Received: 8 November 2023 | Revised: 28 January 2024 | Accepted: 31 January 2024

DOI: 10.1111/ajag.13294

RESEARCH ARTICLE

Australasian Journal on Ageing WILEY

Evaluating a virtual reality dementia training experience using psychophysiological methods: A randomised controlled study

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Funding information
Curtin University of Technology; Curtin University School of Pharmacy and Biomedical Sciences Early and Mid-Career Researcher Grant

Abstract

Objectives: Virtual reality (VR) is increasingly used for training the dementia care workforce. It is unknown whether VR is superior to traditional training techniques in improving dementia care amongst practicing nurses. This study compared the impact of a VR application on nurses' knowledge and attitudes towards people living with dementia, to video-based, non-immersive training.

Methods: Twenty-two registered and enrolled nurses were randomised to either interactive VR experience or video footage captured from within the app. Participants completed surveys pre- and post-training to assess their knowledge of dementia, attitudes towards dementia and person-centredness. Engagement with training was assessed objectively using facial electromyography, and subjectively with self-reported scales.

Results: Virtual reality evoked objectively significant greater positive and negative emotional responses than video (positive emotion fEMG: VR mean .012 mV vs. video .005 mV, $F[1, 20] = 8.70$, $p = .01$; negative emotion fEMG: VR mean .018 mV vs. video .008 mV, $F[1, 20] = 18.40$, $p < .001$). Self-ratings of engagement and emotional state were similar. There was little change in the VR group's knowledge of, and attitudes towards, dementia; the video group's dementia knowledge improved (total DKAS mean differences: VR .1 $t = .07$, df = 9, $p = .95$ vs. video −2.3 $t = -2.265$, df = 11, $p = .045$).

Conclusions: Virtual reality is more engaging than traditional training in highly experienced dementia care practitioners. Despite this, VR may not be superior to traditional training techniques to improve knowledge and attitude for many learners. A focus of future research in the area should be on how to capitalise on VR's greater emotional engagement so that Australia's nursing workforce is better equipped to care for the increasing number of people living with dementia.

KEYWORDS
dementia, education, environment, virtual reality

1 | INTRODUCTION

Dementia is characterised by changes in memory, personality and functioning. A majority of people living with dementia will also exhibit changed behaviour, referred to in terms such as *responsive behaviour*, *challenging behaviour*, or *behaviours and psychological symptoms of dementia* (BPSD).[1]

Behaviours and psychological symptoms of dementia are typically either precipitated or exacerbated by environmental factors and unmet needs.[2] Deficits in care provided to those living with dementia in residential aged care facilities (RACFs) are common, and the use of pharmacological agents to alleviate BPSD is concerningly high.[3] Whilst these medications may be of some benefit for some people living with dementia, medication is often used for inappropriate indications for excessive periods. This exposes recipients unnecessarily to a high risk of serious adverse effects, including falls, cerebrovascular events and premature death.[4,5]

An alternative means of preventing or alleviating BPSD is through the provision of person-centred care, an approach initially developed by Kitwood.[6] Person-centred care is a philosophy of care centred on the needs of individuals and is contingent upon knowing their unique preferences through interpersonal relationships. Person-centred care is associated with benefits such as improved quality of life, decreased agitation, improved sleep patterns and maintenance of self-esteem.[2] One of the key components of person-centred care is for care providers to consider the world from the perspective of the person with dementia. Doing so acknowledges that a person's behaviour is a means of communication and encourages connectedness with the person living with dementia in their own reality.[2]

Virtual reality (VR) technology may enhance healthcare professionals' understanding of dementia by enabling them to experience another person's reality.[7,8] Several dementia-specific VR experiences have been developed with this intention, such as Dementia Australia's *Educational Dementia Immersive Experience*,[9] Alzheimer's Research UK's *A Walk Through Dementia*[10] and the Dutch simulation *Into D'mentia*.[11] Whilst research into the outcomes of these VR applications for patients is relatively limited, there is evidence that their use increases empathy and improves attitudes towards dementia amongst healthcare professionals and undergraduates.[7,9,12] However, none of these resources specifically aim to change knowledge and attitudes towards the responsible use of medications.

