *18*(4), 415–428. https://doi.org/https://doi.org/10.1016/j.jaging.2004.06.005

Benoit, M., Guerchouche, R., Petit, P. D., Chapoulie, E., Manera, V., Chaurasia, G., Drettakis, G., & Robert, P. (2015). Is it Possible to Use Highly Realistic Virtual Reality in the Elderly? A Feasibility Study with Image-Based Rendering. *Neuropsychiatric Disease and Treatment*, *11*, 557. https://doi.org/https://doi.org10.2147/NDT.S73179

Berg-Weger, M., & Stewart, D. B. (2017). Non-Pharmacologic Interventions for Persons with Dementia. *Missouri Medicine*, *114*(2), 116–119. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6140014/

Bernstein, M. L., Mccreless, T., & Côté, M. J. (2007). Hospital Topics Five Constants of Information Technology Adoption in Healthcare. *Hospital Topics*, *85*(1), 17–25. https://doi.org/https://doi.org/10.3200/HTPS.85.1.17-26

Bessey, L. J., & Walaszek, A. (2019). Management of Behavioral and Psychological Symptoms of Dementia. *Current Psychiatry Reports*, *21*, 1–11. https://doi.org/https://doi.rog/10.1007/s11920-019-1049-5

Beverly, E., Hommema, L., Coates, K., Duncan, G., Gable, B., Gutman, T., Love, M., Love, C., Pershing, M., & Stevens, N. (2022). A Tranquil Virtual Reality Experience to Reduce Subjective Stress among COVID-19 Frontline Healthcare Workers. *PLOS ONE*, *17*(2), 1–13. https://doi.org/https://doi.org/10.1371/JOURNAL.PONE.0262703

Bimberg, P., Weissker, T., & Kulik, A. (2020). On the Usage of the Simulator Sickness Questionnaire for Virtual Reality Research. *In Proceedings of the IEEE Conference on Virtual Reality and 3D User Interfaces, VRW 2020*, 464–467. https://doi.org/https://doi.org/10.1109/VRW50115.2020.00098

Bird, J. M. (2019). The use of virtual reality head-mounted displays within applied sport psychology. *Journal of Sport Psychology in Action*, *11*(2), 115–128. https://doi.org/https://doi.org/10.1080/21520704.2018.1563573

Blackman, T. (2024). Virtual Reality and Videogames: Immersion, Presence, and the Performative Spatiality of 'Being There' in Virtual Worlds. *Social & Cultural Geography*, *25*(3), 404–422. https://doi.org/https://doi.org/10.1080/14649365.2022.2157041

Blythe, M., Wright, P., Bowers, J., Boucher, A., Jarvis, N., Reynolds, P., & Gaver, B. (2010). Age and Experience: Ludic engagement in a residential care setting. *In Proceedings of the 8th ACM Conference on Designing Interactive Systems*, 161–170. https://dl.acm.org/doi/pdf/10.1145/1858171.1858200

Boedecker, C., Huettl, F., Saalfeld, P., Paschold, M., Kneist, W., Baumgart, J., Preim, B., Hansen, C., Lang, H., & Huber, T. (2021). Using Virtual 3D-Models in Surgical Planning: Workflow of an Immersive Virtual Reality Application in Liver Surgery. *Langenbeck's Archives of Surgery*, *406*, 911–915. https://doi.org/https://doi.org/10.1007/s00423-021-02127-7

Boeldt, D., Mcmahon, E., Mcfaul, M., & Greenleaf, W. (2019). Using Virtual Reality Exposure Therapy to Enhance Treatment of Anxiety Disorders:

Identifying Areas of Clinical Adoption and Potential Obstacles. *Frontiers in Psychiatry*, *10*, 1–6. https://doi.org/https://doi.org/10.3389/fpsyt.2019.00773

Boise, L., Wild, K., Mattek, N., Ruhl, M., Dodge, H. H., & Kaye, J. (2013). Willingness of Older Adults to Share Data and Privacy Concerns after Exposure to Unobtrusive Home Monitoring. *Gerontechnology*, *11*(3), 428–435. https://doi.org/https://doi.org/10.4017/gt.2013.11.3.001.00

Bökberg, C., Ahlström, G., & Karlsson, S. (2017). Significance of Quality of Care for Quality of Life in Persons with Dementia at Risk of Nursing Home Admission: A Cross-Sectional Study. *BMCNursing*, *16*, 1–11. https://doi.org/https://doi.org/10.1186/s12912-017-0230-6

Bouman, A. I. E., Wetzels, T. P., Beek, R. B., Van, A. P. A., De, J., Bouman, I. E., Ettema, T. P., Wetzels, R. B., Van Beek, A. P. A., De Lange, J., & Dröes, R. M. (2011). Evaluation of Qualidem: A Dementia-Specific Quality of Life Instrument for Persons with Dementia in Residential Settings. Scalability and Reliability of Subscales in Four Dutch Field Surveys. *International Journal of Geriatric Psychiatry*, *26*(7), 711–722. https://doi.org/https://doi.org/10.1002/gps.2585/abstract

Bourazeri, A., & Stumpf, S. (2018). Co-Designing Smart Home Technology with People with Dementia or Parkinson's Disease. *In Proceedings of the ACM International Conference Proceeding Series*, 609–621. https://doi.org/https://doi.org/10.1145/3240167.3240197

Bowling, A., Rowe, G., Adams, S., Sands, P., Samsi, K., Crane, M., Joly, L., & Manthorpe, J. (2015). Quality of life in dementia: a systematically conducted narrative review of dementia-specific measurement scales. *Aging & Mental Health*, *19*(1), 13–31. https://doi.org/10.1080/13607863.2014.915923

Brereton, L., wahlster, P., Mozygemba, K., Lysdahl, K. B., Burns, J., Polus, S., Tummers, M., Refolo, P., Sacchini, D., Leppert, W., Chilcott, J., Ingleton, C., Gardiner, C., & Goyder, E. (2017). Stakeholder Involvement throughout Health Technology Assessment: An Example from Palliative Care. *International Journal of Technology Assessment in Health Care*, *35*(5), 1–25. https://doi.org/https://doi.org/10.1017/S026646231700068X

Brimelow, R. E., Dawe, B., & Dissanayaka, N. (2020). Preliminary Research: Virtual Reality in Residential Aged Care to Reduce Apathy and Improve Mood. *Cyberpsychology, Behavior, and Social Networking*, *23*(3), 165–170. https://doi.org/https://doi.org/10.1089/CYBER.2019.0286/ASSET/IMAGES/LARGE/CYBER.2019.0286_FIGURE1.JPEG

Brimelow, R., & Thangavelu, K. (2022). Feasibility of Group-Based Multiple Virtual Reality Sessions to Reduce Behavioral and Psychological Symptoms in Persons Living in Residential Aged Care. *Journal of the American Medical Directors Association*, *23*(5), 1–7. https://doi.org/https://doi.org/10.1016/j.jamda.2021.07.026

Brooke, J. (1996). SUS - A Quick and Dirty Usability Scale. In P. Jordan, B. Thomas, B. weerdmeester, & I. McClelland (Eds.), *Usability Evaluation in Industry* (Vol. 189, pp. 189–194). Taylor & Francis. http://www.tbistafftraining.info/smartphones/documents/b5_during_the_trial_usability_scale_v1_09aug11.pdf

Bui, V., & Alaei, A. (2022). Virtual Reality in Training Artificial Intelligence-Based Systems: A Case Study of Fall Detection. *Multimedia Tools and Applications*, *81*(22), 32625–32642. https://doi.org/https://doi.org/10.1007/s11042-022-13080-y

Caggianese, G., Chirico, A., De Pietro, G., Gallo, L., Giordano, A., Predazzi, M., & Neroni, P. (2018). Towards a Virtual Reality Cognitive Training System for Mild Cognitive Impairment and Alzheimer's Disease Patients. *In Proceedings of the 32nd IEEE International Conference on Advanced Information Networking and Applications Workshops, WAINA 2018*, *2018-January*, 663–667. https://doi.org/https://doi.org/10.1109/WAINA.2018.00164

Campbell, M. (1997). The Family as Stakeholder. *Business Strategy Review*, *8*(2), 29–37. https://doi.org/https://doi.org/10.1111/1467-8616.00018

Carl, E., Stein, A. T., Levihn-Coon, A., Pogue, J. R., Rothbaum, B., Emmelkamp, P., Asmundson, G. J. G., & Powers, M. B. (2018). Virtual Reality Exposure Therapy for Anxiety and Related Disorders: A Meta-Analysis of Randomized Controlled Trials. *Journal of Anxiety Disorder*, *61*, 27–36. https://doi.org/https://doi.org/10.1016/j.janxdis.2018.08.003

Carretero, S. (2015). *Mapping of Effective Technology-Based Services for Independent Living for Older People at Home*. Publications Office. https://doi.org/https://doi.org/10.2791/395556

Cavenett, W., Baker, S., Waycott, J., Carrasco, R., Robertson, E., Vetere, F., & Hampson, R. (2018). Deploying New Technology in Residential Aged Care. *In*

Proceedings of the 30th Australian Conference on Computer-Human Interaction, 200–204. https://doi.org/https:doi.org/10.1145/3292147.3292214

Chamberlain, S. A., Gruneir, A., Hoben, M., Squires, J. E., Cummings, G. G., & Estabrooks, C. A. (2017). Influence of Organizational Context on Nursing Home Staff Burnout: A Cross-Sectional Survey of Care Aides in Western Canada. *International Journal of Nursing Studies*, *71*, 60–69. https://doi.org/https://doi.org/10.1016/J.IJNURSTU.2017.02.024

Chandra, M., Harbishettar, V., Sawhney, H., & Amanullah, S. (2021). Ethical Issues in Dementia Research. *Indian Journal of Psychological Medicine*, *43*(5_suppl), S25–S30. https://doi.org/https://doi.org/10.1177/02537176211022224

Chaze, F., Hayden, L., Azevedo, A., Kamath, A., Bucko, D., Kashlan, Y., Dube, M., De Paula, J., Jackson, A., Reyna, C., Warren-Norton, K., Dupuis, K., & Tsotsos, L. (2022). Virtual Reality and Well-being in Older Adults: Results from a Pilot Implementation of Virtual Reality in Long-Term Care. *Journal of Rehabilitation and Assistive Technologies Engineering*, *9*, 205566832110723. https://doi.org/https:doi.org/10.1177/20556683211072384

Chenoweth, L., King, M. T., Jeon, Y.-H., Brodaty, H., Stein-Parbury, J., Norman, R., Haas, M., & Luscombe, G. (2009). Caring for Aged Dementia Care Resident Study (CADRES) of Person-Centred Care, Dementia-Care Mapping, and Usual Care in Dementia: A Cluster-Randomised Trial. *The Lancet Neurology*, 317–325. https://doi.org/https://doi.org/10.1016/S1474

Cherniack, E. P. (2011). Not Just Fun and Games: Applications of Virtual Reality in the Identification and Rehabilitation of Cognitive Disorders of the Elderly. *Disability and Rehabilitation: Assistive Technology*, *6*(4), 283–289. https://doi.org/https://doi.org/10.3109/17483107.2010.542570

Cherry, B., Carter, M., Owen, D., & Lockhart, C. (2008). Factors Affecting Electronic Health Record Adoption in Long-Term Care Facilities. *Journal for Healthcare Quality*, *30*(2), 37–47. https://doi.org/https://doi.org/10.1111/j.1945-1474.2008.tb01133.x

Cheung, E., Ppali, S., Xygkou, A., Covaci, A., Jawharieh, H., Thomas, C., & Ang, C. S. (2023). Meaningful Spaces, Meaningful Places: Co-creating VR Experiences with People Living with Dementia. *DIS Companion- ACM Designing Interactive Systems Conference*, 217–221. https://doi.org/https://doi.org/10.1145/3563703.3596624

Chi, W., Graf, E., Hughes, L., Hastie, J., Khatutsky, G., Shuman, S. B., Jessup, E. A., Karon, S., & Lamont, H. (2019). *Community-Dwelling Older Adults with Dementia and Their Caregivers: Key Indicators from the National Health and Aging Trends Study*. https://aspe.hhs.gov/reports/community-dwelling-older-adults-dementia-their-caregivers-key-indicators-national-health-aging-0

Chiang, D. H., Huang, C. C., Cheng, S. C., Cheng, J. C., Wu, C. H., Huang, S. S., Yang, Y. Y., Yang, L. Y., Kao, S. Y., Chen, C. H., Shulruf, B., & Lee, F. Y. (2022). Immersive Virtual Reality (VR) Training Increases the Self-Efficacy of In-hospital Healthcare Providers and Patient Families Regarding Tracheostomy-Related Knowledge and Care Skills A Prospective Pre-Post Study. *Medicine*

(United States), *101*(2), E28570. https://doi.org/https://doi.org/10.1097/MD.0000000000028570

Ching-Teng, Y., Ya-Ping, Y., Chia-Ju, L., & Hsiu-Yueh, L. (2020). Effect of group reminiscence therapy on depression and perceived meaning of life of veterans diagnosed with dementia at veteran homes. *Social Work in Health Care*, *59*(2), 75–90. https://doi.org/10.1080/00981389.2019.1710320

Cho, H. K. (2018). The Effects of Music Therapy-Singing Group on Quality of Life and Affect of Persons With Dementia: A Randomized Controlled Trial. *Frontiers in Medicine*, *5*, 279. https://doi.org/https://doi.org/10.3389/fmed.2018.00279

Chong, H. T., Lim, C. K., & Tan, K. L. (2018). Challenges in Virtual Reality System: A Review. *In Proceedings of the 3rd International Conference on Applied Science and Technology*, *2016*, 1–7. https://doi.org/https://doi.org/10.1063/1.5055439

Chu, H., Yang, C. Y., Lin, Y., Ou, K. L., Lee, T. Y., O'Brien, A. P., & Chou, K. R. (2014). The Impact of Group Music Therapy on Depression and Cognition in Elderly Persons With Dementia: A Randomized Controlled Study. *Biological Research for Nursing*, *16*(2), 209–217. https://doi.org/https://doi.org/10.1177/1099800413485410

Cipresso, P., Giglioli, I. A. C., Raya, M. A., & Riva, G. (2018). The Past, Present, and Future of Virtual and Augmented Reality Research: A Network and Cluster Analysis of the Literature. *Frontiers in Psychology*, *9*, 1–20. https://doi.org/https://doi.org/10.3389/fpsyg.2018.02086

Clay, F., Hunt, R., Obiefuna, N., Solly, J. E., Watson, E., Wilkinson, A., Chohan, R., Hatfield, C., Fletcher, P. C., & Underwood, B. R. (2024). The Use of Immersive Virtual Reality in Sensory Sessions on a Specialist Dementia Unit: Service Evaluation of Feasibility and Acceptability, Occupational Therapy In Health Care. *Occupational Therapy in Health Care*, *38*(2), 317–330. https://doi.org/https://doi.org/10.1080/07380577.2023.2270052

Clifton, J., & Palmisano, S. (2019). Effects of Steering Locomotion and Teleporting on Cybersickness and Presence in HMD-Based Virtual Reality. *Virtual Reality 2019 24:3*, *24*(3), 453–468. https://doi.org/https://doi.org/10.1007/S10055-019-00407-8

Coelho, C. M., Waters, A. M., Hine, T. J., & Wallis, G. (2009). The Use of Virtual Reality in Acrophobia Research and Treatment. *Journal of Anxiety Disorders*, *23*, 563–574. https://doi.org/https://doi.org/10.1016/j.janxdis.2009.01.014

Coelho, T., Marques, C., Moreira, D., Soares, M., Portugal, P., Marques, A., Ferreira, A. R., Martins, S., & Fernandes, L. (2020). Promoting Reminiscences with Virtual Reality Headsets: A Pilot Study with People with Dementia. *International Journal of Environmental Research and Public Health*, *17*(24), 1–13. https://doi.org/https://doi.org/10.3390/ijerph17249301

Cohen-Mansfield, J., Marx, M. S., Freedman, L. S., Murad, H., Regier, N. G., Thein, K., & Dakheel-Ali, M. (2011). The Comprehensive Process Model of Engagement. *The American Journal of Geriatric Psychiatry*, *19*(10), 859–870. https://doi.org/https://doi.org/10.1097/JGP.0B013E318202BF5B

Cohen-Mansfield, J., Shmotkin, D., & Hazan, H. (2010). The Effect of Homebound Status on Older Persons. *Journal of the American Geriatrics Society*, *58*(12), 2358–2362. https://doi.org/https://doi.org/10.1111/J.1532-5415.2010.03172.X

Coldham, G., & Cook, D. M. (2017). VR Usability from Elderly Cohorts: Preparatory Challenges in Overcoming Technology Rejection. *National InformationTechnology Conference*. https://doi.org/https://doi.org/10.1109/NITC.2017.8285645

Collins, M. E. (2018). Occupational Therapists' Experience with Assistive Technology in Provision of Service to Clients with Alzheimer's Disease and Related Dementias. *Physical and Occupational Therapy in Geriatrics*, *36*(2–3), 179–188. https://doi.org/https://doi.org/10.1080/02703181.2018.1458770

Costa, R. Q. M. da, Pompeu, J. E., de Mello, D. D., Moretto, E., Rodrigues, F. Z., Dos Santos, M. D., Nitrini, R., Morganti, F., & Brucki, S. M. D. (2018). Two New Virtual Reality Tasks for the Assessment of Spatial Orientation: Preliminary Results of Tolerability, Sense of Presence and Usability. *Dementia e Neuropsychologia*, *12*(2), 196–204. https://doi.org/https://doi.org/10.1590/1980-57642018dn12-020013

Costello, H., Cooper, C., Marston, L., & Livingston, G. (2019). Burnout in UK Care Home Staff and its Effect on Staff Turnover: MARQUE English National Care Home Longitudinal Survey. *Age and Ageing*, *49*(1), 74–81. https://doi.org/https://doi.org/10.1093/ageing/afz118

Costello, H., Walsh, S., Cooper, C., & Livingston, G. (2019). A Systematic Review and Meta-Analysis of the Prevalence and Associations of Stress and Burnout among Staff in Long-Term Care Facilities for People with Dementia. *International Psychogeriatrics*, *31*(8), 1203–1216. https://doi.org/https://doi.org/10.1017/S1041610218001606

Cotelli, M., Manenti, R., & Zanetti, O. (2012). Reminiscence Therapy in Dementia: A Review. *Maturitas*, *72*(3), 203–205. https://doi.org/hhttps://doi.org/10.1016/J.MATURITAS.2012.04.008

Cunningham, E., McGuinness, B., Herron, B., & Passmore, A. (2015). Dementia. *The Ulster Medical Journal*, *84*(2), 79. https://doi.org/10.1177/0091217416636579

Czech, O., Rutkowski, S., Kowaluk, A., Kiper, P., & Malicka, I. (2023). Virtual Reality in Chemotherapy Support for the Treatment of Physical Functions, Fear, and Quality of Life in Pediatric Cancer Patients: A Systematic Review and Meta-Analysis. In *Frontiers in Public Health* (Vol. 11). Frontiers Media S.A. https://doi.org/http://doi.org/10.3389/fpubh.2023.1039720

Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly* , *13*(3), 319–340. https://www.jstor.org/stable/249008#metadata_info_tab_contents

D'Cunha, N. M., Isbel, S. T., Frost, J., Fearon, A., McKune, A. J., Naumovski, N., & Kellett, J. (2021). Effects of a Virtual Group Cycling Experience on People Living with Dementia: A Mixed Method Pilot Study. *Dementia*, *20*(5), 1518–1535. https://doi.org/https://doi.org/10.1177/1471301220951328

D’Cunha, N. M., Nguyen, D., Naumovski, N., McKune, A. J., Kellett, J., Georgousopoulou, E. N., Frost, J., & Isbel, S. (2019). A Mini-Review of Virtual Reality-Based Interventions to Promote Well-Being for People Living with Dementia and Mild Cognitive Impairment. In *Gerontology* (Vol. 65, Issue 4, pp. 430–440). S. Karger AG. https://doi.org/https://doi.org/10.1159/000500040

D’cunha, N. M., Nguyen, D., Naumovski, N., Mckune, A. J., Kellett, J., Georgousopoulou, E. N., Frost, J., Isbel, S., Martin, N., & Cunha, D. ’. (2019). A Mini-Review of Virtual Reality-Based Interventions to Promote Well-being for People Living with Dementia and Mild Cognitive Impairment. *Gerontology*, 430–440. https://doi.org/https://doi.org/10.1159/000500040

De Boer, B., Hamers, J. P. H., Zwakhalen, S. M. G., Tan, F. E. S., & Verbeek, H. (2017). Quality of Care and Quality of Life of People with Dementia Living at Green Care Farms: A Cross-Sectional Study. *BMC Geriatrics*, *17*, 1–10. https://doi.org/https://doi.org/10.1186/s12877-017-0550-0

De Luca, R., Leonardi, S., Portaro, S., Le Cause, M., De Domenico, C., Colucci, P. V., Pranio, F., Bramanti, P., & Calabrò, R. S. (2021). Innovative Use of Virtual Reality in Autism Spectrum Disorder: A Case-Study. *Applied Neuropsychology: Child*, *10*(1), 90–100. https://doi.org/https://doi.org/10.1080/21622965.2019.1610964

