

Integrating VR technology in reminiscence therapy for dementia patients

A systematic literature review to assess effects of VR on cognition and well-being

Steklov, C., Master program positive psychology and technology

Master Thesis

University of Twente

Student Number: 2704102

Gerben Westerhof

Alexandra Ghita

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

2

## Abstract

The following work deals with virtual reality in the context of reminiscence interventions on patients with dementia and related diseases. Due to the aging population, the treatment of dementia in the context of memory techniques is of increasing importance. Ten studies were included to answer the following research questions: Which different kinds of VR technologies were used in reminiscence interventions in for patients with dementia and related diseases? How was reminiscence incorporated in the VR technologies? Which outcomes of VR usage for reminiscence interventions were reported on cognition? And which outcomes of VR usage for reminiscence interventions were reported on well-being? To answer the research questions, a systematic literature review was exploited to be able to draw a more general statement about the use of virtual reality technologies for reminiscence interventions in dementia therapy. Overall, the selection process resulted in ten studies being included for the final review. Overall, the VRHEAT (virtual reality training system), VR images, VR environments (a forest included), and a VR navigation system were the instruments used in the studies. The current studies show a variety of different techniques for integrating reminiscence elements in VR technology interventions, thereby also shaping the path for future research. Interventions carried out using VR can prove to be very effective in stabilizing and training cognitive abilities in persons with incipient or mild dementia. Virtual reality techniques such as panorama pictures, entire virtual environments and cognitive training systems achieve a mostly desirable effect in cognition and wellbeing. Nevertheless, the samples were small and had limits, like their geographical scope or cultural background. There is a need for further research in this field to educate more about the topic as it becomes more relevant soon.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

3

Integrating VR technology in reminiscence therapy for dementia patients

A systematic literature review to assess effects of VR on cognition and well-being

## Introduction

The global life expectancy has increased steadily in the recent decades and is expected to further increase until 2100, which results in a growing number of older people in global society<sup>1</sup>. Global statistics indicate that in 2020, over 55 million people worldwide are living with age-related diseases, such as dementia (Alzheimer's Disease International, 2021). Dementia, a disease that often occurs at an older age, thus plays an important role in the society, as well as in healthcare (Höfler et al., 2015).

In 2015, the global estimated cost of dementia was about 818 US\$, in 2021 it is over 1.3 trillion US\$ and by 2050 it is expected to rise up to 2.8 trillion US\$ (Alzheimer's Disease International, 2021). By 2030, there will be 78 million and by year 2050, around 139 million people will suffer from dementia. In total, over 10 million people worldwide develop new cases of dementia each year. This corresponds to the statement that someone develops dementia every three second and the trend is rising (Alzheimer's Disease International, 2021). These statistics highlight the relevance of interdisciplinary research to counteract the challenges of the aging generation suffering from dementia. It is therefore necessary to examine intervention strategies which aim to find a way to facilitate the life of this target group. One promising approach towards this goal are advanced methods which work within the framework of reminiscence:

---

<sup>1</sup> <https://www.statista.com/statistics/673420/projected-global-life-expectancy/>

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

4

Since the late 1970s, reminiscence therapy plays a role as an intervention option for dementia patients, after it was identified as beneficial for mental health of older adults in the 1960s (Woods, 2018; Butler, 1963). Beginning as a simple form as pure conversation therapy with tangible clues about past experiences, a digital shift in reminiscence therapy has now taken hold, opening new possibilities for the field (Subramaniam, 2010; Woods, 2018). One of these digital shifts includes the integration of virtual reality within reminiscence therapy (Chapoulie, 2014). To examine, to which extents this approach shows promising results for dementia care, particularly in light of cognitive and well-being impact, this literature review focuses on virtual reality as part of reminiscence interventions. A recent systematic review shows that reminiscence interventions in general have a positive effect on people suffering from dementia concerning cognitive measures and mood (Woods et. Al., 2018). Reminiscence interventions are therefore promising regarding to cognition and communication.

Digitally based interventions as one way to implement reminiscence therapy have started in the recent decade and showed promising results (Lazar, 2014). This literature review will therefore focus on the impact of virtual reality (VR) as specific type of technology within reminiscence interventions on relevant outcomes of dementia therapy, i.e. cognition and well-being. The importance of virtual reality in the healthcare sector has increased significantly in recent years and might be a solution for various medical issues (Keswani et al., 2020). Considering VR as increasingly relevant for healthcare interventions and taking into account the promising results of technology-based reminiscence intervention (Lazar, 2014), this review will shed light on an overall evaluation of VR based reminiscence interventions.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

5

First, theoretical background of dementia, VR and reminiscence interventions will be given. Afterwards, scope, criteria and method of the systematic review will be discussed. Further, the studies included in the review will be summarized and discussed shortly to give an overview over the current state of research on virtual reality usage in dementia therapy, using reminiscence interventions. The main objective was to give an overview on all the studies which used virtual reality as reminiscence intervention for dementia and to thus identify and interpret patterns in research of this field.

## **Dementia**

Dementia derives from the Latin term "demens", which is understood to mean "without mind" or "without spirit" (Krämer & Förstl, 2008). If the term is translated literally, it is understood to mean the loss of cognitive abilities (Matolycz, 2016). Many different definitions can be found for the term dementia. For this paper, the definition of ICD-10, the Systematic Index of International Statistical Classification of Diseases and Related Health Problems (2018) will be used. According to the ICD-10 (2018): "Dementia (F00-F03) is a syndrome due to disease of the brain, usually of a chronic or progressive nature, in which there is disturbance of multiple higher cortical functions, including memory, thinking, orientation, comprehension, calculation, learning capacity, language, and judgement. Consciousness is not clouded. The impairments of cognitive function are commonly accompanied, and occasionally preceded, by deterioration in emotional control, social behavior, or motivation. This syndrome occurs in Alzheimer disease, in cerebrovascular disease, and in other conditions primarily or secondarily affecting the brain." Dementia manifests itself not only through one specific symptom, rather

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

6

there are various disturbances in the areas of orientation, psyche, behaviour or physical functions. Depending on the type of symptoms and at what time they occur, it can be diagnosed which form of dementia it is (Kastner & Löbach, 2018). Dementia symptoms are divided into three main groups:

1. Cognitive symptoms: These include memory and orientation disorders as well as attention, speech and movement disorders.
2. Behavioral changes: These may manifest themselves, for example, in apathy, delusions, or misperceptions. In addition, they are characterized by wandering, shouting/ screaming, aggressiveness or reduced drive. Closely related are also mental disorders such as suicidal tendencies, anxiety, confusion, hallucinations and delusions of theft.
3. Physical Symptoms are according to Kastner & Löbach (2018) sleep disturbance, any type of mobility limitation, swallowing and eating disorders, incontinence and sensitivity disorders.

