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Moyle, Wendy; Jones, Cindy; Dwan, Toni; Petrovich, Tanya

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Effectiveness of a Virtual Reality Forest on People with Dementia: A Mixed Methods Pilot Study

Professor Wendy Moyle[a,b*] *PhD, MHSc, BN, RN* w.moyle@griffith.edu.au

Dr. Cindy Jones[a,b] *PhD, GDipPsych, GCertHigherEd, BA (Psych), BB (HRM)*

c.jones@griffith.edu.au

Ms. Toni Dwan[a] *B Psych (Hons)* t.dwan@griffith.edu.au

Dr. Tanya Petrovich[c] *PhD, BSc(Hons), Grad Dip Ed*

Dr.Tanya.Petrovich@alzheimers.org.au

[a]Menzies Health Institute Queensland – Optimising Health Outcomes, Griffith University, Nathan, Brisbane, Queensland, Australia

[b]School of Nursing and Midwifery, Nathan Campus, Griffith University, Nathan, Brisbane, Queensland, Australia

[c]Alzheimer's Australia Vic, Parkville, Victoria, Australia

Corresponding Author: *****Professor Wendy Moyle, Menzies Health Institute Queensland – Optimising Health Outcomes, Griffith University, 2.10 Health Sciences (N48), 170 Kessels Road, Nathan, Brisbane, Queensland 4111, Australia; Email: w.moyle@griffith.edu.au; Telephone: +61 7 3735 5526; Facsimile: +61 3735 5431.

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Effectiveness of a Virtual Reality Forest on People with Dementia: A Mixed Methods Pilot Study

Abstract

Purpose of the Study: To measure and describe the effectiveness of a Virtual Reality Forest (VRF) on engagement, apathy and mood states of people with dementia, and explore the experiences of staff, people with dementia and their families.

Design and Methods: A mixed-methods study conducted between February and May 2016. Ten residents with dementia, 10 family members, and 9 care staff were recruited from two residential aged care facilities, operated by one care provider, located in Victoria, Australia. Residents participated in one facilitated VRF session. Residents' mood, apathy and engagement were measured by the Observed Emotion Rating Scale, Person-Environment Apathy Rating Scale, and Types of Engagement. All participants were interviewed.

Results: Overall, the VRF was perceived by residents, family members and staff to have a positive effect. During the VRF experience, residents experienced more pleasure ($p = .008$) and a greater level of alertness ($p < .001$). They also experienced a greater level of fear/anxiety during the forest experience than the comparative normative sample ($p = .016$).

Implications: This initial, small-scale study represents the first to introduce the VRF activity and describe the impact on people with dementia. The VRF was perceived to have a positive effect on people with dementia, although, compared to the normative sample, a greater level of fear/anxiety during the VRF was experienced. This study suggests virtual reality may have the potential to improve quality of life, and the outcomes can be used to inform the development of future Virtual Reality activities for people with dementia.

Keywords: Technology, Long-Term Care, Mood, Engagement

Introduction

The use of gaming technology for example, Nintendo Wii (Fenney & Lee, 2010), interactive websites (Fowler et al 2014) and virtual reality (McEwen et al., 2014) for people with dementia is an emerging field, particularly in residential aged care facilities (RACFs) where opportunities to engage residents (also known as connection or interaction, Jones et al., 2015) in a meaningful way can be limited (Alm et al., 2009; Siriaraya & Ang, 2014; Span, Hettinga, Vernooij-Dassen, Eefsting, & Smits, 2013). An interactive and immersive virtual environment such as the Virtual Reality Forest, discussed in this paper, encourages the creation of virtual, but realistic environments for people with dementia to be immersed in.

The Virtual Reality Forest is a sensory experience, utilising a large interactive screen, and designed to immerse the user in the virtual environment with the aim to improve quality of life for the person living with dementia. It was designed by Alzheimer's Australia Vic (Alzheimer's Australia Vic, 2016), with the input of designer Efterpi Soropos of HUMAN ROOMS™. The Virtual Reality Forest uses video game technology, involving vivid graphics and motion sensors, to create an interactive and immersive environment. The imagery of the Virtual Reality Forest includes a river spanned by a bridge winding through trees and flowers, which is accompanied by a background soundtrack incorporating peaceful white noise and forest sounds, such as bird calls (see Figure 1). The seasons and various animated objects can be manipulated through Microsoft Kinect® motion sensors allowing participants to interact with the scene through hand and arm movements. Particular movements trigger and move animated objects such as ducks, fish, a dragonfly, butterfly, and a boat. Additionally, a large exaggerated handclap can stimulate a change between the seasons of spring and autumn. Animated objects remain on the screen to be manipulated only while the user's hands are detectable by the motion sensors.