Dementia Training Australia (DTA) recently developed a VR application that aims to develop health professionals' understanding of BPSD and its management. This includes a simulation of some of the effects of antipsychotic medications. The VR application, *Meaningful Spaces*, is utilised in a half-day face-to-face workshop to help participants experience altered perceptions common in individuals with dementia, enhancing their understanding of the impact of environment and medications on managing BPSD.

This study aimed to compare the impact of the *Meaningful Spaces* VR application on health-care professionals' knowledge and attitudes towards people living with dementia, to a traditional video-based, non-immersive training experience. Each users' level of engagement with the training experience was assessed subjectively and objectively to potentially account for differences in the outcomes of the training.

Policy Impact

This study found that virtual reality (VR) may not be superior to traditional training techniques to improve knowledge and attitudes in experienced dementia care nurses. This suggests that resource-intensive VR experiences have limited application in training this sector of the dementia-care workforce.

Practice Impact

Residential aged care training managers with limited resources should consider restricting the use of virtual reality training to workers with limited experience of dementia care. Future research should aim to identify when to use VR most effectively when training nurses who provide care for people living with dementia.

2 | METHODS

2.1 | Design

This between-subject, quasi-experimental, pretest–posttest study was undertaken at the Consumer Research Lab, a facility operated by Curtin University's Business School. Specifically, participants were randomly assigned to either one of two training conditions: (1) traditional video learning (control condition) or (2) VR simulation learning (intervention condition). During both conditions, participants were exposed to environments designed to be either disabling or enabling for a person living with dementia (see below for more details). At the conclusion of each condition, participants underwent a structured debriefing with a member of the research team. The debriefing protocol adhered to the Promoting Excellence and Reflective Learning in Simulation framework.[13]

2.2 | Virtual reality simulation (intervention condition)

The VR simulation was primarily developed by a team of three experts in dementia care for Dementia Training Australia (University of Wollongong, Australia), in collaboration with digital studio Viewport (Fremantle, Australia). The experts involved were a nurse, a psychologist and a pharmacist, each with considerable relevant experience with care provision, environmental design and medication management for people living with dementia.

The VR simulation was developed in Unity (Unity Technologies, San Francisco, USA) for the Oculus Rift (Facebook Technologies, San Francisco, USA) VR system. The simulation was comprised of two scenarios. Both scenarios consisted of high-fidelity three-dimensional graphical environments that represented an aged care facility, in which the participant viewed the environment from the first-person perspective of a resident of the facility (see Figure 1 for examples). The scenarios required the participants to navigate from the resident's bedroom to other areas of the facility, including the dining room, communal bathroom and garden. There was a time limit for each navigational step, with the simulation ending if the required task was not achieved within the allotted time.

Whilst the tasks were identical in the two scenarios, the built environments were markedly different. The first scenario was disabling and poorly designed ('dementia-unfriendly'), incorporating elements such as minimal signage, obstructed lines of sight, unhelpful aural stimulation and poor contrast. Conversely, the second scenario was a more enabling ('dementia-friendly') environment, based on the principles of sound environmental design for people living with dementia.[14]

Prior to attempting the VR scenario, participants were introduced to the simulation via a short orientation presentation by a researcher, followed by an interactive tutorial using the VR system.

2.3 | Video recording (control condition)

Recent criticism of the predominant approach to studies of VR health applications has found that they typically lack ecological validity and do not examine differences with baseline traditional media such as serious games (standard 2D videogames) or live action video.[15] Therefore, for the control participants in this study, non-interactive video-screen playback versions of VR app footage were prepared for both scenarios. With the visual and audio elements held consistent between the two conditions, this allowed the video recording (control condition) to be comparable with the VR simulation (intervention condition). The footage showed the protagonist attempting the same tasks as per the VR scenarios from a first-person perspective. These scenarios were presented in a single-shot format to faithfully replicate the embodied VR experience. The duration of the videos ranged from 3 to 5 min, consistent with the time required to complete the VR scenarios. As such, the video recording can be considered a valid passive representation of the immersive VR experience, excluding interactive elements and the sensation of wearing the VR headset.

