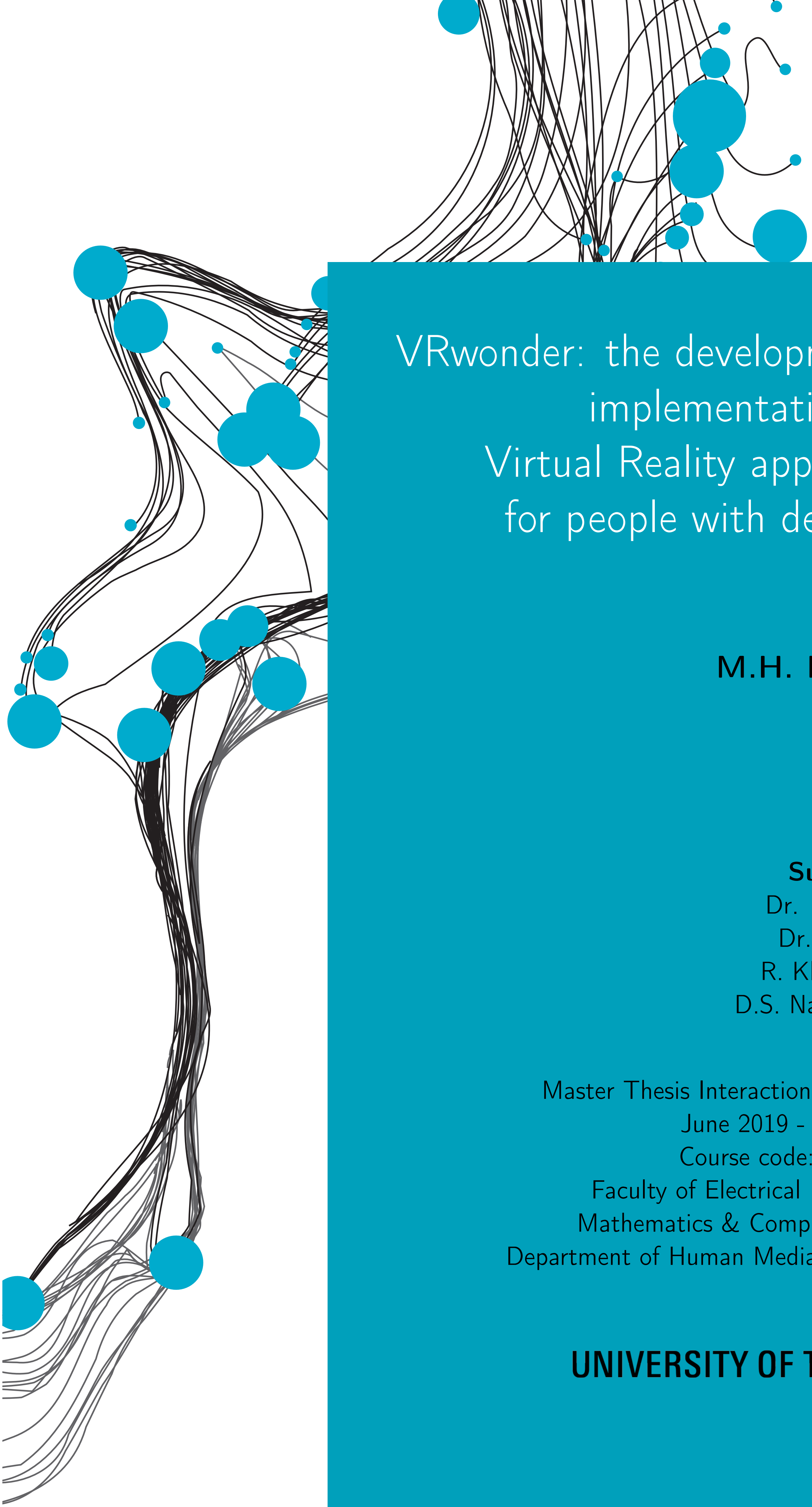


VRwonder: the development & implementation of a Virtual Reality application for people with dementia

M.H. Berkhoff

Supervisors:
Dr. K.P. Truong
Dr. M. Theune
R. Klaassen PhD
D.S. Nazareth MSc

Master Thesis Interaction Technology
June 2019 - March 2020
Course code: 201900195
Faculty of Electrical Engineering,
Mathematics & Computer Science
Department of Human Media Interaction

UNIVERSITY OF TWENTE.