Virtual reality, also referred to as virtual worlds or virtual environments, surrounds the person in images and sound so that they may feel physically present in the virtual world. Such a presence may address the need for more self-engaging activities for persons with dementia. The core of virtual reality is immersion, which is defined as the perception of being physically present in a virtual world (Slater & Steed, 2000). Removing real world sensations and replacing them with virtual experiences such as the experience of being in a forest can help to achieve immersion. Virtual reality has been used as a therapy for people to practice stress management, to treat anxiety, and memory rehabilitation (Bouchard, Baus, Bernier, & McCreary, 2010; Caglio et al., 2012; Repetto & Riva, 2011). Apart from a recent 8-month study by Siriaraya and Ang (2014) and a virtual reality rehabilitation program (McEwen et al., 2014), virtual reality appears not to have been used in dementia. There are concerns that cognitive challenges associated with dementia may prevent participants from attaining the level of presence required to engage with these environments (Garcia, Kartolo, & Méthot-Curtis, 2012).

The Siriaraya and Ang (2014) study aimed to evaluate the use of virtual reality for people with dementia in a RACF. These authors suggested virtual reality provided useful opportunities for people with dementia, but they recommended the incorporation of intelligent social agents, such as an avatar, which is an image representing the person participating in the virtual world, to help guide users, and a tangible interface to assist people with severe dementia. They suggested that such developments may assist with promoting a sense of self-efficacy in the user and help carergivers to support a person with dementia. The Virtual Reality Forest outlined in this manuscript was developed prior to the Siriaraya and Ang (2014) evaluation of virtual reality for people with dementia.

This pilot study aimed to measure and describe (a) the effectiveness of a Virtual Reality Forest on engagement, apathy and mood states of people with dementia; and explore (b) the

experiences of using the Virtual Reality Forest in a RACF from the perspectives of staff, people with dementia and their families. Clinical features of dementia include apathy and loss of engagement with activities, low mood states and as a result limited quality of life (Grand et al., 2011). It was assumed that the Virtual Reality Forest would immerse the person with dementia and as a result this would engage them in the activity and thereby reduce their apathy, and as a consequence improve their mood states.

Design and Methods

Study Design and Participants

This mixed-method study was conducted between February 2016 (data collection) and May 2016 (data analysis and interpretation), and included video recorded observations and interviews. Institutional ethical approval (NRS/2015/907) and written consent was obtained from participants that were determined by the RACF manager as being capable of giving informed consent or of providing assent at their session. For the majority of participants substituted consent from legal guardians was obtained. Residents with dementia, family members and care staff were drawn from two RACFs; both with a 60-bed capacity, in Victoria, Australia. Residents were included in the study if they had a documented diagnosis of dementia and were aged $\geq$ 60 years.

Intervention

Residents were engaged in one Virtual Reality Forest session for a maximum of 15 minutes in a room set aside for the Virtual Reality activity. A trained facilitator from each care facility facilitated the Virtual Reality Forest experience. Facilitators were care workers employed by each facility for activity coordination. Alzheimer's Australia (Vic) and HUMAN ROOMS™ staff trained the care workers in the use of the technology.

Data collection

Trained Research Assistants collected the following data: Ten minutes of video recordings were recorded at two time-points for residents with dementia: pre (baseline) and post (after) the Virtual Reality Forest experience, plus a further maximum 15 minutes during the intervention (total of 35 minutes). This was then followed by an individual interview with each participant, their family member, and care staff who had observed the resident using the Virtual Reality Forest.

Quantitative video data evaluations were completed off-site and these focused on the effect the Virtual Reality Forest had on mood states, apathy and engagement of residents with dementia utilising the following validated measures:

1) Observed Emotion Rating Scale (OERS) (Lawton, Van Haitsma, & Klapper, 1999a). OERS is an observational tool for rating two positive emotions – pleasure and general alertness, and three negative emotions – anger, anxiety/fear and sadness. The videos were observed and residents rated in terms of each of the five emotions by choosing one of six possible pre-defined time intervals (e.g., 1 = never; 2 = < 16 seconds; 3 = 16–59 seconds; 4 = 1–5 min; 5 = > 5 min; and 7 = not in view) to indicate the amount of time the participant displayed each of the five emotions. Lawton et al. (1999a) established variations in emotional expression of people with dementia as environmental context changed (i.e. morning care, meal time, down time and activity time). Resident OERS scores during the Virtual Reality Forest experience were compared to those established by Lawton, Van Haitsma, Perkinson, and Ruckdeschel (1999b) for residents with dementia in an activity context. Higher scores indicate a longer duration of expression of that emotion.