2.4 | Participants

The study sample comprised 22 registered or enrolled nurses working in Perth, Western Australia. The sole additional inclusion criterion for the study was a minimum of 5 years of experience working in nursing homes. Participants were recruited using flyers distributed via

FIGURE 1 Screen captures from the VR simulation area of interest 3 (AOI3), showing poor environmental design (left) and enabling design (right). Whilst the floorplan is identical in both images, differences in interior decorating, lighting and contrast between floors, doors and walls are particularly evident.

email through relevant aged care networks. Thirty potential participants initially expressed interest in participating; 23 provided informed consent, one of whom was excluded for being neither a registered nor an enrolled nurse.

Participants were booked into individual testing sessions upon providing written consent to participate. They were randomly assigned to either the control or intervention group using a sequence generated by https://www.random.org/sequences.© Each participant's booking was created without the knowledge of whether the participant was to be exposed to the intervention or control to reduce the risk of bias.

Ethics approval was granted by the Curtin University Human Research Ethics Committee prior to the study's commencement (HRE2020-0448). Data were collected over a 6-week period in October and November 2020. All participants provided informed consent to participate in the research prior to the commencement of the study.

2.5 | Measures

Sociodemographic characteristics including gender, age, training and workplace history, history of a family member with dementia and employment circumstances were collected.

Three validated tools were used to assess participants' dementia knowledge and attitudes towards individuals living with dementia, as follows:

- the Dementia Attitude Scale (DAS) was used to measure the affective, behavioural and cognitive components of participants' attitudes towards individuals with dementia.[16]
- the Dementia Knowledge Assessment Scale (DKAS) assessed participants' knowledge of dementia[17]; and
- the Person-centred Care of Older People with Cognitive Impairment in Acute Care Scale (POPAC) evaluated participants' person-centredness.[18]

The participants' perceptions of their emotional states during the VR or video experiences were measured with the Self-Assessment Manikin (SAM) questionnaire.[19] Their engagement with the VR or video experience was subjectively measured with a modified version of the User Engagement Scale.[20] Facial expression was monitored using facial electromyography (fEMG) as an objective measure of learning enjoyment, in accordance with fEMG guidelines.[21]

Further information regarding these measures is provided in Appendix S1.

2.6 | Statistical analysis

A target sample size of 20 was calculated based on detecting a 25-point difference in the DAS score, at an alpha of .05 and a power of 80%. Sample characteristics were described using descriptive statistics, including means, standard deviations and frequencies. Cohorts were compared at baseline for differences in demographic characteristics using comparative statistics (*t*-tests, χ^2). Shapiro–Wilk tests for normality were used where required. Differences between the video and VR cohorts in the self-reported measures of DAS, DKAS and POPAC were compared using independent sample *t*-tests prior to the training experience, and again post-training. Paired *t*-tests were used to compare within-subject changes in DAS, DKAS and POPAC before and after the training experiences. Due to the moment-by-moment nature of psychophysiological data, average fEMG responses were computed for the simulation of a good versus bad environment at the five areas of interest (AOIs) and the full experience. Two-by-two mixed-design ANOVAs were used to examine the effects of format (VR vs. video) and design (i'dementia-friendly' vs. 'dementia-unfriendly') on the respondents' positive emotional responses. Violation of sphericity was tested with Mauchly's sphericity test. Any significant results from the ANOVAs were followed up by a *t*-test with Bonferroni correction. A *p*-value of <.05 was used in all analyses as the threshold for significance. All analyses were conducted in SPSS Version 27 (IBM Corporation, Armonk, USA).

3 | RESULTS

3.1 | Participant demographics

A total of 22 participants were recruited for the study, with the majority being registered nurses. Their general demographics are presented in Table 1. No significant differences in any of the demographic measures were identified, and few had any experience with dementia-related VR training.

3.2 | Self-reported measures

The results of the self-reported measures of dementia knowledge and attitudes are presented in Tables 2 and 3. Prior to the training, the VR group scored higher in the *Evidence* domain of the POPAC than the video group, with this difference resolving posttraining (Table 2). Minor negative changes in the VR group POPAC scores

TABLE 1 Participant demographics.

