# Bringing the Outside In: The Feasibility of Virtual Reality with People with Dementia in an Inpatient Psychiatric Care Setting

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## Abstract

**Background and Objectives:** Emerging research supports virtual reality (VR) use with people with dementia in the community, but is limited to this area, warranting further investigation in different environments. The feasibility of VR within an inpatient psychiatric care setting was therefore explored.

**Research Design and Methods:** Eight people with dementia and sixteen caregivers were recruited in January and February 2018 from a UK hospital specialising in progressive neurological conditions. A mixed methods design measured affect and behaviour using the Observed Emotion Rating Scale, Overt Aggression Scale-Modified for Neurorehabilitation and St Andrew's Sexual Behaviour Assessment. Thematic analysis was conducted following semi-structured interviews. Caregivers who worked at the hospital supported people with dementia throughout the process and were interviewed for their views on Head Mounted Display-Virtual Reality (HMD-VR) use with people with dementia.

**Results:** HMD-VR was tried and accepted by people with dementia. Participants viewed HMD-VR positively as a 'change in environment' and would use it again. People with dementia experienced more pleasure during and after HMD-VR compared to before exposure, as well as increased alertness after. Three core themes emerged: 'Virtual Reality Experiences', 'Impact of Virtual Reality' and 'Experiences within the Virtual Environment'. Caregivers discussed preconceptions about VR use and how these changed.

**Discussion and Implications:** This is the first study to explore the feasibility of HMD-VR with people with mild to moderately severe dementia in hospital, and found that overall HMD-VR is viable. Findings evidence the clinical feasibility of HMD-VR implementation in this environment and inform future research.


*Keywords:* Dementia; Virtual Reality; Wellbeing; Immersive Technology; Person-Centred Care; Analysis-Mixed Methods.

# Bringing the Outside In: The Feasibility of Virtual Reality with People with Dementia in an Inpatient Psychiatric Care Setting

There are an estimated 850,000 people with dementia[1] in the UK (Prince et al., 2014), 9.4 million people with dementia in the US and 50 million people with dementia worldwide (Alzheimer's Disease International, 2018). The National Dementia Strategy (Department of Health, 2009) set out to improve quality of life (QoL), with three key objectives: improved awareness; earlier diagnosis and intervention; and higher quality of care. Cameron's Challenge on Dementia (Department of Health, 2012) later identified 'better research' as one of three key commitments. In line with the strategy objectives, Banerjee explored the prescription of medication for dementia and found antipsychotics for the treatment of behavioural disturbances to be overprescribed (Banerjee, 2009), ineffective and causing unwanted side effects including sedation and respiratory problems (Banerjee et al., 2011). The Department of Health (2009) supported Banerjee's recommendation that best practice considers the use of pharmacological interventions only as a last resort to treat complex cases where non-pharmacological interventions have proven unsuccessful. The increasing prevalence of dementia further drives the need to continue to deliver excellent care and strive towards developing innovative interventions that support, manage and enhance QoL.

A number of non-pharmacological interventions aim to improve QoL (Spector et al., 2003; Aguirre et al., 2013) and cognition of people with dementia (Logson, McCurry & Terri, 2007; Woods, Aguirre, & Orell, 2012), as well as reduce behavioural disturbance (Mapelli, Rosa, Nocita, & Sava, 2013). These include reminiscence, relaxation, life story work, music and cognitive stimulation therapy within a person centred therapeutic milieu (Brechin, Murphy, James, & Codner, 2013).

The use of gaming technology including virtual reality (VR) has also entered the world of healthcare and in recent years low cost consumer-facing immersive VR systems have become widely available (e.g. Google Cardboard, Gear VR, Oculus Rift[2]). VR is a term used to describe the combination of software and hardware that simulates a 360° virtual environment (VE), allowing the user to engage in a three-dimensional computer generated environment, or 360° video footage. Depending on the programmed complexity, the user can immerse in the

[1] The term 'people with dementia' is used throughout in line with the DEEP Guidelines.
[2] https://store.google.com/product/google_carboard, www.samsung.com/global/galaxt/wearables/gear-vr , www.oculus.com

virtual world by looking around, walking through, manipulating objects or performing a series of actions (Weiss, Kizony, Feintuch, & Katz, 2006). VR has been successfully used therapeutically, including pain management, physical rehabilitation and psychotherapy (Matsangidou, Ang, & Sakel, 2017; Matsangidou, Ang, Mauger, Otkhmezuri, & Tabbaa, 2017; Morris, Louw, & Grimmer-Somers, 2009; Riva, 2005), and for phobias (Rothbaum et al., 1995).

People with dementia have been involved in research that has explored the feasibility of VR, including both semi-immersive[3] (Flynn et al., 2003; Siriaraya & Ang, 2014; Manera et al., 2016; Moyle, Jones, Dwan, & Petrovich, 2017) and fully-immersive[4] systems (Mendez, Joshi, & Jimenez, 2014). The existing literature-base indicated that VR (although conclusions complicated by varying levels of immersion) can be feasible for people with 'mild to moderate' dementia (Manera et al., 2016) and in one case, people at 'moderate to later' stages (Moyle et al., 2017) living in the community or residential homes, with it being viewed as a welcomed distraction that increases alertness and pleasure. Nevertheless, there was evidence of adverse effects, specifically increases in fear and anxiety (Moyle et al., 2017) and the experience of negative memories (Siriaraya & Ang, 2014). Moyle et al. (2017) reported that caregivers felt the level of cognitive impairment of people was a variable that affected the experience, with VR not being stimulating enough for those within the early stages of dementia. Some caregivers observed VR to be more stimulating with people in the moderate to later stages where some people were observed to become bored, whilst other caregivers perceived the experience to be confusing for people in the later stages (see Rose et al. 2018).

More research is required to explore the feasibility of VR in later stages of dementia, particularly in environments beyond the community where behaviour that challenges is not uncommon. The current study evaluated VR use with people with dementia in an inpatient psychiatric care setting, and explored the impact on wellbeing and behaviour. In addition to replicating previous positive effects, it was anticipated that engagement with VR would reduce behaviour that challenges and increase wellbeing for people with any stage of dementia.

[3] A semi-immersive system has a graphical display which is projected on a large screen.
[4] A fully-immersive system is a Head Mounted Display system where the users' vision is fully enveloped.

## Design and Methods

### Design

A mixed methods design was used to collect data over a two month period, including observations and semi-structured interviews. Participants were recruited from an inpatient psychiatric care setting specialising in patients with progressive neurological conditions who may present with behaviour that challenges and/or offence-related risk. Ethical approval was sought from the hospital ([21]) as well as the London - Camden and Kings Cross Research Ethics Committee (17/LO/1477). Written informed consent forms were completed by participants. Where concerns were expressed with regards to an individual's capacity to consent, capacity assessments were completed. The consent process was carried out in line with the Mental Capacity Act (2005), inviting a relevant consultee to consider providing consent on behalf of the person.