2) Person-Environment Apathy Rating (PEAR) (Jao, Algase, Specht, & Williams, 2015). PEAR was used to assess concurrent apathy and environmental stimulation over the three time

periods of video recording. Apathy was measured by observing facial expressions, eye contact, physical engagement, purposeful activity, verbal tone and verbal expression. Environmental stimulation was measured by observing stimulation clarity, stimulation strength, stimulation specificity, interaction involvement, physical accessibility and environmental feedback. Each subscale consists of six items rated on a 1–4 scale. Higher scores on each subscale indicate a higher level of environmental stimulation and apathy.

3) Type of Engagement. Each resident's engagement during the Virtual Reality Forest experience was coded into three types: i) Self-engagement: the resident engages in the activity without encouragement; ii) Facilitated engagement: engagement in the activity is encouraged and supported by another person; and iii) No engagement: the resident is not engaging in the activity. The average duration of time spent in each type of engagement was used to describe engagement of the resident.

An experienced Research Assistant who had been trained by the research team completed the three validated measures. The Research Assistant had also previously undertaken similar video data evaluations in another project where a high level of inter-rater reliability with a trainer and other evaluators was attained.

Semi-structured interviews were conducted to evaluate the overall experience and effect of using the Virtual Reality Forest in a RACF setting from the perspectives of care staff, residents living with dementia and their families. In particular, the following areas were addressed during the interviews:

- *Residents living with dementia*: their experience of using the Virtual Reality Forest.
- *Family members*: their perceptions of the experience and the reaction they observed when their family member (resident living with dementia) used the Virtual Reality Forest; and perceived strengths and limitations of the Virtual Reality Forest.

- *Care staff*: their perceptions of the experience and reaction of residents using the Virtual Reality Forest; perceived challenges in setting up the Virtual Reality Forest for use by residents; and perceived strengths and limitations of the Virtual Reality Forest.

Results

A total of 10 residents living with dementia, 10 family members and 9 care staff participated in the study. Demographic characteristics of participants are presented in Table 1 and 2. Residents' level of cognitive functioning is depicted using a Psychogeriatric Assessment Scale (PAS) score, obtained from their medical files. A higher score represents a higher level of cognitive impairment/decline. Residents' scores ranged from 7.35–20, with an average score of 13.21.

[Insert Tables 1 and 2 about here]

There were vast differences between the two facilities where the Virtual Reality Forest experience was conducted. The first was environmental. At one facility, the Virtual Reality Forest was set up in a quiet, dark room in the basement of the facility, with dimmed lighting and little thoroughfare of residents, staff or families. Conversely, at the other facility, the Virtual Reality Forest was set up in the main lounge area, next to the kitchen. This was a bright, sunny room with a great deal of noise coming from the kitchen and many staff and residents walking by. Additionally, a budgerigar in the room was quite noisy. In general, the first facility offered an environment that was soothing and supported focused attention on the Virtual Reality Forest, whereas the second facility was busy and potentially distracting for participants.

The second major difference between the facilities was the facilitation style of the two staff members. The staff member in the quiet environment practiced supportive facilitation, whereby she stepped in only at times when the resident stopped participating or was having difficulty.

Conversely, the facilitator in the more chaotic environment used an active style of facilitation. That is, she modelled and encouraged engagement with the Virtual Reality Forest and also engaged residents in conversation related to the scenery. For example, she would ask residents if they remembered fishing or riding in boats when the fish or boat appeared. Thus, her facilitation style was likely to assist in eliciting past memories and enhance pleasure and satisfaction for residents.

Observed Emotions

T-tests were conducted to compare residents' OERS scores with established OERS scores for people with dementia in an activity context. As illustrated in Figure 2, results related to emotional observations indicated that residents with dementia expressed significantly more pleasure ($p = .008$) and alertness ($p < .001$) during the Virtual Reality Forest experience than those previously established for people living with dementia in an activity context (Lawton et al., 1999b). Specifically, four residents displayed 1-5 minutes of pleasure and 9 out of 10 residents displayed alertness for more than 5 minutes. Fifty per cent of residents' also expressed significantly greater levels of anxiety/fear during the Virtual Reality Forest experience than norms previously established for people living with dementia in an activity context ($p = .016$). Two residents were observed to display 1-5 minutes of anxiety/fear and three residents between 16 seconds to 1 minute. There was no observed anger or sadness during the Virtual Reality Forest experience ($p > .05$).