Parameter	Group[a] VR ($n=10$)	Video ($n=12$)	Total ($n=22$)	Analysis
Sex				
Female	10 (100)	9 (75)	19 (86)	$\chi^2=2.89$, df=1, $p=.22$
Male	0 (0)	3 (25)	3 (14)	
Age (years; mean ± SD)	51.5 (10.4)	46.7 (11.9)	48.9 (11.3)	$t=.98$, df=20, $p=.34$
Nursing qualification				
Enrolled Nurse (EN)	2 (20)	1 (8)	3 (14)	$\chi^2=.63$, df=1, $p=.43$
Registered Nurse (RN)	8 (80)	11 (92)	19 (86)	
Years' experience in RACF				
Less than 5 years	1 (10)	0 (0)	1 (5)	
Between 5 and 10 years	4 (40)	8 (67)	12 (55)	
Between 11 and 15 years	1 (10)	1 (8)	2 (9)	
Between 16 and 20 years	2 (20)	1 (8)	3 (14)	
More than 21 years	2 (20)	2 (17)	4 (18)	
Average weekly working hours				
Less than 8 h	0 (0)	1 (8)	1 (5)	
Between 26 and 30 h	3 (30)	4 (33)	7 (32)	
More than 31 h	7 (70)	7 (58)	14 (64)	
Personal experience of dementia				
No	5 (50)	7 (58)	12 (55)	$\chi^2=.15$, df=1, $p=.70$
Yes	5 (50)	5 (42)	10 (46)	
Previous VR training in dementia				
No	8 (80)	11 (92)	19 (86)	$\chi^2=.43$, df=1, $p=.57$
Yes	2 (20)	1 (8)	3 (14)	

[a]Number (% of column) unless otherwise stated.

were identified in the *Assessments*, *Evidence* and *Total* domains, whereas there were no differences in any domain of the POPAC in the video group. In contrast, a significant improvement in the mean DKAS score was identified in the video group, which was due to increased knowledge of *Risks and health promotion*. Table 4 presents the results of the participants' subjective assessments of the two different training modalities. There was no difference between the VR and video conditions in any of the domains of the SAM or UES, nor overall.

3.3 | Psychophysiological measures

The results of the psychophysiological testing are shown in Table 5. Of the planned five AOIs, data for only three were available for analysis as few of the VR participants progressed beyond AOI3 in the allotted time. Overall, there was a significant effect of training format on emotional response, whereby the VR condition evoked significantly higher positive and negative emotional responses than the video condition. Regarding the individual AOIs, the VR condition evoked significantly greater negative emotional responses in all three AOIs when compared to the video condition. There were no significant differences in positive emotional responses in any of the individual AOIs.

3.4 | Summary

The key findings of the study are as follows:

- At baseline, participants' demographics were well-matched. The cohort had limited VR-based dementia training exposure, and their knowledge of and attitudes towards dementia were similar.
- The participants' self-ratings of their engagement and emotional state in the two experimental conditions were similar.
- The VR evoked objectively greater positive and negative emotional responses than the video.

TABLE 2 Differences between participant groups in DAS, POPAC and DKAS scores, before and after the training experiences (independent samples *t*-tests).