### Sample

The inpatient psychiatric hospital delivers a variety of specialist therapies designed to reduce behaviour that challenges and encourage positive life experiences. Referrals are made nationally because of high levels of risk not easily met by local NHS provision. Patients are extremely complex, potentially combining cognitive, physical, psychiatric and forensic needs.

A total of 153 people were screened for inclusion. Presence of aggression and/or inappropriate sexual or overfamiliar behaviour was not a direct inclusion criteria, however, people in the care setting presented with periodic behaviour that challenges.. Fifty-one people were identified as having dementia. After the exclusion criteria, the total eligible sample included 38 people with dementia. Exclusions included: epilepsy (n=5); multidisciplinary team's (MDT) clinical judgement (n=5); visual impairment (n=1); imminent discharge (n=1); death (during selection process, n=1). There were no exclusions on the basis of motion sickness. Of those individuals deemed to have capacity to consent to their participation (n=8), six individuals consented and two declined. Of those who required an assessment to explore their capacity to consent to their participation (n=30), 12 capacity assessments were not completed by the MDTs due to time constraints. The remaining 18 individuals were found to lack capacity. For these individuals, a potential consultee was contacted to consider consent to participate on their behalf (next of kin or an advocate). A total of 13 consultees did not respond and three consultees declined consent to be approached. Two consultees gave consent to be

approached and finally consent to participate. Therefore, the final sample included six individuals who consented to participate and two individuals with consultee consent.

Twenty-four participants (8 people living with dementia, 16 caregivers) were recruited. The mean age for people with dementia was 69.63 years (range=41-88 years). The mean Global Deterioration Scale rating (GDS: Resiberg, Ferris, DeLeon, & Crook, 1982) completed by the treating MDT was 5/7 "moderate" (range=2-6: "mild to moderately severe"). Once recruited, people with dementia did not report to have previously used HMD-VR, although this was not part of the criteria. Caregivers were staff supporting people with dementia in the care setting (see Tables 1 and 2).

**Table 1.** ***People with dementia demographics***

| | People with dementia (*n*=8) |
|---|---|
| | Frequency |
| **Age** | 69.63 (41-88) [a] |
| 35-44 | 1 |
| 45-54 | 0 |
| 55-64 | 2 |
| 65-74 | 1 |
| 75-84 | 3 |
| 85-94 | 1 |
| **Gender** | |
| Male | 6 |
| Female | 2 |
| **Primary diagnosis** | |
| Alzheimer's disease | 2 |
| Unspecified Dementia | 2 |
| Dementia in Huntington's disease | 2 |
| Mixed Cortical and Subcortical Vascular Dementia | 1 |
| Frontotemporal Dementia | 1 |
| **Secondary diagnosis** | |
| Recurrent Depressive Disorder | 3 |
| Depressive Episode | 1 |
| Organic Mood Disorder | 1 |

| | |
|---|---|
| Paranoid Schizophrenia | 1 |
| **Global Deterioration Scale rating (GDS)** | 5 (2-6) [a] |
| 1 No cognitive decline | 0 |
| 2 Very mild cognitive decline (age associated memory impairment) | 1 |
| 3 Mild cognitive decline (mild cognitive impairment) | 0 |
| 4 Moderate cognitive decline (mild dementia) | 2 |
| 5 Moderate severe cognitive decline (moderate dementia) | 4 |
| 6 Severe cognitive decline (moderately severe dementia) | 1 |
| 7 Very severe cognitive decline (severe dementia) | 0 |

*Note:* [a]Mean (range).

**Table 2.** ***Caregiver professions***

| | |
|---|---|
| **Professions** | |
| Nursing | 11 |
| Occupational Therapy | 3 |
| Psychology | 1 |
| Physiotherapy | 1 |
| **Registered/unregistered caregiver** | |
| Registered | 3 |
| Unregistered | 13 |

## Materials

For 360° video playbacks, a mobile Head Mounted Display, Samsung Gear VR with Samsung Galaxy S6 mobile phone (HMD-VR) was used to stream audio and visual content (see Figure 1). It allowed the participant to be fully-immersed by controlling the viewing direction by rotating their head as they would normally in the physical world. Virtual Environments were used in the form of 360° video, also known as immersive or spherical videos, where video recording uses a omnidirectional camera (such as Ricoh Theta S[5] and Samsung Gear 360°[6]) to capture a view in every direction.. The HMD-VR digital content was streamed to an external flat screen which allowed caregivers to see what the person with

[5] https://theta360.com
[6]https://www.samsung.com

dementia was seeing and provide relevant prompts and reassurance during the exposure. A dictaphone was used for audio recording interviews and a video recorder to film people with dementia engaging in HMD-VR. Capacity was assessed using the hospital's 'Mental Capacity Act 2005 Assessment Checklist' (see Supplementary Appendix 1).


**Figure 1:** ***Samsung Gear VR.*** [7]

**Procedure**

People with dementia were invited to use HMD-VR, with a familiar caregiver in a familiar room on the ward. They were offered a 'menu' of five VE's to choose from (forest; countryside; sandy beach; rocky beach; cathedral, see Figure 2). People with dementia were offered a maximum of 15 minutes of HMD-VR exposure, viewing the VE(s) using the headset. Exposure time was consistent with Moyle et al. (2015) and selected to reduce the risk of side effects. A technical researcher managed the equipment whilst a clinical researcher instructed the patient how to wear and use the headset. The caregiver directed the patient's attention to the VE as mirrored on the flat screen. Patient's interactions with HMD-VR were video recorded for later evaluations by the clinical researcher (OERS; OAS-MNR; SASBA; time exposed). After HMD-VR exposure patient's completed a semi-structured interview. In addition to the HMD-VR exposure, a clinical researcher observed patient's 15 minutes before their invitation to take part and 15 minutes following the interview, in care as usual. Caregivers were invited to try the headset, for up to five minutes, following the observation of the person with dementia

[7] https://www.samsung.com/uk/wearables/gear-vr-r322/

and engaged in a semi-structured interview. A second session of HMD-VR two weeks later was offered using the same procedure with a different caregiver.