[Insert Figure 2 about here]

Environmental Stimulation and Apathy

A repeated measures analysis of variance was conducted to evaluate changes in environmental stimulus and apathy for the residents over the three time points (i.e., pre, during and post). Post

hoc comparisons were conducted to determine pairwise differences between the three time points. An overall significant environmental stimulation effect for time (i.e., pre, during and post) observation was found (p = .004). Environmental stimulation scores were significantly higher during the Virtual Reality Forest experience than before (p = .002) or after (p = .002) the experience, indicating the Virtual Reality Forest had stimulating qualities including: stimulation clarity, stimulation strength, stimulation specificity, encouraged interaction, was physically accessible and prompted responses from residents. There was no significant difference between the pre and post Virtual Reality Forest environmental stimulation scores (p > .05). An overall significant apathy effect for time (i.e. pre, during and post) observation was also found (p = .02). Apathy scores were significantly lower during the Virtual Reality Forest experience than before (p = .01) or after (p = .005) the experience. There was no significant difference between pre and post Virtual Reality Forest apathy scores (p > .05). Results from the PEAR analyses (Table 3) suggest that participating residents were immersed in the experience of the Virtual Reality Forest resulting in reduced apathy during the experience. However, the effect of apathy reduction was not sustained or maintained following exposure to the Virtual Reality Forest.

[Insert Table 3 about here]

Type of Engagement

Type of engagement was evaluated by comparing the amount of time (in minutes) spent in each type of engagement (self-engagement, facilitated engagement and no engagement) by using paired sample t-tests. There were no significant differences between the observed types of engagement during the Virtual Reality Forest experience. Total time spent interacting with the Virtual Reality Forest ranged from 8.03 to 12.30 minutes, with an average of 10.22 minutes

(*SD* = 1.07). On average, 4.45 minutes (*SD* = 2.4) was spent in no engagement; 3.33 minutes (*SD* = 1.57) in facilitated engagement; and 2.44 minutes (*SD* = 2.11) spent in self-engagement.

Interviews

Thematic analysis was used to identify and code salient themes that emerged from the interviews. The qualitative findings below are supported by exemplar quotations and coded representation of residents (R), family (F) or staff (S), as either Female (F) or Male (M) and a numerical code.

People with Dementia

Positive perceptions: The majority (*n* = 6) of participants reported a positive perception of the Virtual Reality Forest. They talked about it being good and enjoying the opportunity (*"It's marvellous"* [RF3], *"I enjoyed doing it"* [RM1]). Others talked about specific aspects of the Virtual Reality Forest such as the ducks, boat, water and leaves. Four participants enjoyed the opportunity to control and move the objects (*"I don't know just working it and getting them to come out, the ducks and that"* [RF3]) and one participant felt in awe of the virtual reality (*"I felt in awe"* [RF2]). Two participants mentioned the activity gave them the opportunity to reminisce about their childhood.

Other perceptions: Not all participants found the Virtual Reality Forest experience to be positive. One participant reported that the activity was a bit boring (*"A bit boring but I do it"* [RF1]) and another two participants were confused by the experience and stated that it made them feel strange, as it was not something that they had previously experienced, while others found the experience did not change the way they were feeling (*"I don't feel any different… I don't feel anything"* [RF2]). One participant was very clear in what they did not like (*"I've got no real control. There's no music. I can't make it tilt (Sic)"* [RM1]).

Times of use: Times that participants wanted to use the Virtual Reality Forest varied from morning to evening. One participant did not want to use it regularly in case it became a habit, while the other participants suggested they only wanted to use it occasionally.

Facilitation: When participants were asked if they wanted to undertake the Virtual Reality Forest experience with a facilitator, only one participant expressed they wanted a facilitator during the experience, and another wanted to undertake the experience with his wife. The facilitator had previously been unable to encourage this second resident to attend the room where the Virtual Reality Forest was placed. The resident was highly anxious and framed his activities around his wife's presence. On the day of our viewing his wife managed to convince him to attend. While he exhibited some enjoyment with the activity he continued to state that he only wanted to attend with his wife.

Suggested changes: When asked if they would like to change the Virtual Reality Forest suggestions were given about making the experience more active ("*So maybe next time you can stand up and make it feel like as if you're walking through a garden will be more enjoyable for you than just sitting down and just moving the things with your hand?"* [RF1])

Family Members

Benefits: The majority (n = 9) of family members reported that their relative with dementia responded and reacted positively to the Virtual Reality Forest. Some family members noted an improvement in mood ("*I could see a bit of a lift in the mood … She was really down before she went up there and did that,… then as soon as they got her moving and interacting with it her mood had changed"* [FF2]), while others noted that their family members were stimulated by, and interacted with the Virtual Reality Forest ("*She was very interactive with it"* [FF3]). A further positive effect of the Virtual Reality Forest noted by family members was an improved sense of self-efficacy for the person with dementia. For example, one person noted, "*Mum was*

using her hands to control the movement. It means she's got control of something in her life, that control element. What other control has she really got?" [FF6].