These core features of dementia focusing on cognitive and functioning deficits can be extended through psychological symptoms of dementia, which reflect heterogenous non-cognitive symptoms, including disturbances in emotional experience and resulting declines in well-being (Cerejeira et al., 2012). As the ICD-10 (2018) definition already briefly explains, dementia is divided into a primary and secondary form. The primary dementing disease, also called brain-organic dementia, results from changes directly in the brain.

The primary forms of dementia include Alzheimer's disease, vascular dementia, Lewy-Body dementia, frontotemporal dementia, and neurological disease (Kastner & Löbach, 2018). In difference to secondary dementia, the cause of the disease is triggered by medication or external

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

7

influencing factors such as metabolic diseases, symptoms of poisoning due to drug abuse, vitamin deficiencies or even depression (Engdahl, S., 2013). The most common form of dementia is the Alzheimer's disease (60-80%), which is mainly manifested by loss of mental abilities. These can negatively affect activities of daily living (Alzheimer Society, 2018; Krämer & Förstl, 2008).

Beyond dementia, one preliminary stage of dementia is the syndrome of mild cognitive impairment, which will also be considered for this work: „Mild cognitive impairment is a syndrome defined as cognitive decline greater than expected for an individual's age and education level but that does not interfere notably with activities of daily life.” (The Lancet et al., 2006, p. 1262-1270). In contrast to dementia patients, however, their independent lifestyle is not impaired. Studies have shown that around 10 to 20 percent of those suffering from MCI develop dementia within a year, but often the disorder remains unchanged or even regresses. Most commonly, mild cognitive impairment is associated with gradual memory problems, sometimes with difficulty performing more complex everyday tasks, such as planning a trip or filling out a form. The causes of the disorder can vary widely. In some cases, it occurs as a result of a brain injury or another illness, such as depression. Emotional crises, stressful situations or medication can also cause a mild cognitive disorder (Peterson RC, 2003).

The treatment approach for both dementia related diseases and MCI include pharmacotherapy and psycho-social interventions. These include, for example, physicians, qualified nursing staff physiotherapy, occupational therapy, speech therapy, music therapy or psychotherapy. (Garcia-Betances et al., 2014). As a systematic review by McLaren et al. (2013) shows, non-pharmacological interventions have a positive effect on physical functions, among

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

8

other things, and admission to a nursing institution can also be postponed. The author also describes that this type of therapy has proven to be particularly effective in the prevention of dementia and related diseases and improving quality of life. Moreover, the National Institute for Health and Care Excellence (NICE, 2013) consider a group reminiscence session for people living with mild to moderate dementia as an effective intervention regarding wellbeing.

## **Reminiscence, interventions and technologies**

Reminiscence is a form of therapy that was first defined and introduced by Butler (1963) and focuses on the process of remembering. With the help of multiple elements, memories of patients are to be stimulated, thus fulfilling social, instrumental, and interactive functions (Woods, 2018, Tominari 2021). Following Erikson and Butler, reminiscence is similar to life-review therapy and has the idea that while telling others about past events and reflecting on them, positive feelings are enhanced (Butler, R.N., 1963, p. 60-75). Reminiscence interventions in health care sector have the aim to improve the quality of life, social relations, mood and cognitions by finding meanings in memories (Woods, 2018). It is defined as the process in which patients think or explain to somebody their past experiences which were personally remarkable and important. Those memories are then processed in an organized way, focusing on significant life events. Reminiscing activities contain a number of different forms, such as autobiographical storytelling (simple reminiscence), discussions and songs about meaningful topics in the past (Woods, 2018). It is not only useful for dementia patients, moreover it includes therapists, family members and also carers.



# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

9

Recently, there have been advances in using technological tools for reminiscence interventions (Lazar, 2014; Horwitz, S., 2021). Technological interventions in general are characterized by the use of information and communication technologies (ICT), which have developed by the time as technology in general has improved as well. These can be clearly differentiated to traditional reminiscence interventions, which, in contrast to that, work with paper books or pictorial memories (Lazar et al., 2014). When considering technological interventions for reminiscence, particular care has to be taken whether such multimedia-based materials, such as cameras, GPS or graphic monitors are accessible to the patients (Lazar et al., 2014). In addition, technologies in reminiscence offer new opportunities to include persons who would be excluded from classic reminiscence due to physical disabilities. For example, people with walking disabilities can still be enabled to "move around" in a virtual reality without leaving their wheelchairs. The environment is thus perceived more actively and vividly. The authors also identify tools such as the use of video recorders that can relieve staff and save time in explanation and delivering the intervention. This in turn is an advantage that promotes efficiency (Lazar et al., 2014).

One type of technological interventions which has gained relevance in recent years is the use of virtual reality for reminiscence interventions (Garcia-Betances et al., 2015). According to the authors, the use of virtual reality reminiscence improves confidence, self-esteem and engagement by stimulating mental activity. VR as an active experience is able to reproduce content we already have in our memory store (Garcia-Betances et al., 2015). Virtual reality (VR) is a computer-generated reality, which includes several sensory inputs, for example visual,

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

10

auditory or haptic. VR is defined through the three I's, which stand for immersion, interaction and imagination.

A first characteristic of VR is immersion, which mainly refers as stimulation of different senses through VR, while the second is interaction and describes the real-time reaction of a VR system and imagination is the given possibility to perceive things that exist only within the virtual environment (Sheridan, 2000; Burdea & Coiffet, 2003). Immersive technologies like VR can through these features create remarkable experiences by integrating the physical world with a digital or simulated reality (Garcia- Betances et al., 2015).

VR is transmitted via large screens, in special rooms (Cave Automatic Virtual Environment, CAVE for short) or via a head-mounted display (video or VR glasses). The degree of immersion can vary within different types of VR, including three different types of immersion: non-immersive, semi-immersive and full immersion. In the non-immersive system, the user interacts with the virtual environment using an environment with the aid of a PC monitor, keyboard, mouse, or joystick. Semi-immersive virtual reality consists of better graphics and larger flat screens. In full immersion, one is surrounded with projection screens like 3D screens or 3D head-mounted displays. This makes it possible for the subject to fully interact with the virtual environment (Garcia- Betances et al., 2015).

With the help of VR, it is possible for people to make use of the third characteristic, which is interaction with the virtual world. Various activities, tasks and tests can be carried out in the virtual environment. Furthermore, VR can be tailored to the different needs of the person (Garcia-Betances et al., 2015). A virtual world simulation system consists of the following components: a graphics rendering system, software, and a special input and output tool (Raggi et

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

11

al., 2017). Depending on the type of virtual environment, a distinction can be made between allocentric and egocentric perception (Garcia-Betances et al., 2015): the former constructs representations through subject-to-object relations, where the reference frame is self-centered, while the latter is defined by object-to-object relations where locations are represented independently of the individual (Serino et. al., 2014).

Through the level of stimulation or the device, the level of interaction can be determined. Devices that are nowadays often used to interact with the virtual environment, such as joysticks, gloves or specially designed surfaces. The tools already mentioned are used in the analysis of the selected studies and are therefore of high importance. These characteristics of virtual reality make it a promising tool for reminiscence interventions in dementia because it can give a vivid and more profound meaning to an old experience. Therefore, this work aims to examine whether and in which forms the virtual reality technologies prove to be effective in dementia therapy, particularly for reminiscence interventions.