Deighan, M. T., Ayobi, A., & O’Kane, A. A. (2023). Social Virtual Reality as a Mental Health Tool: How People Use VRChat to Support Social Connectedness and Wellbeing. *In Proceedings of the Conference on Human Factors in Computing Systems*, 1–13. https://doi.org/https://doi.org/10.1145/3544548.3581103

Dementia UK. (2024a). *Medication for People Living with Dementia*. Dementia UK. https://www.dementiauk.org/information-and-support/health-advice/medication-for-people-living-with-dementia/

Dementia UK. (2024b). *What is Dementia?* Dementia UK. https://www.dementiauk.org/information-and-support/about-dementia/what-is-dementia/

Dichter, M. N., Ettema, T. P., Schwab, C. G. G., Meyer, G., Bartholomeyczik, S., Halek, M., Dröes, R.-M., Rose-, P., & Dröes, M. (2016). *QUALIDEM User Guide*. DZNE & VUmc. http://www.dzne.de/en/sites/witten/projekte/qol-dem.htmlhttp://www.emgo.nl/team/190/rose-mariedroes/publications/

Djabelkhir, L., Wu, Y. H., Vidal, J. S., Cristancho-Lacroix, V., Marlats, F., Lenoir, H., Carno, A., & Rigaud, A. S. (2017). Computerized cognitive stimulation and engagement programs in older adults with mild cognitive impairment: Comparing feasibility, acceptability, and cognitive and psychosocial effects. *Clinical Interventions in Aging*, *12*, 1967–1975. https://doi.org/https://doi.org/10.2147/CIA.S145769

Donaldson, C., Tarrier, N., & Burns, A. (1998). Determinants of Carer Stress in Alzheimer's Disease. *International Journal of Geriatric Psychiatry*, *13*(4), 248–256. https://doi.org/https://doi.org/10.1002/(SICI)1099-1166(199804)13:4<248::AID-GPS770>3.0.CO;2-0

Duong, S., Patel, T., & Chang, F. (2017). Dementia: What Pharmacists Need to Know. *Canadian Pharmacists Journal*, *150*(2), 118–129. https://doi.org/https://doi.org/10.1177/1715163517690745

Edmeads, J., & Metatla, O. (2019). Designing for Reminiscence with People with Dementia. *In Proceedings of the Conference on Human Factors in Computing Systems* , 1–6. https://doi.org/https://doi.org/10.1145/3290607.3313059

Edvardsson, D., Fetherstonhaugh, D., & Nay, R. (2010). Promoting a Continuation of Self and Normality: Person-Centred Care as Described by People with Dementia, their Family Members and Aged Care Staff. *Journal of Clinical Nursing*, *19*(17–18), 2611–2618. https://doi.org/https://doi.org/10.1111/J.1365-2702.2009.03143.X

Eghtesadi M. (2020). Taking the Right Measures to Control COVID-19: A Viewpoint on Improving Access to Technology in Long-Term Care Facilities. *Journal of the American Geriatrics Society*, *68*(5), 949–950. https://doi.org/https://doi.org/10.1111/jgs.16478

Ehizogie, P. A., Chioma, A. O., & Olumuyiwa, T. O. (2024). A Review of the Integration of Virtual Reality in Healthcare: Implications for Patient Education and Treatment Outcomes. *International Journal of Science and Technology Research Archive*, *6*(1), 079–088. https://doi.org/https://doi.org10.53771/ijstra.2024.6.1.0032

Emmelkamp, P. M. G., & Meyerbröker, K. (2021). Virtual Reality Therapy in Mental Health. *Annual Review of Clinical Disorder*, 495–419. https://doi.org/https://doi.org/10.1146/annurev-clinpsy-081219

Eppes, E. V., Augustyn, M., Gross, S. M., Vernon, P., Caulfield, L. E., & Paige, D. M. (2023). Engagement with and Acceptability of Digital Media Platforms for Use in Improving Health Behaviors among Vulnerable Families: Systematic

Review. *Journal of Medical Internet Research*, *25*(1), e40934. https://doi.org/https://doi.org/10.2196/40934

Evans, N., & Collier, L. (2019). An Exploration of the Experience of Using Calendar Reminders for People with Dementia and Family Carers. *Dementia*, *18*(5), 1912–1933. https://doi.org/https://doi.org/10.1177/1471301217734916

Farra, S. L., Gneuhs, M., Hodgson, E., Kawosa, B., Miller, E. T., Simon, A., Timm, N., & Hausfeld, J. (2019). Comparative Cost of Virtual Reality Training and Live Exercises for Training Hospital Workers for Evacuation HHS Public Access. *Comput Inform Nurs*, *37*(9), 446–454. https://doi.org/https://doi.org/10.1097/CIN.0000000000000540

Fjelltun, A.-M. R., Henriksen, N., Norberg, A., Gilje, F., Ketil Normann, H., & Rnt, R. (2009). Functional Levels and Nurse Workload of Elderly Awaiting Nursing Home Placement and Nursing Home Residents: A Comparative Study. *Scandinavian Journal of Caring Sciences*, *23*(4), 736–747. https://doi.org/https://doi.org/10.1111/j.1471-6712.2008.00672.x

Flynn, A., David Healy, Barry, M., Brennan, A., Redfern, S., Houghton, C., & Casey, D. (2022). Key Stakeholders' Experiences and Perceptions of Virtual Reality for Older Adults Living With Dementia: Systematic Review and Thematic Synthesis. *JMIR Serious Games*, *10*(4), 1–21. https://doi.org/https://doi.org/10.2196/37228

Flynn, D., Schaik, P. Van, Blackman, T., Femcott, C., Hobbs, B., & Calderon, C. (2003). Developing a Virtual Reality-Based Methodology for People with

Dementia: A Feasibility Study. *CyberPsychology & Behavior*, *6*(6), 591–611. https://doi.org/https://doi.org/10.1089/109493103322725379

Foà, C., Guarnieri, M. C., Bastoni, G., Benini, B., Giunti, O. M., Mazzotti, M., Rossi, C., Savoia, A., Sarli, L., & Artioli, G. (2020). Job Satisfaction, Work Engagement and Stress/Burnout of Elderly Care Staff: A Qualitative Research. *Acta Bio Medica* , *91*(Suppl 12), 1–12. https://doi.org/https://doi.org/10.23750/ABM.V91I12-S.10918

Foloppe, D. A., Richard, P., Yamaguchi, T., Etcharry-Bouyx, F., & Allain, P. (2018). The Potential of Virtual Reality-Based Training to Enhance the Functional Autonomy of Alzheimer's Disease Patients in Cooking Activities: A Single Case Study. *Neuropsychological Rehabilitation*, *28*(5), 709–733. https://doi.org/https://doi.org/10.1080/09602011.2015.1094394

Fossey, A., Masson, J. ;, & Stafford, S. ; (2014). The Disconnect between Evidence and Practice: A Systematic Review of Person-Centred Interventions and Training Manuals for Care Home Staff Working with People with Dementia. *International Journal Og Geriatric Psychiatry*. https://doi.org/https://doi.org/1o.1002/gps.4072

Franzosa, E., Gorbenko, K., Brody, A. A., Leff, B., Ritchie, C. S., Kinosian, B., Sheehan, O. C., Federman, A. D., & Ornstein, K. A. (2021). "There Is Something Very Personal About Seeing Someone's Face": Provider Perceptions of Video Visits in Home-Based Primary Care During COVID-19. *Journal of Applied Gerontology*, *40*(11), 1417–1424. https://doi.org/https://doi.org/10.1177/07334648211028393

Freeman, D., Rosebrock, L., Waite, F., Loe, B. S., Kabir, T., Petit, A., Dudley, R., Chapman, K., Morrison, A., O'Regan, E., Aynsworth, C., Jones, J., Murphy, E., Powling, R., Peel, H., Walker, H., Byrne, R., Freeman, J., Rovira, A., … Lambe, S. (2023). Virtual Reality (VR) Therapy for Patients with Psychosis: Satisfaction and Side Effects. *Psychological Medicine*, *53*(10), 4373–4384. https://doi.org/https://doi.org/10.1017/S0033291722001167

Freitas, R., Peres, B., & Campos, P. (2021). Virtual Reality Exposure Treatment in Phobias: a Systematic Review. *Psychiatric Quarterly*, *92*(4), 1685–1710. https://doi.org/https://doi.org/10.1007/s11126-021-09935-6

Gandhi, R. D., & Patel, D. S. (2018). Virtual Reality- Opportunities and Challenges. *International Research Journal of Engineering and Technology* , *5*(1), 482–490. www.irjet.net

Garcia, L., Kartolo, A., & Methot-Curtis, E. (2012). A Discussion of the Use of Virtual Reality in Dementia. In *Virtual Reality in Psychological, Medical and Pedagogical Applications* (pp. 123–136). InTech. https://doi.org/http://dx.doi.org/10.5772/46412

García-Betances, R. I., Jiménez-Mixco, V., Arredondo, M. T., & Cabrera-Umpiérrez, M. F. (2015). Using Virtual Reality for Cognitive Training of the Elderly. *American Journal of Alzheimer's Disease and Other Dementias*, *30*(1), 49–54. https://doi.org/https://doi.org/10.1177/1533317514545866

Garrett, B., Taverner, T., Gromala, D., Tao, G., Cordingley, E., & Sun, C. (2018). Virtual Reality Clinical Research: Promises and Challenges. *JMIR Serious Games*, *6*(4), e10839. https://doi.org/https://doi.org/10.2196/10839

Gaspar, P., Westberg, K., Baker, A., Dunlap, T., & Nordlinger, K. (2018). What are the QoL Outcomes of a Group Virtual Reality Experience for Assisted Living and Independent Living Residents? *Innovation in Aging*, *2*. https://doi.org/https://doi.org/10.1093/geroni/igy031.3751

Gasteiger, N., Ahn, H. S., Fok, C., Lim, J. Y., Lee, C., MacDonald, B. A., Kim, G. H., & Broadbent, E. (2022). Older Adults' Experiences and Perceptions of Living with Bomy, an Assistive Daily Care Robot: A Qualitative Study. *Assistive Technology*, *34*(4), 487–497. https://doi.org/https://doi.org/10.1080/10400435.2021.1877210

Gasteiger, N., van der Veer, S. N., Wilson, P., & Dowding, D. (2022). How, for Whom, and in Which Contexts or Conditions Augmented and Virtual Reality Training Works in Upskilling Health Care Workers: Realist Synthesis. *JMIR Serious Games*, *10*(1). https://doi.org/https://doi.org//10.2196/31644

Gaugler, J. E. (2010). Family Involvement in Residential Long-Term Care: A Synthesis and Critical Review. *Aging & Mental Health*, *9*(2), 105–118. https://doi.org/https://doi.org/10.1080/13607860412331310245

Gaugler, J. E., & Mitchell, L. L. (2022). Reimagining Family Involvement in Residential Long-Term Care. *Journal of the American Medical Directors Association*, *23*(2), 235–240. https://doi.org/https://doi.org/10.1016/j.jamda.2021.12.022

Gedde, M. H., Husebo, B. S., Erdal, A., Puaschitz, N. G., Vislapuu, M., Angeles, R. C., & Berge, L. I. (2021). Access to and Interest in Assistive Technology for Home-Dwelling People with Dementia during the COVID-19 Pandemic

(PAN.DEM). *International Review of Psychiatry*, *33*(4), 404–411. https://doi.org/https://doi.org/10.1080/09540261.2020.1845620

Geletta, S. (2013). Administrator Turnover and Quality of Care in Nursing Homes. *Annals of Long-Term Care*, *21*(4), 27–30. https://www.hmpgloballearningnetwork.com/site/altc/articles/administrator-turnover-and-quality-care-nursing-homes

Geraets, C. N. W., Van Der Stouwe, E. C. D., Pot-Kolder, R., & Veling, W. (2021). Advances in Immersive Virtual Reality Interventions for Mental Disorders: A New Reality? *Current Opinion in Psychology*, *41*, 40–45. https://doi.org/https://doi.org/10.1016/j.copsyc.2021.02.004

Gerardi, M., Rothbaum, B. O., Ressler, K., Heekin, M., & Rizzo, A. (2008). Virtual Reality Exposure Therapy Using a Virtual Iraq: Case Report. *Journal of Traumatic Stress*, *21*(2), 209–213. https://doi.org/https://doi.org/10.1002/JTS.20331

Gerling, W. (2018). Photography in the Digital: Screenshot and in-Game Photography. *Photographies*, *11*(2–3), 149–167. https://doi.org/https://doi.org/10.1080/17540763.2018.1445013

Gil, I. M. de A., Costa, P. J. D. S., Bobrowicz-Campos, E. M., Cardoso, D. F. B., de Almeida, M. de L. F., & Apóstolo, J. L. A. (2017). Reminiscence Therapy: Development of a Program for Institutionalized Older People with Cognitive Impairment. *Revista de Enfermagem Referencia*, *4*(15), 121–132. https://doi.org/https://doi.org/10.12707/RIV17052

Girvan, C. (2018). What is a Virtual World? Definition and Classification. *Educational Technology Research and Development*, *66*(5), 1087–1100. https://doi.org/https://doi.org/10.1007/s11423-018-9577-y

Glasgow, R. E., Vogt, T. M., Boles, S. M., & Glasgow, E. (1999). Evaluating the Public Health Impact of Health Promotion Interventions: The RE-AIM Framework. *American Journal of Public Health*, *89*(9), 1322–1327. https://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.89.9.1322

Gómez-Romero, M., Jiménez-Palomares, M., Rodríguez-Mansilla, J., Flores-Nieto, A., Garrido-Ardila, E. M., & González-López-Arza, M. V. (2017). Benefits of Music Therapy on Behaviour Disorders in Subjects Diagnosed with Dementia: A Systematic Review. *Neurología (English Edition)*, *32*(4), 253–263. https://doi.org/https://doi.org/10.1016/j.nrleng.2014.11.003

Gong, M., Xu, Y., & Yu, Y. (2004). An Enhanced Technology Acceptance Model for Web-Based Learning. *Journal of Information Systems Education*, *15*(4), 365–374.

Grand, J. H. G., Caspar, S., & MacDonald, S. W. S. (2011a). Clinical Features and Multidisciplinary Approaches to Dementia Care. *Journal of Multidisciplinary Healthcare*, *4*, 125–147. https://doi.org/10.2147/JMDH.S17773

Grand, J. H. G., Caspar, S., & MacDonald, S. W. S. (2011b). Clinical Features and Multidisciplinary Approaches to Dementia Care. *Journal of Multidisciplinary Healthcare*, *4*, 125–147. https://doi.org/https://doi.org/10.2147/JMDH.S17773

Gräske, J., Meyer, S., & Wolf-Ostermann, K. (2014). Quality of Life Ratings in Dementia Care: A Cross-Sectional Study to Identify Factors Associated with Proxy-Ratings. *Health and Quality of Life Outcomes*, *12*, 1–11. https://doi.org/https://doi.org/10.1186/s12955-014-0177-1

Groeneweg-Koolhoven, I., De Waal, M. W. M., Van Der Weele, G. M., Gussekloo, J., & Van Der Mast, R. C. (2014). Quality of Life in Community-Dwelling Older Persons with Apathy. *American Journal of Geriatric Psychiatry*, *22*, 186–194. https://doi.org/https://doi.org/10.1016/j.jagp.2021.10.024

Guest, G., MacQueen, K., & Namey, E. (2012). Introduction to Applied Thematic Analysis. In *Applied Thematic Analysis*. SAGE Publications, Inc. https://methods.sagepub.com/book/applied-thematic-analysis

Gulliver, A., Calear, A. L., Sunderland, M., Kay-Lambkin, F., Farrer, L. M., & Batterham, P. J. (2021). Predictors of acceptability and engagement in a self-guided online program for depression and anxiety. *Internet Interventions*, *25*, 1–9. https://doi.org/https://doi.org/10.1016/J.INVENT.2021.100400

Hadwen, T., Smallbon, V., Zhang, Q., & D'Souza, M. (2017). Energy Efficient LoRa GPS Tracker for Dementia Patients. *Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS*, 771–774. https://doi.org/https://doi.org/10.1109/EMBC.2017.8036938

Halbig, A., Babu, S. K., Gatter, S., Latoschik, M. E., Brukamp, K., & von Mammen, S. (2022). Opportunities and Challenges of Virtual Reality in

Healthcare – A Domain Experts Inquiry. *Frontiers in Virtual Reality*, *3*. https://doi.org/https://doi.org/10.3389/frvir.2022.837616

Harmer, B. J., & Orrell, M. (2008). What is Meaningful Activity for People with Dementia Living in Care Homes? A Comparison of the Views of Older People with Dementia, Staff and Family Carers. *Aging and Mental Health*, *12*(5), 548–558. https://doi.org/https://doi.org/10.1080/13607860802343019

Harrington, C., Woolhandler, S., Mullan, J., Carrillo, H., & Himmelstein, D. U. (2001). Does Investor Ownership of Nursing Homes Compromise the Quality of Care? *American Journal of Public Health*, *91*(9), 1452–1455. https://doi.org/https://doi.org/10.2105/AJPH.91.9.1452

Harth, J. (2018). Being There, Being Someone Else: Leisure and Identity in the Age of Virtual Reality. In *Global Leisure and the Struggle for a Better World* (pp. 141–159). Springer International Publishing. https://doi.org/https://doi.org/10.1007/978-3-319-70975-8_7

Hayhurst, J. (2018). How Augmented Reality and Virtual Reality is Being Used to Support People Living with Dementia—Design Challenges and Future Directions. In *Augmented Reality and Virtual Reality* (pp. 295–305). Springer, Cham. https://doi.org/hhttps://doi.org/10.1007/978-3-319-64027-3_20

Hennelly, N., Cooney, A., Houghton, C., & O'Shea, E. (2021). Personhood and Dementia care: A Qualitative Evidence Synthesis of the Perspectives of People with Dementia. *The Gerontologist*, *61*(3), E85–E100. https://doi.org/https://doi.org//10.1093/GERONT/GNZ159

Hennings, J., Froggatt, K., & Payne, S. (2013). Spouse Caregivers of People with Advanced Dementia in Nursing Homes: A Longitudinal Narrative Study. *Palliative Medicine*, *27*(7), 683–691. https://doi.org/https://doi.org/10.1177/0269216313479685

Hicks, B., Karim, A., Jones, E., Burgin, M., Cutler, C., Tang, W., Thomas, S., & Nyman, S. R. (2022). Care Home Practitioners' Perceptions of the Barriers and Facilitators for Using off-the-Shelf Gaming Technology with People with Dementia. *Dementia*. https://doi.org/https://doi.org/10.1177/14713012221085229

Hicks, B., Konovalova, I., Myers, K., Falconer, L., & Board, M. (2023). Taking "A Walk through Dementia: Exploring Care Home Practitioners" Experiences of Using a Virtual Reality Tool to Support Dementia Awareness. *Ageing & Society*, *43*, 1042–1067. https://doi.org/https://doi.org/10.1017/S0144686X21000994

Hodge, J., Balaam, M., Hastings, S., & Morrissey, K. (2018). Exploring the Design of Tailored Virtual Reality Experiences for People with Dementia. *In Proceedings of the Conference on Human Factors in Computing Systems , 2018-April*, 1–13. https://doi.org/https://doi.org/10.1145/3173574.3174088

Hodges, H., Fealko, C., & Soares, N. (2020). Autism Spectrum Disorder: Definition, Epidemiology, Causes, and Clinical Evaluation. *Translational Pediatrics*, *9*(Suppl 1), S55. https://doi.org/https://doi.org/10.21037/TP.2019.09.09

Hoe, J., & Thompson, R. (2010). Promoting Positive Approaches to Dementia Care in Nursing. *Nursing Standard*, *25*(4), 47–56. www.nursing-standard.co.uk.