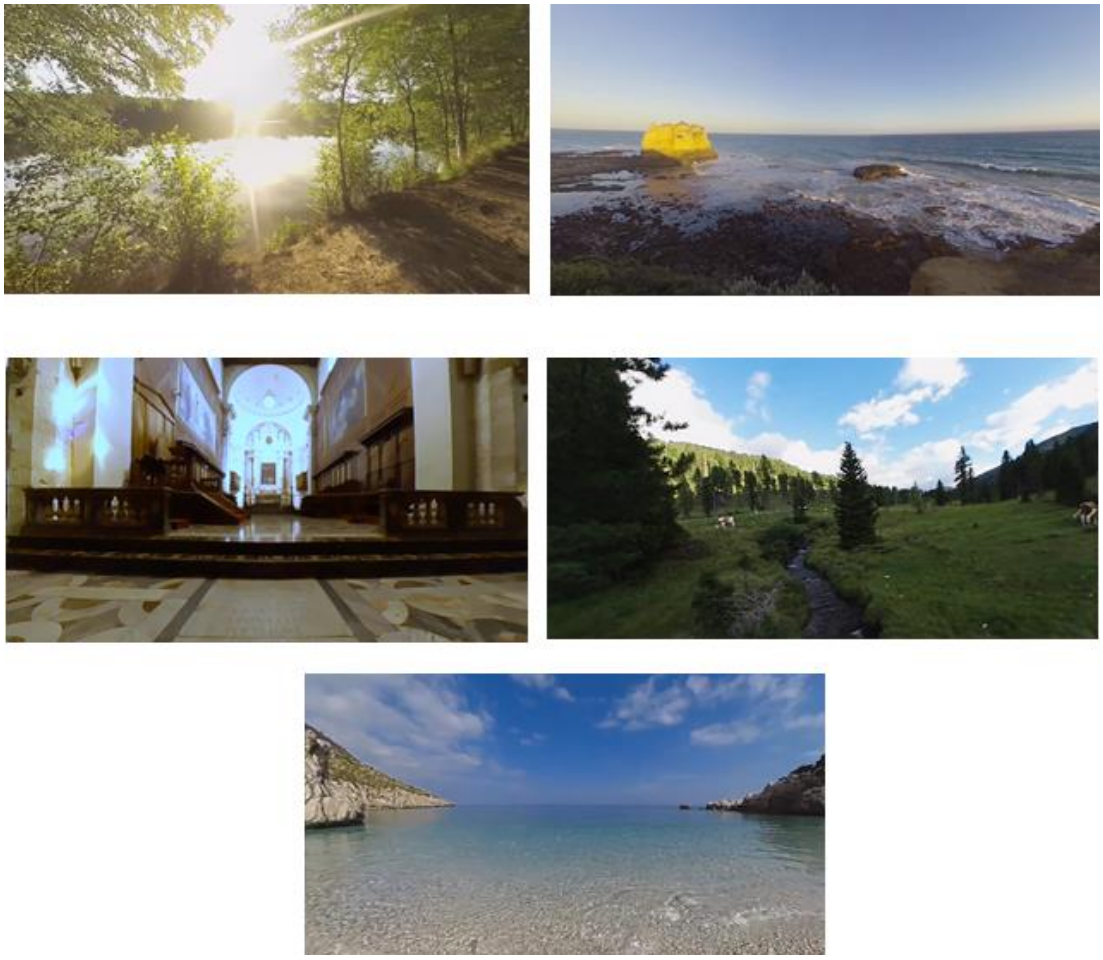

**Figure 2:** ***Still images of VE's offered to participants.***

**Data collection**

Quantitative data was collected by a clinical researcher, who was experienced in using the following measures:

**1. Overt Aggression Scale-Modified for Neurorehabilitation (OAS-MNR; Alderman, Knight & Morgan, 1997).** Used routinely in the care setting, the scale offers continuous direct observation and assessment of antecedents, contexts, behaviours and interventions. It records the type and severity of aggression from four categories: verbal aggression, physical aggression against objects; physical aggression against self; physical aggression against others. In relation to reliability, Alderman et al. reported Kappa values from 0.638 (substantial agreement) to 1.000 (almost perfect agreement).

**2. St Andrews Sexual Behaviour Assessment (SASBA; Knight, Alderman, Johnson, Green, Birkett-Swan & Yorston, 2008).** Used routinely in the care setting, the scale measures in the same way as the OAS-MNR but captures inappropriate or overfamiliar behaviour across four categories: verbal comments; non-contact; exposure; touching others. Knight et al reported Kappa values from 0.41 (moderate agreement) to 0.94 (almost perfect agreement).

**3. Observed Emotion Rating Scale (OERS; Lawton, Van Haitsma & Klapper, 1999).** Used routinely in the care setting, the scale offers direct observation of the time spent expressing five affect types: pleasure; anger; anxiety; sadness; and general alertness. The tool was used for the duration of the HMD-VR exposure as determined by the participation (maximum of 15 minutes). This was in order to maximise the richness of the data. Kappa values range from 0.76 (substantial agreement) to 0.89 (almost perfect agreement) (Landis & Koch, 1977).

**4. Time.** Participants could choose to spend up to 15 minutes exposed to HMD-VR. Time exposed was measured in minutes and seconds.

Semi-structured interviews (see Supplementary Appendix 2) were conducted by two researchers. The schedule explored the 'technology acceptance' of HMD-VR, using a combination of the Usability Evaluation in Industry Questionnaire (Brooke, 1996) and 'presence' using the Presence Questionnaire (Nichols, Haldane, & Wilson, 2000). Questions were also included that reflected the emotional effects of using HMD-VR. Caregivers engaged in the same interviews, but the aim was to reflect on their observations of the person with dementia using HMD-VR and seek professional opinions about the usability of HMD-VR in the inpatient environment.

Interviews were transcribed verbatim by two researchers and analysed using thematic analysis (Braun & Clarke, 2006). The analysis aimed to provide a detailed account of a group of themes within the data, driven by our specific research question and using a theoretical thematic analysis. Themes were identified at the semantic level, with a focus on explicit meanings of the data. Analysis and interpretation was guided by an essentialist epistemology, assuming a largely unidirectional relationship between meaning and experience and language. Familiarisation with data and manual generation of initial codes was completed by the clinical and technical researchers. One transcript was coded simultaneously by the two and discussed to explore congruency. Searching for initial themes was conducted by the same two researchers. Reviewing, and then defining and naming themes was completed by all researchers. The 'keyness' of each theme was determined in relation to the overall question of

feasibility of HMD-VR, with prevalence regarded at the level of the data item (i.e. did the theme appear anywhere) as well as considering the entire data set.

## Results

A range of sources of data were analysed. As can be seen from the results detailed below, there was great congruency in the positive acceptability of HMD-VR use by people with dementia.

### Observed emotions

Friedman test indicated that ratings of pleasure significantly differed between before (*Mdn*=1.250), during (*Mdn*=2.000) and after (*Mdn*=1.750) HMD-VR exposure, $\chi^2$ (2) = 8.000, p = 0.018. Wilcoxon signed-rank tests revealed a significant increase in pleasure from before (*Mdn*=1.250) HMD-VR to during (*Mdn*=2.000) HMD-VR exposure Z= -2.060, p=0.039 and from before (*Mdn*=1.250) to after (*Mdn*=1.750) HMD-VR exposure Z= -2.060, p=0.039. There was no significant difference between during (*Mdn*=2.000) and after (*Mdn*=1.750) HMD-VR exposure (p=0.285 n.s).

There was no significant difference in ratings of anger (p=1.000 n.s), anxiety/fear (p=0.212 n.s) or sadness (p=0.229 n.s) before, during and after HMD-VR exposure.