## **Research goal and research question**

Recently, studies have repeatedly examined the effect and relevance of VR for interventions in dementia health care (Garcia-Betances et al., 2014; 2015, Coyle et al., 2015; Appel et al, 2021). These studies demonstrate the advantages of virtual reality for dementia mainly through the possibility to bring imaginary memories vividly. The literature review by Garcia-Betances et al. (2014) addressed the questions of how virtual reality affects elderly and how it can help family members and health care professionals to improve the quality of life in mild cognitive impairment and dementia. Critically, they found how most virtual reality

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

12

technologies used in dementia are not state of the art, thereby missing sufficient immersion and/or interaction levels. Moreover, according to the authors, although the tools were technologically advanced, they were not adapted to the appropriate target group in terms of their usability. Another systematic review by Garcia-Betances et al. (2015) looked at the different types of virtual reality and their potential for use on patients with Alzheimer's disease as an assessment tool for diagnostic purposes and cognitive training. The study included virtual reality applications like head-mounted displays and 3D smart TV technologies. The result was that most of the instruments were not able to take full advantage on the target group yet.

Referring to the outcomes, Coyle, Traynor & Solowij (2015) placed a focus on cognition in relation to virtual reality therapy of dementia on patients with dementia, MCI and Alzheimer disease: The systematic review looked at the effects of virtual reality cognitive training on individuals with mild cognitive impairment and dementia and reported some positive no-ion on how virtual reality combined with computerized cognitive training can be a promising approach regarding cognitive decline. The authors found positive effects in cognitions and wellbeing. Appel et al. (2021) focused mainly on well-being as outcome in their scoping review method for VR interventions for patients with dementia. They reported mostly positive results of VR on emotional outcomes, social and functional aspects of well-being, overall demonstrating the effectiveness of this intervention type.

However, no review could be found that included different forms of virtual reality in context of reminiscence interventions, which narrows the scope of the search. In addition, the studies make a reference to cognitive functioning and memory, however, there is not yet a clear reference to reminiscence as an intervention itself. Therefore, in my work I will focus on whether

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

13

and in which forms virtual reality technologies are promising for reminiscence interventions as a specific type of dementia therapy. To reach an overall evaluation of VR technology usage for reminiscence intervention in dementia, I will conduct a systematic literature review, which aims to provide an overview of studies implementing these types of interventions for individuals diagnosed with dementia. The focus lies on the relation of virtual reality and reminiscence, and effects of interventions on both cognition and well-being in dementia patients. This results in four main research questions:

- Which different kinds of VR technologies were used in reminiscence interventions in for patients with dementia and related diseases?
- How was reminiscence incorporated in the VR technologies?
- Which outcomes of VR usage for reminiscence interventions were reported on cognition?
- Which outcomes of VR usage for reminiscence interventions were reported on well-being?

These research questions will be answered through a systematic review, to aim at a general statement resulting from the sum of previous studies identified. Furthermore, this systematic review did not only focus on the effects on cognition, but also on the effects on mood and well-being. According to Woods, both outcomes are important to reminiscence interventions and should be evaluated in further studies (Woods, 2018).

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

14

## Method

To answer the research questions, a systematic literature review was exploited to be able to draw a more general statement about the use of virtual reality technologies for reminiscence interventions in dementia therapy.

### Literature review

For the literature review, keywords were identified and defined to start the literature search in the databases Google Scholar, PubMed and PsychInfo. PsychInfo as a disciplinary, psychological data base is particularly good at recognizing abstracts. The Pubmed search mask is also suitable for clinical questions (based on methodological search filters) and offers a medical-specific focus, whereas Google Scholar provides more general comprehensive information. The following keywords and their related concepts were defined and used in the search masks: 'virtual reality'; 'reminiscence'; 'reminiscence interventions'; 'Mild cognitive impairment'; 'Dementia' and 'Alzheimer disease'. The first three keywords were always combined with one of the different target groups, whereas dementia was more general and MCI and Alzheimer disease a more specific search. In the review, only articles published in peer-reviewed journals in English language were included. In addition, studies from 2011 to the present were used to identify progress and keep them as up-to-date as possible. Additionally, the relevance and scope of the research question, thereby focus on reminiscence interventions for dementia patients, and usage of VR, were checked. This analysis was guided by the PICO framework, and only articles were selected that addressed and included all of the following criteria:

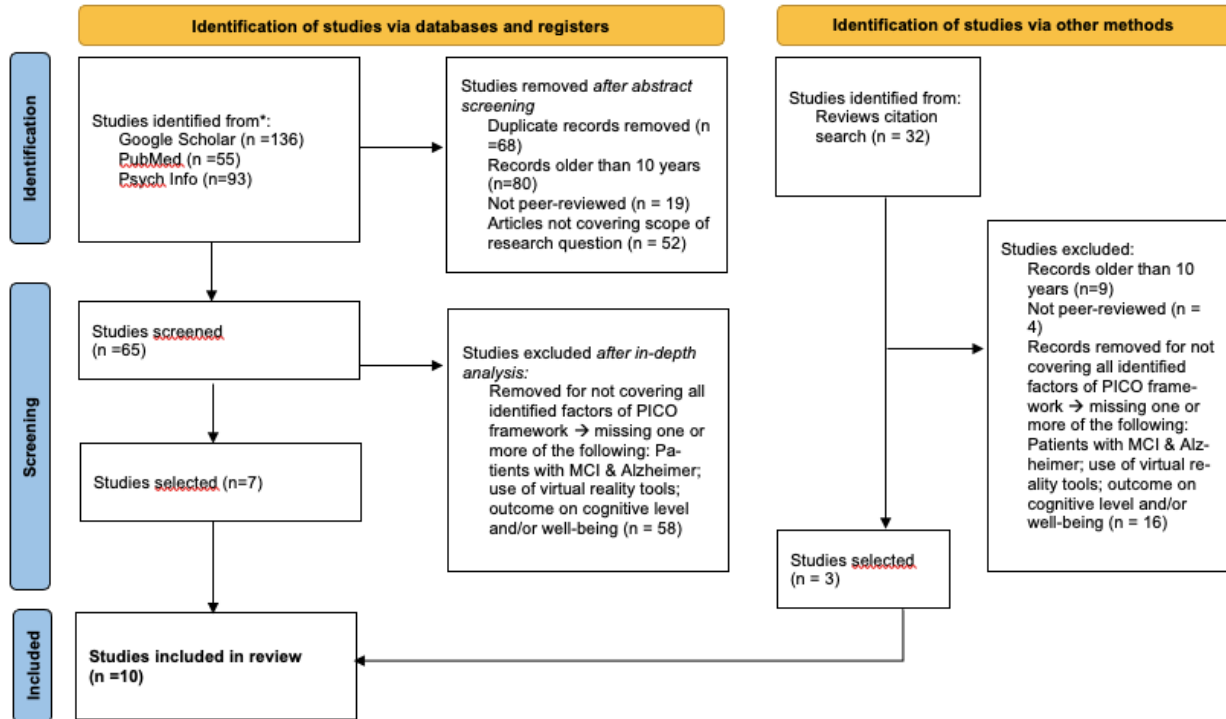
# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

15

- Patient/ Problem: The patient suffers from MCI as well as Dementia (Alzheimer's disease included).
- Intervention: The use of virtual reality tools regarding to reminiscence technologies.
- Comparison: Several types of studies were included, also those without comparison groups. This aims at depicting a broader picture of research state of the art and allows inclusion of different method types.
- Outcome: The outcome concentrates on cognitive effects as well as well-being. This includes studies with either one or both of the outcomes.