Hogan-Murphy, D., Stewart, D., Tonna, A., Strath, A., & Cunningham, S. (2021). Use of Normalization Process Theory to Explore Key Stakeholders' Perceptions of the Facilitators and Barriers to Implementing Electronic Systems for Medicines Management in Hospital Settings. *Research in Social and Administrative Pharmacy*, *17*, 398–405. https://doi.org/https://doi.org/10.1016/j.sapharm.2020.03.005

Holthe, T., Halvorsrud, L., Karterud, D., Hoel, K. A., & Lund, A. (2018). Usability and Acceptability of Technology for Community-Dwelling Older Adults with Mild Cognitive Impairment and Dementia: A Systematic Literature Review. *Clinical Interventions in Aging*, *13*, 863–886. https://doi.org/https://doi.org/10.2147/CIA.S154717

Holthe, T., Halvorsrud, L., & Lund, A. (2022). Digital Assistive Technology to Support Everyday Living in Community-Dwelling Older Adults with Mild Cognitive Impairment and Dementia. *Clinical Interventions in Aging*, *17*, 519–544. https://doi.org/https://doi.org/10.2147/CIA.S357860

Houben, M., Brankaert, R., Bakker, S., Kenning, G., Bongers, I., & Eggen, B. (2019). Foregrounding Everyday Sounds in Dementia. *In Proceedings of the 2019 ACM Designing Interactive Systems Conference*, 71–83. https://doi.org/https://doi.org/10.1145/3322276.3322287

Hsieh, M. C., & Lee, J. J. (2018). Preliminary Study of VR and AR Applications in Medical and Healthcare Education. *Journal of Nursing and Health Studies*, *3*(1), 1–5. https://doi.org/https://doi.org/10.21767/2574-2825.100030

Hu-Au, E., Lee, J., Lee, J. J., Hu-Au, E., & Lee, J. (2017). Virtual Reality in Education: A Tool for Learning in the Experience Age. *International Journal of Innovation in Education*, *4*(4), 215–226. https://doi.org/http://doi.org/10.1504/IJIIE.2017.10012691

Hughes, S., Warren-Norton, K., Spadafora, P., & Tsotsos, L. E. (2017). Supporting Optimal Aging through the Innovative Use of Virtual Reality Technology. *Multimodal Technologies and Interaction*, *1*(4). https://doi.org/http://doi.org/10.3390/mti1040023

Hung, L., Mann, J., Wallsworth, C., Upreti, M., Kan, W., Temirova, A., Wong, K. L. Y., Ren, H., To-Miles, F., Wong, J., Lee, C., Kar Lai So, D., & Hardern, S. (2023). Facilitators and Barriers to Using Virtual Reality and its Impact on Social Engagement in Aged Care Settings: A Scoping Review. *Gerontology and Geriatric Medicine*, *9*, 1–16. https://doi.org/https://doi.org/10.1177.23337214231166355

Hussain, S., Qazi, S., Ahmed, R. R., Vveinhardt, J., & Streimikiene, D. (2019). Innovative User Engagement and Playfulness on Adoption Intentions of Technological Products: Evidence from SEM-based Multivariate Approach. *Economic Research-Ekonomska Istraživanja*, *32*(1), 555–577. https://doi.org/https://doi.org/10.1080/1331677X.2018.1558086

Ijaz, K., Ahmadpour, N., Naismith, S. L., & Calvo, R. A. (2019). An Immersive Virtual Reality Platform for Assessing Spatial Navigation Memory in Predementia Screening: Feasibility and Usability Study. *JMIR Mental Health*, *6*(9), e13887. https://doi.org/https://doi.org/10.2196/13887

Ijaz, K., Tran, T. M., Kocaballi, A. B., Calvo, R. A., Berkovsky, S., & Ahmadpour, N. (2022). Design Considerations for Immersive Virtual Reality Applications for Older Adults: A Scoping Review. *Multimodal Technologies and Interaction*, *6*(7), 1–26. https://doi.org/https://doi.org/10.3390/mti6070060

Islam, M. S., Baker, C., Huxley, P., Russell, I. T., & Dennis, M. S. (2017). The Nature, Characteristics and Associations of Care Home Staff Stress and Wellbeing: A National Survey. *BMC Nursing*, *16*(1), 1–10. https://doi.org/https://doi.org/10.1186/S12912-017-0216-4/TABLES/4

Jawharieh, H., Tabbaa, L., Siang Ang, C., Cheung, E., & Covaci, A. (2024). Care Beyond Borders: Investigating Virtual Reality Deployment Opportunities & Challenges Through the Lens of Dementia Care. *International Journal of Human-Computer Interaction*, 1–19. https://doi.org/https://doi.org/10.1080/10447318.2024.2400400

Jia, P., Lu, Y., & Wajda, B. (2015). Designing for Technology Acceptance in an Ageing Society Through Multi-Stakeholder Collaboration. *Procedia Manufacturing*, *3*, 3535–3542. https://doi.org/https://doi.org/10.1016/j.promfg.2015.07.701

Jones, C., Jones, D., & Moro, C. (2021). Use of Virtual and Augmented Reality-Based Interventions in Health Education to Improve Dementia Knowledge and Attitudes: An Integrative Review. *BMJ Open*, *11*, 53616. https://doi.org/https://doi.org/10.1136/bmjopen-2021-053616

Jones, C., Sung, B., & Moyle, W. (2015). Assessing Engagement in People with Dementia: A New Approach to Assessment Using Video Analysis. *Archives of*

Psychiatric Nursing, *29*(6), 377–382. https://doi.org/https://doi.org/10.1016/j.apnu.2015.06.019

Jones, C., Sung, B., & Moyle, W. (2018a). Engagement of a Person with Dementia Scale: Establishing Content Validity and Psychometric Properties. *Journal of Advanced Nursing*, *74*(9), 2227–2240. https://doi.org/https://doi.org/

Jones, C., Sung, B., & Moyle, W. (2018b). Engagement of a Person with Dementia Scale: Establishing Content Validity and Psychometric Properties. *Journal of Advanced Nursing*, *74*(9), 2227–2240. https://doi.org/https://doi.org/10.1111/jan.13717

Jung, J.-Y., Park, S.-Y., & Kim, J.-K. (2018). The Effects of a Client-Centered Leisure Activity Program on Satisfaction, Self-Esteem, and Depression in Elderly Residents of a Long-Term Care Facility. *Journal of Physical Therapy Science*, *30*(1), 73–76. https://www.jstage.jst.go.jp/article/jpts/30/1/30_jpts-2017-431/_pdf

Jütten, L. H., Mark, R. E., & Sitskoorn, M. M. (2018). Can the Mixed Virtual Reality Simulator Into Dementia Enhance Empathy and Understanding and Decrease Burden in Informal Dementia Caregivers? *Dementia and Geriatric Cognitive Disorders Extra*, *8*(3), 453–466. https://doi.org/https://doi.org/10.1159/000494660

Juul, A., Wilding, R., & Baldassar, L. (2019). The Best Day of the Week: New Technology Enhancing Quality of Life in a Care Home. *International Journal of Environmental Research and Public Health*, *16*(6). https://doi.org/https://doi.org/10.3390/ijerph16061000

Kane, R. A. (2001). The Forum Long-Term Care and a Good Quality of Life: Bringing them Closer Together. *The Gerontologist*, *41*(3), 293–304. https://doi.org/https://academic.oup.com/gerontologist/article/41/3/293/632406

Kang, M., Kim, T., Kim, Y., & Ahn, J. (2015). FamCom: A Communication Service Enhancing Conversation Quality Between Elders Residing in Care Hospital and their Family Member. *In Proceedings of the Conference on Human Factors in Computing Systems*, *18*, 13–18. https://doi.org/https://doi.org/10.1145/2702613.2726952

Kang, Y., Hur, Y., Tuckett, G., & Tchounwou, P. B. (2021). Nurses' Experience of Nursing Workload-Related Issues during Caring Patients with Dementia: A Qualitative Meta-Synthesis. *International Journal of Environmental Research and Public Health 2021, Vol. 18, Page 10448*, *18*(19), 10448. https://doi.org/https://doi.org/10.3390/IJERPH181910448

Kang, Y. J., & Ku, J. (2008). Development and Clinical Trial of Virtual Reality-Based Cognitive Assessment in People with Stroke: Preliminary Study. *CyberPsychology & Behavior*, *11*(3), 329–339. https://doi.org/https://doi.org/10.1089/cpb.2007.0116

Karaosmanoglu, S., Kruse, L., Stein, C., Steinicke, F., & Rings, S. (2021). Lessons Learned from a Human-Centered Design of an Immersive Exergame for People with Dementia; Lessons Learned from a Human-Centered Design of an Immersive Exergame for People with Dementia. *In the Proceedings of the ACM Human-Computer Interaction*, *5*, 1–27. https://doi.org/https://doi.org/10.1145/3474679

Karlsson, S., Bleijlevens, M., Roe, B., Saks, K., Soto Martin, M., Stephan, A., Suhonen, R., Zabalegui, A., Karlsson Assistant Professor, S. R., Roe RHV Professor, B. R., Saks Associate Professor, K., Stephan MScN, A. R., Suhonen Professor, R. R., Zabalegui FEANS Director of Nursing, A. R., & Hallberg FEANS FAAN Senior Professor, I. R. (2014). Dementia Care in European Countries, from the Perspective of People with dementia and their Caregivers. *Journal of Advanced Nursing*, *71*(6), 1405–1416. https://doi.org/https://doi.org/10.1111/jan.12581

Ke, F., Moon, J., & Sokolikj, Z. (2022). Virtual Reality–Based Social Skills Training for Children With Autism Spectrum Disorder. *Journal of Special Education Technology*, *37*(1), 49–62. https://doi.org/10.1177/0162643420945603

Kelley, R., Griffiths, A. W., Shoesmith, E., McDermid, J., Couch, E., Robinson, O., Perfect, D., & Surr, C. A. (2020). The Influence of Care Home Managers on the Implementation of a Complex Intervention: Findings from the Process Evaluation of a Randomised Controlled Trial of Dementia Care Mapping. *BMC Geriatrics*, *20*(1). https://doi.org/https://doi.org/10.1186/s12877-020-01706-5

Keswani, B., Mohapatra, A. G., Mishra, T. C., Keswani, P., Mohapatra, P. C. G., Akhtar, M. M., & Vijay, P. (2020). World of Virtual Reality (VR) in Healthcare. In *Advanced Computational Intelligence Techniques for Virtual Reality in Healthcare* (Vol. 875, pp. 1–23). Springer, Cham. https://doi.org/https://doi.org/10.1007/978-3-030-35252-3_1

Khosla, R., Nguyen, K., & Chu, M.-T. (2017). Human Robot Engagement and Acceptability in Residential Aged Care. *International Journal of Human-*

Computer Interaction, *33*(6), 510–522. https://doi.org/10.1080/10447318.2016.1275435

Kim, J. H., Park, S., & Lim, H. (2021). Developing a Virtual Reality for People with Dementia in Nursing Homes Based on their Psychological Needs: A Feasibility Study. *BMC Geriatrics*, *21*(1), 1–10. https://doi.org/https://doi.org/10.1186/S12877-021-02125-W

Kim, K.-U., Kim, S.-H., & Oh, H.-W. (2017). The Effects of Occupation-Centered Activity Program on Fall-Related Factors and Quality of Life in Patients with Dementia. *The Journal of Physical Therapy Science*, *29*, 1188–1191. https://doi.org/https://doi.org/10.1589/jpts.29.1188

Kim, O., Pang, Y., & Kim, J.-H. (2019). The Effectiveness of Virtual Reality for People with Mild Cognitive Impairment or Dementia: A Meta-Analysis. *BMI Psychiatry*, *19*, 1–10. https://doi.org/https://doi.org/10.1186/s12888-019-2180-x

Kirkevold, Ø., & Engedal, K. (2006). The quality of care in Norwegian nursing homes. *Scandinavian Journal of Caring Sciences*, *20*(2), 177–183. https://doi.org/https://doi.org/10.1111/J.1471-6712.2006.00396.X

Kitching, D. (2015). Depression in Dementia. *Australian Prescriber*, *38*(6), 209. https://doi.org/https://doi.org/10.18773/AUSTPRESCR.2015.071

Kleinberger, R., Rieger, A., Sands, J., & Baker, J. (2019). Supporting Elder Connectedness through Cognitively Sustainable Design Interactions with the Memory Music Box. *In Proceedings of the 32nd Annual ACM Symposium on User Interface Software and Technology*, 355–369. https://doi.org/https://doi.org/10.1145/3332165.3347877

Koru, G., Alhuwail, D., Topaz, M., & Norcio, A. F. (2016). Investigating the Challenges and Opportunities In-Home Care to Facilitate Effective Information Technology Adoption. *Journal of the American Medical Directors Association*, *17*(1), 53–58. https://doi.org/https://doi.org/10.1016/j.jamda.2015.10.008

Kouijzer, M. M. T. E., Kip, H., Bouman, Y. H. A., & Kelders, S. M. (2023). Implementation of Virtual Reality in Healthcare: A Scoping Review on the Implementation Process of Virtual Reality in Various Healthcare Settings. *Implementation Science Communications*, *4*, 67. https://doi.org/https://doi.org/10.1186/s43058-023-00442-2

Kourtesis, P., & Macpherson, S. E. (2021). How immersive virtual reality methods may meet the criteria of the National Academy of Neuropsychology and American Academy of Clinical Neuropsychology: A software review of the Virtual Reality Everyday Assessment Lab (VR-EAL). *Computers in Human Behaviour Reports*, *4*, 1–14. https://doi.org/https://doi.org/10.1016/j.chbr.2021.100151

Kruse, C. S., Mileski, M., Alaytsev, V., Carol, E., Williams, A., Clemens, D., & Kruse, S. (2015). Adoption Factors Associated with Electronic Health Record among Long-Term Care Facilities: A Systematic Review. *BMJ Open*, *5*, 1–9. https://doi.org/https://doi.org/10.1136/bmjopen-2014

Kruse, L., Karaosmanoglu, S., Rings, S., Ellinger, B., Apken, D., Feziwe Mangana, T., & Steinicke, F. (2021). A Long-Term User Study of an Immersive Exergame for Older Adults with Mild Dementia during the COVID-19 Pandemic. *In the Proceedings of the International Conference on Artificial*

Reality and Telexistence, 9–18. https://doi.org/https://doi.org/10.2312/egve.20211322

Lakshminarayanan, V., Ravikumar, A., Chattu, V. K., Sriraman, H., & Alla, S. (2023). Health Care Equity Through Intelligent Edge Computing and Augmented Reality/Virtual Reality: A Systematic Review. *Journal of Multidisciplinary Healthcare*, *16*, 2839–2859. https://doi.org/https://doi.org/10.2147/JMDH.S419923

Lawrence, V., & Banerjee, S. (2010). Improving Care in Care Homes: A Qualitative Evaluation of the Croydon Care Home Support Team. *Aging and Mental Health*, *14*(4), 416–424. https://doi.org/https://doi.org/10.1080/13607860903586144

Lawrence, V., Fossey, J., Ballard, C., Moniz-Cook, E., & Murray, J. (2012). Improving Quality of Life for People with Dementia in Care Homes: Making Psychosocial Interventions Work. *The British Journal of Psychiatry* , *201*, 344–351. https://doi.org/https://doi.org/10.1192/bjp.bp.111.101402

Lawton, M. P., Van Haitsma, K., & Klapper, J. (1999). Observed Emotion Rating Scale. *Journal of Mental Health and Aging*, *5*(1), 69–82.

Lazar, A., Thompson, H., & Demiris, G. (2014). A Systematic Review of the Use of Technology for Reminiscence Therapy. *Health Education & Behavior*, *41*(1_suppl), 51S-61S. https://doi.org/https://doi.org/10.1177/1090198114537067

Lazarou, I., Karakostas, A., Stavropoulos, T. G., Tsompanidis, T., Meditskos, G., Kompatsiaris, I., & Tsolaki, M. (2016). A Novel and Intelligent Home

Monitoring System for Care Support of Elders with Cognitive Impairment. *Journal of Alzheimer's Disease*, *54*(4), 1561–1591. https://doi.org/https://doi.org/10.3233/JAD-160348

Lecavalier, N. C., Ouellet, É., Boller, B., & Belleville, S. (2018). Use of Immersive Virtual Reality to Assess Episodic Memory: A Validation Study in Older Adults. *Neuropsychology Rehabilitation*, *30*(3), 462–480. https://doi.org/https://doi.org/10.1080/09602011.2018.1477684

Lee, E. J., & Park, S. J. (2020). A Framework of Smart-Home Service for Elderly's Biophilic Experience. *Sustainability*, *12*, 1–26. https://doi.org/https://doi.org/10.3390/SU12208572

Lee, L. N., Kim, M. J., & Hwang, W. J. (2019). Potential of Augmented Reality and Virtual Reality Technologies to Promote Wellbeing in Older Adults. *Applied Sciences* , *9*(17). https://doi.org/http://doi.org/10.3390/app9173556

Li, A., Li, J., Wu, W., Zhao, J., & Qiang, Y. (2023). Effect of Virtual Reality Training on Cognitive Function and Motor Performance in Older Adults With Cognitive Impairment Receiving Health Care: A Randomized Controlled Trial. *International Journal of Human-Computer Interaction*. https://doi.org/https://doi.org/10.1080/10447318.2023.2271240

Liang, A., Piroth, I., Robinson, H., MacDonald, B., Fisher, M., Nater, U. M., Skoluda, N., & Broadbent, E. (2017). A Pilot Randomized Trial of a Companion Robot for People With Dementia Living in the Community. *Journal of the American Medical Directors Association*, *18*(10), 871–878. https://doi.org/10.1016/J.JAMDA.2017.05.019

Lin, C. X., Lee, C., Lally, D., & Coughlin, J. F. (2018a). Impact of Virtual Reality (VR) Experience on Older Adults' Well-being. In *In International Conference on Human Aspects of IT for the Aged Population : Vol. 10927 LNCS* (pp. 89–100). Springer Cham. https://doi.org/https://doi.org/10.1007/978-3-319-92037-5_8

Lin, C. X., Lee, C., Lally, D., & Coughlin, J. F. (2018b). Impact of Virtual Reality (VR) Experience on Older Adults' Well-Being. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *10927 LNCS*, 89–100. https://doi.org/https://doi.org/10.1007/978-3-319-92037-5_8/TABLES/4

Lindauer, A., Wild, K., Natonson, A., Mattek, N., Wolf, M., Steeves-Reece, A., & Messecar, D. (2020). Dementia 360 ECHO: Using Technology to Facilitate Diagnosis and Treatment. *Gerontology & Geriatrics Education*, *43*(2), 202–208. https://doi.org/https://doi.org/10.1080/02701960.2020.1835658

Liu, L., Cruz, A. M., & Juzwishin, D. (2018). Caregivers as a Proxy for Responses of Dementia Clients in a GPS Technology Acceptance Study. *Behaviour & Information Technology*, *37*(6), 634–645. https://doi.org/https://doi.org/10.1080/0144929X.2018.1470672

Logsdon, R., Gibbons, L., McCurry, S., & Teri, L. (1999). Quality of Life in Alzheimer's Disease: Patient and Caregiver Reports. *Journal of Mental Health and Aging*, *5*(1), 21–32.

Lopez, R. P., Mazor, K. M., Mitchell, S. L., & Givens, J. L. (2013). What is Family-Centered Care for Nursing Home Residents with Advanced Dementia?

American Journal of Alzheimer's Disease and Other Dementias, *28*(8), 763–768. https://doi.org/https://doi.org/10.1177/1533317513504613

Lorenz, K., Freddolino, P. P., Comas-Herrera, A., Knapp, M., & Damant, J. (2019). Technology-Based Tools and Services for People with Dementia and Carers: Mapping Technology onto the Dementia Care Pathway. *Dementia*, *18*(2), 725–741. https://doi.org/https://doi.org/10.1177/1471301217691617

Luijkx, K., Peek, S., & Wouters, E. (2015). "Grandma, You Should Do It-It's Cool" Older Adults and the Role of Family Members in Their Acceptance of Technology. *International Journal of Environmental Research and Public Health*, *12*, 15470–15485. https://doi.org/https://doi.org/10.3390/ijerph121214999

Luo, H., Li, G., & Yang, Y. (2021). Virtual Reality in K-12 and Higher Education: A Systematic Review of the Literature from 2000 to 2019. *Journal of Computer Assisted Learning*, *37*(3), 887–901. https://doi.org/https://doi.org/10.1111/jcal.12538

Ma, M., & Zheng, H. (2011). Virtual Reality and Serious Games in Healthcare. In *Advanced Computer Intelligence Paradigms in Healthcare 6. Virtual Reality in Psychotherapy, Rehabilitation, and Assessment.Studies in Computatial Intelligence* (Vol. 337, pp. 169–192). https://doi.org/https://doi.org/10.1007/978-3-642-17824-5_9

Mahoney, D. F., Purtilo, R. B., Webbe, F. M., Alwan, M., Bharucha, A. J., Adlam, T. D., Jimison, H. B., Turner, B., & Becker, S. A. (2007). In-home Monitoring of Persons with Dementia: Ethical Guidelines for Technology Research and

Development. *Alzheimer's and Dementia*, *3*(3), 217–226. https://doi.org/https://doi.org/10.1016/j.jalz.2007.04.388

Malhotra, Y., & Galletta, D. F. (1999). Extending the Technology Acceptance Model to Account for Social Influence: Theoretical Bases and Empirical Validation. *In Proceedings of the 32nd Hawaii International Conference on System Sciences*, 1–14. https://doi.org/https://doi.org/10.1109/HICSS.1999.772658

Mallari, B., Spaeth, E. K., Goh, H., & Boyd, B. S. (2019). *Virtual Reality as an Analgesic for Acute and Chronic Pain in Adults: A Systematic Review and Meta-Analysis*. https://doi.org/10.2147/JPR.S200498

Malley, J., & Fernández, J. L. (2010). Measuring Quality in Social Care Services: Theory and Practice. *Annals of Public and Cooperative Economics*, *81*(4), 559–582. https://doi.org/https://doi.org/10.1111/j.1467-8292.2010.00422.x

Malmgren Fänge, A., Carlsson, G., Chiatti, C., & Lethin, C. (2020). Using Sensor-Based Technology for Safety and Independence – The Experiences of People with Dementia and their Families. *Scandinavian Journal of Caring Sciences*, *34*(3), 648–657. https://doi.org/https://doi.org/10.1111/SCS.12766