Ratings of general alertness significantly differed between before (*Mdn*=4.500), during (*Mdn*=5.000) and after (*Mdn*=5.000) HMD-VR exposure, $\chi 2$ (2) = 6.300, p = 0.043. Wilcoxon signed-rank tests revealed a significant increase in general alertness from before (*Mdn*=4.500) to after (*Mdn*=5.000) HMD-VR exposure Z= -2.060, p=0.039. There were no significant differences between before (*Mdn*=4.500) and during (*Mdn*=5.000) HMD-VR exposure (p=0.236 n.s) or during (*Mdn*=5.000) and after (*Mdn*=5.000) HMD-VR exposure (p=0.414 n.s) (Table 3; Figure 3).

**Table 3.** ***Observed ratings of emotions before, during and after VR exposure using OERS.***

| Affect | p | | m | Mdn | Phase | p |
|---|---|---|---|---|---|---|
| | | Before | 1.313 | 1.250 | Before-during | 0.039 |
| | | During | 1.813 | 2.000 | Before-after | 0.039 |
| Pleasure | 0.018 | After | 2.125 | 1.750 | During-after | 0.285 |
| | | Before | 1.063 | 1.000 | Before-during | 1.000 |
| Anger | 1.000 | During | 1.063 | 1.000 | Before-after | 1.000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | After | 1.063 | 1.000 | During-after | 1.000 |
| | | Before | 1.938 | 1.750 | Before-during | 0.104 |
| | | During | 1.250 | 1.000 | Before-after | 0.236 |
| Anxiety/fear | 0.212 | After | 1.625 | 1.250 | During-after | 0.102 |
| | | Before | 2.313 | 1.250 | Before-during | 0.102 |
| | | During | 1.438 | 1.000 | Before-after | 0.221 |
| Sadness | 0.229 | After | 1.625 | 1.000 | During-after | 0.414 |
| | | Before | 4.000 | 4.500 | Before-during | 0.236 |
| | | During | 4.500 | 5.000 | Before-after | 0.039 |
| Alertness | 0.043 | After | 4.688 | 5.000 | During-after | 0.414 |

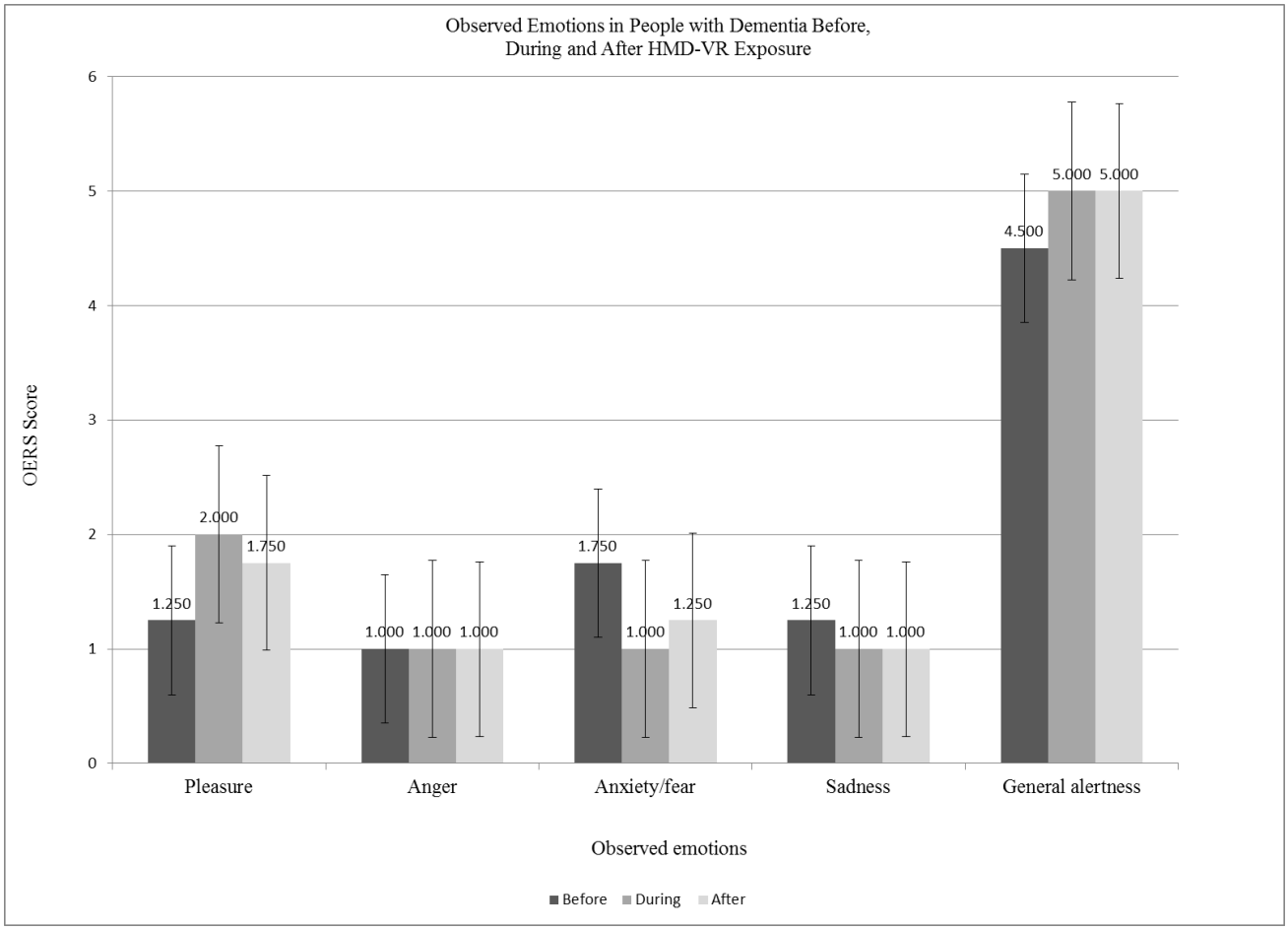


**Figure 3:** ***Median observed ratings of emotions before, during and after HMD-VR exposure using the OERS.***

**Time spent exposed to HMD-VR**

A Wilcoxon signed-rank test demonstrated that there were no significant differences between people for time spent exposed to HMD-VR from the first session of exposure (*Mdn*=13:30) to the second session (*Mdn*=15:00) Z = -1.483, p = 0.138 (Figure 4).