Time requirements: There was general agreement (*n* = 8) among participants that five to 10 minutes was enough time in one sitting to use the Virtual Reality Forest. Concerns related to boredom ("*Yeah I think if it was too long she'd just get bored with it"* [FF1]), repetition ("*If you've got the same three or four items coming in at each time it could get a little bit repetitive"* [FF2]), and physical fatigue ("*I think he gets tired. So I reckon 10 minutes would be about all he could probably do"* [FF3]) were reasons cited to time limit usage. Only one family member reported that more time would be beneficial to her relative with dementia.

Design: Many family members indicated that they thought the scenery and objects were well designed ("*She loves trees, gardens, all of that sort of stuff and the different animals*" [FF3], but additional scenes ("*I would like to see multiple programs where they could choose which scene they'd like to have today … So it's not the same thing all the time"* [FF2]), animated objects ("*I would like to see more animals come in to play … particularly forest animals"* [FF2]), and changes to the sound ("*I think that perhaps the noise of the different activities could be a bit higher so that they can actually get the hearing with the senses and the eyes"* [FF3]) would improve the Virtual Reality Forest experience. Some relatives thought the Virtual Reality Forest could be improved by adding tasks or goals to the forest ("… *maybe getting them to use their imagination a little bit more by finding something within the forest"* [FF2], "*if there was something on the tree flashing so she knows I've got to get that butterfly and put it there"* [FF3]).

Facilitation: The majority (*n* = 8) of family members indicated that they thought their relative with dementia needed facilitation and assistance when using the Virtual Reality Forest. Only one family member thought their relative would be able to use the Virtual Reality Forest independently.

Staff Members

Positive impact: All of the staff members (*n* = 9) interviewed indicated the Virtual Reality Forest had a positive impact on most residents ("*The majority of the residents seem to really enjoy it. I see their faces smiling, and they seem quite relaxed with it"* [SF1]). However, several (*n* = 6) staff members also noted individual differences in how residents responded. Those who noted a positive impact on residents particularly highlighted positive effects on mood ("*I think it just lifts them up a little bit"* [SF3]), cognition ("*She could remember the whole forest and she found it so interesting"* [SF7]) and self-efficacy ("*Their faces light up when they also realise that they're controlling what's happening on the screen"* [SF2]).

A calming effect of the Virtual Reality Forest was also noted as a positive impact. Three staff members noted that some residents simply enjoyed the sounds and watching the forest without interacting, which induced calm for some residents. ("… *happy just sitting there with closed eyes listening to it. Just listening to the music seems to have calmed her down"* [SF7]; "*Sometimes they enjoy just sitting watching and listening more so than actually doing the physical effort because they find it a bit too difficult to do"* [SF8]; "*She just likes to sit down there and listen. She doesn't even lift her arms up, because she doesn't want to, but she will sit there and she's quite calm because of the sound"* [SF9]).

Resident limitations impacting on use: The majority of staff (*n* = 8) suggested that stages of dementia and physical functioning were important indicators of whether residents would enjoy the Virtual Reality Forest. Comments from these staff indicate that individuals in the earlier stages of dementia become bored easily when engaging with the Virtual Reality Forest ("*But his comment now is, I've done it, I don't want to do it again. He has mild dementia"* [SF7]; "*I've noticed that it is more stimulating for people with more advanced dementia than perhaps people who are in the early to moderate stage"* [SF 4]; "*Early stage dementia I find they're not ready for the forest, they've gone this is a little childish"* [SF5]). Whereas staff (*n*

= 8) indicated that cognitive decline leads the resident to be confused about what they are doing, making participation difficult for people in later stages of dementia. Two staff reported that mid stage dementia is the right time to introduce the Virtual Reality Forest. ("*I haven't in my experience had success with people in later stage dementia, but I find the middle stage works really well"* [SF4]. ("*Why am I here? It doesn't really make sense for me"* [SF7]; *"I've had their responses of … this is confusing, or they're finding it hard to focus to look at the screen"* [SF1]). The majority of staff (*n* = 8) also reported that age and dementia-related physical decline limited usage and enjoyment of the Virtual Reality Forest ("*A lot of them couldn't raise their arms or they couldn't do a lot of the arm movements"* [SF8]; *"They can get quite tired and they'll say my arms are tired now, I need to stop"* [SF2].

Setting up: The staff reported very few technical difficulties with setting up the Virtual Reality Forest. It was noted that most of the difficulties experienced were related to the care facility's computers and included viruses and hardware difficulties. Additionally, the majority of staff (*n* = 6) noted that they were able to access peer help for problems or consult the troubleshooting guide ("*We were given a troubleshooting guide. It went through the step by step how to get it started and then it's also got a section in there for if something's not working"* [SF2]). A few staff (*n* = 3) did note difficulties in registering residents on the virtual device if they were sitting low in chairs or wheelchairs ("*But if they're very small or if they're in a wheelchair there was some difficulty with the Kinect recognising them"* [SF7]).