Maloca, P. M., Williams, E. A., Mushtaq, F., Rueppel, A., Müller, P. L., Lange, C., de Carvalho, E. R., Inglin, N., Reich, M., Egan, C., Hasler, P. W., Tufail, A., Scholl, H. P. N., & Cattin, P. C. (2022). Feasibility and Tolerability of Ophthalmic Virtual Reality as a Medical Communication Tool in Children and Young People. *Acta Ophthalmologica*, *100*(2), e588–e597. https://doi.org/https://doi.org/10.1111/AOS.14900

Mandal, S. (2013). Brief Introduction of Virtual Reality & its Challenges. *International Journal of Scientific & Engineering Research*, *4*(4). http://www.ijser.org

Manera, V., Abrahams, S., Ag, L., Bremond, F., David, R., Fairchild, K., Gros, A., ecile Hanon, C., Husain, M., Lockwood, P. L., Pino, M., Radakovic, R., Robert, G., Slachevsky, A., Stella, F., Tribouillard, A., Davide Trimarchi, P., Verhey, F., Yesavage, J., … Robert, P. (2020). Recommendations for the Nonpharmacological Treatment of Apathy in Brain Disorders A R T I C L E I N F O. *The American Journal of Geriatric Psychiatry*, *28*, 410–420. https://doi.org/https://doi.org/10.1016/j.jagp.2019.07.014

Manera, V., Chapoulie, E., Bourgeois, J., Guerchouche, R., David, R., Ondrej, J., Drettakis, G., & Robert, P. (2016). A Feasibility Study with Image-Based Rendered Virtual Reality in Patients with Mild Cognitive Impairment and Dementia. *PLOS ONE*, *11*(3), e0151487. https://doi.org/hhttps://doi.org/10.1371/JOURNAL.PONE.0151487

Marin, R. S. (1990). Differential Diagnosis and Classification of Apathy. *Am J Psychiatry*, *147*(1), 22–30. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=f5819db0471e3103627937f90325221b09c7f851

Maskey, M., Lowry, J., Rodgers, J., Mcconachie, H., & Parr, J. R. (2014). Reducing Specific Phobia/Fear in Young People with Autism Spectrum Disorders (ASDs) through a Virtual Reality Environment Intervention. *PLoS ONE*, *9*(7), 100374. https://doi.org/https://doi.org/10.1371/journal.pone.0100374

Matsangidou, M., Fotos Frangoudes, ·, Schiza, · Eirini, Kleanthis, ·, Neokleous, C., Papayianni, · Ersi, Katerian Xenari, ·, Marios Avraamides, ·, & Pattichis, C. S. (2023). Participatory Design and Evaluation of Virtual Reality Physical Rehabilitation for People Living with Dementia. *VirtualReality*, *27*, 421–438. https://doi.org/https://doi.org/10.1007/s10055-022-00639-1

Matsangidou, M., Frangoudes, F., Hadjiaros, M., Schiza, E., Neokleous, K. C., Papayianni, E., Avraamides, M., & Pattichis, C. S. (2022). "Bring me Sunshine, Bring me (Physical) Strength": The Case of Dementia. Designing and Implementing a Virtual Reality System for Physical Training during the COVID-19 Pandemic. *International Journal of Human-Computer Studies*, *165*. https://doi.org/https://doi.org/10.1016/j.ijhcs.2022.102840

Matsangidou, M., Schiza, E., Hadjiaros, M., Neokleous, K. C., Avraamides, M., Papayianni, E., Frangoudes, F., & Pattichis, C. S. (2020). Dementia: I am Physically Fading. Can Virtual Reality Help? Physical Training for People with Dementia in Confined Mental Health Units. In *In International Conference on human-computer interaction* (pp. 366–382). Springer. https://doi.org/https://doi.org/10.1007/978-3-030-49282-3_26

Mayes, S. D., Calhoun, S. L., Aggarwal, R., Baker, C., Mathapati, S., Molitoris, S., & Mayes, R. D. (2013). Unusual Fears in Children with Autism. *Research in Autism Spectrum Disorders*, *7*(1), 151–158. https://doi.org/https://doi.org/10.1016/J.RASD.2012.08.002

McDermott, O., Charlesworth, G., Hogervorst, E., Stoner, C., Moniz-Cook, E., Spector, A., Csipke, E., & Orrell, M. (2019). Psychosocial Interventions for People with Dementia: a synthesis of systematic reviews. *Aging and Mental*

Health, *23*(4), 393–403. https://doi.org/https://doi.org/10.1080/13607863.2017.1423031

McKinstry, B., & Sheikh, A. (2013). The Use of Global Positioning Systems in Promoting Safer Walking for People with Dementia. *Journal of Telemedicine and Telecare*, *19*(5), 288–292. https://doi.org/https://doi.org/10.1177/1357633X13495481/FORMAT/EPUB

Mendez, M. F., Joshi, A., & Jimenez, E. (2015). Virtual Reality for the Assessment of Frontotemporal Dementia, a Feasibility Study. *Disability and Rehabilitation: Assistive Technology*, *10*(2), 160–164. https://doi.org/https://doi.org/10.3109/17483107.2014.889230

Miller, E., Baker, S., Caldwell, G. A., Wilding, R., Neves, B. B., & Waycott, J. (2023). Transforming Aged Care with Virtual Reality: How Organisational Culture Impacts Technology Adoption and Sustained Uptake. *Australasian Journal on Ageing*. https://doi.org/https://doi.org/10.1111/ajag.13248

Morrissey, K., McCarthy, J., & Pantidi, N. (2017). The Value of Experience-Centred Design Approaches in Dementia Research Contexts. *In Proceedings of the Conference on Human Factors in Computing Systems* , *2017-May*, 1326–1338. https://doi.org/https://doi.org/10.1145/3025453.3025527

Moyle, W., Jones, C., Dwan, T., Ownsworth, T., & Sung, B. (2019). Using Telepresence for Social Connection: Views of Older People with Dementia, Families, and Health Professionals from a Mixed Methods Pilot Study. *Aging & Mental Health*, *23*(12), 1643–1650. https://doi.org/https://doi.org/10.1080/13607863.2018.1509297

Moyle, W., Jones, C., Dwan, T., & Petrovich, T. (2018). Effectiveness of a Virtual Reality Forest on People with Dementia: A Mixed Methods Pilot Study. *The Gerontologist*, *58*(3), 478–487. https://doi.org/http:doi.org/10.1093/geront/gnw270

Moyle, W., Jones, C. J., Murfield, J. E., Thalib, L., Beattie, E. R. A., Shum, D. K. H., O'Dwyer, S. T., Mervin, M. C., & Draper, B. M. (2017). Use of a Robotic Seal as a Therapeutic Tool to Improve Dementia Symptoms: A Cluster-Randomized Controlled Trial. *Journal of the American Medical Directors Association*, *18*(9), 766–773. https://doi.org/https://doi.org/10.1016/j.jamda.2017.03.018

Moyle, W., Jones, C., & Sung, B. (2020). Telepresence Robots: Encouraging Interactive Communication between Family Carers and People with Dementia. *Australasian Journal on Ageing*, *39*(1), e127–e133. https://doi.org/https://doi.org/10.1111/ajag.12713

Moyle, W., Skinner, J., Rowe, G., & Gork, C. (2003). Views of Job Satisfaction and Dissatisfaction in Australian Long-Term Care. *Journal of Clinical Nursing*, *12*(2), 168–176. https://doi.org/https://doi.org/10.1046/J.1365-2702.2003.00732.X

Munoz, D., Favilla, S., & Pedell, S. (2021). Evaluating an App to Promote a Better Visit through Shared Activities for People Living with Dementia and their Families. *In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–13. https://doi.org/https://doi.org/10.1145/3411764.3445764

Navarro-Haro, M. V, Modrego-Alarcón, M., Hoffman, H. G., López-Montoyo, A., Navarro-Gil, M., Montero-Marin, J., García-Palacios, A., Borao, L., & García-Campayo, J. (2019). *Evaluation of a Mindfulness-Based Intervention With and Without Virtual Reality Dialectical Behavior Therapy R Mindfulness Skills Training for the Treatment of Generalized Anxiety Disorder in Primary Care: A Pilot Study*. https://doi.org/http://doi.org/10.3389/fpsyg.2019.00055

Neerincx, M. A., Kallen, V. L., Factors, H., Brouwer, A.-M., Human, T., & Van Der Leer, L. (2010). Virtual Reality Exposure and Neuro-Bio Feedback to Help Coping with Traumatic Events. *In Proceedings of the 28th Annual European Conference on Cognitive Ergonomics*, 367–369. https://doi.org/https://doi.org/10.1145/1962300.1962388

Neves, B. B., Franz, R., Judges, R., Beermann, C., & Baecker, R. (2019). Can Digital Technology Enhance Social Connectedness among Older Adults? A Feasibility Study. *Journal of Applied Gerontology*, *38*(1), 49–72. https://doi.org/http://doi.org/10.1177/0733464817741369

Nichols, S., & Patel, H. (2002). Health and Safety Implications of Virtual Reality: A review of Empirical Evidence. *Applied Ergonomics*, *33*(3), 251–271. https://doi.org/https://doi.org/10.1016/S0003-6870(02)00020-0

Niki, K., Okamoto, Y., Maeda, I., Mori, I., Ishii, R., Matsuda, Y., Takagi, T., & Uejima, E. (2019). A Novel Palliative Care Approach Using Virtual Reality for Improving Various Symptoms of Terminal Cancer Patients: A Preliminary Prospective, Multicenter Study. *Journal of Palliative Medicine*, *22*(6), 702–707. https://doi.org/https://doi.org/10.1089/JPM.2018.0527

Nilsen, E. R., Stendal, K., & Gullslett, M. K. (2020). Implementation of eHealth Technology in Community Health Care: The Complexity of Stakeholder Involvement. *BMC Health Services Research*, *20*, 1–13. https://doi.org/https://doi.org/10.1186/s12913-020-05287-2

Nishiura, Y., Nihei, M., Nakamura-Thomas, H., & Inoue, T. (2021). Effectiveness of Using Assistive Technology for Time Orientation and Memory in Older Adults with or without Dementia. *Disability and Rehabilitation: Assistive Technology*, *16*(5), 472–478. https://doi.org/https://doi.org/10.1080/17483107.2019.1650299

Nolin, P., Stipanicic, A., Henry, M., Joyal, C. C., & Allain, P. (2012). Virtual Reality as a Screening Tool for Sports Concussion in Adolescents. *Brain Injury*, *26*(13–14), 1564–1573. https://doi.org/https://doi.org/10.3109/02699052.2012.698359

Nowaskie, D., Carvell, C. A., Alder, C. A., LaMantia, M. A., Gao, S., Brown, S., Boustani, M. A., & Austrom, M. G. (2020). Care Coordinator Assistants: Job Satisfaction and the Importance of Teamwork in Delivering Person-Centered Dementia Care. *Dementia*, *19*(5), 1560–1572. https://doi.org/https://doi.org/10.1177/1471301218802739/FORMAT/EPUB

Øderud, T., Landmark, B., Eriksen, S., Fossberg, A. B., Aketun, S., Omland, M., Hem, K.-G., Østensen, E., & Ausen, D. (2015). Persons with Dementia and Their Caregivers Using GPS. *Assistive Technology*, 212–221. https://doi.org/https://doi.org/10.3233/978-1-61499-566-1-212

O'Donnell, E., Holland, C., & Swarbrick, C. (2022). Strategies Used by Care Home Staff to Manage Behaviour that Challenges in Dementia: A systematic

Review of Qualitative Studies. In *International Journal of Nursing Studies* (Vol. 133). Elsevier Ltd. https://doi.org/https://doi.org/10.1016/j.ijnurstu.2022.104260

Öner Gücin, N., & Berk, S. (2015). Technology Acceptance in Health Care: An Integrative Review of Predictive Factors and Intervention Programs. *Procedia-Social and Behavioral Sciences*, *195*, 1698–1704. https://doi.org/https://doi.org/10.1016/j.sbspro.2015.06.263

Onyesolu, M. O., & Eze, F. U. (2011). Understanding Virtual Reality Technology: Advances and Application. In *Advances in Computer Science and Engineering* (pp. 53–70). https://books.google.jo/books?hl=en&lr=&id=DcGODwAAQBAJ&oi=fnd&pg=PA53&dq=virtual+reality+technology&ots=7OfwCRrrZV&sig=Mm7_2agEXTY8f1NFKQJHo6Q5o5M&redir_esc=y#v=onepage&q=virtual%20reality%20technology&f=false

Oosterveld-Vlug, M., Onwuteaka-Philipsen, B., Ten Koppel, M., Van Hout, H., Smets, T., Pivodic, L., Tanghe, M., Van Den Noortgate, N., Hockley, J., Payne, S., Moore, D. C., Kijowska, V., Szczerbińska, K., Kylänen, M., Leppaäho, S., Mercuri, C., Rossi, P., Mercuri, M., Gambassi, G., … Pasman, H. R. (2019). Evaluating the Implementation of the PACE Steps to Success Programme in Long-Term Care Facilities in Seven Countries According to the RE-AIM Framework. *Implementation Science*, *14*(1), 1–19. https://doi.org/https://doi.org/10.1186/s13012-019-0953-8

Optale, G., Urgesi, C., Busato, V., Marin, S., Piron, L., Priftis, K., Gamberini, L., Capodieci, S., & Bordin, A. (2010). Controlling Memory Impairment in Elderly Adults Using Virtual Reality Memory Training: A Randomized Controlled Pilot

Study. *Neurorehabilitation and Neural Repair*, *24*(4), 348–357. https://doi.org/https://doi.org/10.1177/1545968309353328

Palmer, J. L., Lach, H. W., & Mcgillick, J. (2014). The Dementia Friendly Hospital Initiative Education Program for Acute Care Nurses and Staff. *The Journal of Continuing Education in Nursing*, *45*(9), 416–424. https://doi.org/https://doi.org/10.3928/00220124-20140825-20

Paparella, G. (2016). *Person-Centred Care in Europe: A Cross-Country Comparison of Health System Performance, Strategies and Structures*. www.pickereurope.org

Pareek, T. G., Mehta, U., Geraldine Bessie Amali, D., & Gupta, A. (2018). A Survey: Virtual Reality Model for Medical Diagnosis. *Biomedical and Pharmacology Journal*, *11*(4), 2091–2100. https://doi.org/https://doi.org/10.13005/bpj/1588

Park, K., Lee, S., Yang, J., Song, T., & Hong, G. R. S. (2019). A Systematic Review and Meta-Analysis on the Effect of Reminiscence Therapy for People with Pementia. *International Psychogeriatrics*, *31*(11), 1581–1597. https://doi.org/https://doi.org/10.1017/S1041610218002168

Parsons, T. D., & Rizzo, A. A. (2008). Affective Outcomes of Virtual Reality Exposure Therapy for Anxiety and Specific Phobias: A Meta-Analysis. *Journal of Behavior Therapy and Experimental Psychiatry*, *39*, 250–261. https://doi.org/https://doi.org/10.1016/j.jbtep.2007.07.007

Peek, S. T. M., Luijkx, K. G., Rijnaard, M. D., Nieboer, M. E., Van Der Voort, C. S., Aarts, S., Van Hoof, J., Vrijhoef, H. J. M., & Wouters, E. J. M. (2016). E-Mail

Regenerative and Technological Section / Original Paper Older Adults' Reasons for Using Technology while Aging in Place. *Gerontology*, *62*(2), 226–237. https://doi.org/https://doi.org/10.1159/000430949

Perski, O., & Short, C. E. (2021). Acceptability of Digital Health Interventions: Embracing the Complexity. *Translational Behavioral Medicine*, *11*(7), 1473–1480. https://doi.org/https://doi.org/10.1093/TBM/IBAB048

Persson, A. C., Dahlberg, L., Janeslätt, G., Möller, M., & Löfgren, M. (2023). Daily Time Management in Dementia: Qualitative Interviews with Persons with Dementia and their Significant Others. *BMC Geriatrics*, *23*(1). https://doi.org/https://doi.org/10.1186/s12877-023-04032-8

Pottle, J. (2019). Virtual Reality and the Transformation of Medical Education. *Future Healthcare Journal*, *6*, 181–186. https://doi.org/https://doi.org/10.7861/fhj.2 019-0036

Preston, A. M., & Padala, P. R. (2022). Virtual Reality on the Verge of Becoming a Reality for Geriatric Research. *International Psychogeriatrics*, *34*(2), 97–99. https://doi.org/https:doi.org/10.1017/S1041610221000867

Radakovic, R., Abrahams, S., & Scotland, A. (2014). Developing a New Apathy Measurement Scale: Dimensional Apathy Scale. *Psychiatry Research*, *219*(3), 658–663. https://doi.org/https://doi.org/10.1016/j.psychres.2014.06.010

Redulla, R. (2019). Reminiscence Therapy for Dementia. *Issues in Mental Health Nursing*, *41*(3), 265–266. https://doi.org/https://doi.org/10.1080/01612840.2019.1654572

Regan, C. (1995). An Investigation into Nausea and Other Side-Effects of Head-Coupled Immersive Virtual Reality. *Virtual Reality*, *1*(1), 17–31. https://doi.org/https://doi.org/10.1007/BF02009710/METRICS

Reitmayr, G., & Schmalstieg, D. (2001). An Open Software Architecture for Virtual Reality Interaction. *In Proceedings of the ACMSymposium on Virtual Reality Software and Technology*, 47–54. https://doi.org/https://doi.org/10.1145/505008.505018

Renaud, K., & Biljon, J. Van. (2008). Predicting Technology Acceptance and Adoption by Elderly: A Qualitative Study. *In Proceedings of the 2008 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on IT Research in Developing Countries: Riding the Wave of Technology* , *October*, 210–219. https://doi.org/https://doi.org/10.1145/1456659.1456684

Reynolds, L., Rodiek, S., Lininger, M., & McCulley, M. A. (2018). Can a Virtual Nature Experience Reduce Anxiety and Agitation in People With Dementia? *Journal of Housing For the Elderly*, *32*(2), 176–193. https://doi.org/https://doi.org/10.1080/02763893.2018.1431583

Riikonen, M., Mäkelä, K., & Perälä, S. (2010). Safety and Monitoring Technologies for the Homes of People with Dementia. *Gerontechnology*, *9*(1). https://doi.org/https://doi.org/10.4017/gt.2010.09.01.003.00

Risi, D., & Palmisano, S. (2019). Effects of Postural Stability, Active Control, Exposure Duration and Repeated Exposures on HMD Induced Cybersickness.