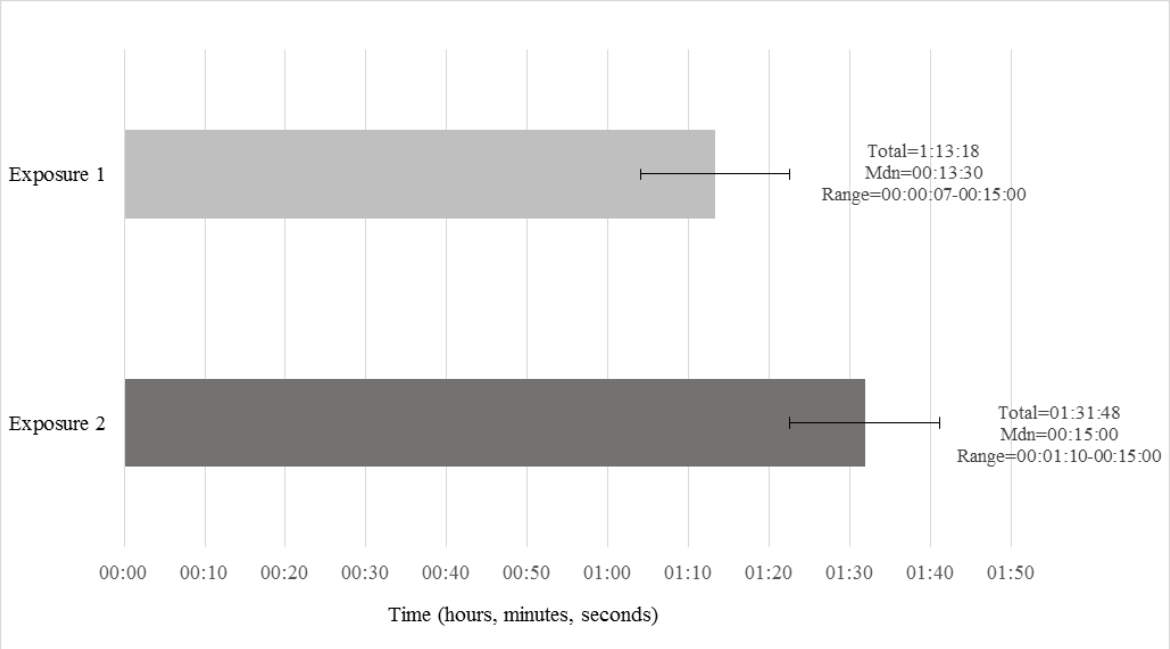


**Figure 4:** ***Total HMD-VR exposure time.***

**Behaviour that challenges**

A total of 9 behaviours were observed and recorded (8=OAS-MNR; 1=SASBA). See Figure 5 for changes in frequency of observed behaviours and aggregate aggression scores (AAS).

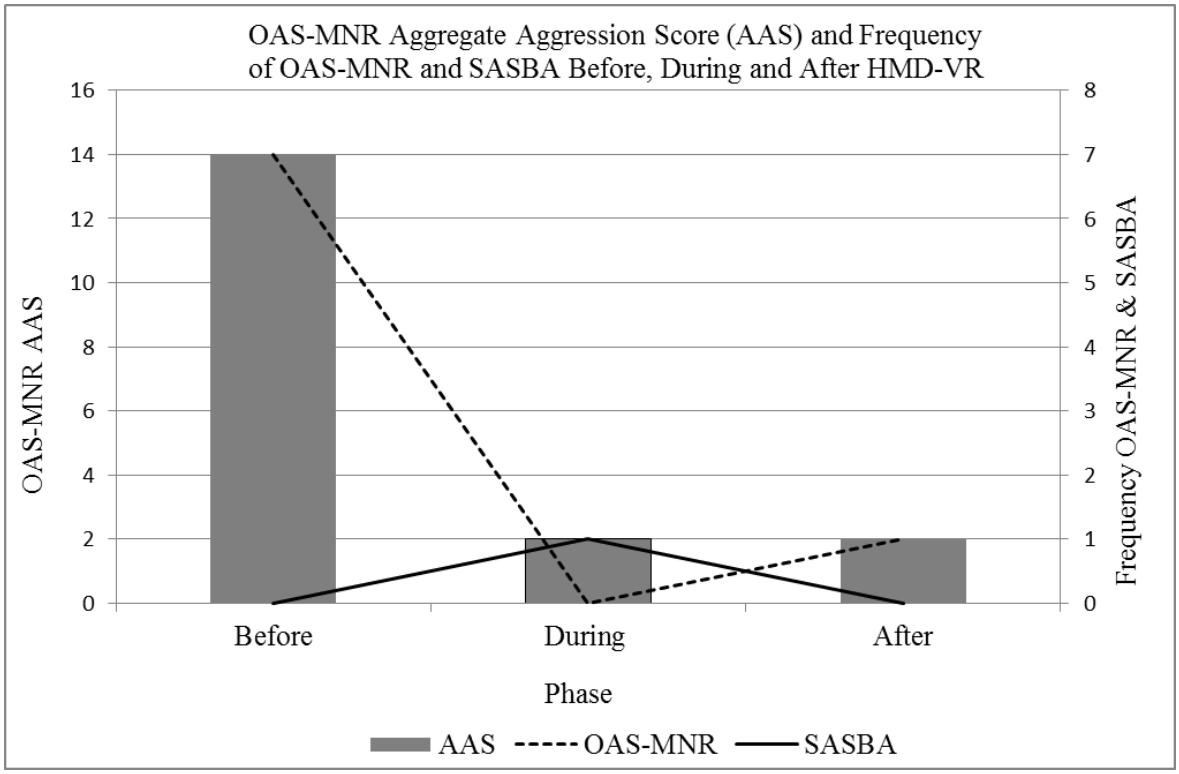


**Figure 5:** ***Frequency of OAS-MNR and SASBA and OAS-MNR AAS before, during and after HMD-VR exposure.***

## Interviews

Thematic analysis revealed three core themes and eight subthemes embedded throughout the interviews. People with dementia and caregivers talked about 'Virtual Reality Experiences', 'Impact of Virtual Reality' and 'Experiences within the Virtual Environment'. Only the caregivers discussed preconceptions they had of HMD-VR use with people with dementia.

**'Virtual Reality Experiences'**. Three subthemes were discovered in relation to the HMD-VR experience: technology acceptability; opportunities generated; individual preferences.