Summary

A growing amount of older adults is affected by some form of dementia: a collective name of neuro-degenerative diseases impairing the nerve cells of the brain. Dementia is a serious illness not only heavily affecting the cognition of someone with the disease, but also behaviour, personality and mental state. No cure is available and therefore the focus lays upon providing valuable care and improving well-being. Healthcare institutions are continuously looking for ways to offer distraction and relaxation to their dementia patients, which could also potentially alleviate some of the symptoms of dementia. One promising technique that could be used for this purpose is Virtual Reality. In this Master Thesis the use of Virtual Reality for people with dementia was researched. The Dutch care institution Zorggroep Apeldoorn provided me with the opportunity to discuss the topic and test at one of their care-homes, Randerode.

The field of Virtual Reality (VR) for people with dementia (PWD) is relatively new. Little research is conducted and mostly focused upon feasibility, formulating guidelines and non-immersive VR. At the same time a gap is seen between the scientific and commercial world. There, the use of full-immersive VR for PWD is already on offer, although no actual use is reported in care-homes. To address the lack of literature on full-immersive VR for PWD and the gap between science and commerce the following main research question was posed: "How can a full-immersive VR application for people with dementia be designed and implemented for long-term use in a care-home?"

Several aspects were of importance in this Final Project to answer the main research question. First, user research was conducted to understand which factors influenced the use of VR for PWD in a care-home. An implementation strategy was formulated which focused on bringing awareness on how to use the VR headset. Second, a first user experience test was performed to gain a better understanding of the response of PWD to VR. Both subjective and physiological measures were used to obtain a complete image of their response. A set of design requirements for a Virtual Reality application for PWD was derived from these two information sources.

A second iteration was performed in which the VR application, VRwonder, was developed and tested in the second user experience & usability test. The most profound characteristic of VRwonder is the ability to let the caregiver watch along with the PWD on a guidance screen. A VR training and manual were developed to inform caregivers on how to use the VR headset with PWD. A final implementation test, in which the caregivers could freely use the VR headset and VRwonder, was conducted to see if the design of the application supported the use of the VR headset within care-home Randerode.

Both the first user experience and second user experience & usability test showed mostly positive responses of the PWD to passive virtual experiences. Especially the virtual experiences designed for recognition purposes elicited active descriptions by the participants. However, it also showed that the use of VR is very personal, not everyone could cope with the weight of the headset or was enthusiastic about continued use. The physiological measures heart rate and heart rate variability were found to support observational data, which is promising to use when the evaluation of PWD becomes harder when the disease progresses. The use of VRwonder was received positively by the caregivers during the second user experience & usability test. They were able to use VRwonder without much guidance and expressed their enthusiasm to use it in the

future. During the implementation test however VRwonder was not used much, which partly coincided with bad timing and unfortunate events at care-home Randeorde at the time of testing. An adjusted implementation strategy was suggested which focused on spreading the awareness on how to use the VR headset and VRwonder.

In conclusion, VR truly is a promising technique to use with PWD. The virtual experiences seemed to activate PWD and could offer them some form of relaxation. The virtual experiences designed for recognition showed the possible use of VR for reminiscence therapy, which is given to improve cognition and mood of PWD. The continued enthusiasm of Zorggroep Apeldoorn about VRwonder and the VR headset illustrated the potential of long-term use of VR within a care-home. The set of design requirements established at the beginning of this Final Project are assumed to have contributed to this growing enthusiasm. Emphasis on the widespread awareness of the use and possibilities of VR for PWD must be given now to stimulate a successful implementation. Overall, this Final Project contributed to the available knowledge on the use of full-immersive VR for PWD and illustrated the potential for using it as a means to offer relaxation, reminiscence and a sense of self to people with dementia.

Acknowledgement

After my Bachelor Psychology & Technology at the Technical University of Eindhoven I made the bold move to come and study for my masters degree at the University of Twente. I was looking for a more practical take on human-technology interaction and was eager to develop my technical skills. This Final Project challenged me to be versatile in many ways, not only doing what I am good at but also to take on things I rather avoid. These past ten months have been quite a roller-coaster sometimes, but I am very pleased and proud on how it turned out. I would like to take this moment to express my gratitude to the people who guided and supported me along the way.

First and foremost I would like to thank Zorggroep Apeldoorn for the great opportunity to conduct my Final Project at care-home Randerode. Petra Salemink, Eslie Vrijmoeth, Saskia Bakker, Thea Gottmer & Karin Ceelen-Lasker, your valuable input and continuing enthusiasm along the way contributed to the success of this project. Special thanks to Eslie Vrijmoeth, whom was always quick to respond to my e-mails and took the challenge to organize the tests and meetings within a busy team.