For research setting, different age groups, and all types of qualitative and quantitative studies were considered valuable. These defined criteria led to an exclusion of studies which were older than 10 years, which were not published in peer reviewed articles and/or did not cover all identified factors of the PICO framework. The method and data extraction of this systematic review are based on the PRISMA approach (Page et al., 2021). Building on this approach, a graphic was constructed which includes all the details of my systematic search process, comprising exclusion criteria. The aim was to focus on studies which used virtual reality in the context of reminiscence interventions and in which cognition and wellbeing are measured as an outcome. The data extraction process is depicted in the PRISMA graphic in Figure 1.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS



A first screening involved checking titles and publication details of studies found in the different databases. A high number of resulting articles (n=284) led to the examination of the articles in closer way regarding their outcome and their empirical relevance about reminiscence. Particular care was taken to only consider articles which matched the pre-defined selection criteria as described above. This led to n=65 articles which were screened deeper and sorted out, if they were not covering one or more of the identified content factors, defined through the PICO framework. As a second source of literature, other cited reviews identified in the process were furthermore sighted analyzed and filtered (n=32) along our inclusion criteria for more relevant references. Those identified as matching to the scope of our review were again screened in more depth. Overall, the selection process resulted in ten studies being included for the final review. After a critical review, the data of the selected studies were extracted according to their year



# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

17

(2014-2021), authors, location, design, data collection, and outcome and summarized in a table below. It classifies studies along their sample (including sample size), methodology employed, type of instruments and outcomes considered.

## Results

Based on the review and its goals, ten international studies were included: One study was from Korea (Moon, Choi & Lee, 2014), one from United Kingdom (Ang, C.S., 2014), one from France (Manera et al., 2016), one from Australia (Moyle et al., 2016), one from Canada (White & Moussavi, 2016), one from Portugal (Coelho et al., 2020), two from Japan (Tominari, M. et al., 2020; Kazuyuki, N. et. al., 2021), one from China (Xu, Y. Wang, B., 2020) and one from Pakistan (Riaz et al., 2021). Among the studies, there are four pilot studies, one of them is a mixed-method pilot study. Furthermore, there is one feasibility study, one mixed-method study and three randomized controlled trial as well as one crossover study.

The following Table 1 is aiming to give a short overview on the selected studies and their details, with studies being sorted by year of publication. The table aims to structure which samples were considered with-in the studies, including sample size and respective dementia diagnoses. Additionally, type of technology used, and methodology exploited are displayed. Further, the outcome variables which were examined within the studies are marked. Following this categorization, studies will be summarized with a stronger focus on details of type of VR used within the reminiscence interventions, as well as outcomes reported.

Table 1. Overview of studies reviewed.

Year	Author	Geographical Scope	Target group and sample size	Type of study	Method	Type of instrument	Type of outcome examined	
							cognition	wellbeing
2014	Moon & Lee	Korea	Dementia, N=30	RCT	Quantitative	"VREHAT" - cognitive rehabilitation and training system	+	+
2014	Ang, C.S.	UK	Dementia, N=20	Pilot Study	Mixed-method	„virtual reality environment”	-	-
2016	Manera et al.	France	MCI, N= 28 and Dementia, N= 29	Feasibility study	Quantitative	"Image-based rendered VR"	+	+
2016	Moyle et al.	Australia	Dementia, N=10	Pilot study	Mixed-method	"Virtual reality forest" (VRF)	+	-
2016	White & Moussavi	Canada	Alzheimer disease, N=1	Single case - pilot study	Mixed-method	"Virtual reality navigation building"	-	+
2020	Coelho et al.	Portugal	Dementia, N=9	Pilot study	Mixed-method	“Virtual reality headsets and 360-degree cameras”		-

## INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

2020	Tominari et al.	Japan	MCI, N = 52	RCT	Quantitative	“virtual-reality panoramas” (pictures)	19	+	
					Mixed-method				
2020	Xu & Wang	China	Alzheimer’s disease, N=30	RCT		“virtual-reminiscence room” using 3D modeling		+	
					Quantitative				
2021	Kazuyuki et al.	Japan	MCI and Dementia, N=10	Pilot Study		“immersive virtual reality (iVR)” / 2 types of virtual reality images (CG and LA)		+	
2021	Riaz et al.	Pakistan	MCI and Dementia, N=7	Pilot Study	Quantitative	“virtual reality environment”		+	+

In the following, studies are summarized and classified along the type of studies. Their main goals employed methodology and type of technology as well as outcome assessment methods are described shortly for all included studies. We summarize the main out-comes, which will be discussed in more detail in light of similarities and differences with-in the discussion section.

### **Feasibility study**

The feasibility study by Manera et al. (2016) focused mainly on the feasibility and acceptance of a VR intervention, considering different well-being outcomes related to the task itself. Additionally, effects on cognition were examined in a comparison between a paper and VR condition through attention tasks. Goal of this study was to examine the feasibility and description of the effects of VR on individuals with mild cognitive impairment and dementia (N = 57). Participants had to fulfil attentional tasks in two conditions, which were presented in random order: the tasks were performed once in the VR application and once on paper. The acceptance of the application was assessed by questionnaire which included satisfaction, interest, feeling of security and discomfort as well as anxiety and fatigue. For both the VR application and paper application, the study participants indicated high satisfaction, interest, and low discomfort. It was also found that study participants were significantly more satisfied with the VR application, but as well reported feeling more unsafety with the VR application than the paper group. At the end of the experiment, the study participants were asked which of the two applications they would prefer to use and where they would prefer to continue playing. 39 study participants (68.4%) indicated to prefer the VR application, while 15 study participants (26.3%) preferred the paper application. Three study participants (5.3%) did not indicate a preference.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

21

This is particularly interesting as results in the cognition task demonstrate a higher performance in the paper task, which was explained through perceived difficulties and news-ness of VR usage.