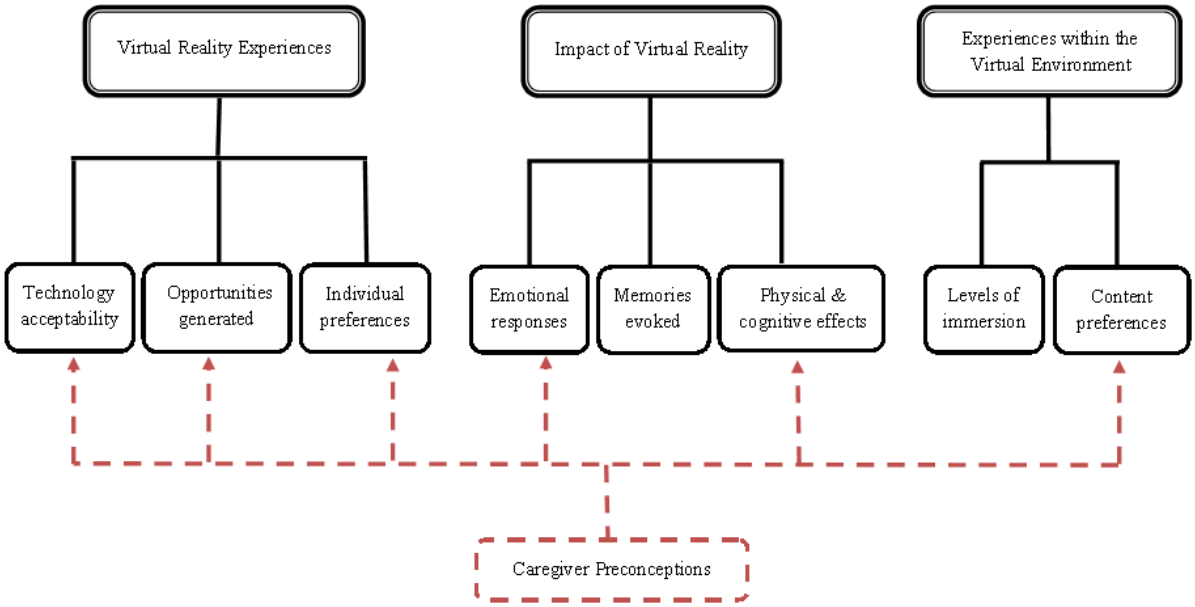


**Figure 6:** ***People with dementia and caregiver themes.***

***Technology acceptability***. Caregivers reported on preconceptions they had of using HMD-VR with individuals they supported. Caregivers thought it could be difficult for people with dementia to try new technology, and have the headset over their eyes, due to their older age and cognitive deficits. Caregivers were unsure whether people with dementia would try HMD-VR at all. Caregivers initially thought that HMD-VR was more suitable for younger people who they thought may know more about technology. They also thought that variables including cognitive impairment may impact acceptance. Caregivers were surprised that some people engaged for the entire HMD-VR session and that it was accepted by patients, including those who could present with aggression. Caregivers reported that their observations of the session changed their views on HMD-VR and they were more open to using it within the setting (Extract 1).

Extract 1

> "with the experience I've got today I think that, every new thing is still good to try because… we cannot say it can't work if we don't try it and I saw it in the patient today I can see a bit of the benefit of that [HMD-VR] for a patient" [CG5, 6, 102-106[8]].

[8] PWD=person with dementia or CG=caregiver; interview number; page number; line number(s).

People with dementia provided feedback on usability of HMD-VR technology, sharing that, "it was comfortable on my head" [Extract 2, PWD10, 3, 47] and easy to use which included putting the headset on and looking around whilst wearing it. They did not report experiencing any lag in the visual content and liked the fact they could look around the VE. PWDH thought, however, that HMD-VR did "not feel natural". Nevertheless, participants' preferences differed, with people with dementia favouring HMD-VR in comparison to conventional television as well as favouring television.

***Opportunities generated.*** Initially caregivers questioned why they could not take people outside rather than offering HMD-VR. Caregivers also considered that people might subsequently want to go to the VE in reality but their hospital leave could be restricted. Caregivers also viewed HMD-VR as a positive opportunity for people unable to access certain environments in reality. Broadly, both caregivers and people with dementia viewed HMD-VR as a tool that created opportunities including a change of environment and routine (Extract 3).

Extract 3

> "You can't get them to a forest walk every day, you can't get them to a beach every day, you can't get them to a cathedral every day and it's as close to those environments that they can then get to regularly. Um so it's… definitely beneficial for them because I mean [PWD] wouldn't have seen the lovely countryside today if it hadn't of been virtual reality unfortunately… so it's great. It stimulated him." [CG4, 1-2, 13-19].

Caregivers reported that people with dementia were looking forward to using HMD-VR and engaged well in sessions. They also reported that HMD-VR had a positive impact on wellbeing after the session and it motivated people to want to go outside. Caregivers reported that from observing the session they discovered new skills and interests of the person with dementia, and felt they could reconsider their participation in other activities due to the success of the session. People with dementia reported that they found HMD-VR "fun" and "quite exciting…you never know what's beyond the corner, do you?" [Extract 4, PWD13, 4, 79-80]. PWD5 thought HMD-VR would be a good way to see what going abroad might be like, "because if you're going abroad, all you get is a video of what's going to be like" [Extract 5, PWD5, 108-109] or to trigger a memory they would not have otherwise experience. HMD-VR was also viewed as a new experience and an opportunity to pass the time whilst being in hospital (Extract 6).

Extract 6

> "Well for someone stuck in a hospital, you know, time drags, so, if we put those video things on…it gets you out of the place" [PWD5, 7, 134 & 140].

***Individual preferences.*** Caregivers explained that they were initially unsure of how people with dementia would react to HMD-VR and felt they would be sceptical about using HMD-VR. Caregivers reported that they liked HMD-VR and reported it was "interesting", "intriguing", and "exciting". However, they reported that they observed the engagement between the first and second session to differ and concluded that the benefits and reaction to HMD-VR could be individual (Extract 7).

Extract 7

> "You might have different reactions from patient A to patient Z…you might have 30 people and 25 of them might like that idea but 5 of them might not" [CG8, 6, 109-111].

People with dementia reported they liked HMD-VR: "I loved it!" [Extract 8, PWD6, 3, 51]. They broadly thought it was a "good idea" and expressed they would continue using HMD-VR. People with dementia were also excited in anticipation of their next opportunity to use HMD-VR and wanted to talk about their experience with others. PWD8 and PWD2 were initially disinterested in using HMD-VR again, although consented to re-try it. Both enjoyed the second experience and requested future opportunities. Caregivers observed people with dementia enjoying using HMD-VR (Extract 9).

Extract 9

> "I think she clearly really enjoyed it… she was smiling, she seemed really relaxed. Yeah she seemed to really enjoy it" [CG15, 2, 26-27].

**'Impact of the Virtual Reality'.** There were three subthemes found that related to the impact of HMD-VR: emotional responses; physical and cognitive effects; memories evoked.

***Emotional responses.*** Caregivers held preconceptions about the emotional impact HMD-VR could have on people with dementia, which included potential distress or agitation as well as the potential experience of negative emotions from reminiscence triggered by the

VE. They also reported that people could find being in the VE "lonely" or "scary". Contrary to expectations, caregivers observed individuals to be calm when using HMD-VR and "it relaxed him at the time" [Extract 10, CG11, 1, 14]. People with dementia also commented on the emotional responses they themselves experienced when using HMD-VR. PWD10 reported feeling sad: "[be]cause I couldn't see the birds I was sad" [Extract 11, PWD10, 4, 74]. Others reported feeling "calm" and "relaxed" as well as "excited" and "happy". PWD12 reported feeling "good" and "I feel excellent…. I can't describe it" [Extract 12, PWD12, 6, 109 & 111] after using HMD-VR. PWD4 reported "I felt quite emotional" [Extract 13, PWD4, 3, 205] and was visibly moved, verbally describing a "happy" emotion.

***Physical and cognitive effects.*** Caregivers also shared their preconceptions around the physical and cognitive effects HMD-VR could cause, specifically potential for disorientation, perseveration and confusion, as well as standing and/or falling whilst using the headset. People with dementia were prompted to reflect on the physical impact of using HMD-VR and shared that HMD-VR did not make them feel tired or dizzy. This was also observed by the supporting caregivers. Nonetheless, PWD4 reported feeling tired and PWD16 reported feeling dizzy from using HMD-VR. A caregiver observed short-term disorientation in PWD7 after using HMD-VR.