Facilitation requirements: There was general agreement (*n* = 8) among participants that staff assistance and encouragement was required for most residents to use the Virtual Reality Forest ("*But I really don't think any of our dementias [sic] would be able to sit there and cope by themselves"* [SF3]) and they also reported that it was a one-on-one activity resulting in the need for people resources ("*It's very one-on-one. If you don't have a lot of resources, people resources, then to spend so much time just on one person is really hard"* [SF7]).

Visually appealing: In a similar vein to family members, most (n = 7) staff agreed the Virtual Reality Forest was visually appealing, but that it could be improved through added scenes (*"It'd be nice to have some other scenes like a beach scene"* [SF2]) and animated objects (*"I think more interactive things on the screen"* [SF3]).

Discussion

The purpose of the pilot study was to assess and describe the effectiveness of a Virtual Reality Forest on engagement, apathy and mood states of people with dementia, and explore the qualitative experiences of staff, people with dementia and their families. Although the Virtual Reality Forest had an overall positive impact on the study participants and, in particular, on those with mid stage dementia readers are reminded to treat the findings with caution because of the exploratory nature of the study, the small sample size and preliminary nature of the estimates. Results of the quantitative analyses indicate that during the Virtual Reality Forest immersion, participants experienced more pleasure and a greater level of alertness. However, we are mindful that the results of the OERS also indicated that, at a group level, residents living with dementia experienced a greater level of fear/anxiety during the forest experience than the normative sample in an activity context. A larger sample may have given a different result.

Further support for the positive perceptions of the Virtual Reality Forest can be surmised from analysis of the PEARS results. This indicated that the Virtual Reality Forest created a stimulating environment and this helped to immerse participants in the experience, which in turn reduced their apathy. Two aspects need to be considered when interpreting the PEARS results. Firstly, it must be noted that apathy levels normalised shortly following the virtual experience, indicating that the sustained effect of the Virtual Reality Forest on apathy is questionable. A return to baseline measurement is not unusual in any population when an

intervention is removed but this does raise the question of the length of time that a person with dementia needs to be immersed in the virtual experience to see sustained changes. A second important consideration is that a staff member facilitated residents during the virtual experience, talking with them and helping them to participate in the activity. The facilitation introduced a possible confounding effect, whereby teasing apart and implying causation is difficult. For example, reductions in apathy may have been associated with the Virtual Reality Forest or with the one-on-one interaction with the staff member. A future controlled trial may help us to understand the effect of facilitation on the virtual experience.

To assist in teasing apart which stimulus impacted apathy, types of engagement were considered. Significantly more self-engagement compared with facilitated engagement would offer support for the Virtual Reality Forest as the salient stimulus. Greater levels of facilitated engagement would offer support for staff interaction as the salient stimulus. Unfortunately, there was no significant difference between the two types of engagement and this may be related to the small sample size. Therefore, a conclusion cannot be drawn from these results.

Evaluation of the qualitative data also indicated that caution should be considered when interpreting the generalised positive perception of family and staff members. There were strong indicators that the impact of the Virtual Reality Forest was individualised and dependent on several variables such as level of cognitive impairment. Siriaraya and Ang (2014) highlighted a similar issue with their virtual worlds, noting the importance of consideration of individual preferences and capabilities when designing a virtual world. Physical functioning, including strength, flexibility and eyesight were also noted as limitations for participation by the informants of this study, as well as Siriaraya and Ang (2014). Both concluded that older people become fatigued when engaging in virtual worlds through the need to continually use arm and hand movements. Additionally, informant interviewees noted that residents who had visuoperceptual difficulties were unable to recognise some of the objects displayed on the

screen. In particular, four staff members reported that the dragonfly was often mistaken for a helicopter and the fish for birds. The ageing process and dementia can bring about visuoperceptual and audio difficulties and, therefore, need to be considered in the development of technology activities.

Individual differences in preference, cognitive functioning and physical ability are factors that may limit the versatility of the Virtual Reality Forest and narrow the group of people with dementia whom it may benefit. In relation to independent use, there was consensus from both the staff and the family group that most residents would need one-to-one assistance to utilise the Virtual Reality Forest. The Virtual Reality Forest was not created as a stand-alone product and these findings support the use of the product with a trained staff member. In addition, other residents may enjoy the opportunity to observe users and the Virtual Reality Forest from a distance. Further studies might explore the cost and effectiveness of the Virtual Reality product compared with, for example, a staff member interacting with a resident or other media/technologies.