## **Pilot studies**

The pilot study by White & Moussavi (2016) aimed to find out whether it is possible for a person with Alzheimer's disease to navigate in the virtual environment and how this continues to affect cognition in the real world. The single case study included one male individual with 74 years of age at the onset of Alzheimer's disease. The study participant suffered from memory loss and had difficulties remembering directions while driving. The intervention contained a cognitive treatment in a VR navigation environment and was conducted in a time frame of seven weeks and conducted three times a day, 45 minutes each. To assess the impact of the intervention, navigation errors within the VR task, his overall cognition reflected through a neuropsychological assessment, and real-world cognitive benefits through a journal method with his wife were assessed. After the end of the training program, the study participant substantially improved his navigation performance, which continued for five weeks after training. His wife also reported progress in daily life after using VR, as well as significant improvements in his mood. The program also helped the participant to remember past events and activities to actively participate in everyday life again. However, his overall cognition score was not impacted.

Another pilot study employing a mixed method design was conducted by Moyle et al. (2016) and addressed the effects of virtual reality on well-being. The aim of the study was to measure the effectiveness of a virtual reality forest on mood, apathy, and occupation, as well as

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

22

the experiences of caregivers, family members, and the study participants them-selves.

Participants consisted of ten residents over 60 years of age diagnosed with dementia from a residential care home in Australia, ten family members, and nine caregivers. The study participants each took part in a 15-minute VR session. The data was analyzed by a ten-minute video, the Observed Emotion Rating Scale (OERS) and Person-Environment Apathy Rating (PEAR). Overall, results showed a positive effect of VR on well-being: Participants reported significantly more pleasure and greater level of alertness. However, they also reported a greater level of anxiety during the VR forest experience.

Coelho et al. (2020) conducted a pilot study to examine whether promoting reminiscence through VR has a positive effect on neuropsychiatric symptoms and quality of life for dementia patients and their caregivers. The authors exploited virtual reality headsets and 360-degree videos with personal relevance in a study with nine patients diagnosed with dementia. The design of intervention material was built on interviews with participants and family members focused on meaningful activities, settings and events they memorize. Building on this, cameras filmed the selected locations from the memories which were relevant to them. Four sessions over two weeks were held and placed where it was most convenient for the participant. Both feasibility and effects of the intervention were studied through pre-post comparisons within subjects, and qualitative interviews with caregivers. The results of this study did not show any significant changes in the outcomes after interventions. Nevertheless, especially caregivers reported a potential benefit in well-being for most participants.

A long-term pilot study by Riaz et al. (2021) strived for a long-term assessment of usability and effects of a VR intervention. Focusing on a quantitative assessment, the study

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

23

included seven participants suffering from MCI or dementia and again used the VR environment setting. The virtual environment design was built around engagement in a familiar environment and gamification of tasks. The long-term study used sessions every two weeks for six months in Pakistan and addressed both outcomes: cognitions and wellbeing. The interaction was measured via the virtual reality sickness questionnaire (VRSQ), whereas through cognitions were calculated through the Montreal cognitive assessment (MoCA) before and after the study. The secondary outcome wellbeing was assessed through the Warwick-Edinburgh Mental Well Being Scale (WEMWBS). Results demonstrated a toleration of VR with significant decrease in VR sickness. For cognition, the study reported a stabilization of cognitive decline and a marginally significant positive effect for well-being.

Another longitude pilot study with a mixed-method approach was conducted by Ang et al. (2014) and concentrated on the effects of a virtual reality world (VW) on patients with dementia, aiming particularly at recreating experiences. The study was carried out for eight months and focused on the interaction with the participant's memory. One of the main aims was to design the VR activity in a more natural way through a real-time rendered 3D environments, gesture-based technology and virtual interaction. One physical limitation was the movement from patients which were in wheelchairs and were only able to move their arms. In total, there were three versions of prototypes:

- 1) Reminiscence room (a full active 3D environment), enhancing the participants memories
- 2) Virtual tour (river and garden tour), appealing on their lucid experiences considering their cognitive impairment regarding to dementia.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

24

3) Gardening, where the participant worked actively with his/her caregiver to design a garden together.

To overcome shortcomings of only one method, the study used observations, focus groups and interviews to determine design issues of VR usage working with reminiscence elements. It showed that ‘no size fits all’: Overall, there was no finding for the “best matching” prototype, but each could be assigned according to the individual needs of the participants in order to receive positive effects. Critically, also, some negative memories appeared during the VW, but these were minimized by playful designs.

Lastly, Kazuyuki et al. (2021) conducted a pilot study employing a crossover study design comparable to the feasibility study of Manera et al. (2016). At a single nursing home, the authors aimed to investigate the efficacy and safety of immersive virtual reality for reminiscence therapy (iVR reminiscence). The ten participants suffered from MCI or dementia and were split up into two groups with a different, randomized order of VR images. The first group started with computer graphics followed by live-action, whereas the second group started reverse. Before the VR interventions the participants responded to the Mini-Mental State Examination (MMSE) and State-Trait Anxiety Inventory (STAI). After the intervention, the state-trait anxiety inventory (STAI) measured the participant’s responds for satisfaction and its side effects. Results showed that the STAI score decreased significantly for participants after viewing VR in both ways, while satisfaction increased.



# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

25

## **Randomized Control Studies (RCT)**

The randomized controlled trial by Moon, Choi & Lee (2014) aimed to determine how a VR-based rehabilitation program affects depression, cognitive function, and physical function in individuals with dementia. A total of 30 persons over 65 years with a diagnosis of dementia living in Korea were included in the study. A control group of 15 and an intervention group of 15 were formed from the 30 participants. The control group completed a cognition and rehabilitation training program, while the intervention group completed the virtual reality-based rehabilitation program. The program was conducted in a time frame of eight weeks from July to August 2014, twice a week and 20-30 minutes per session. Outcome variables which were considered included cognitive function, visual perception, balance ability and depression, therefore including both cognition and well-being aspects. Data was collected using the Mini-Mental Status Examination (MMSE), motor-free visual perception task, Berg Balance Scale and short form geriatric depression scale. Results showed that the training group had a significant improvement in their cognitive function including memories and stories from the participants in their past. Also, they showed significant improvements in visual perception, balance, and depression scales.

The second randomized controlled trial by Tominari et al. (2020) focused on cognition and wellbeing by making use of virtual reality panorama. Like explained before, the instrument is used to project more realistic memories than by photo-based usual reminiscence therapy. 52 participants diagnosed with mild cognitive impairment were randomly assigned into two groups making use of both tools, either the conventional pictures or the VR instrument. The reminiscence interventions took place in eight weekly one-on-one sessions. Participants were

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

26

tested before and after the intervention in both groups, assessing their cognition with the MMSE, the revised PGC morale scale, the multidimensional observation scale for elderly, trail making and word fluency tests. Although the MMSE scores improved in both groups, the VR did not significantly outperform the conventional pictures intervention.