***Memories evoked.*** Whilst using HMD-VR and after exposure, people with dementia reminisced positively about topics including family, geographical origins and travels. People with dementia reported the VE looked like a familiar place and that "it reminds me of the old days" [Extract 14, PWD13, 6, 113]. Caregivers also identified a process of reminiscence. On the second HMD-VR exposure, people with dementia both recalled their first experience as part of the study and forgot. Caregivers also reported that people remembered the first exposure two weeks prior.

**'Experiences within the Virtual Environment'.** In relation to the VE, two sub-themes were generated: immersion and content preferences.

***Immersion.*** It was harder for people with dementia who spent less time in HMD-VR to assess whether they were immersed. Of those who chose to spend longer, when asked about whether HMD-VR felt 'real', they reported that HMD-VR felt "real" and they felt like they were "in" the VE (Extract 15).

Extract 15

"I felt like I was in the beach… it was very good feeling" [PWD4, 7, 141 &144].

Caregivers reported that HMD-VR "felt real". CG4 reported "you feel like you're within it I guess. You can't see the room that you're actually in, so you are in that picture" [Extract 16, CG4, 3, 48-49]. Caregivers felt the people they were supporting were immersed in the VE, and HMD-VR could make people "think they've been somewhere because they've got this little time, and some relaxation" [Extract 17, CG14, 8, 175-176]. They explained that the effects of being immersed could be positive for people with dementia. Caregivers only spent a short time trying HMD-VR (a maximum of 5 minutes) and surmised that the amount of time spent using HMD-VR could affect the feeling of immersion. Consequently, caregivers also reported immersion was not achieved. For example, CG02 reported being aware of their surroundings (although, commented they did not mind others being present).

***Content preferences.*** Preferences relating to the VE content were provided by people with dementia and caregivers. CG16, had a preconception that a particular VE would be loved by the person with dementia they supported. Caregivers observed people exploring the VE by moving their heads as well as verbalising their real time experiences. People with dementia were both able and unable to communicate a particular VE preference. They indicated that they liked the VEs offered and described comparisons between the VEs and the real world. During interviews, people with dementia described elements within the VE (Extract 18) and found exploring the VE "exciting" and "interesting".

Extract 18

"You can see all the trees and that and the conifers, different colour conifers" [PWD5, 1, 8-9].

When asked specifically, people with dementia commented on enjoying the VE sounds, including "you hear the choir, and everything. And umm, it was quite a good experience" [Extract 19, PWD13, 7,137-138). However, people with dementia also did not find the VE interesting and did not like the sounds. When giving feedback, memory was also a factor, with people commenting that they could not recall either certain elements in the VE or the sounds.

## Discussion

HMD-VR has the advantage of creating a naturalistic VE which provides opportunities that may be difficult to achieve or inaccessible (Siriaraya & Ang, 2014). This could be due to

ill health, a place of interest or artefact no longer existing, or someone being restricted under the Mental Health Act. HMD-VR can also be implemented immediately after invitation to participate. In addition, HMD-VR has the potential to provide care that is wholly consistent; if a person enjoys a particular VE they have the opportunity to revisit it without the risk of extraneous variables such as weather or caregiver accessibility. The purpose of the study was to explore whether HMD-VR use was feasible with people with moderate to severe dementia who reside in an inpatient psychiatric care setting. Despite the broad patient group, difficulties were faced in accessing more participants with severe cognitive impairment. This was largely due to the lengthy process of assessing capacity which relied on busy MDTs and seeking consent from potential consultees, many of whom relied on postal correspondence. The study consequently included participants with mild to moderately severe cognitive impairment within the context of dementia.

Contrary to caregiver's reported expectations, people with dementia tried the HMD-VR, and the time engaged in HMD-VR increased from the first to the second exposure albeit not statistically significantly (although likely due to HMD-VR use towards the maximum time offered during the first exposure). With regards to behaviour that challenges, analysis was limited due to the small number of behaviours observed in total. Interestingly however, behaviours occurred only around the first HMD-VR exposure timeframe. Overall, the HMD-VR experience had a positive impact upon people with dementia, with significant improvements observed from before to after HMD-VR exposure in pleasure and alertness, as well as before to during HMD-VR exposure for pleasure. The current study found no adverse effects in the form of fear/anxiety, sadness and anger.

Qualitative analysis explored the reported experiences of using HMD-VR from the perspective of the people with dementia and the caregivers supporting them. Participants talked about their HMD-VR experience in relation to technology acceptance, the opportunities generated for user wellbeing, and the importance of individual preferences. The impact of the HMD-VR exposure was also discussed in relation to the emotional responses of people with dementia along with the physical and cognitive effects and the memories evoked. Lastly, in relation to the VE, participants reported on their experiences of immersion and actual content. Caregivers also expressed preconceptions about HMD-VR use with people with dementia and how these changed following the exposures. Prior to exposure, caregivers referred to the level of cognitive impairment as a factor that could potentially impact on unfamiliar technology acceptance. However, much to their reported surprise, people with dementia all tried HMD-

VR and most used the maximum amount of time offered. The VEs were typically viewed positively, however a minority commented on wanting more time within the VE. Individual differences were a prominent theme, with some people with dementia preferring alternative technology (including television) over HMD-VR, although still expressing interest in trying HMD-VR again. One person's negative views changed a fortnight later when offered the second opportunity, when they then requested repeat exposure.

In terms of the usability of HMD-VR technology, we took into consideration the evaluations of both Moyle et al. (2017) and Siriaraya and Ang (2014) in that participants were seated, and the experience did not require a lot of physical interaction. This was a strength of the design, reducing risk of fatigue or discomfort. We used a mobile HMD that provided visual and audial feedback and were interested in whether people with dementia would be content to wear it. Using a wireless mobile HMD allowed flexibility in setting up the equipment quickly and unobtrusively in different familiar locations, allowing caregivers to easily focus on introducing the equipment and supporting the person.

We were also interested to further explore affect, including fear and anxiety, as had been previously recommended. Participants were offered a choice of five VEs and were supported by familiar staff to promote a person centred approach. This was a strength of the research design and may have contributed to the positive experience observed overall.

**Limitations of the current study**

The sample was relatively small and restricted to a single inpatient setting, limiting generalisability of findings. Nevertheless, important evidence about the feasibility of HMD-VR technology use with a potentially challenging patient group has been demonstrated. These initial findings are particularly significant given the infancy of the research area.

During data collection it was not always possible to observe the person directly before and after their exposure to HMD-VR due to circumstances beyond our control (e.g. the individual being supported with personal care). Therefore some behaviours or aspects of emotional presentation could not be captured on the observational tools. Further, ratings from the video recordings (during the HMD-VR exposure) could have been more accurate than ratings from observations conducted in real time as the timeframes could be re-watched. Inter-rater reliability for the OAS-MNR, SASBA and OERS was not measured due to only one clinical researcher collecting data. This also opened the possibility for data bias. All three

measures were familiar to the clinical researcher who was already trained for routine clinical practice.