Displays, *60*, 9–17. https://doi.org/https://doi.org/10.1016/J.DISPLA.2019.08.003

Roberts, A. R., De Schutter, B., Franks, K., & Radina, M. E. (2018). Older Adults' Experiences with Audiovisual Virtual Reality: Perceived Usefulness and Other Factors Influencing Technology Acceptance. *Clinical Gerontologist*, *42*(1), 27–33. https://doi.org/https://doi.org/10.1080/07317115.2018.1442380

Rodić, B., Stevanović, V., Labus, A., Kljajić, D., Trajkov, M., Rodi, B., Stevanovi, V., & Kljaji, D. (2023). Adoption Intention of an IoT Based Healthcare Technologies in Rehabilitation Process. *International Journal of Human-Computer Interaction*. https://doi.org/https://doi.org/10.1080/10447318.2023.2175160

Rolland, Y., Tavassoli, N., Philipe, ;, Barreto, S., Perrin, A., Laffon De Mazières, C., Rapp, T., Hermabessière, S., Tournay, E., Vellas, B., & Andrieu, S. (2020). Systematic Dementia Screening by Multidisciplinary Team Meetings in Nursing Homes for Reducing Emergency Department Transfers The IDEM Cluster Randomized Clinical Trial. *JAMA Network Open*, *3*(2), 200049. https://doi.org/https://doi.org/10.1001/jamanetworkopen.2020.0049

Rose, V., Stewart, I., Jenkins, K. G., Ang, C. S., & Matsangidou, M. (2018). A Scoping Review Exploring the Feasibility of Virtual Reality Technology Use with Individuals Living with Dementia. *In Proceedings of International Conference on Artificial Reality and Telexistence*, 1–8. https://doi.org/https://doi.org/10.2312/egve.20181325

Rose, V., Stewart, I., Jenkins, K. G., Tabbaa, L., Ang, C. S., & Matsangidou, M. (2021). Bringing the Outside in: The Feasibility of Virtual Reality with People with Dementia in an Inpatient Psychiatric Care Setting. *Dementia*, *20*(1), 106–129. https://doi.org/https://doi.org/10.1177/1471301219868036

Rosenberg, L., Kottorp, A., Winblad, B., & Nygård, L. (2009). Perceived Difficulty in Everyday Technology Use among Older Adults with or without Cognitive Deficits. *Scandinavian Journal of Occupational Therapy*, *16*(4), 216–226. https://doi.org/10.3109/11038120802684299

Rothbaum, B. O., & Schwartz, A. C. (2002). Exposure Therapy for Posttraumatic Stress Disorder. *American Journal of Psychotherapy*, *56*(1), 59–75. https://psychotherapy.psychiatryonline.org/doi/pdf/10.1176/appi.psychotherapy.2002.56.1.59

Rutkowski, S., Czech, O., Wrzeciono, A., Kiper, P., Szczepańska-Gieracha, J., & Malicka, I. (2021). Virtual Reality as a Chemotherapy Support in Treatment of Anxiety and Fatigue in Patients with Cancer: A Systematic Review and Meta-Analysis and Future Research Directions. *Complementary Therapies in Medicine*, *61*. https://doi.org/https://doi.org/10.1016/j.ctim.2021.102767

Saab, M. M., Landers, M., Murphy, D., O'Mahony, B., Cooke, E., O'Driscoll, M., & Hegarty, J. (2022). Nursing Students' Views of Using Virtual Reality in Healthcare: A Qualitative Study. *Journal of Clinical Nursing*, *31*(9–10), 1228–1242. https://doi.org/https://doi.org/10.1111/jocn.15978

Sagnier, C., Loup-Escande, E., Lourdeaux, D., Thouvenin, I., & Valléry, G. (2020). User Acceptance of Virtual Reality: An Extended Technology

Acceptance Model. *International Journal of Human-Computer Interaction*, *36*(11), 993–1007. https://doi.org/https://doi.org/10.1080/10447318.2019.1708612

Sait, U., Ravishankar, V. D., Kumar, tarun, Shivakumar, S., Singh, M., Lal, G., Bhalla, K., Manvendra, S., & Bhaumik, R. (2019). Memhans: An Assistive Device for Dementia Patients. *In Proceedings of IEEE Global Humanitarian Technology Conference*, 1–5. https://doi.org/https://doi.org/10.1109/GHTC46095.2019.9033140

Sampson, E. L., & Goldberg, S. E. (2022). Hospitals, people with cognitive impairment and agitation: how virtual reality could improve real world care. *Age and Ageing*, *51*(7), 1–2. https://doi.org/https://doi.org/10.1093/ageing/afac160

Sánchez-Nieto, D., Castaño-Castaño, S., Navarro-Martos, R., Obrero-Gaitán, E., Cortés-Pérez, I., & Nieto-Escamez, F. (2023). An Intervention on Anxiety Symptoms in Moderate Alzheimer's Disease through Virtual Reality: A Feasibility Study and Lessons Learned. *International Journal of Environmental Research and Public Health 2023, Vol. 20, Page 2727*, *20*(3), 2727. https://doi.org/https://doi.org/10.3390/IJERPH20032727

Sánchez-Prieto, J. C., Olmos Migueláñez, S., & García-Peñalvo, F. J. (2014). ICTs Integration in Education: Mobile Learning and the Technology Acceptance Model (TAM). *In Proceedings of Second International Conference on Technological Ecosystems for Enhancing Multiculturality*, 683–687. https://doi.org/https://doi.org/10.1145/2669711.2669974

Sancho-Esper, F., Ostrovskaya, L., Rodriguez-Sanchez, C., & Campayo-Sanchez, F. (2022). Virtual Reality in Retirement Communities: Technology Acceptance and Tourist Destination Recommendation. *Journal of Vacation Marketing*, 1–16. https://doi.org/https://doi.org/10.1177/13567667221080567

Saragih, I. D., Tonapa, S. I., Sun, T. L., Chia-Ju, L., & Lee, B. O. (2021). Effects of Robotic Care Interventions for Dementia Care: A Systematic Review and Meta-Analysis Randomised Controlled Trials. In *Journal of Clinical Nursing* (Vol. 30, Issues 21–22, pp. 3139–3152). John Wiley and Sons Inc. https://doi.org/https://doi.org/10.1111/jocn.15856

Saredakis, D., Keage, H. A., Corlis, M., & Loetscher, T. (2021). Virtual reality intervention to improve apathy in residential aged care: protocol for a multi-site trial. *BMJ Open*, *11*(2). https://doi.org/https://doi.org/10.1136/bmjopen-2020-046030

Saredakis, D., Keage, H. A. D., Corlis, M., & Loetscher, T. (2020). Virtual Reality Intervention to Improve Apathy in Residential Aged Care: Protocol for a Multi-Site Trial. *Journal of Medical Internet Research*, *23*(9), 1–23. https://doi.org/https://doi.org/10.1136/bmjopen-2020-046030

Sas, C., Davies, N., Clinch, S., Shaw, P., Mikusz, M., Steeds, M., & Nohrer, L. (2020). Supporting Stimulation Needs in Dementia Care through Wall-Sized Displays. *In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–16. https://doi.org/https://doi.org/10.1145/3313831.3376361

Sävenstedt, S., Brulin, C., & Sandman, P.-O. (2003). Family Members' Narrated Experiences of Communicating via Video-Phone with Patients with Dementia Staying at a Nursing Home. *Journal of Telemedicine and Telecare*, *9*, 216–220. https://doi.org/https://doi.org/10.1258/135763303322225544

Sayma, M., Tuijt, R., Cooper, C., Walters, K., & Heyn, P. C. (2020). Are we there yet? Immersive Virtual Reality to Improve Cognitive Function in Dementia and Mild Cognitive Impairment. *The Gerontologist*, *60*(7), e502–e512. https://doi.org/https://doi.org/10.1093/GERONT/GNZ132

Scott, I. A., Carter, S. M., & Coiera, E. (2021). Exploring Stakeholder Attitudes towards AI in Clinical Practice. *BMJ Health Care Inform*, *28*, 100450. https://doi.org/https://doi.org/10.1136/bmjhci-2021-100450

Scott, J., & Clare, L. (2003). Do People with Dementia Benefit from Psychological Interventions Offered on a Group Basis? *Clinical Psychology and Psychotherapy*, *10*(3), 186–196. https://doi.org/https://doi.org/10.1002/CPP.369

Seiger Cronfalk, B., Ternestedt, B. M., & Norberg, A. (2017). Being a Close Family Member of a Person with Dementia Living in a Nursing Home. *Journal of Clinical Nursing*, *26*(21–22), 3519–3528. https://doi.org/https://doi.org/10.1111/JOCN.13718

Selai, C. E., Trimble, M. R., Rossor, M. N., & Harvey, R. J. (2001). Assessing Quality of Life in Dementia: Preliminary Psychometric Testing of the Quality of Life Assessment Schedule (QOLAS). *Neuropsychological Rehabilitation*, *11*(3–4), 219–243. https://doi.org/https://doi.org/10.1080/09602010042000033

Shephard, E., Bedford, R., Milosavljevic, B., Gliga, T., Jones, E. J. H., Pickles, A., Johnson, M. H., Charman, T., & Team, T. B. (2019). Early developmental pathways to childhood symptoms of attention-deficit hyperactivity disorder, anxiety and autism spectrum disorder. *The Journal of Child Psychology and Psychiatry*, *60*(9), 963–974. https://doi.org/https://doi.org/10.1111/jcpp.12947

Shiells, K., Pivodic, L., Holmerov, I., & Van Den Block, L. (2020). Self-Reported Needs and Experiences of People with Dementia Living in Nursing Homes: A Scoping Review. *Aging & Mental Health*, *24*(10), 1553–1568. https://doi.org/https://doi.org/10.1080/13607863.2019.1625303

Shree Adhyaru, J., & Kemp, C. (2022). Virtual Reality as a Tool to Promote Wellbeing in the Workplace. *Digital Health*, *8*, 1–12. https://doi.org/https://doi.org/10.1177/20552076221084473

Simón-Vicente, L., Rodríguez-Cano, S., Delgado-Benito, V., Ausín-Villaverde, V., & Cubo Delgado, E. (2022). Cybersickness. A Systematic Literature Review of Adverse Effects Related to Virtual Reality. *Neurología*, 1–9. https://doi.org/https://doi.org/10.1016/j.nrl.2022.04.009

Singh, S., & Srivastava, P. (2019). Social Media for Outbound Leisure Travel: A Framework Based on Technology Acceptance Model (TAM). *Journal of Tourism Futures*, *5*(1), 43–61. https://doi.org/https://doi.org/10.1108/JTF-10-2018-0058

Siriaraya, P., & Ang, C. S. (2014). Recreating Living Experiences from Past Memories through Virtual Worlds for People with Dementia. *In Proceedings of the Conference on Human Factors in Computing Systems - Proceedings*, 3977–3986. https://doi.org/https://doi.org/10.1145/2556288.2557035

Siriaraya, P., & Ang, C. S. (2017). Developing Virtual Environments for Older Users Case studies of Virtual Environments Iteratively Developed for Older Users and People with Dementia. *In Proceedings of the 2nd International Conference on Information Technology (INCIT)*, 1–6. https://doi.org/https://doi.org/10.1109/INCIT.2017.8257867

Siriaraya, P., & Ang, C. S. (2019). The Social Interaction Experiences of Older People in a 3D Virtual Environment. In *In Perspectives on Human-Computer Interaction Research with Older People* (pp. 101–117). Springer. https://doi.org/https://doi.org/10.1007/978-3-030-06076-3_7

Sisto, S. A., Forrest, G. F., & Glendinning, D. (2015). Virtual Reality Applications for Motor Rehabilitation After Stroke. *Stroke Rehabilitation*, *8*(4), 11–23. https://doi.org/https://doi.org/10.1310/YABD-14KA-159P-MN6F

Slater, M., Lotto, R., Arnold, M., & Sanchez-Vives, M. (2009). How we Experience Immersive Virtual Environments: The Concept of Presence and its Measurement. *Anuario de Psicologia*, *40*, 193–210. http://diposit.ub.edu/dspace/bitstream/2445/49643/1/631349.pdf

Slater, M., & Sanchez-Vives, M. V. (2016). Enhancing Our Lives with Immersive Virtual Reality. *Frontiers in Robotics and AI*, *3*, 1–47. https://doi.org/https://doi.org/10.3389/frobt.2016.00074

Slater, M., & Wilbur, S. (1997). A Framework for Immersive Virtual Environments (five): Speculations on the Role of Presence in Virtual Environments. *Presence: Teleoperators and Virtual Environments*, *6*(6), 603–616. https://doi.org/https://doi.org/10.1162/pres.1997.6.6.603

Smith, N., Towers, A. M., Palmer, S., Beecham, J., & Welch, E. (2018). Being Occupied: Supporting 'Meaningful Activity' in Care Homes for Older People in England. *Ageing & Society*, *38*(11), 2218–2240. https://doi.org/https://doi.org/10.1017/S0144686X17000678

Sommerlad, A., Park, H. K., Marston, L., Livingston, G., & Livingston, G. (2022). Apathy in UK Care Home Residents with Dementia: Longitudinal Course and Determinants. *Journal of Alzheimer's Disease*, *87*(2), 731–740. https://doi.org/https://doi.org/10.3233/JAD-215623

Stafford, B. E. (2020). *Perceptions of Health Care Stakeholders toward Electronic Health Record Integrations*. https://www.proquest.com/openview/49489cee6ac55de1f9cccde96017dd9b/1?pq-origsite=gscholar&cbl=51922&diss=y

Subramaniam, P., & Woods, B. (2012). The impact of individual reminiscence therapy for people with dementia: systematic review. *Expert Review of Neurotherapeutics*, *12*(5), 545–555. https://doi.org/10.1586/ERN.12.35

Sujan, M. A., White, S., Habli, I., & Reynolds, N. (2022). Stakeholder Perceptions of the Safety and Assurance of Artificial Intelligence in Healthcare. *Safety Science*, *155*, 105870. https://doi.org/https://doi.org/10.1016/j.ssci.2022.105870

Sultana, M., Campbell, K., Jennings, M., Montero-Odasso, M., Orange, J. B., Knowlton, J., St George, A., & Bryant, D. (2020). Virtual Reality Experience In Long Term Care Resident Older Adults With Dementia: A Case Series. *Research Square*, 1–18. https://doi.org/https://doi.org/10.21203/rs.3.rs-16210/v3

Suresh, L. R., & George, C. (2019). Virtual Reality Distraction on Dental Anxiety and Behavior in Children with Autism Spectrum Disorder. *Journal of International Dental and Medical Research*, *12*(3), 1004–1010. http://www.jidmr.com

Syed-Abdul, S., Malwade, S., Nursetyo, A. A., Sood, M., Bhatia, M., Barsasella, D., Liu, M. F., Chang, C. C., Srinivasan, K., Raja, M., & Li, Y. C. J. (2019). Virtual Reality among the Elderly: A Usefulness and Acceptance Study from Taiwan. *BMC Geriatrics*, *19*(1), 1–10. https://doi.org/https://doi.org/10.1186/S12877-019-1218-8/FIGURES/3

Tabbaa, L., Ang, C. S., Rose, V., Siriaraya, P., Stewart, I., Jenkins, K. G., & Matsangidou, M. (2019). Bring the Outside In: Providing Accessible Experiences Through VR for People with Dementia in Locked Psychiatric Hospitals. *In Proceedings of the Conference on Human Factors in Computing Systems - Proceedings*, 1–15. https://doi.org/https://doi.org/10.1145/3290605.3300466

Tabbaa, L., Ang, C. S., Siriaraya, P., She, W. J., & Prigerson, H. G. (2021). A Reflection on Virtual Reality Design for Psychological, Cognitive and Behavioral Interventions: Design Needs, Opportunities and Challenges. *International Journal of Human–Computer Interaction*, *37*(9), 851–866. https://doi.org/https://doi.org/10.1080/10447318.2020.1848161

Tanaka, S., Yamagami, T., & Yamaguchi, H. (2021). Effects of a Group-Based Physical and Cognitive Intervention on Social Activity and Quality of Life for Elderly People with Dementia in a Geriatric Health Service Facility: A Quasi-Randomised Controlled Trial. *Psychogeriatrics*, *21*(1), 71–79. https://doi.org/http://doi.org/10.1111/PSYG.12627

Teixeira, J., & Palmisano, S. (2021). Effects of Dynamic Field-of-View Restriction on Cybersickness and Presence in HMD-Based Virtual Reality. *Virtual Reality*, *25*(2), 433–445. https://doi.org/https://doi.org/10.1007/S10055-020-00466-2/METRICS

Ter Meulen, R., & Wright, K. (2012). Family Solidarity and Informal Care: The Case of Care for People with Dementia. *Bioethics*, *26*(7), 361–368. https://doi.org/https://doi.org/10.1111/j.1467-8519.2012.01992.x

Thach, K., Lederman, R., & Waycott, J. (2020). Virtual Reality in Residential Aged Care: A Study of Adoption and System Complexity. *In Proceedings of the Australian Conference on Information Systems*, 1–13. https://www.researchgate.net/publication/347445245_Virtual_Reality_in_Residential_Aged_Care_a_study_of_adoption_and_system_complexity

Thach, K., Lederman, R., & Waycott, J. (2021, May 8). Guidelines for Developing the VR Program in Residential Aged Care: A Preliminary Study from Staff Members' Perspective. *In Proceedings of the Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/https://doi.org/10.1145/3411763.3451706

Thach, K. S., Lederman, J., & Waycott, R. (2020). How Older Adults Respond to the Use of Virtual Reality for Enrichment: A Systematic Review. *In Proceedings of the 32nd Australian Conference on Human-Computer Interaction*, 303–313. https://doi.org/https://doi.org/10.1145/3441000.3441003

The Health Foundation. (2016). *Person-Centred Care Made Simple: What Everyone Should Know about Person-Centred Care*.

https://www.health.org.uk/sites/default/files/PersonCentredCareMadeSimple.pdf

Thompson, G. N., & Roger, K. (2014a). Understanding the Needs of Family Caregivers of Older Adults Dying with Dementia. *Palliative and Supportive Care*, *12*(3), 223–231. https://doi.org/https://doi.org/10.1017/S1478951513000461

Thompson, G. N., & Roger, K. (2014b). Understanding the Needs of Family Caregivers of Older Adults Dying with Dementia. *Palliative & Supportive Care*, *12*(3), 223–231. https://doi.org/https://doi.org/10.1017/S1478951513000461

Thraves, L. (2016). *Fix Dementia Care: NHS and Care Homes*. https://www.alzheimers.org.uk/sites/default/files/migrate/downloads/fix_dementia_care_nhs_and_care_homes_report.pdf

Tominari, M., Uozumi, R., Becker, C., & Kinoshita, A. (2021). Reminiscence Therapy Using Virtual Reality Technology Affects Cognitive Function and Subjective Well-being in Older Adults with Dementia. *Cogent Psychology*, *8*(1), 1–20. https://doi.org/https://doi.org/10.1080/23311908.2021.1968991

Tousignant, M., Boissy, P., Ne Moffet, H., Ne Corriveau, H., Cabana, F., Marquis, F., & Simard, J. (2011). Patients' Satisfaction of Healthcare Services and Perception with In-Home Telerehabilitation and Physiotherapists' Satisfaction Toward Technology for Post-Knee Arthroplasty: An Embedded Study in a Randomized Trial. *Telemedicine and E-Health*, *17*(5), 376–382. https://doi.org/https://doi.org/10.1089/tmj.2010.0198

Towers, A.-M., Smith, N., Allan, S., Vadean, F., Collins, G., Rand, S., Bostock, J., Ramsbottom, h, Forder, J., Lanza, S., & Cassell, J. (2021). Care Home residents' Quality of Life and its Association with CQC Ratings and Workforce Issues: the MiCareHQ Mixed-Methods Study. In *Health Services and Delivery Research* (Vol. 9, Issue 19). https://doi.org/https://doi.org/10.3310/hsdr09190

Trinkoff, A. M., Storr, C. L., Lerner, N. B., Yang, B. K., & Han, K. (2017). CNA Training Requirements and Resident Care Outcomes in Nursing Homes. *The Gerontologist*, *57*(3), 501–508. https://doi.org/https://doi.org/10.1093/geront/gnw049

Tsao, Y.-C., Shu, C.-C., & Lan, T.-S. (2019). Development of a Reminiscence Therapy System for the Elderly Using the Integration of Virtual Reality and Augmented Reality. *Sustainability* , *11*(17), 4792–4801. https://doi.org/https://doi.org/10.3390/su11174792

Unbehaun, D., Aal, K., Daniel Vaziri, D., David Tolmie, P., Wieching, R., Randall, D., & Wulf, V. (2020). Social Technology Appropriation in Dementia: Investigating the Role of Caregivers in engaging People with Dementia with a Videogame-based Training System. *In Proceedings of 2020 CHI Conference on Human Factors in Computer Systems*, 1–15. https://doi.org/https://doi.org/10.1145/3313831.3376648

Van Der Ploeg, E. S., Eppingstall, B., & O'Connor, D. W. (2016). Internet Video Chat (Skype) Family Conversations as a Treatment of Agitation in Nursing Home Residents with Dementia. *International Psychogeriatrics*, *28*(4), 697–698. https://doi.org/https://doi.org/10.1017/S1041610215001854

Van der Roest, H. G., Wenborn, J., Pastink, C., Dröes, R. M., & Orrell, M. (2017). Assistive Technology for Memory Support in Dementia. *Cochrane Database of Systematic Reviews*, *2017*(6). https://doi.org/https://doi.org/10.1002/14651858.CD009627.pub2

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/https://doi.org/10.2307/30036540

Verbeek, H., Gerritsen, D. L., Backhaus, R., de Boer, B. S., Koopmans, R. T. C. M., & Hamers, J. P. H. (2020). Allowing Visitors Back in the Nursing Home during the COVID-19 Crisis: A Dutch National Study into First Experiences and Impact on Well-being. *Journal of the American Medical Directors Association*, *21*(7), 900–904. https://doi.org/https://doi.org/10.1016/J.JAMDA.2020.06.020

Verbeek, H., Zwakhalen, S. M. G., van Rossum, E., Ambergen, T., Kempen, G. I. J. M., & Hamers, J. P. H. (2010). Dementia care redesigned: Effects of small-scale living facilities on residents, their family caregivers, and staff. *Journal of the American Medical Directors Association*, *11*(9), 662–670. https://doi.org/http://doi.org/10.1016/j.jamda.2010.08.001

Vernooij-Dassen, M., & Moniz-Cook, E. (2016). Person-Centred Dementia Care: Moving beyond Caregiving. *Aging and Mental Health*, *20*(7), 667–668. https://doi.org/10.1080/13607863.2016.1154017

Vogelsang, K., Steinhüser, M., & Hoppe, U. (2013). A Qualitative Approach to Examine Technology Acceptance. *In Proceedings of the International*

Conference on Information Systems. https://core.ac.uk/download/pdf/301361231.pdf

Vondras, D. D., Flittner, D., Malcore, S. A., & Pouliot, G. (2009). Workplace Stress and Ethical Challenges Experienced by Nursing Staff in a Nursing Home. *Educational Gerontology*, *35*(4), 323–341. https://doi.org/https://doi.org/10.1080/03601270802605382

Waite, J., Poland, F., & Charlesworth, G. (2019). Facilitators and Barriers to Co-Research by People with Dementia and Academic Researchers: Findings from a Qualitative Study. *Health Expectations*, *22*(4), 761–771. https://doi.org/https://doi.org/10.1111/hex.12891

Walters, R. K., Gale, E. M., Barnoud, J., Glowacki, D. R., & Mulholland, A. J. (2022). The emerging Potential of Interactive Virtual Reality in Drug Discovery. *Expert Opinion on Drug Discovery*, *17*(7), 685–698. https://doi.org/https://doi.org/10.1080/17460441.2022.2079632

Wang, Y. guang, Liu, M. hui, & Shen, Z. hua. (2019). A Virtual Reality Counterconditioning Procedure to Reduce Methamphetamine Cue-Induced Craving. *Journal of Psychiatric Research*, *116*, 88–94. https://doi.org/https://doi.org/10.1016/J.JPSYCHIRES.2019.06.007