Xu, Y., and Wang B. (2020) aimed to show in their randomized controlled trial the efficacy of VR on reminiscence therapy for patients suffering from Alzheimer's disease. 30 participants were randomly assigned to the following groups: VR-based reminiscence, photo-based reminiscence, and control group. It resembled a Chinese "rural cottage" in the 1970's with antique objects that had a recognizable value to reproduce life scenes. Sessions took place in the reception hall of the institution so that every participant felt comfortable. The study assessed autobiographical memory through narrative recall and TEM-Pau scale, as well as acceptability through three questionnaires of motivation, presence and VR-sickness. The score on memory scale was higher in both intervention groups compared to the control group. The use of three different questionnaires (motivation, presence, and VR-sickness) showed stronger effects for the participants of the VR and photo group than for the blank one in relation to the outcome on cognitions. Furthermore, the VR group seemed to enjoy the sessions more due to the design of the environment.

To draw an overall conclusion, this study used a systematic review method to explore the effects of VR interventions for dementia patients with a particular focus on reminiscence. In order to give an overview on both the use of VR technologies and reminiscence details as well as on the reported outcomes cognition and well-being, results will be summarized along the prior defined research questions in the following.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

27

RQ 1: Which different kinds of VR technologies were used in reminiscence interventions in for patients with dementia and related diseases?

Overall, the VRHEAT (virtual reality training system), VR images, VR environments (a forest included), and a VR navigation system were the instruments used in the studies. The pilot studies (as well as the mixed method studies by Moyle et al. (2016) and Ang (2014) were focusing more on VR based environments whereas the feasibility study and two randomized controlled trials (Tominari et al., 2020 and Xu & Wang, 2020) where focusing on image-based VR instruments. As described within the technological background, VR technologies consists of three I's: Immersion, Interaction and Imagination, which were all employed in the identified studies. The VR environment in the pilot study of White and Moussavi (2016) consisted of a building with three floors, thereby including an imagination aspect. At the beginning, the study participant was shown the building from an outsider's point of view, where a randomly selected window was marked with an X. The study participant's task was to enter the building and find the window marked with X from the inside. For immersion, Moyle et al. (2016) created whole environment forest which consisted of a river with a bridge, trees, plants, ducks, fish, a dragonfly, and a boat, as well as background music of forest sounds such as birds chirping, thereby using different sensory elements within the VR technology. Within the same studies, the Microsoft Kinect motion sensors allowed participants interaction with the forest through hand and arm movements. The Microsoft Kinect motion sensor was used to detect gestures and motions.

To exploit both imagination and immersion aspects, the image-based VR applications in the feasibility study of Manera et al. (2016) and randomized controlled trials by Tominari et al.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

28

(2020) and Xu & Wang (2020) used a large screen, video game technology, motion sensors and vibrant graphics. VR glasses called “Oculus Rift DK2 goggles” were used to provide the study participants with a 360° panoramic view, which further integrated him into the virtual reality in an immersive way. Furthermore, the study participants were seated in front of an LED wall in comfortable chair a few meters from the video wall. To allow interaction with the virtual world, a wireless mouse was provided. Lastly, Moon et al. (2014) conducted in their randomized controlled trial the VR-based rehabilitation program "VREHAT", which consisted of a motion detection camera, a module to measure grip strength, a computer grip strength, a computer, and a large monitor. The program consisted of 20 different tasks and could be carried out in five levels, depending on the study participant. Those elements particularly were used to integrate both an imagination and immersion aspects. Through motion detection gloves, interaction was as well made possible.

RQ2: How was reminiscence incorporated in the VR technologies?

In the pilot studies of White and Moussavi (2016) and Moyle (2016), as well as in the randomized controlled trial by Moon, Choi & Lee (2014), the term reminiscence is not explicitly mentioned, but its characteristics are included: the participants were instructed to remember their own past experiences and emotion, and design of the intervention aimed to make them feel joy and self-confidence. Furthermore, the studies include past personal memories that have been used to lead to rehabilitation and satisfaction for those participating. The other pilot studies by Coelho et al. (2020) and Riaz et al. (2021) incorporated reminiscence in the design of VR environments by making use of semi-structured inter-views in which the participants and caregivers, which elements were integrated into the intervention using film material of locations

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

29

involved in past experiences. The mixed-method study by Ang et al. (2014) used the virtual reality world as an instrument which supports reminiscence activities and encouraged patients to participate in an active role within their environment. Also, the two randomized controlled trials by Tominari et al. (2020) and Xu, Y., and Wang B. (2020) as well as the feasibility study by Manera et. Al. (2016) were making use of VR-based reminiscence and photo-based reminiscence based on the idea of reminiscence therapy. Lastly, Kazuyuki et al. (2021) used a photo-based reminiscence approach, exploiting live-action and computer graphics of the mid- to late show era, which played a significant role in participants' life span. Going back to the introduction, Garcia-Betances et al. (2014, 2015) noted that most virtual reality interventions lack state of the art technology usage and not yet a clear reference to reminiscence as an intervention itself. The studies have shown that virtual reality tools are incorporated into reminiscence interventions. Based on the concept of simple reminiscence (Woods, 2018), technological advances have shown that there are more possibilities in the field. The current studies show a variety of different techniques for integrating reminiscence elements in VR technology interventions, thereby also shaping the path for future research. This is particularly true as most studies report a positive engagement with the used elements, as will be discussed later in RQ4 on well-being outcomes.

RQ3. Which outcomes of VR usage for reminiscence interventions were reported on cognition?

Looking at the results of Xu & Wang (2020), Moon, Choi & Lee (2014) and Tominari (2021), they have in common that after VR application, participants with dementia showed significant improvements in memory performance. On the one hand, this could be interpreted as

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

30

attention and concentration being strengthened through the use of VR. In the VR world, the study participants were exposed to an environment in which objects were always in the same place. This was supposed to increase attention and concentration on the task and thus improved memory performance, which argues for the positive effects on cognition described in the three studies (Xu & Wang, 2020; Moon, Choi & Lee, 2014; Tominari, 2021). By using multiple sensory modalities in the VR world, the attention was increasing and thus could contribute to the improvement of cognition. Furthermore, Riaz et al. (2020) showed that for participants that were still at the beginning or in an early stage of the dementia disease, positive effects of VR as a stabilization of cognitive decline can be found. This points towards the direction, that for results in the cognitive area, it is important to start cognition training especially in the early stages of dementia. This can contribute to stabilization or improvements in cognition. Based on the results of Tominari et al. (2020), the statement can be strengthened. Another finding by White & Moussavi (2016), Ang, C.S. (2014), and Riaz et al. (2021), in addition to the positive effects on cognition, was the resulting positive effects on orientation. This shows one mechanism through which cognitive training plays an important role. Interventions carried out using VR can prove to be very effective in stabilizing and training cognitive abilities in persons with incipient or mild dementia.

On the other hand, some studies also demonstrate inconsistent results of reminiscence therapy through VR on cognition: In Coelho (2020) et al., no significant changes after intervention were found, which is also shown in Manera et al. (2016): for the attentional task in their study, participants showed a higher performance in the paper condition than in the VR condition which was explained through perceived difficulties and newness of VR usage. Also,

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

31

critically, although there were reported changes in navigation skills in White & Moussavi, the participants' overall cognition score was not impacted. It seems furthermore worth discussing, whether VR interventions in reminiscence therapy do really have an advantage in comparison to established ways of reminiscence: Neither in Xu et al. (2020), nor in Tominari et al. (2020), the VR intervention outperformed a more traditional way of reminiscence. Future research should take this as a starting point under which conditions VR is more beneficial to use in reminiscence therapy, also taking into account the discussions on acceptance and satisfaction of VR usage reflected in the following.