Scale / Domain	Pretraining Score (mean ± SD) VR (n = 10)	Pretraining Score (mean ± SD) Video (n = 12)	Pretraining Analysis	Posttraining Score (mean ± SD) VR (n = 10)	Posttraining Score (mean ± SD) Video (n = 12)	Posttraining Analysis
DAS						
Comfort	61.1 ± 4.3	59.4 ± 8.3	$t=3.63$, df = 20, $p=.57$	59.4 ± 5.9	61.8 ± 3.4	$t=1.18$, df = 20, $p=.25$
Knowledge	64.9 ± 4.0	64.5 ± 10.6	$t=1.16$, df = 20, $p=.91$	65.6 ± 4.8	68.3 ± 2.2	$t=1.76$, df = 20, $p=.09$
Total	126.0 ± 7.6	123.9 ± 18.0	$t=1.83$, df = 20, $p=.19$	125.0 ± 10.3	130.1 ± 4.8	$t=1.52$, df = 20, $p=.14$
POPAC						
Assessments	12.6 ± 1.6	12.3 ± 2.5	$t=1.42$, df = 20, $p=.70$	11.4 ± 1.6	12.0 ± 2.7	$t=-.62$, df = 20, $p=.54$
Evidence	5.6 ± 2.2	3.9 ± 1.2	$t=2.28$, df = 20, $p=.03$	4.9 ± 1.7	4.2 ± 2.0	$t=.91$, df = 20, $p=.37$
Individualising	12.7 ± 4.1	11.0 ± 3.2	$t=1.09$, df = 20, $p=.29$	12.1 ± 4.8	11.3 ± 3.4	$t=.48$, df = 20, $p=.63$
Total	30.9 ± 6.9	27.2 ± 6.2	$t=1.34$, df = 20, $p=.20$	28.4 ± 6.9	27.4 ± 7.4	$t=.32$, df = 20, $p=.75$
DKAS						
Care considerations	7.9 ± 2.2	8.3 ± 2.6	$t=-.41$, df = 20, $p=.68$	8.4 ± 2.2	8.1 ± 2.7	$t=.30$, df = 20, $p=.77$
Causes and characteristics	10.3 ± 2.6	9.3 ± 3.6	$t=.77$, df = 20, $p=.45$	9.0 ± 3.7	9.3 ± 3.4	$t=-.16$, df = 20, $p=.87$
Communication and behaviour	8.9 ± 2.2	8.9 ± 2.5	$t=-.02$, df = 20, $p=.99$	8.9 ± 2.8	9.8 ± 2.5	$t=-.75$, df = 20, $p=.46$
Risks and health promotion	6.4 ± 3.4	5.8 ± 2.8	$t=.49$, df = 20, $p=.63$	7.1 ± 3.0	7.4 ± 2.9	$t=-.25$, df = 20, $p=.81$
Total	33.5 ± 9.6	32.3 ± 9.7	$t=.30$, df = 20, $p=.77$	33.4 ± 10.6	34.5 ± 9.1	$t=-.26$, df = 20, $p=.80$

- Despite this, there was little change in the VR group's knowledge of, and attitudes towards, dementia. In contrast, the video group's knowledge of dementia improved

4 | DISCUSSION

This study examined how the VR application 'Meaningful Spaces' impacts experienced nurses' knowledge and attitudes towards people living with dementia compared to a traditional non-immersive training video. The findings suggest that, whilst VR may elicit objectively stronger emotional responses than video, it is not superior to video in changing dementia knowledge and attitudes in this cohort.

Virtual reality elicited objectively stronger emotional responses than the video condition as measured by psychophysiological means. Previous studies have also reported VR to be more engaging than traditional training methods. For example, Thompson et al.[22] investigated the use of VR in undergraduate nursing student workshops in anatomy, physiology and health assessment. In their study, the students self-rated their engagement with VR to be greater than traditional teaching methods.

Our study's finding that VR was not more effective than the video in developing knowledge is not without precedent. In a similar study design, Stargatt et al.[23] compared the effectiveness of a dementia-specific VR application for non-health-care professional dementia carers against still images and video outcomes. In that study, VR was more effective than still images and video in developing empathy in older participants, but not younger ones. Grassini et al.[24] compared the outcomes of training students in procedural skills with VR to an instructional video. They identified no differences between students trained with video and those trained with VR. Chen et al.[25] meta-analysed 12 studies that investigated the effectiveness of VR in nursing education in the areas of knowledge, skills, satisfaction, confidence and performance time. They concluded that VR may improve knowledge when used in nursing education but is not more effective than other education methods in areas of skills, satisfaction, confidence and performance time. These findings are consistent with criticisms of 'evangelical' approaches to VR in education discussed by Bender and Broderick.[15]

Whilst the VR was more emotionally engaging than the video in the current study, it was not more effective at improving dementia knowledge and attitudes. The extensive experience of the study participants might have attenuated the impact of the training because, as volunteers,

TABLE 3 Differences within participant groups in DAS, POPAC and DKAS scores, before and after the training experiences (paired *t*-tests).