Waycott, J., Davis, H., Vetere, F., Morgans, A., Gruner, A., Ozanne, E., & Kulik, L. (2014). Captioned Photographs in Psychosocial Aged Care: Relationship Building and Boundary Work. *In Proceedings of the Conference on Human Factors in Computing Systems* , 4167–4176. https://doi.org/https://doi.org/10.1145/2556288.2557290

Waycott, J., Kelly, R. M., Baker, S., Barbosa Neves, B., Saoane Thach, K., & Lederman, R. (2022). The Role of Staff in Facilitating Immersive Virtual Reality for Enrichment in Aged Care: An Ethic of Care Perspective. *In Proceedings of TheCHI Conference on Human Factors in Computing Systems*, 1–17. https://doi.org/https://doi.org/10.1145/3491102.3501956

Weber, S., Weibel, D., & Mast, F. W. (2021). How to Get There When You Are There Already? Defining Presence in Virtual Reality and the Importance of Perceived Realism. *Frontiers in Psychology | Www.Frontiersin.Org*, *12*, 628298. https://doi.org/https://doi.org/10.3389/fpsyg.2021.628298

Welsh, D., Morrissey, K., Foley, S., Mcnaney, R., Salis, C., Mccarthy, J., & Vines, J. (2018). Ticket to Talk: Supporting Conversation between Young People and People with Dementia through Digital Media. *In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–14. https://doi.org/https://doi.org/10.1145/3173574.3173949

West, D., Quigley, A., & Kay, J. (2007). MEMENTO: A Digital-Physical Scrapbook for Memory Sharing. *Personal and Ubiquitous Computing*, *11*(4), 313–328. https://doi.org/https://doi.org/10.1007/s00779-006-0090-7

White, P. J. F., & Moussavi, Z. (2016). Neurocognitive Treatment for a Patient with Alzheimer's Disease Using a Virtual Reality Navigational Environment. *Journal of Experimental Neuroscience*, *10*, 129–135. https://doi.org/https://doi.org/10.4137/JEn.s40827

Wijma, E. M., Veerbeek, M. A., Prins, M., Pot, A. M., & Willemse, B. M. (2018). A Virtual Reality Intervention to Improve the Understanding and Empathy for

People with Dementia in Informal Caregivers: Results of a Pilot Study. *Aging and Mental Health*, *22*(9), 1115–1123. https://doi.org/https://doi.org/10.1080/13607863.2017.1348470

Wiley, E., Khattab, S., & Tang, A. (2022). Examining the effect of virtual reality therapy on cognition post-stroke: a systematic review and meta-analysis. *Disability and Rehabilitation: Assistive Technology*, *17*(1), 50–60. https://doi.org/https://doi.org/10.1080/17483107.2020.1755376

Williams, G., Riaz, M., Drini, E., & Riches, S. (2024). Virtual Reality Relaxation for Mental Health Staff in Complex Care Services: A Feasibility and Acceptability Study. *Mental Health & Prevention*, *33*, 200318. https://doi.org/https://doi.org/10.1016/J.MHP.2023.200318

Witmer, B. G., & Singer, M. J. (1998). Measuring Presence in Virtual Environments. *Presence: Teleoperators and Virtual Environments*, *7*(3), 225–240. https://doi.org/https://doi.org/10.1162/105474698565686

Wolfs, C. A. G., Dirksen, C. D., Severens, J. L., & Verhey, F. R. J. (2006). The added value of a multidisciplinary approach in diagnosing dementia: A review. *International Journal of Geriatric Psychiatry*, *21*(3), 223–232. https://doi.org/10.1002/GPS.1454

Wolfs, C. A. G., Kessels, A., Dirkins, C. D., Severens, J. L., & Verhey, F. R. J. (2008). Integrated Multidisciplinary Diagnostic Approach for Dementia Care: Randomised Controlled Trial. *The British Journal of Psychiatry*, *192*, 300–305. https://doi.org/https://doi.org/10.1192/bjp.bp.107.035204

Won, A. S., Bailey, J., Bailenson, J., Tataru, C., Yoon, I. A., & Golianu, B. (2017). Immersive Virtual Reality for Pediatric Pain. *Children*, *4*(52), 1–15. https://doi.org/https://doi.org/10.3390/children4070052

Woodhead, E. L., Northrop, L., & Edelstein, B. (2016). Stress, Social Support, and Burnout among Long-Term Care Nursing Staff. *Journal of Applied Gerontology*, *35*(1), 84–105. https://doi.org/https://doi.org/10.1177/0733464814542465

Woods, B., O'Philbin, L., Farrell, E. M., Spector, A. E., & Orrell, M. (2018). Reminiscence Therapy for Dementia. In *Cochrane Database of Systematic Reviews* (Issue 3). John Wiley and Sons Ltd. https://doi.org/https://doi.org//10.1002/14651858.CD001120.pub3

World Health Organisation. (2024). *Dementia*. WHO. https://www.who.int/news-room/fact-sheets/detail/dementia

Yamamoto-Mitani, N., Aneshensel, C. S., & Levy-Storms, L. (2002). Patterns of Family Visiting with Institutionalized Elders: The Case of Dementia. *Journal of Gerontology: Social Sciences*, *57*(4), S234–S246. https://doi.org/https://doi.org/10.1093/geronb/57.4.S234

Yamazaki, R., Kase, H., Nishio, S., & Ishiguro, H. (2019). A Conversational Robotic Approach to Dementia Symptoms Measuring Its Effect on Older Adults. *In Proceedings of the 7th International Conference on Human-Agent Interaction*, 110–117. https://doi.org/https://doi.org/10.1145/3349537.3351888

Yang, Y.-H., Situmeang, R. F., Ong, P. A., & Liscic, R. M. (2022). Application of Virtual Reality for Dementia Management. *Brain Science Advances*, *8*(3), 210–220. https://doi.org/https://doi.org/10.26599/bsa.2022.9050019

Yanping, L., Xudong, W., Fule, W., Xiaojun, C., Chengtao, W., & Guofang, S. (2014). Development and Validation of a Surgical Training Simulator with Haptic Feedback for Learning Bone-Sawing Skill. *Journal of Biomedical Informatics*, *48*, 122–129. https://doi.org/https://doi.org/10.1016/j.jbi.2013.12.010

Yildirim, G., Elban, M., & Yildirim, S. (2018). Analysis of Use of Virtual Reality Technologies in History Education: A Case Study. *Asian Journal of Education and Training*, *4*(2), 62–69. https://doi.org/https://doi.org/10.20448/journal.522.2018.42.62.69

Yondjo, J., & Siette, J. (2024). "VR is the Future": Perspectives of Healthcare Professionals on Virtual Reality as a Diagnostic Tool for Dementia Status in Primary Care. *BMC Medical Informatics and Decision Making*, *24*(9), 1. https://doi.org/https://doi.org/10.1186/s12911-023-02413-y

Zakzanis, K. K., Quintin, G., Graham, S. J., & Mraz, R. (2009). Age and Dementia Related Differences in Spatial Navigation within an Immersive Virtual Environment. *Medical Science Monitor* , *15*(4), CR140–CR150. http://www.medscimonit.com/abstract/index/idArt/869613

Zamir, S., Hennessy, C., Taylor, A., & Jones, R. (2020). Intergroup 'Skype' Quiz Sessions in Care Homes to Reduce Loneliness and Social Isolation in Older

People. *Geriatrics* , *5*(4), 1–16. https://doi.org/https://doi.org/10.3390/geriatrics5040090

Zaudig, M., Mittelhammer, J., Hiller, W., Pauls, A., Thora, C., Morinigo, A., & Mombour, W. (1991). SIDAM – A Structured Interview for the Diagnosis of Dementia of the Alzheimer type, Multi-Infarct Dementia and Dementias of Other Aetiology According to ICD-10 and DSM-III-R. *Psychological Medicine*, *21*, 225–236. https://doi.org/https://doi.org/10.1017/S0033291700014811

Zhang, M., Ding, H., Naumceska, M., & Zhang, Y. (2022). Virtual Reality Technology as an Educational and Intervention Tool for Children with Autism Spectrum Disorder: Current Perspectives and Future Directions. *Behavioral Sciences 2022, Vol. 12, Page 138*, *12*(5), 138. https://doi.org/https://doi.org/10.3390/BS12050138

Zhao, W., Baker, S., & Waycott, J. (2020). Challenges of Deploying VR in Aged Care: A Two-Phase Exploration Study. *In Proceedings of the 32nd Australian Conference on Human-Computer Interaction*, 87–98. https://doi.org/https://doi.org/10.1145/3441000.3441018

Zheng, J. M., Chan, K. W., & Gibson, I. (1998). Virtual Reality. *IEEE Potentials*, *17*(2), 20–23. https://doi.org/https://doi.org/10.1109/45.666641

Zimmerman, S., Williams, C. S., Reed, P. S., Boustani, M., Preisser, J. S., Heck, E., & Sloane, P. D. (2005). Attitudes, Stress, and Satisfaction of Staff Who Care for Residents With Dementia. *The Gerontologist*, *45*(suppl_1), 96–105. https://doi.org/https://doi.org/10.1093/GERONT/45.SUPPL_1.96

Zmora, R., Statz, T. L., Birkeland, R. W., McCarron, H. R., Finlay, J. M., Rosebush, C. E., & Gaugler, J. E. (2019). Transitioning to Long-Term Care: Family Caregiver Experiences of Dementia, Communities, and Counseling. *Journal of Aging and Health*, *33*(2), 133–146. https://doi.org/https://doi.org/10.1177/0898264320963588

Zsiga, K., Tóth, A., Pilissy, T., Péter, O., Dénes, Z., & Fazekas, G. (2018). Evaluation of a Companion Robot Based on Field Tests with Single Older Adults in their Homes. *Assistive Technology*, *30*(5), 259–266. https://doi.org/https://doi.org/10.1080/10400435.2017.1322158

Zucchella, C., Sinforiani, E., Tamburin, S., Federico, A., Mantovani, E., Bernini, S., Casale, R., & bartolo, M. (2018). The Multidisciplinary Approach to Alzheimer's Disease and Dementia. A Narrative Review of Non-Pharmacological Treatment. *Frontiers in Neurology | Www.Frontiersin.Org*, *9*, 1058. https://doi.org/https://doi.org10.3389/fneur.2018.01058

Zwijsen, S. A., Niemeijer, A. R., & Hertogh, C. M. P. M. (2011). Ethics of Using Assistive Technology in the Care for Community-Dwelling Elderly People: An Overview of the Literature. *Aging & Mental Health*, *15*(4), 419–427. https://doi.org/https://doi.org/10.1080/13607863.2010.543662

Appendices

Appendix A: Focus Groups Questions

1. Have you had any previous experience using virtual reality (VR)? If so, could you share your experience?
2. What did you enjoy most about your experience with VR?
3. Do you feel that VR offered you an experience you couldn't have in real life? If so, what made it unique or enjoyable?
4. Now that you've tried the VR headset, how did you find the experience? Was it enjoyable? If so, can you please share details?
5. What do you think about the idea of sharing a VR experience, like watching a sunset, with someone who has dementia?
6. Besides enabling shared experiences, what other potential benefits do you think VR could bring to dementia care?
7. What other advantages might VR offer for people with dementia?
8. Do you have any concerns about using VR for people with dementia?
9. In your opinion, could VR experiences be distressing for someone with dementia?
10. What do you think about the practicality of using a VR headset in care settings?
11. What challenges or barriers might prevent you from using VR in your work?
12. What makes it easy or accessible for you to use and enjoy the VR headset?
13. Given your experience, would you consider using VR with your residents?
14. Would you like to see any changes or improvements in how VR is currently used?
15. Are there specific types of VR content (e.g., museums, locations) you would like to see in future experiences?
16. What kind of support would you need when using a VR headset—either for setup or during use?
17. Is there anything else you would like to add about your experience or thoughts on VR in dementia care?

Appendix B: Discussion Rounds Questions

1. What are the current technical capacities (e.g., internet speed, power access, device compatibility) in your care setting, and how might these affect VR deployment?
2. What technical challenges do you foresee in setting up or maintaining VR equipment in your facility?
3. Are there specific infrastructure upgrades needed (e.g., dedicated space, Wi-Fi boosters) to support a stable and comfortable VR experience?
4. What kind of training would care staff require to confidently facilitate VR sessions?
5. What do you think would help staff feel ready to lead or support VR sessions?
6. How much time can realistically be allocated for staff training within your organisation's workflow?
7. What ongoing support (technical or educational) would staff need to feel competent using VR?
8. In your view, what criteria should guide the inclusion or exclusion of people with dementia in VR sessions?
9. Are there any specific health conditions, behaviours, or cognitive stages that would make someone more or less suitable to use VR?
10. How should care staff themselves be selected or prepared to assist with or lead VR activities?
11. How might VR sessions be incorporated into daily routines or existing activity schedules?
12. What would be the ideal frequency and duration of VR use within your care environment?
13. What potential barriers might prevent the regular or effective use of VR in your organisation (e.g., staffing levels, scheduling, competing activities)?
14. What concerns do you have about the ethical use of VR in dementia care, particularly around consent, confusion, or distress?
15. What safety protocols (e.g., supervision, emergency response) do you believe are essential when someone with dementia is using VR?
16. In your opinion, what added value could VR bring to dementia care in your setting?
17. Can you foresee VR enhancing specific areas like emotional well-being, cognitive stimulation, or social connection?

Appendix C: Mental Capacity Act Course Certificate

e-LfH

NHS
Health Education England

e-LfH
e-Learning for Healthcare

This is to certify that

Hiba Jawharieh

completed the programme

Mental Capacity Act (MCA)

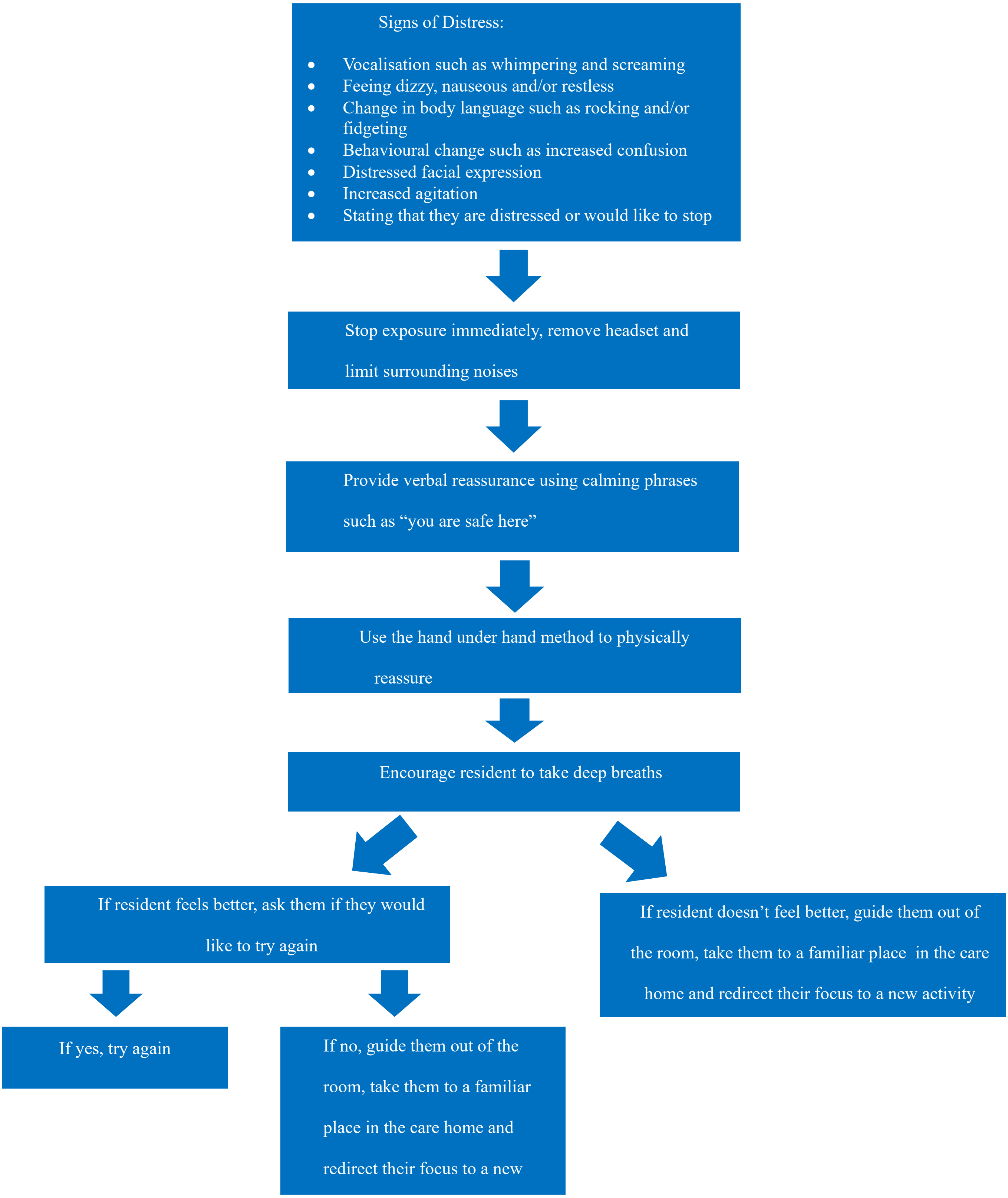
On

21 June 2021

This document is a record of completion of the e-learning material and, where applicable, successful completion of any associated summative assessments. It does not constitute certification or a formal qualification.

Certificate Generated On 21 June 2021

Appendix D: Protocol to Manage Distress



Appendix E: Toolkit

Virtual Reality Deployment Toolkit for Caregivers & Activities Coordinators

Table of Content

1. Introduction

1.1 What is Virtual Reality (VR)?

VR is a head-mounted device that a person can wear, presenting visual and audio information about various places, allowing them to experience it as if they were really there.

1.2 What are the benefits of VR to the residents?

This experience will allow the residents to see and visit places that are not easily accessible anymore. By wearing the headset, they would feel as if they were truly in one of their favourite areas, transported to a place dear to their heart. As a meaningful activity, VR brings enjoyment to the residents. They become talkative, showing signs of excitement and sharing stories about their life and past experiences. Recent studies have highlighted the efficacy of VR as a pathway to enhance cognitive functioning, mood and quality of life for elderly individuals living with dementia. These studies also show that such experiences positively impact their relationships and interactions with their caregivers.

1.3 Who cannot participate in this activity?

- A resident who has a substantial visual impairment.
- A resident with a history of motion sickness.
- A resident who has experienced hallucinations (auditory and visual) and/or delusions.
- A resident who suffers from seizures, headaches and or earaches.
- A resident with a pacemaker or wears a hearing aid.
- Anyone under 13 years old.

1.4 What are the risks and burdens of using the VR headset?

There is no foreseen risk or burden. However, a resident may feel tired at the end of the session. If this happens, it is recommended that the care staff member allow the person with dementia to rest for a few minutes before they leave to minimise this burden. If they show any signs of distress because of the VR exposure, such as feeling dizzy, nauseous, or restless, a protocol to manage this situation can be found in Appendix (A).

1.5 What do you need before you start this activity?

A. A good Wi-Fi connection is essential for the full experience of this activity. Without it, the videos may not download properly onto the headset, or they may not play correctly on the website when used with the resident.

B. A swivel chair for the resident to sit on enhances their experience by allowing them to easily turn around if they wish.

C. A designated area for this activity, away from walls and other people, is important to prevent hazardous accidents.

1.6 When is a good time for this activity?

This activity can be scheduled at any convenient time for the residents. However, it is recommended to avoid fitting it into a tight schedule or close to essential care routines, such as mealtimes, as this might cause distress. For instance, a resident may become agitated if they perceive the activity might interfere their meal.

2. Dos and Don'ts

- **Dos**

- Turn on the headset and set it up before logging into the website.
- Ensure residents are in the right mood for this activity.

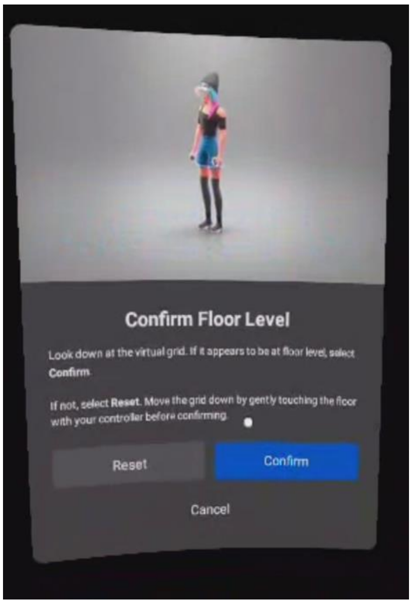
- Use appropriate language when introducing this activity to residents. Emphasis that it is an option to experience "visiting a cathedral" or "walking in a forest" ant not a replacement for physically being in these locations.
- Watch the video on the website to initiate conversations with residents using engagement prompts such as "have you been to a beach like this before?", "Does this forest remind you of anything?" and "look to your right, there is a river!".
- Conduct the session with the resident seated in a comfortable swivel chair to reduce the likelihood of dizziness.
- The resident may wear their glasses while using the headset.