RQ4. Which outcomes of VR usage for reminiscence interventions were reported on well-being?

Wellbeing includes factors such as social contacts, self-determination, positive and negative emotions, safety self-esteem or enjoyment of activities which were especially present in the studies of Coelho et al. (2020) and Kazuyuki et al. (2021). In their results, the authors showed positive effects on the well-being of the participants. In a survey of study participants, their relatives, and caregivers, it was described that the use of VR significantly improved participants' mood, their enjoyment in the use of VR, and that there was an increase in self-efficacy. A majority would continue the use at any time due to the positive experience (Ang, C.S., 2014, Moyle et al., 2016; Manera et al., 2016). This is further strengthened by results of Xu et al.: Motivation and presence were experienced stronger by the VR group than within the control group. Furthermore, the VR group seemed to enjoy the sessions more due to the design of the environment. Overall, studies showed that patients enjoyed the sessions and memorizing their experiences through VR. Data showed a positive effect not only on participants but also on

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

32

family members and caregivers when included. The VR applications were praised as a more engaging and motivating experience.

Also taking into account possible negative effects on well-being through usage of VR, Manera et al. (2016) and Ang (2014) were able to demonstrate that anxiety during the VR session was expressed by some study participants in addition to the positive effects. Anxiety may further occur when individuals with dementia interchange things from the past with things from the present. This shows that anxiety cannot be ruled out when using VR for reminiscence, because it can manifest itself at any time and in a large proportion of persons with dementia. As Manera et al. (2016) discuss based on their finding of lower attention performance in tasks conducted in VR vs. on paper, the insecurity associated with the use of technology in VR can even hinder positive effects of such interventions. This strengthens the need of more longitude research, focusing on whether VR usage does improve both: cognition and well-being especially when participants are more used to the technology.

## Discussion

In summary, virtual reality, in all its forms, has a mostly positive effect on reminiscence technologies, including wellbeing.

The included articles have also shown that due to the technical progress more virtual reality possibilities are offered which can be included in reminiscence therapy. Depending on the severity of dementia, recent research has shown that participants can actively engage in their environment. Regardless of their physical condition, exercises could be performed in both sitting



# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

33

and standing positions. The inclusion of past meaningful memories was a significant point not only for cognition but also for functionality and well-being in everyday life. Interestingly, one of the studies worked not only with remembered experiences by the participant but also by caregivers and family members: This means that not only scientists but also caregivers and family members should be involved in this process (Woods, 2018). Furthermore, the progress of technological tools in general has already had a significant impact on our morals and skills (Marloney et al., 2021). According to the authors, the following ethical recommendations can be made; First, the welfare of each participant should be ensured. This includes that the researcher has enough time to deal with the instrument and to understand it, as well as to consider cultural and social backgrounds. Opportunities should also be provided to protect the privacy and anonymity of participants. If enough participants are recruited, a wide range of interests and diverse perspectives can be included. The available studies show that today still few women are represented in this survey (Marloney et al. 2021)

Further research should be conducted on broader effects of virtual reality in reminiscence therapy on individuals with dementia as there is still limited literature on this topic and the current review demonstrates still some inconsistency in the results. Moreover, studies were conducted within a short time frame and with a small sample size, so it is recommended that more randomized controlled intervention studies with a longer time frame and larger sample size be included to provide more meaningful results. Likewise, future re-search into what type of application of virtual reality would be useful in the future.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

34

## **Limitations**

From a critical lens, the selection of studies that included all criteria was limited. For example, there were many older studies from 2011 that did not specifically address reminiscence. As well, the study did not contain a geographical scope because there was too little selection for the European region. Although dementia is a global problem, a more cultural perspective could help structure the results of studies better. One further limitation which is particularly relevant for the employed method of a literature review is the pre-defined selection of constructs and related keywords: Although the prior selection helps to structure the research and answer the research questions, it at the same time limits the results to the records found within this scope. The method of a systematic review always includes the potential for being biased as selection and exclusion of studies depend heavily on the researcher (Sovacool, Axsen & Sorrell, 2018).

## **Conclusions**

Dementia is nowadays a significant and increasingly serious issue, which also affects future generations more. This disease will affect an increasing number of people one day. Based on a systematic literature review conducted, virtual reality in the context of reminiscence interventions has shown mostly positive effects on well-being and cognition. Personal memories can be used to add value to the present beyond the past. More studies with a longer duration and larger percentages should be published on this to educate more about the topic on the one hand and to link the technical progress of virtual reality in healthcare with reminiscence on the other hand.

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

35

## References

**Ang, C.S., Siriaraya, P.** (2014). *Recreating living experiences rom past memories through virtual reality worlds for people with dementia*. In Proceedings of the SIGCHI Conference in Human Factors in Computing Systems (pp. 3977-3986).

**Appel, L., Ali, S., Narag, T., Mozeson, K., Pasat, Z., Orchanian-Cheff, A., & Campos, J.L.** (2021). *Virtual reality to promote wellbeing in persons with dementia: A scoping review*. Journal of Rehabilitation and Assistive Technologies Engineering, 8, 20556683211053952.

**Butler, R.N.** (1963). *"The life review: an interpretation of reminiscence in the aged"*. Psychiatry.

**Cerejeia, J., Lagarto, L., & Mukaetova-Ladinska, E.B.** (2012). *Behavioral and psychological symptoms of dementia*. Frontiers in neurology, 3, 73.

**Chapouie, E., Guerhouche, R., Petit, P.D., Chaurasia, G., Robert, P., & Drettakis G.** (2014). *Reminiscence therapy using image-based rendering in VR*. In 2014 IEE Virtual Reality (VR) (pp.45-50). IEEE.

**Coelho T, Marques C, Moreira D, Soares M, Portugal P, Marques A, Ferreira AR, Martins S, Fernandes L.** (2020). *Promoting Reminiscences with Virtual Reality Headsets: A Pilot Study with People with Dementia*. International Journal of Environmental Research and Public Health; 17(24):9301. <https://doi.org/10.3390/ijerph17249301>

**Coyle, H, Traynor, V, Solowij, N.** (2015). *„Computerized and Virtual Reality Cognitive Training for Individuals at High Risk of Cognitive Decline: Systematic Review of the Literature”*, The American Journal of Geriatric Psychiatry, vol. 23, pp. 335-359, doi: 10.1016/j.jagp.2014.04.009

**INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR  
DEMENTIA PATIENTS**

36

**Endgahl, S.** (2013). *“Dementia - Perspectives on Diseases & Disorders”*. Greenhaven Publishing LLC.

**Foloppe, A-D, Richard, P, Yamaguchi, T, Etcharry-Bouyx, F, Allain, P.** (2018). *„The potential of virtual reality-based training to enhance the functional autonomy of Alzheimer’s disease patients in cooking activities: A single case study”*, *Neuropsychological Rehabilitation*, vol. 28, pp. 709-733, doi: 10.1080/09602011.2015.1094394

**Garcia–Betances, R-I, Arredondo Waldmeyer, M-T, Fico, G, Cabrera-Umpierrez, M-F.** (2015). *„A succinct overview of virtual reality technology use in Alzheimer’s disease “*, *Frontiers in Aging Neuroscience*, vol. 7, pp. 1-8, doi: 10.3389/fnagi.2015.00080n.