Secondly, the weekly meetings with my supervisors of the University of Twente, dr. Khiet Truong and Deniece Nazareth, Msc, helped me to keep on track of my project. Thank you for all the discussions which helped me in my train of thought, and for the valuable feedback.

My special gratitude goes out to my boyfriend Dennis, who was always of great support, interested in my progress and helped me out where ever he could. Without his help I would not have been able to develop the Virtual Reality application VRwonder as it is now.

I would like to thank my family for their eternal support of my choices during my study. My mum, always available for advise and dad, always proud on his little girl. My sister Anne, who was very eager to read along with my thesis and provided me with valuable feedback and mostly compliments. You are the best!

Lastly, I want to attribute this Master Thesis to my lovely grandmother, who suffered from dementia for several years. Having seen the impact of the disease at a loved-one sparked my interest in this field of research, and contributed to my motivation to carry out this Final Project. Although I was not able to alleviate her pain, I hope this research lays the foundation for providing more qualitative long-term care for people with dementia in the future.

Contents

First Iteration

Second Iteration

Chapter 1

Introduction

Dementia is a disease which we almost all have encountered in one way or another. A family member, a neighbour, an acquaintance from your (grand-)parents, you probably do not have to think long to come up with a name or face of someone who is living or has lived with this disease. And if you still belong to the lucky group of not knowing someone with dementia, chances are that this is going to change rather quickly in the coming years. The Netherlands has a prognosis of more than half a million people suffering from dementia by 2050 (Alzheimer Nederland, 2019). Present day, dementia is already one of the main causes of death in the Netherlands. Dementia is an incurable, degenerative disease with a rather long duration of illness. Therefore the healthcare costs are relatively high. Because there is no treatment available for dementia, the focus in long-term healthcare lays upon improving well-being by alleviating the symptoms of dementia, and offering distraction and relaxation from the disease for both the person affected by the disease as for its close relatives. There is a growing need for products that achieve these purposes. This Master thesis therefore focuses on one of these promising products: the application of Virtual Reality for people with dementia. In this introduction it is illustrated why Virtual Reality could be promising for people with dementia and present the gaps in the literature and the resulting research questions.

1.1 Virtual Reality for people with dementia

Dementia is a neuro-degenerative disease affecting the nerve cells in the brain. Dementia is mostly associated with cognitive decline, but the disease also often triggers behavioural and psychological symptoms (BPSD). Examples of these symptoms are agitation, apathy, and depression (Margallo-Lana et al., 2001; Lyketsos et al., 2002; Steinberg et al., 2008). BPSD could both affect the person experiencing the symptoms as the person taking care of the person with dementia. Not only could these symptoms be stressful for the patient, also the realisation of being ill and slowly losing your capabilities can have a high impact. Therefore care institutions continue to search for something that could help alleviate symptoms and provide distraction or relaxation for someone with dementia.

Virtual Reality (VR) is a technique that is already used in several healthcare domains, with deploying Virtual Reality for phobias as the most well-known application (North, North, & Coble, 1998). Some researchers proposed to extend the use of Virtual Reality to the domain of dementia and conducted feasibility studies (Flynn et al., 2003; Manera et al., 2016). These studies reported the acceptability of and positive attitude towards VR by people with dementia, and showed the potential of using VR for people with dementia. Several possible application domains for VR were established by Flynn et al. (2003): VR as a cognitive assessment technique, VR as a cognitive rehabilitation technique, VR as a therapeutic activity, VR for indoor and outdoor design for dementia and VR for training caregivers. Most research conducted in the field of VR for people with dementia (PWD) focused towards the domains of using VR as a cognitive assessment technique or as a rehabilitation technique. Guidelines were proposed for designing suitable virtual experiences for PWD which recommend the personalization of virtual environments (VEs), making it a shared experience which addresses multiple senses, and adjusting it to the mental models and capabilities of PWD (Hodge, Balaam, Hastings, & Morrissey, 2018; Klein, Uhlig, & Will, 2018).

Another noticeable trend observable when looking at the available literature is the lack of studies on full-immersive VR. Most studies were reporting on non-immersive or semi-immersive virtual environments (García-Betances, Arredondo Waldmeyer, Fico, & Cabrera-Umpiérrez, 2015) and it is not known if these results could be extended to full-immersive virtual environments. The existing literature thus displays a gap in the research on full-immersive virtual environments (VEs) for therapeutic activity, indoor and outdoor design for dementia, and training for caregivers. Full-immersive VR could be promising in providing an (therapeutic) activity due to the level of control of the virtual environments. Depending on the needs of the PWD a more calm or more stimulating virtual environment can be offerd. The full immersion aspect could contribute to the impact of the offered virtual environments. The focus of this research therefore will be on using full-immersive VR to provide an (therapeutic) activity for PWD. A more extensive overview of the available literature is presented in Chapter 2.