▪ **Don'ts**

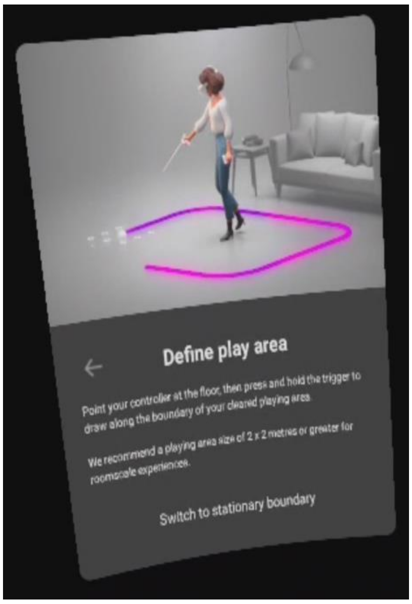
- Do not continue the session if you notice any signs of distress in a resident, such as dizziness, nausea, increased agitation, changes in behaviour or body language, restlessness or distressed facial expressions. If this occurs, stop the session immediately, remove the headset and minimise the surrounding noises.
- Do not use the headset outdoors.
- Avoid sitting in direct sunlight while using the headset, as it can affect the experience.
- Ensure the resident's swivel chair is not placed near a wall or other people to prevent hazardous accidents.
- It is recommended not to play a video with audio content featuring a narrator during a remote session, as this may distract the flow of conversation flow between the resident and their loved one.
- Do not select the stationary boundary on the headset. Always choose the "room-scale" boundary for better image quality, especially if the resident moves.

3. Setting up the Oculus Quest 2 headset and connect it to the VR Passport website

3.1 Turn on the headset by pressing the button located on its right-hand side.



3.2 This is the first image displayed on the headset's screen. To confirm the floor level, gently touch the floor while holding the controller. Then, select "confirm".

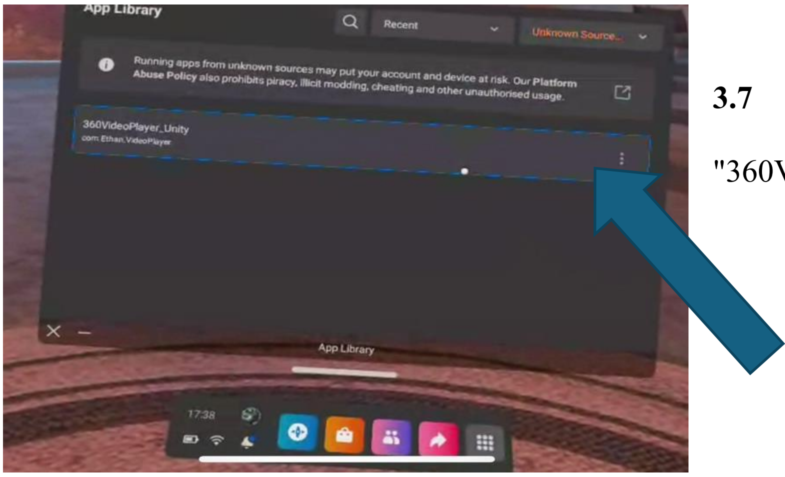


3.3 To draw the room-scale boundary, point the controller at the floor and press and hold the trigger to draw along the edges of your cleared play/exposure area.

3.4 When you get to this menu, select the "Applications" button.

3.5 When you get to the Applications page, select the drop-down menu.

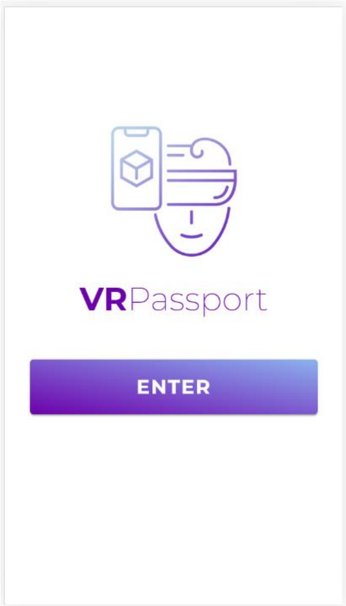
3.6 Select "Unknown sources" from the drop-down menu.



3.7 Select "360VideoPlayer_Unity"

3.8 The headset is set up and ready to play videos from the VR Passport website.

4. Accessing the VR Passport website



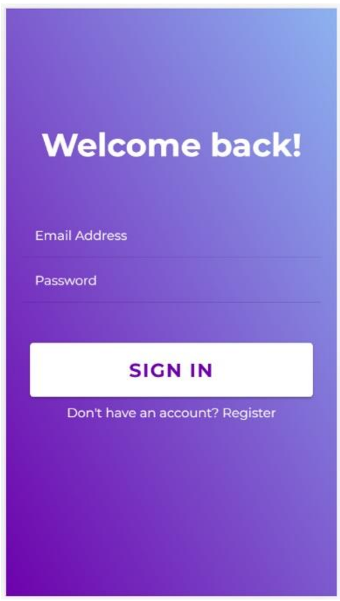
Go to the start-up page

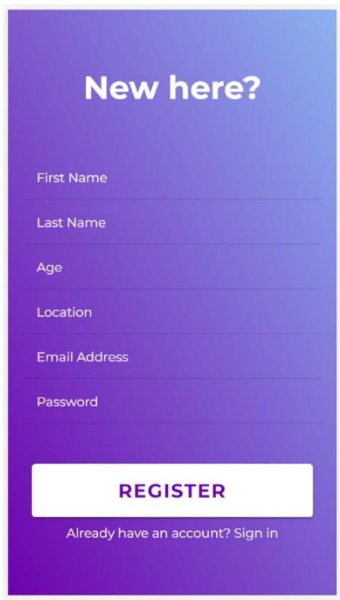
through this address

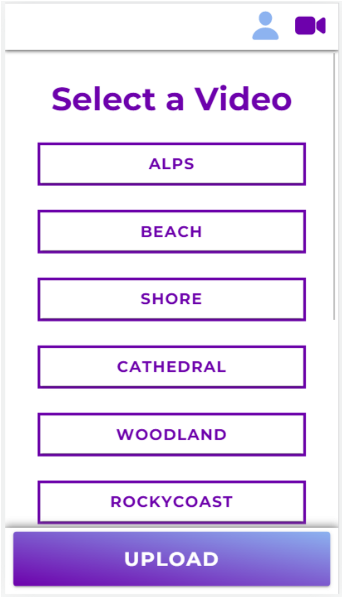
https://passportvrpwa.web.

If you don't have an account, register for one.

If you have an account, sign in.

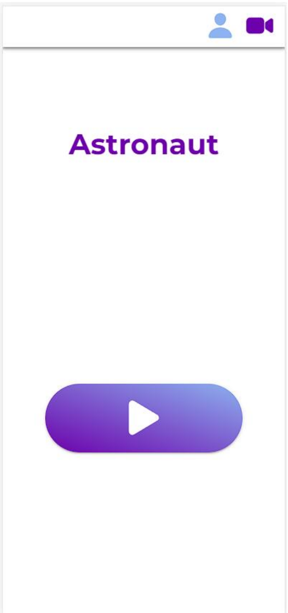




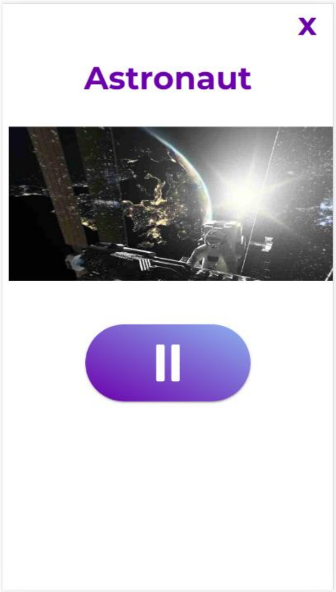


Once you are signed in, select a video, wait for it to fully download then press the "Play" button.

This is a screenshot of the website while the VR video is downloading. Wait until it is fully downloaded (the play button becomes darker) then press "Play".



This is a screenshot of the website when the VR video is fully downloaded. Now press "play". Be patient while the video is downloading, as the process could take a few seconds.



You will be able to watch the video playing on the headset via your tablet or laptop.

5. Key considerations for suitable VR content include the following guidelines:

- The resolution should be at least 2K (2048x1080) or higher to maintain high-quality visuals.
- Avoid sudden transition between scenes to prevent startling or confusing the residents.
- Ensure the video is free from shaky, unstable camera recording to avoid inducing motion sickness.
- Exclude animals or people who are close to the camera, as this may be appear startling or scary.
- Avoid high-arousal, negative content that could be perceived as alarming.
- The audio content should be consistent with the visual content, aiming to provide coherent audial-visual feedback without distraction.
- Ensure audial content is not perceived as too loud, low, or noisy.
- Avoid explicit audio narration to enable residents to hear directions and prompts from their loved one or caregiver while using the VR.
- Refrain from including computer-generated content or special effects due to the lack of evidence on their impact on the residents.
- Avoid aerial videos to prevent inducing motion sickness or disorientation.

6. Protocol to Deploy VR

Before You Start the First Session: Introduce the VR to the residents and obtain their consent to participate in this activity.

Get Ready for the Session: The resident is to sit on a comfortable chair away from walls, people and direct sunlight.

Select the VR Video Collaboratively: Go through the video list, discuss the content options with residents and help them choose something they like.

Wearing the Headset: Show the resident the headset and allow them to touch it if they wish. Inform them before putting the headset on. Adjust it through the straps and make sure they feel comfortable wearing it.

Play the Chosen Video: Inform the resident that you are about to play the video and that they are about to enter the virtual world. Guide them through the experience using engagement prompts. Periodically, check if they are enjoying the activity or would prefer to "visit" another location. If the resident shows any signs of distress, follow the protocol outlined in Appendix A to manage distress.

Remove the Headset and Prepare to End the Session: Inform the resident that you are about to remove the headset and that they will transition from the virtual world and back to the real one. After removing the headset, engage them in conversation about what they experienced and their thoughts on the session.

End the Session: Clean the headset with anti-viral wipes to ensure it is clean and ready for the next use.

7. Modes of Session Delivery

A. Face-to-face Session

A session can be conducted with the resident alone. This mode of delivery can take place in a private or communal area. The communal area can help promote the system to other residents. All that is need is a VR headset and a tablet to access the website through this address https://passportvrpwa.web.app

B. Remote Session

A loved one can be involved in a session, allowing them to watch what the resident is experiencing in real-time and engage in a conversation about it. This mode of delivery requires sending the loved one two links; one link for a video-conferencing platform such as Zoom or Teams and another for watching the video (vr.sipanote.com). The second link becomes active once the resident starts watching the video on the headset.

8. Protocol to Manage Distress

As shown in Appendix 1

9. Common Problems and Basic Troubleshooting

- **Inconsistent Performance and Errors:** Ensure the Wi-Fi connection is stable. If the connection is fine and you are still experiencing performance issues and encountering errors that are difficult to identify, performing a full reboot of the headset will help. To reboot, hold down the power button and select *Power Off* or *Restart* from the power menu. This process typically resolves basic or unidentifiable problems. If accessing the menu is not possible, hold down the power button until the headset turns off, then turn it back on.
- **Blurry or Uncomfortable Visuals:** If the image on the headset appears blurry, distorted or uncomfortable to view, adjust the IPD (interpupillary distance) setting on the headset. IPD is the distance between the centres of your eyes. To correct

this, move the lenses and display panels so they align more directly with the pupils. This adjustment can be made by nudging the lenses either further apart or closer together.

- **Tracking and Guardian Problems:** Occasionally, the guardian system or headset tracking may become inconsistent, and you might even see errors about the headset "lost tracking". Here are some potential causes and fixes for these issues:

- Use the headset in an indoor area that is well-lit but avoid direct sunlight. The headset is not designed for outdoor use or direct sunlight. If indoors, consider closing the blinds slightly to avoid light while keeping the area well-lit.
- Clean the tracking cameras. Smudges and fingerprints on the four external tracking cameras located on each corner of the headset might cause issues. Regularly, wipe them with a microfiber cloth to ensure proper functioning.
- Mirrors and small string lights, such as Christmas tree lights, can interfere with the headset's tracking system. Avoid using the headset near these objects.
- If none of the above resolves the issue, perform a full reboot as previously outlined. This can often fix persistent tracking problems.

- **Controller Problems:** If the headset fails to detect one of the controllers, check the battery (size AA), which is located under a removable cover on the front of the controller. Controller tracking may also degrade as the battery nears depletion, so consider replacing them early if you notice a decline in performance.
- **Black Screen of Death:** This error manifests as a black screen, either completely unlit or with a faint glow but no content display. Common causes include dead batteries, stuck updates or hardware issues. To resolve this issue, try the following:

- Charge the headset: Ensure the headset is fully charged. If it has no charge, only a black screen will appear.

- Try opening the Oculus menu: While facing the black screen, press the menu button on the left controller and the Oculus button on the right controller. If the menu appears, try launching an app to see resolve the issue.
- Check the Oculus app: Open the Oculus app on a mobile and log in if necessary. Verify that the app recognises the headset. Then, launch a game from the app, place the headset on and check if the problem is fixed.
- Keep the headset on and plugged in: If charging doesn't resolve the issue and a compatible charger is being used, leave the headset plugged in for at least 30 minutes. If the black screen is caused by an update in progress, this will allow the update to complete and restore normal operation.
- Inspect the proximity sensor: Locate the proximity senor between the lenses in your headset. Cover the sensor with a thumb to check if the black screen disappears. If the issue persists, clean the sensor using a dry microfiber cloth.
- Perform a full reboot as outlined earlier if none of the above steps resolve the issue.

- **Videos are not downloading:** Limited access to videos and failure to download them may indicate that headset is not connecting to the tablet. To resolve this, log out of the tablet and log back in. Restart the headset can also help. Ensure both devices are close to each other during the pairing process.
- **Videos and/or audio are lagging:** Verify the Wi-Fi signal strength. Move closer to the router if the signal is weak. If the issue persists, consider relocating to an area with a stronger signal.
- **Colours on the headset:**

- **Red:** The battery is very low.
- **Orange:** The battery is charging.

- **Green:** The battery is fully charged.

- **The headset is not turning on:** Insufficient battery may be the cause. Plug in the device and leave it to charge for approximately 30 minutes before attempting to turn it on. A full charge takes 2.5 hours.

Appendix 1

Protocol to Manage Residents' Distress

Signs of Distress:

- Vocalisation such as whimpering and screaming
- Feeing dizzy, nauseous and/or restless
- Changing body language such as rocking and/or fidgeting
- Behavioural change such as increased confusion
- Distressed facial expression
- Increased agitation
- Stating that they are distressed or would like to stop

Stop the exposure immediately, remove headset and limit surrounding noises

Provide verbal reassurance using calming phrases such as "you are safe here"

Encourage resident to take deep breaths

If resident feels better, ask them if they would like to try again

If resident doesn't feel better, go through the steps again

If yes, try again

If no, guide them out of the room, take them to a familiar place in the care home and redirect

Appendix F: Resident Information Sheet

You are being invited to take part in this research project. Please take the time to carefully read this information sheet before deciding to do so. Your participation is entirely voluntary. This project is carried out by Hiba Jawharieh, supervised by Dr Chee Siang Ang, School of Engineering and Digital Arts at the University of Kent, in collaboration with Dr Andrew Sommerlad, Division of Psychiatry at University College London. This study is sponsored by the University of Kent.

This information sheet will be read out to you if needed.

Thank you for considering participating in this study.

What is the purpose of the study?

The study aims to investigate the opportunities and challenges of deploying Virtual Reality (VR) to support and help improve the well-being of people with dementia in a care home setting.

What is virtual reality?

Virtual Reality is a head-mounted device you can wear, which will present visual and audio information of various places to you in such a way that you would experience it as if you were really there.

Why have I been invited?

You have been invited to take part in our study as a resident living in a care home to test a new system that has been produced and to contribute any feedback for improving the system in the future.

Do I have to take part?

Your participation is entirely voluntary. If you do decide to take part, you will be asked to sign a consent form before any further procedures.

You are free to withdraw from the research study at any time and without giving any reason. If this happens, we will not use your data in the research.

What are the possible benefits of taking part?

We hope you will find this research interesting and enjoy the VR experience. We hope that the information and feedback you contribute to this study will help us improve and develop a novel system that can improve the quality of life of people with dementia.

What do I need to know, and what are the possible disadvantages and risks of taking part?

We will audio record the sessions from beginning to end. We want you to know that these recordings will be kept on a secure drive protected by a firewall and password, and we guarantee that only the research members mentioned above will have access to them. Once audio tapes are transcribed, and the data analysis is completed, they will all be deleted.

The researchers believe that there are no risks involved in this study. Nevertheless, you may feel tired after the end of the study. If it happens, we recommend you rest for a few minutes before leaving. If at any point you might feel distressed because of the VR exposure, we have a protocol in place to make you feel better.

What will happen to me if I take part?

You will be asked to attend the experiment at a suitable time for you, the care staff, and the researcher.

The procedure of the study will be split into two parts:

1) **Two VR face-to-face sessions**, during which you and a carer explore a VR experience together by selecting various videos to watch and engaging in a casual conversation audio recorded for data analysis (each session lasting no longer than 30 minutes). This exposure will be followed by a brief interview, during which you and

a carer will answer a few short questions about the product experienced, including any thoughts and potential improvements (lasting no longer than 15 minutes).

2) **One VR remote session**, enabling you and a family member to explore a VR experience remotely by selecting various videos to watch and engaging in a casual conversation online, which will be recorded for data analysis (lasting no longer than 30 minutes). This exposure will be followed by a brief interview, where you and a family member will respond to a few short questions regarding the product experienced, including thoughts and potential improvements (lasting no longer than 15 minutes).

How will you protect my confidentiality and anonymity?

All information obtained in this study will be kept strictly confidential. The data collected from you will be anonymised. We will not include your name and remove any other potentially identifying information about you. Access to all the data is restricted. All data will be stored and kept safely in line with the Data Protection Act. The researchers will keep the data for up to 6 months before destroying it.

What will happen to the results of the study?

The results serve exclusively academic purposes. When the study is completed, we will analyse the collected data and report the findings. It will be reported in an appropriate journal or presented at a conference. You will not be identified in any report or publication. If you wish to receive a copy of any reports resulting from the research, please ask us to include you in our mailing list.

Contact Details:

If you have a concern or an enquiry about any aspect of this study, you should ask to speak to the researcher, Hiba Jawharieh, who will do her best to answer your questions (07934799631) or send an email to hhfj2@kent.ac.uk. If you remain unhappy and wish to complain formally, contact the Head of Research Policy & Support in Research & Innovation Services At headrps@kent.ac.uk. If you have any concerns regarding the data collected, you can contact the Data Protector officer at the University of Kent via email at dataprotection@kent.ac.uk

If you are still unhappy with their response or believe they are processing your data in a way that is not right or lawful, you can complain to the Information Commissioner's Office (ICO) (www.ico.org.uk or 0303 123 1113).

Appendix G: Family Member Information Sheet

You are being invited to take part in this research project. Please take the time to carefully read this information sheet before deciding to do so. Your participation is entirely voluntary.

This project is carried out by Hiba Jawharieh, supervised by Dr Chee Siang Ang, School of Engineering and Digital Arts at the University of Kent, in collaboration with Dr Andrew Sommerlad, Division of Psychiatry at University College London. This study is sponsored by the University of Kent.

Thank you for considering participating in this study.

What is the purpose of the study?

The study aims to investigate the opportunities and challenges of deploying Virtual Reality (VR) to support and help improve the well-being of people with dementia in a care home setting.

What is virtual reality?

Virtual Reality is a head-mounted device you can wear, which will present visual and audio information of various places to you in such a way that you would experience it as if you were really there.

Why have I been invited?

You have been invited to take part in our study as a relative of a loved one living in a care home/ attend an adult day centre to test a new system that has been produced and to contribute any feedback for improving the system in the future.

Do I have to take part?

Your participation is entirely voluntary. If you do decide to take part, you will be asked to sign a consent form before any further procedures.

You are free to withdraw from the research study at any time and without giving any reason.

If this happens, we will not use your data in the research.

What are the possible benefits of taking part?

We hope you will find this research interesting and enjoy the VR experience. We hope that the information and feedback you contribute to this study will help us improve and develop a novel system that can improve the quality of life of people with dementia.

What do I need to know, and what are the possible disadvantages and risks of taking part?

We will audio record the session from beginning to end. We want you to know that these recordings will be kept on a very secure drive with a firewall and password protection, and we guarantee you that only the research members mentioned above will have access to them. Once videos and audio tapes are transcribed and the data analysis is completed, they will all be deleted.

The researchers believe that there are no risks involved in this study.

What will happen to me if I take part?

You will be asked to attend an online experiment at a suitable time for you, your loved one, the care staff, and the researcher.

The procedure of the study will be split into 2 parts:

1) **An interview**, during which you respond to a few questions to gather more feedback regarding the residents' background to provide suitable virtual environments (lasting no longer than 15 minutes).

2) Attend **an online training** (lasting 40 minutes) that will include the study aims, an introduction to VR technology, its benefits and guidance on using the system (i.e. setting up the links for the remote session). The training session will be presented by the researcher, who will dedicate some time at the end to answer questions as they arise.