**Garcia–Betances, R-I, Jimenez-Mexico, V, Arredondo, M-T, Cabrera-Umpierrez, M-F.** (2014). *„Using Virtual Reality for Cognitive Training of the Elderly“*, *American Journal of Alzheimer’s Disease & Other Dementias*, vol. 30, doi: 10.1177/1533317514545866.

**Horwitz, S.** (2021). *Virtual Reality as a Tool for Education and Training in Intensive Care*. In *European Conference on Software Process Improvement* (pp. 730-740). Springer, Cham.

**Kazuyuki, N. Megumi, Y. Inagaki, M. Takahashi, N. Watanabe, A. Takeshi, O. Mikiko, U. Iwai, D. Kosuke S. Toshinori, I.** (2021) *Immersive Virtual Reality Reminiscence Reduces Anxiety in the Oldest-Old Without Causing Serious Side Effects: A Single-Center, Pilot, and Randomized Crossover Study*. *Frontiers in Human Neuroscience*.

DOI=10.3389/fnhum.2020.598161

**Keswani, B., Mohapatra, A. G., Mishra, T. C., Keswani, P., Mohapatra, P.C.G., Akhtar, M. M., & Vijay, P.** (2020). *World of virtual reality (VR) in healthcare*. In *Advanced*

# INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR DEMENTIA PATIENTS

37

Computational Intelligence Techniques for Virtual Reality in Healthcare (pp. 1-23). Springer, charm.

**Lazar, A.,** Thompson, H., & Demiris, G. (2014). *A systematic review of the use of technology for reminiscence therapy*. Health education & behavior, 41(1\_suppl), 51S-61S.

**Maloney, D.,** Freeman, G., & Robb, A. (2021). *Social virtual reality: ethical considerations and future directions for an emerging research space*. In 2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)

**Manera, V,** Chapoulie, E, Bourgeois, J, Guerchouche, R, David, R, Ondrej, J, Drettakis, G, Robert, P. (2016). „*A Feasibility Study with Image-Based Rendered Virtual Reality in Patients with Mild Cognitive Impairment and Dementia* “, PLoS One, pp. 1-14, doi:10.1371/journal.pone.0151487.

**McEwen, D,** Taillon-Hobson, A, Bilodeau, M, Sveistrup, H, Finestone, H. (2014). „*Two week virtual reality Training for dementia: Single – case feasibility study* “, Journal of Rehabilitation Research and Development, pp. 1069-1076, doi: 10.1682/JRRD.2013.10.0231.

**McLaren, N-A,** LaMantia, A-M, Callahan, M-C (2013). „*Systematic Review of NonPharmacologic Interventions to Delay Functional Decline in Community-Dwelling Patients with Dementia*”, Aging Ment Health, vol. 17, pp. 655-666, doi: 10.1080/13607863.2013.781121.

**Moon, J-H,** Choi, R-Y, Lee K-S., (2014). „*Effects of virtual reality cognitive rehabilitation program on cognitive function, physical function and depression in the elders with dementia* “, Journal of International Academy of Physical Therapy Research, pp. 730-737, doi:10.5854/JIAPTR.2014.10.31.730.

**INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR  
DEMENTIA PATIENTS**

38

**Moyle, W, Jones, C, Dwan, T, Petrovich, T. (2016).** „*Effectiveness of a Virtual Reality Forest on People With Dementia: A Mixed Methods Pilot Study* “, *The Gerontologist*, pp. 1-10, doi:10.1093/geront/gnw270.

**National Institute for Health and Care Excellence. (2018).** *Dementia:assessment, management and support for people living with dementia and their carers.* [NICE Guideline No. 143]. <https://www.nice.org.uk/guidance/ng143>

**Peterson, RC. (2003).** “*Mild Cognitive Impairment: Aging to Alzheimer's Disease*”. Oxford University Press, USA.

**Page, MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. (2020).** *The PRISMA 2020 statement: an updated guideline for reporting systematic reviews.* *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

**Raggi, A., Tasca, D., & Ferri, R. (2017).** *A brief essay on non-pharmacological treatment of Alzheimer’s disease.* *Reviews in the Neurosciences*, 28(6), 587-597.

**Riaz W, Khan ZY, Jawaid A, Shahid S. (2021).** *Virtual Reality (VR)-Based Environmental Enrichment in Older Adults with Mild Cognitive Impairment (MCI) and Mild Dementia.* *Brain Sciences*. 11(8):1103. <https://doi.org/10.3390/brainsci11081103>

**Serino, S., Cipresso, P., Morganti, F., & Riva, G. (2014).** *The role of egocentric and allocentric abilities in Alzheimer’s disease: A systematic review.* *Ageing Research Reviews*, 16, 32–44. <https://doi.org/10.1016/j.arr.2014.04.004>

**Sovacool, B.K., Axsen, J., & Sorrell, S. (2018).** *Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design.* *Energy Research & Social Science*, 45, 12-42

**INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR  
DEMENTIA PATIENTS**

39

**Subramaniam, P., & Woods, B.** (2010). *Towards the therapeutic use of information and communication technology in reminiscence work for people with dementia: a systematic review*. International Journal of Computers in Healthcare, 1(2), 106-125

**Tominari, M. Uozumi, R. Becker, C. Kinoshita, A.** (2020). “*Reminiscence therapy using virtual reality technology affects cognitive function and morale of elderly with dementia*” <https://doi.org/10.1002/alz.047538>

**White, J-F, P, Moussavi, Z.,** (2016). „*Neurocognitive Treatments for a Patient with Alzheimer’s Disease Using a Virtual Reality Navigational Environment* “. Journal of Experimental Neuroscience, pp. 129-135, doi:10.4137/JEN.S40827.

**Woods B, O'Philbin L, Farrell EM, Spector AE, Orrell M.** (2018). *Reminiscence therapy for dementia*. Cochrane Database of Systematic Reviews, Issue 3. Art. No.: CD001120. DOI: 10.1002/14651858.CD001120.pub3.

**Xu, Y. Wang, B.** (2020). “*Efficacy of VR-Based Reminiscence Therapy in Improving Autobiographical Memory for Chinese Patients with AD*” DOI: 10.1007/978-3-030-51038-1\_47

**INTEGRATING VR TECHNOLOGY IN REMINISCENCE THERAPY FOR  
DEMENTIA PATIENTS**