Scale	VR group ($n=10$)			Video group ($n=12$)		
Domain	Mean difference	95% CI	Analysis	Mean difference	95% CI	Analysis
DAS						
Comfort	1.0	−4.6, 6.6	$t=.40$, df=9, $p=.70$	−6.2	−15.8, 3.5	$t=1.41$, df=11, $p=.19$
Knowledge	1.7	−2.3, 5.7	$t=.97$, df=9, $p=.36$	−2.3	−6.6, 1.9	$t=1.20$, df=11, $p=.26$
Total	−.7	−2.6, 1.2	$t=.84$, df=9, $p=.42$	−3.8	−9.7, 2.0	$t=1.45$, df=11, $p=.18$
POPAC						
Assessments	1.2	.4, 2.0	$t=3.34$, df=9, $p=.009$	.3	−.4, .9	$t=.90$, df=11, $p=.39$
Evidence	.7	.2, 1.2	$t=3.28$, df=9, $p=.01$	−.3	−.9, .4	$t=-.90$, df=11, $p=.39$
Individualising	.6	−.8, 2.0	$t=1.00$, df=9, $p=.34$	−.3	−.9, .4	$t=-.82$, df=11, $p=.43$
Total	2.5	.9, 4.1	$t=3.64$, df=9, $p=.005$	−.3	−1.5, 1.0	$t=-.45$, df=11, $p=.66$
DKAS						
Care considerations	−.5	−1.6, .6	$t=-1.05$, df=9, $p=.32$	.3	−.1, .6	$t=1.39$, df=11, $p=.19$
Causes and characteristics	1.3	−.9, 3.5	$t=1.31$, df=9, $p=.22$	.0	−1.0, 1.0	$t=.000$, df=11, $p>.99$
Communication and behaviour	.0	−1.4, 1.4	$t=.000$, df=9, $p>.99$	−.8	−2.3, .6	$t=-1.24$, df=11, $p=.24$
Risks and health promotion	−.7	−1.9, .5	$t=-1.30$, df=9, $p=.23$	−1.7	−2.6, −.7	$t=-3.85$, df=11, $p=.003$
Total	.1	−3.3, 3.5	$t=.07$, df=9, $p=.95$	−2.3	−4.4, −.1	$t=-2.26$, df=11, $p=.045$

TABLE 4 Differences between participant groups in assessments of the training experiences using SAM and UES (independent samples *t*-tests).

Scale	Score (mean ± SD)		
Domain	VR ($n=10$)	Video ($n=12$)	Analysis
SAM			
Valence	6.2 ± 1.0	5.4 ± 2.2	$t=1.02$, df=20, $p=.32$
Arousal	5.9 ± .7	5.8 ± 1.4	$t=.13$, df=20, $p=.89$
Dominance	4.4 ± 1.6	4.0 ± 1.9	$t=.53$, df=20, $p=.60$
UES			
Endurability	4.7 ± .6	4.9 ± .2	$t=-1.05$, df=20, $p=.31$
Focused attention	4.4 ± .4	4.2 ± .7	$t=.95$, df=20, $p=.35$
Novelty	4.4 ± .9	4.7 ± .4	$t=-.97$, df=20, $p=.34$
Perceived usability	3.5 ± .8	3.7 ± .7	$t=-.57$, df=20, $p=.57$
Total	4.2 ± .5	4.3 ± .5	$t=-.32$, df=20, $p=.75$

they likely had a preexisting interest in delivering high-quality dementia care. Evidence of this are their relatively high baseline scores for knowledge of, and attitudes towards, dementia care. Were participants less experienced in dementia care, greater effects might have been observed in the VR group, as seen in previous studies. Sari et al.[26] reported that a VR educational program positively influenced attitudes towards dementia and a sense of community amongst community members. Similarly, Wijma et al.[27] reported that a VR application significantly improved empathy, confidence and positive interactions among informal caregivers for persons with dementia. The participants in these earlier studies likely had less understanding or experience of dementia than those in the current study, resulting in a more profound training effect in the earlier studies.

The findings of this study raise important questions as to the value of VR in dementia training. Virtual reality's hardware and software requirements increase its cost and complexity compared to traditional training techniques. The equivocal outcomes in this study suggest that VR does not provide greater benefits than more accessible training

TABLE 5 Positive and negative emotions, as measured by fEMG, towards the design and format of the individual AOIs and training experiences overall. Statistical analyses are two-by-two mixed-design ANOVA tests.