3) **One VR remote session**, during which you and your loved one explore a VR experience remotely by selecting various videos to watch and engaging in a casual conversation online, which will be recorded for data analysis (lasting no longer than 30 minutes). This exposure will be followed by a brief interview, where you and your loved one will respond to a few short questions about the product you experienced, including thoughts and potential improvements (lasting no longer than 15 minutes).

How will you protect my confidentiality and anonymity?

All information obtained in this study will be kept strictly confidential. The data collected from you will be anonymised. We will not include your name and remove any other potentially identifying information about you. Access to all the data is restricted. All data will be stored and kept safely in line with the Data Protection Act. The researcher will keep data for up to 6 months before destroying all data.

What will happen to the results of the study?

The results serve exclusively academic purposes. When the study is completed, we will analyse the collected data and report the findings. It will be reported in an appropriate journal or presented at a conference. You will not be identified in any report or publication. If you wish to receive a copy of any reports resulting from the research, please ask us to include you in our mailing list.

Contact Details:

If you have a concern or an enquiry about any aspect of this study, you should ask to speak to the researcher, Hiba Jawharieh, who will do her best to answer your questions (07934799631) or send an email to hhfj2@kent.ac.uk. If you remain unhappy and wish to complain formally, contact the Head of Research Policy & Support in Research & Innovation Services At headrps@kent.ac.uk. If you have any concerns regarding the data collected, you can contact the Data Protector officer at the University of Kent via email at dataprotection@kent.ac.uk

If you are still unhappy with their response or believe they are processing your data in a way that is not right or lawful, you can complain to the Information Commissioner's Office (ICO) (www.ico.org.uk or 0303 123 1113).

Appendix H: Care Staff Information Sheet

You are being invited to take part in this research project. Please take the time to carefully read this information sheet before deciding to do so. Your participation is entirely voluntary.

This project is carried out by Hiba Jawharieh, supervised by Dr Chee Siang Ang, School of Engineering and Digital Arts at the University of Kent, in collaboration with Dr Andrew Sommerlad, Division of Psychiatry at University College London. This study is sponsored by the University of Kent.

Thank you for considering participating in this study.

What is the purpose of the study?

The study aims to investigate the opportunities and challenges of deploying Virtual Reality (VR) to support and help improve the well-being of people with dementia in a care home setting.

What is virtual reality?

Virtual Reality is a head-mounted device you can wear, which will present visual and audio information of various places to you in such a way that you would experience it as if you were really there.

Why have I been invited?

You have been invited to take part in our study as a care staff along with a resident in your care to test a new system that has been produced and to contribute any feedback for improving the system in the future.

Do I have to take part?

Your participation is entirely voluntary. If you do decide to take part, you will be asked to sign a consent form before any further procedures.

You are free to withdraw from the research study at any time and without giving any reason. If this happens, we will not use your data in the research.

What are the possible benefits of taking part?

We hope you will find this research interesting and enjoy the VR experience. We hope that the information and feedback you contribute to this study will help us improve and develop a novel system that can improve the quality of life of people with dementia.

What do I need to know, and what are the possible disadvantages and risks of taking part?

We will audio record the sessions from beginning to end. We want you to know that these recordings will be kept on a very secure drive with a firewall and password protection, and we guarantee you that only the research members mentioned above will have access to them. Once videos and audio tapes are transcribed and the data analysis is completed, they will all be deleted.

The researchers believe that there are no risks involved in this study.

What will happen to me if I take part?

You will be asked to attend the experiment at a suitable time for you, the resident, and the researcher.

The procedure of the study will be split into 7 parts:

1) **An interview**, during which you respond to a few questions to gather more feedback regarding the residents' background to provide suitable virtual environments (lasting no longer than 15 minutes).

2) Attend **a training session** (lasting 2 hours) that will include an introduction to VR technology, its benefits and guidance on using the system, managing distress and deploying VR effectively. It will also include instructions on completing the following forms: The Engagement of People with Dementia Scale (EPWDS) and The Observed Emotional Rating Scale (OERS), as well as

3) **Two VR demonstrations**, during which you and the resident explore a VR experience together by selecting various videos to watch and engaging in a casual conversation audio recorded for future analysis (each session lasting no longer than 30 minutes).

4) **One VR remote session**, during which you assist a resident in selecting various videos to watch with their family members online. The session will be audio-recorded for data analysis (lasting no longer than 30 minutes).

5) **An interview**, where you and the resident will respond to a few brief questions related to the product that you experienced, including thoughts and potential improvements (lasting no longer than 15 minutes).

6) **Observe the participant** resident and fill out two forms before and after the experiment.

How will you protect my confidentiality and anonymity?

All information obtained in this study will be kept strictly confidential. The data collected from you will be anonymised. We will not include your name and remove any other potentially identifying information about you. Access to all the data is restricted. All data will be stored and kept safely in line with the Data Protection Act. The researcher will keep data for up to 6 months before destroying all data.

What will happen to the results of the study?

The results serve exclusively academic purposes. When the study is completed, we will analyse the collected data and report the findings. It will be reported in an appropriate journal or presented at a conference. You will not be identified in any report or publication. If you wish to receive a copy of any reports resulting from the research, please ask us to include you in our mailing list.

Contact Details:

If you have a concern or an enquiry about any aspect of this study, you should ask to speak to the researcher, Hiba Jawharieh, who will do her best to answer your questions (07934799631) or send an email to hhfj2@kent.ac.uk. If you remain unhappy and wish to complain formally, you can contact the Head of Research Policy & Support in Research & Innovation Services At headrps@kent.ac.uk. If you have any concerns regarding the data collected, you can contact the Data Protector officer at the University of Kent via email at dataprotection@kent.ac.uk

If you are still unhappy with their response or believe they are processing your data in a way that is not right or lawful, you can complain to the Information Commissioner's Office (ICO) (www.ico.org.uk or 0303 123 1113).

Appendix I: Interview Questions for Residents and Care Staff (Elaborate)

Thank you for joining me for this interview. We would like to know more about your experience in VR. I will record the interview (audio-only) to get all the information you provide.

- **Usability Questions:**

- Would you like to use this system frequently? If yes: How frequently and why?
- Did you find the system unnecessarily complex? If yes: what troubled you?
- Was the system easy to use? Can you tell us more?
- Do you think that you will need the support of a technical person to be able to use this system? If yes: Why? What needs to be done to ensure the easy use of the system?
- Did you find the various functions in this system were well integrated?
- Was there too much inconsistency in this system? If yes: Can you give us an example?
- Would you imagine that most people would learn to use this system very quickly? Can you tell us more?
- Was the system very cumbersome to use? If yes: Why? What needs to be done to ensure the easy use of the system?
- Did you feel very confident using the system? If yes: What do you think made you feel that way?
- Did you need to learn a lot of things before you could get going with this system? If yes: Can you tell us a couple of things you feel needed to learn?

- Presence and Immersion Questions:

- In the computer-generated world, did you have the sense of "being there"? If yes: Can you tell us more? How exactly did you feel?
- During the VR session, did you think of the other person(s) in the room (e.g., the caregivers)? If yes: how often did you think of them?

- Did you feel that the VE was flat and missing in depth? If yes: How flat and missing in depth did the VE appear?
- Was the VE a picture or more like a place you could have been? Can you tell us more?
- Will it be more enjoyable to use the VE with no-one else in the room? If yes: How much more? Why?
- Was there a lag or delay between your movements of the controls and the response in the computer-generated world? If yes: How disturbing was it?
- Whilst you used the game, music played in the background. How much attention did you pay to it? {This question will be adjust based on the VE}
- At the time you used the VR, did you feel like the VE was more real or present to you than the real world? If yes: How real?
- Can you tell us how it felt? Did you feel exhilarated after the experience? If yes: How much?

Extra Interview Questions for Care Staff

- Feasibility use in a care home setting (Avante Care):

- Please tell us your general impression of using the VR headset with the residents.
- What do you see as the benefits of using VR for people with dementia? Can you tell us more?
- What do you think are challenging issues of using VR in a care home environment involving people with dementia, and why?
- What can we change to improve the technology for clinical use?

- Are you keen to see this technology adopted in dementia management in Avante Care homes? If yes: what needs to be done to ensure the successful adoption?
- How else do you think VR can be used in Avante Care homes?

Appendix J: Simplified Interview Questions for Residents

- Usability Questions:

- Was it easy or hard to look around?
- Would you want to try it again later?
- Did you want to take it off?
- Do you prefer using these goggles or TV?

- Do you prefer watching this video using these goggles or TV? O
- Did it make you feel dizzy?
- Is it exciting or boring?
- Is it comfortable?

- **Likability and emotional impact:**

- Did you like it?
- Was it fun or scary?
- Did it make you feel happy or sad?
- How do you feel now after watching this video?

- **Immersion:**

- Did it feel like you were at the ...? What else did you see?
- Did you listen to the sounds of the ...? What else did you hear?
- Did you forget that you were with ... (mention people in the room)?
- Did it feel real? Like you were really there?
- Did you forget that you were in this room?
- Is it annoying to look at when you turn around your head? (lag or delay)

Appendix K: Interview Questions for Family Members

Thank you for joining me for this interview. We would like to know more about your experience in VR. I will record the interview (audio-only) to get all the information you provide.

- Please tell me your general impression of this remote VR experience. Is it beneficial? If so, how?

- Is there anything you would like to change in this experience? If so, can you share more details?
- Do you think you loved ones enjoyed the experience today? If so, can you share more details please?
- How familiar were you with VR technology before this session?
- Did you find the instructions for setting up the VR system clear and easy to follow? How so?
- Was it simple to connect both the video and VR links at the same time? If not, what challenges did you face?
- Were there any specific technical concerns (such as internet connectivity or device compatibility) that you had to address?
- Did you need any external support to get the system to work? If so, can you share more details please?
- What did you think of the VR content that you experienced today? Do you think it was relevant to your loved one preference and interest?
- Would you like to do more remote sessions in the future?

Appendix L: Care Staff Information Sheet

You are being invited to take part in this research project. Please take the time to carefully read this information sheet before deciding to do so. Your participation is entirely voluntary.

This project is carried out by Hiba Jawharieh, supervised by Dr Chee Siang Ang, School of Engineering and Digital Arts at the University of Kent. This study is sponsored by the University of Kent.

Thank you for considering participating in this study.

What is the purpose of the study?

The study aims to evaluate the efficacy & deployment of Virtual Reality (VR) to support and help improve the well-being of residents in a care home setting.

What is virtual reality?

Virtual Reality is a head-mounted device you can wear, which will present visual and audio information of various places to you in such a way that you would experience it as if you were really there.

Why have I been invited?

You have been invited to take part in our study as a caregiver along with a resident in your care to test a new system that has been produced and to contribute any feedback for improving the system in the future.

Do I have to take part?

Your participation is entirely voluntary. If you do decide to take part, you will be asked to sign a consent form before any further procedures.

You are free to withdraw from the research study at any time and without giving any reason. If this happens, we will not use your data in the research.

What are the possible benefits of taking part?

We hope you will find this research interesting and enjoy the VR experience. We hope that the information and feedback you contribute to this study will help us improve and develop a novel system that can improve the quality of life of residents in care homes.

What do I need to know, and what are the possible disadvantages and risks of taking part?

We will audio record the interviews from beginning to end. We want you to know that these recordings will be kept on a secure drive protected by a firewall and password, and we guarantee that only the research members mentioned above will have access to them. Once audio tapes are transcribed and the data analysis is completed, they will all be deleted.

The researchers believe that there are no risks involved in this study.

What will happen to me if I take part?

You will attend the following meetings:

1. Weekly virtual meetings will follow up on the rollout progression, get feedback regarding the intervention, and discuss improvements if needed for the week after.

2. Monthly face-to-face interviews to understand how beneficial you think VR was for the residents, share instances (positive or negative) that stood out to you, re-evaluate the usability and acceptability of VR in your care setting after using VR and co-create means of improvement of the use of VR in this setting.

We will schedule the time to conduct the meetings at your convenience, and we will be part of your usual rota.

How will you protect my confidentiality and anonymity?

All information obtained in this study will be kept strictly confidential. The data collected from you will be anonymised. We will not include your name and remove any other potentially identifying information about you. Access to all the data is restricted. All data will be stored and kept safely in line with the Data Protection Act. The researcher will keep data for up to 6 months before destroying all data.

What will happen to the results of the study?

The results serve exclusively academic purposes. When the study is completed, we will analyse the collected data and report the findings. It will be reported in an appropriate journal or presented at a conference. You will not be identified in any report or publication. If you wish to receive a copy of any reports resulting from the research, please ask us to include you in our mailing list.

Contact Details:

If you have a concern or an enquiry about any aspect of this study, you should ask to speak to the researcher, Hiba Jawharieh, who will do her best to answer your questions (07934799631) or send an email to hhfj2@kent.ac.uk. If you remain unhappy and wish to complain formally, contact the Head of Research Policy & Support in Research & Innovation Services At headrps@kent.ac.uk. If you have any concerns regarding the data collected, you can contact the Data Protector officer at the University of Kent via email at dataprotection@kent.ac.uk

If you are still unhappy with their response or believe they are processing your data in a way that is not right or lawful, you can complain to the Information Commissioner's Office (ICO) (www.ico.org.uk or 0303 123 1113).

Appendix M: Care Staff Checklist

<table>
<tr><th>Week</th><th colspan="2">Sessions
(Tick once completed)</th><th>Meetings</th></tr>
<tr><td rowspan="8">1</td><td colspan="2">Resident 1 Session 1</td><td rowspan="8">Online follow-up meeting (15 min)</td></tr>
<tr><td colspan="2">Resident 1 Session 2</td></tr>
<tr><td>Resident1 Session 3</td><td>QUALIDEM</td></tr>
<tr><td colspan="2">Resident 2 Session 1</td></tr>
<tr><td colspan="2">Resident 2 Session 2</td></tr>
<tr><td>Residents 2 Session 3</td><td>QUALIDEM</td></tr>
<tr><td colspan="2">Residents 3 Session 1</td></tr>
<tr><td colspan="2">Resident 3 Session 2</td></tr>
</table>

	Resident 3 Session 3	QUALIDEM	
2	Resident 1 Session 1		Online follow-up meeting (15 min)
	Resident 1 Session 2		
	Resident1 Session 3	QUALIDEM	
	Resident 2 Session 1		
	Resident 2 Session 2		
	Residents 2 Session 3	QUALIDEM	
	Residents 3 Session 1		
	Resident 3 Session 2		
	Resident 3 Session 3	QUALIDEM	
3	Resident 1 Session 1		Online follow-up meeting (15 min)
	Resident 1 Session 2		
	Resident1 Session 3	QUALIDEM	
	Resident 2 Session 1		
	Resident 2 Session 2		
	Residents 2 Session 3	QUALIDEM	
	Residents 3 Session 1		
	Resident 3 Session 2		
	Resident 3 Session 3	QUALIDEM	
4	Resident 1 Session 1		Face-to-face focus group (40 min)
	Resident 1 Session 2		
	Resident1 Session 3	QUALIDEM	
	Resident 2 Session 1		
	Resident 2 Session 2		
	Residents 2 Session 3	QUALIDEM	
	Residents 3 Session 1		
	Resident 3 Session 2		
	Resident 3 Session 3	QUALIDEM	

Appendix N: VR Session Log for Residents

Appendix O: Weekly Follow up Meetings with Care Staff

Week	Resident	Session Duration (VR Exposure)	
		Start	End
1	Resident 1 Session 1		
	Resident 1 Session 2		
	Resident 1 Session 3		
	Resident 2 Session 1		
	Resident 2 Session 2		
	Resident 2 Session 3		
	Residents 3 Session 1		
	Residents 3 Session 2		
	Residents 3 Session 3		
2	Resident 1 Session 1		
	Resident 1 Session 2		
	Resident 1 Session 3		
	Resident 2 Session 1		
	Resident 2 Session 2		
	Resident 2 Session 3		
	Residents 3 Session 1		
	Residents 3 Session 2		
	Residents 3 Session 3		
3	Resident 1 Session 1		
	Resident 1 Session 2		
	Resident 1 Session 3		
	Resident 2 Session 1		
	Resident 2 Session 2		
	Resident 2 Session 3		
	Residents 3 Session 1		
	Residents 3 Session 2		
	Residents 3 Session 3		
4	Resident 1 Session 1		
	Resident 1 Session 2		
	Resident 1 Session 3		
	Resident 2 Session 1		
	Resident 2 Session 2		
	Resident 2 Session 3		
	Residents 3 Session 1		
	Residents 3 Session 2		
	Residents 3 Session 3		

Topics to touch upon during these meetings include providing technical support if needed, ensuring the sessions' progression, investigating the practicality of the deployment and any concerns and getting ready for the following week.

- How did the week Go?
- Did you feel confident about using VR technology with the residents?
- Did you experience any challenges before, after or during the sessions?
- How did planning and scheduling the sessions go? Can you give me details?
- Is there anything you would like to improve for next week?
- Is there anything positive or negative you would like to share?
- What was your reaction when you observed the residents' responses to the sessions?
- Do you need any support for next week? If so, what can I do to support you?
- Have you noticed residents sharing VR experiences amongst themselves? Have any residents talked to other residents about their VR experience after the VR session?
- Have you noticed a resident sharing some advice during and after the VR session? It could be related to travelling to a particular country or how to do something specific.

Appendix P: Monthly Interviews with Care Staff

Thank you for joining me for this interview. We would like to know more about your experience in VR. This interview will take around 20 minutes, and I will record the interview (audio-only) so that I can get all the information you provide.

Technical Acceptance & Deployment

- Would you like to use VR frequently with residents? If yes, why? What was good about it?
- Was the system easy to use? Can you tell me more? Did you find it hard to use VR? Was the system unnecessarily complex? Can you tell me more?
- Do you think that you will need the support of a technical person to be able to use this system? If yes, why? What needs to be done to ensure the system is easy to use?
- Did you find the various functions in this system were well integrated?
- Was there too much inconsistency in this system? If so, can you give me an example?
- Would you imagine that most people would quickly learn to use this system? Can you tell me more?
- Did you feel very confident using the system? If yes, what do you think made you feel that way?
- Did you need to learn many things before starting with this system? Can you tell me what you feel needs to be remembered?
- Was there a lag or delay between the resident's movements and the response in the app? If yes, how disturbing was it?
- Did you feel very confident using VR again? If yes, what do you think made you feel that way?
- Did you need to learn many things before starting with this system? If so, can you give me examples?

Toolkit

- Do you think the Toolkit was practical? What exactly did you like/dislike about it?
- Do you think the Toolkit is missing important information? Like what?
- Did you refer to the Toolkit before/during sessions?
- Do you think it's essential to incorporate the Toolkit for a successful deployment? Is there anything else you feel is missing from the package?

Content

- What do you think of the content available on the facilitator's app? Do you believe they are suitable for older people? Do you think they have a positive effect?
- Can you think of any VR experience that residents didn't like or experienced adverse effects such as nausea, motion sickness, or blurriness?
- Can you think of any VR experience that residents negatively reacted to? Can you tell me more?
- Can you think of any VR experience that stood out and positively impacted a resident?
- Can you think of a resident reaction that was particularly unique or interesting to you?
- What do you think of the content available on the facilitator's app? Do you believe they are suitable for older people? Did they echo the interests of the residents? Can you share specific examples with me?
- Do you have ideas about how to find the right VR content to reflect residents' interests and identities to support person-centred care?
- Can you think of any VR experience that residents didn't like or experienced adverse effects such as nausea, motion sickness, or blurriness?

- Can you think of any VR experience that residents negatively reacted to? Can you tell me more?
- Can you think of any VR experience that residents positively reacted to? Can you tell me more?
- Can you think of a resident reaction that was particularly unique or interesting to you?
- Did you learn anything new about the residents through the VR sessions? Can you tell me more?
- When a new person moves to the care home, we assume that it could be challenging to find more about their "personhood and identity" depending on their stage of dementia; in what ways do you think VR can help bridge this gap? What are the opportunities it can grant you?
- How do you usually gather information about new residents? Do you see a potential in VR to upgrade this process/add to it/play a role in it?
- Did adding new content based on your recommendations help the sessions? Did that impact the residents' decision to use VR? Did you feel that providing them with personalised content impacted their experience? Can you please share some details?

Usage of VR to enhance the residents' quality of life and improve apathy

- Overall, do you think VR can benefit residents at Avante Care? If so, what kind of benefits does it bring?

- Overall, do you think VR can be used as a tool to enhance the residents' quality of life? Can you tell me more?
- Overall, do you think VR could be used to enhance residents' social connectedness? Can you tell me more?
- Overall, do you think VR can be used as a tool to enhance and enrich conversations with residents? Can you tell me more?
- Overall, do you think VR helped residents feel motivated to participate in an activity? Can you tell me more?
- Overall, how was the residents' energy level during the session?
- Overall, how did the residents react emotionally to VR during the session?
- Overall, do you think having these sessions and changing residents' daily routines was beneficial? In what ways? Can you tell me more?
- Overall, do you think VR could be an alternative to visiting places residents cannot visit anymore?

Brooke, J. (1996) 'SUS-A Quick and Dirty Usability Scale, Usability Evaluation in Industry, p. 189.