Challenges were faced when using the OERS. The tool measures time spent within each observed affect, which corresponds to a rated score. People who spent less than five minutes exposed to HMD-VR were therefore unable to score the maximum rating of 'more than 5 minutes'. Future research will need to accommodate this in order to measure the quality of shorter HMD-VR exposures. In addition, the data collected relating to 'eyes' on the OERS could not be rated due to the headset covering the patients' eyes. Instead, the rater relied on additional indicators for each of the five affect types, including the upper face, nose and mouth, as well as posture, gross motor movement and verbal communication.

Whilst visual impairment was an exclusion criterion, we did not test for hearing impairment and are unable to conclude whether hearing may have affected individuals' HMD-VR experience. Physical effects of HMD-VR were not formally measured in our study, a limitation that could be considered for future research. People with dementia either reported or were observed to find the HMD-VR exposure a positive experience; however one person reported feeling temporarily dizzy, but still reported they would try HMD-VR again. It is worth nothing that the dizziness was reported in parallel to the headset being frequently moved to and from their eyes which may have contributed, as the selected headset was designed to be kept on. All other participants used the headset in the designed manner and did not report dizziness.

**Implications**

The current study supports previous findings exploring the use of HMD-VR technology by people with dementia (Moyle et al., 2017; Siriaraya & Ang, 2014; Manera et al., 2016; Mendez et al., 2014) and extends feasibility to people with more advanced dementia residing in an inpatient psychiatric care setting. The key issues regarding feasibility of HMD-VR that were worked through in the study are summarised in Table 4. HMD-VR was largely well received by people with dementia and their caregivers, opening up clinical implementations as a person centred intervention. Further, HMD-VR could provide opportunity for additional positive effects that might not be otherwise triggered, including subsequent reminiscence, promoting social interaction with others through sharing experiences, and inspiration to go outside.

**Table 4.** ***Feasibility Framework***

| (1) **Resources required** | (2) **Facilitation requirements** | (3) **Problems observed** |
|---|---|---|
| **Participants** | Assessment of mental capacity. | Length of time required for assessment completion and difficulties liaising with consultees for potential participants lacking mental capacity. |
| **VR Hardware** | HMD-VR and a linked laptop to enable carer to support the interaction and use of the equipment. | Some people with dementia preferring alternative technology (including television) over HMD-VR. Dizziness reported by a person who frequently moved the headset to and from their eyes. All others used the headset in the designed manner and did not report dizziness. |
| **VR Software (VEs)** | People with dementia were offered a choice of five neutral VEs and were supported by familiar staff to promote a person centred approach. | The positive or negative effects may have been underplayed because the VE's were not personalised. |
| **Distraction free and comfortable location** | Participants were seated, and the experience did not require a lot of physical interaction, reducing the risk of fatigue or discomfort. There were no environmental distractions noted. | Unable to test feasibility in a busy shared environment. |

| | | |
|---|---|---|
| **Observational measures to monitor effects of exposure to HMD-VR and VEs** | Appropriate measures to address intervention goals: OAS-MNR, SASBA and OERS | Insufficient frequencies of behaviour that challenges for the duration of study observations precluded valid statistical analysis.<br>Unable to rate observations of affect specifically in relation to eyes due to HMD-VR headset covering the participants' eyes.<br>Due to care needs (e.g. personal care), after exposure observations were on occasion delayed. |

A number of learning points have been highlighted for consideration at clinical implementation level. For example, the benefits of offering a menu choice of VEs. Further, considering the additional opportunities for customisation of VEs to an individual's hobbies or interests, or specific personal environments. We recommend the use of a programme that wirelessly mirrors the users' real-time experience onto an external flat screen so caregivers can see what the user is experiencing. This allows carers to better support and interact with the person in real-time. Although the HMD-VR exposures within the research context were perceived to be generally positive, some caregivers still expressed concerns about using HMD-VR clinically. This seemed to relate to the practicalities of using the technology within a hospital environment rather than its use with the patient group. We recognise that for some this could be a barrier to future clinical implementation. The potential of devising clear technical and clinical guidelines or a package to support and encourage implementation could therefore be considered. We also recommend educating caregivers on HMD-VR in order to address any preconceptions and maximise technology acceptance.

This study has explored the feasibility of the HMD-VR technology; however, in future research it would be interesting to explore the attributes of HMD-VR as a non-pharmacological person-centred intervention in comparison to 'care as usual', as well as comparison with other interventions already evidenced in national dementia practice guidelines. A larger scale study with multi sites could maximise potential participation and open up opportunity to explore

variables such as: age; gender; level of previous exposure to technologies; type of dementia diagnosis; co-morbidities; stage of disease progression; symptom profiles including specific cognitive impairments, mood or behaviour that challenges. To begin with, participants suggested that specific VEs were associated with negative emotions because of missing visual cues (e.g. birds). In future research, further evaluation of VEs and levels of immersion could be sought, as well as exploring idiosyncratic preferences. Taking into consideration that some people reported a preference for flat screen projection (i.e. television) in comparison to HMD-VR, different types of VR systems could also be investigated to explore whether there is interaction between the impact of VR and the type of immersive system. Research could also explore whether or not the caregiver supporting the person with dementia had an impact on the HMD-VR experience; this was not measured in our study. This may be difficult to measure given that cognitive impairment means that VR without carer presence is likely to be unavoidable. In addition, it might also be interesting to explore if relatives have the same preconceptions as the caregiver participants were found to have.

Additional considerations for future research methodology include: screening hearing impairment as part of the inclusion and exclusion criteria; use of a validated tool for measuring dizziness; improving accuracy of 'before' and 'after' ratings by video recording care as usual; accounting for inter-rater factors in relation to the observation tools; and analysing the interaction between the person with dementia, the caregiver and researcher and how these might impact on the experience as a whole. In addition, it would also be interesting to invite relatives to play more of an active role in research, beyond that of providing consent for those without capacity. Their involvement may have a positive impact on both the person with dementia's engagement and experience of the HMD-VR.

Future research involving people with dementia should also follow the Mental Capacity Act (2005) to maximise opportunity for participation at all stages of dementia. The act presents clear guidelines on the process of gaining consent with people who may lack capacity to consent. We adopted these guidelines, and inherently faced challenges in recruiting participants due to the lengthy process. We advise future projects consider inviting relatives to have the opportunity to play more of an active role in the research, which may subsequently attract more potential participants.

## Conclusion

The outcomes of the current study suggest that HMD-VR use is feasible for people living with a mild to moderately severe dementia, even those presenting with periodic behaviour that challenges and residing in hospital. This is exciting and innovative in terms of the implications for future clinical implementation. However, the therapeutic benefit of HMD-VR compared to other person centred interventions and the potential for personalisation of VEs as well as refinement of available VR technologies still warrants further investigation.

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## Declaration of Conflicting Interests

The Authors declare that there is no conflict of interest.

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