A further consideration indicated by the results was duration of use. Staff and family informants indicated that residents used the Virtual Reality Forest between five and 10 minutes and this was confirmed by our observations. This indicates that residents either become bored or fatigued in that timeframe. One of the ways to address boredom is to incorporate additional scenes and objects. However, this would add to the cost, and it may be difficult to create virtual scenarios that can be enjoyed by most people. Once again readers are reminded that a future study using more rigorous methods is needed to confirm these findings.

A strength of this research is the inclusion of participants with dementia in the qualitative evaluation of the Virtual Reality Forest. The perceptions of the participants with dementia may help us to understand changes that could be incorporated into the Virtual Reality Forest. For

example, enabling more interaction between the Virtual Reality Forest and participants including encouragement of reminiscence may help to improve the product for end users.

Limitations of the feasibility evaluation

There are some methodological limitations to this study. Methodological flaws may have contributed to confounding of results. In particular, the differences between the two RACFs made comparison and analysis of the findings difficult. There was no consistency between the environments, although both facilities were owned and operated by the one provider. As outlined previously, staff who facilitated the Virtual Reality Forest immersion provided different facilitation methods during the experience. Although a statistical comparison between the two groups revealed no significant difference, the results of this comparison may have differed with larger sample sizes. However, a recent meta-analysis demonstrated no significant associations between methodological rigour and treatment efficacy within the virtual reality field of research, indicating that significant outcomes remained efficacious in spite of sub-optimal rigour (Turner & Casey, 2014).

Implications

The pilot findings suggest the Virtual Reality Forest encouraged residents to become immersed in the experience and the experience was reported by staff as being most appropriate for people with mid stage dementia. Our pilot findings support previous research in the field (Alm et al., 2009; Siriaraya & Ang, 2014) however, further research with a larger sample using a controlled trial is needed to confirm these findings. To provide people with dementia with opportunities for immersion through virtual reality, the technology must be appropriate for end users. The

next steps to consider in the future development and use of virtual technology include the following:

1. *An engaging, attractive and colourful interface that promises enjoyment*

This was one of the core strengths of the Virtual Reality Forest and is important to include in any future virtual technology development. Its rich, vivid scenery and objects were highly praised by participants. It was inviting, colourful, vibrant and engaging. People were interested and wanted to engage. While engaged, they derived pleasure from being immersed in the experience.

2. *Always obvious what to do next, either because of the way the interface behaves or because of a specific prompt*

There were no prompts or obvious behaviours in the Virtual Reality Forest interface to encourage engagement. This contributed to the resource intensive nature of the Virtual Reality Forest because staff prompting was required to maintain engagement. However, the two styles of facilitation noted during this project demonstrated that participants can be left to be immersed in the areas they find captures their interest (supportive facilitation), and active facilitation can be used when required to further engage participants. As indicated earlier a controlled trial is needed to clarify the importance of supportive or active facilitation.

3. *An element of challenge and skill mastery to the experience (i.e., there is a 'point' to it, even for people with little working memory)*

The Virtual Reality Forest aimed to immerse individuals in the experience captured by the colours, movement and bird sounds. It did not aim to be a game that participants played. Cognitive impairment was considered in the design of the Virtual Reality Forest. Further consideration of the severity of cognitive impairment may be useful in any future development. For example, where there is no challenge a person with early stage dementia may become bored

whereas people with severe cognitive impairment may find the experience confusing. Future development might focus the immersive Virtual Reality experience either to mid stage of dementia or to individual needs across the trajectory of cognitive impairment.

4. *Continual feedback provided on the user's performance – "…encouragement when they are not succeeding at a task, and praise when they do succeed*" (Alm et al., 2009: pp. 241)

The staff members facilitating the interaction provided feedback to each participant. This contributed to the demand on staff resources, and feedback varied between staff members. Use and enjoyment of the Virtual Reality Forest was further restrained by residents' physical limitations but may have also been beneficial in encouraging physical activity. The motions required to engage in the activity quickly led to fatigue in the majority of residents. The Virtual Reality Forest may benefit from the incorporation of multiple movements that are less strenuous and can be worked up to if residents are physically capable.

Conclusion

The creation of the Virtual Reality Forest has been a unique innovation in the use of technology to engage and enrich the lives of those living with dementia. In this small study, initial indications would suggest that the Virtual Reality Forest has a positive impact, improving both pleasure and alertness for people living with dementia. Results around fear and anxiety warrant further investigation with a larger sample. The extent to which any impact is sustained needs to be balanced with the daily experience of living with dementia and that few activities are likely to have a sustained impact. Given the limited size of the sample in this pilot study it is recommended that further evaluations be undertaken of larger numbers using the Virtual Reality Forest to establish further evidence of its effectiveness.