	AIO1			AIO2			AIO3			Overall		
	Mean fEMG, mV (±SD)			Mean fEMG, mV (±SD)			Mean fEMG, mV (±SD)			Mean fEMG, mV (±SD)		
	VR	Video	VR vs. video	VR	Video	VR vs. video	VR	Video	VR vs. video	VR	Video	VR vs. video
Positive emotion (zygomatic muscle)												
Disabling design	.0055 (.0023)	.0042 (.0024)	$F(1,20)=1.73$, $p=.20$	.0102 (.0083)	.0042 (.0021)	$F(1,20)=3.38$, $p=.08$	.0089 (.0057)	.0067 (.0065)	$F(1,20)=1.00$, $p=.33$	.0121 (.0079)	.0045 (.0019)	$F(1,20)=8.70$, $p=.008$
Enabling design	.0053 (.0020)	.0044 (.0024)		.0062 (.0030)	.0061 (.0035)		.0064 (.0020)	.0053 (.0022)		.01155 (.0085)	.0051 (.0023)	
Negative emotion (eyebrow)												
Disabling design	.01190 (.0060)	.0071 (.0047)	$F(1,20)=5.75$, $p=.03$	.01444 (.0047)	.0070 (.0045)	$F(1,20)=11,38$, $p=.003$	.0223 (.0102)	.0087 (.0048)	$F(1,20)=13.54$, $p=.002$	.0182 (.0077)	.0077 (.0048)	$F(1,20)=18.40$, $p<.001$
Enabling design	.01358 (.0092)	.0069 (.0031)		.0147 (.0105)	.0066 (.0036)		.0161 (.0101)	.0070 (.0038)		.0163 (.0075)	.0111 (.0072)	

methods. However, as this study only involved highly experienced practitioners, it does not provide evidence that VR should be wholly abandoned in dementia care training. Our results indicate that there is a need to identify areas where VR is superior to other training so that valuable resources are not potentially wasted on unnecessarily complex VR training. There is emerging evidence that characteristics such as age and language background influence the effectiveness of dementia-related training using VR.[23] Hence, one avenue for future research is to investigate the optimal time to utilise VR in the career path of nurses who will provide dementia care.

There are several limitations to this study. First, the sample size is small, and participants were recruited from a geographically isolated area, so the results may not represent those of nursing staff in other areas of Australia and the world. Second, the study only evaluated the effect of the training upon the participants' knowledge and attitudes, and not their care provision or other important influences on care such as empathy. Similarly, no qualitative assessment was conducted, so participants' perceptions of the training may not be fully captured. The study did not explore effects of training on individuals with dementia cared for by the participants or evaluate the training's long-term impact on practice. In addition, it is not known whether the VR environment provides a realistic translation of practice.

Despite the limitations, this study provides important insight into the use of the *Meaningful Spaces* VR app in training nurses to provide dementia care. Future research should focus on leveraging the app's emotional engagement with highly experienced dementia care practitioners, to better equip Australia's nursing workforce to care for the increasing number of people living with dementia.

5 | CONCLUSIONS

There is a strong interest in using VR applications to enhance dementia care through workforce training. For many learners, VR may not be superior to traditional training techniques, and further research is required to identify when to use VR most effectively when training nurses who provide care for people living with dementia.

ACKNOWLEDGEMENTS

The involvement of Dementia Training Australia in facilitating this research is acknowledged with gratitude. Dementia Training Australia is supported by the Australian Government. Open access publishing facilitated by Curtin University, as part of the John Wiley & Sons Australia Ltd; Curtin University agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

A Stafford is a former Director of Dementia Training Australia. No other author has any relevant financial or non-financial interests to disclose.

DATA AVAILABILITY STATEMENT

The datasets generated during and/or analysed during this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Stafford A, Bender S, Parsons K, Sung B. Evaluating a virtual reality dementia training experience using psychophysiological methods: A randomised controlled study. *Australas J Ageing*. 2024;43:523-532. doi:10.1111/ajag.13294