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Table and Figure Legends

Table 1. Residents with Dementia and Family Members Characteristics (*n* = 20)

Table 2. Staff characteristics (*n* = 9)

Table 3. Person-Environment Apathy Rating results (*n* = 10)

Figure 1. Virtual Reality Forest Image

Figure 2. Ratings of Observed Emotions

Table 1. Residents with Dementia and Family Members Characteristics (*n* = 20)

	Residents (*n* = 10)	Family Members (*n* = 10)
	Frequency	Frequency
Age[a]	89 (4.97)	-
35–44	-	1
45–54	-	3
55–64	-	3
65–74	-	1
75–84	-	1
Undisclosed	-	1
Gender		
Male	3	2
Female	7	7
Undisclosed	-	1
Relationship to resident		
Spouse	-	1
Child	-	4
Other	-	4
Undisclosed	-	1
Diagnosis		
Alzheimer's Disease	7	-
Undisclosed	3	-
Duration in facility (months)[a]	21.5 (35.20)	-

[a]*Mean (SD).*

Table 2. Staff characteristics (*n* = 9)

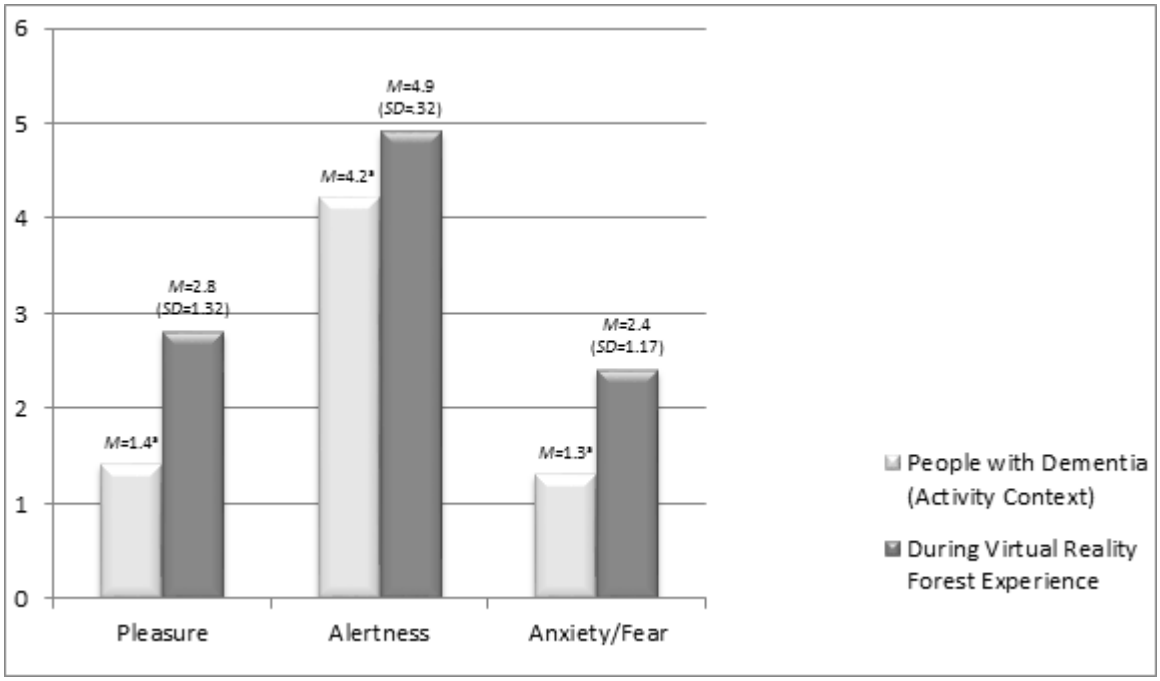
		Frequency
Age	35–44	3
	45–54	3
	55–64	1
	≥ 65	1
	Undisclosed	1
Gender	Female	9
Profession	Personal Care worker	7
	Enrolled Nurse	1
	Other	1
Education	Year 10 or 12	3
	Technical and Further Education (TAFE)	4
	Other	2
Months in aged care[a]	-	149.67 (104.49); 6-300
Months at current facility[a]	-	39 (35.75); 6-126

[a]*Mean (SD); Range.*

Table 3. Person-Environment Apathy Rating results (*n* = 10)

Subscale	Pre	During	Post
	M (SD)	*M (SD)*	*M (SD)*
Environmental stimulus	15.90 (5)	23.00 (0)	16.70 (4.52)
Apathy	18.30 (5.1)	12.10 (2.69)	18.70 (4.24)

Figure 1. Virtual Reality Forest Image



[a]*Standard deviation (SD) was not reported in the Lawton et al. (1999a) paper*

Figure 2. Ratings of Observed Emotions