1.2 Application of Virtual Reality for people with dementia

Care-institutions are continuously searching for new ways to offer relaxation and distraction to PWD, which could also possibly help in alleviating some behavioural and psychological symptoms. Despite the lack in literature on full-immersive VR for PWD, there are some small companies already selling full-immersive VR solutions for PWD or their caregivers (ImmersiCare, 2019; Rendever, 2019; HumanXR, 2019; LookBack, 2019; The Wayback, 2019).

The availability of full-immersive VR applications for PWD on the market and the lack of literature on this topic illustrates a gap between the commercial and scientific world. Full-immersive VR applications for PWD are developed and used without the knowledge of possible negative or positive effects of VR for PWD. Not only the effects of VR on PWD are unknown, also the acceptance of VR by PWD and how to evaluate their responses is uncertain. Feasibility studies mostly focused on people with early or probable dementia (Flynn et al., 2003; Manera et al., 2016). These people are considered to be still capable of expressing their opinion clearly. However, people with more moderate forms of dementia could experience problems in expressing their opinion. People with moderate to advanced dementia are assumed to reside in care-homes while people with probable or early dementia mostly still live at home. The available VR solutions for PWD offered by several companies promote use within care-homes, thus using it for people with moderate to advanced dementia. These companies report positive responses to their VR solutions, however little is known about evaluating the response of people with moderate to advanced dementia. Using VR for PWD with moderate to advanced dementia therefore asks for a more careful approach, and some handles to evaluate their responses to a virtual experience and a full-immersive VR headset.

The potential of VR to use with people with dementia is also noticed by care-institutions, and that is why the University of Twente was approached by Zorggroep Apeldoorn. Zorggroep Apeldoorn was interested to see whether VR could possibly be used as a new activity for their residents. In exchange they provided us with the opportunity to research the acceptability of VR by PWD in one of their care-homes, Randerode.

1.3 Research questions

The above showed the promising possibility of using VR for PWD. VR has the potential to be a new activity for PWD which could offer distraction or relaxation, and might even help in alleviating symptoms related to their disease. VR could for example be used during individual activities as an aid to start a conversation, or could offer the opportunity to lock out of a too stimulating environment. The immersion level by which VR is characterized enables a way to directly control the amount of stimulation offered. It also provides the opportunity for the viewer to step out of the real world and explore another world in which they can forget they are ill. This level of immersion is hard to find in other activities. However, little is known about the responses on VR by people with moderate to advanced dementia and how their responses could be evaluated. Guidelines are available on designing virtual environments for PWD, but these guidelines are only tested by few (Hodge et al., 2018; Klein et al., 2018). Whether these guidelines are also useful for designing experiences for people with moderate to advanced dementia is not known yet. How to make a virtual environment pleasurable and user-friendly for PWD is something to be researched.

Despite the availability of VR solutions for PWD on the market, there is no report on actual widespread use of VR for PWD within care-institutions. I therefore was interested in how the use of Virtual Reality could be stimulated, while researching the responses of PWD on virtual experiences. The scope of this project is therefore to design a VR application for actual use in a care-home of Zorggroep Apeldoorn. Focus will lay upon implementation of the VR application, and thereby not only taking into account the residents using the VR headset, but also the people, e.g., caregivers, that must guide the residents in their use. Besides, the feasibility of a more objective way of evaluating a PWD's experience will be tested in order to gain more insight into the experience of people with moderate to advanced dementia.

In general this project is characterized by its explorative nature. The aim was to research whether the use of VR in a care-home could be influenced during the design process and how full-immersive VR experiences for people with dementia could be evaluated. This led to the following main research question:

> How can a full-immersive VR application for people with dementia be designed and implemented for long-term use in a care-home?

To answer the main question several sub-research questions were formulated.

RQ1 What design-based factors influence the implementation process of VR in a care-home?

RQ2 How can the experience and emotional state of a PWD wearing a full-immersive VR headset be evaluated?

RQ3 How do you make the VR experience easily accessible and user-friendly to residents and staff?

1.4 Approach

This Final Project consisted of several phases to answer the research questions. A visual image of these phases is depicted in Figure 1.1. It also shows the structure of this report.

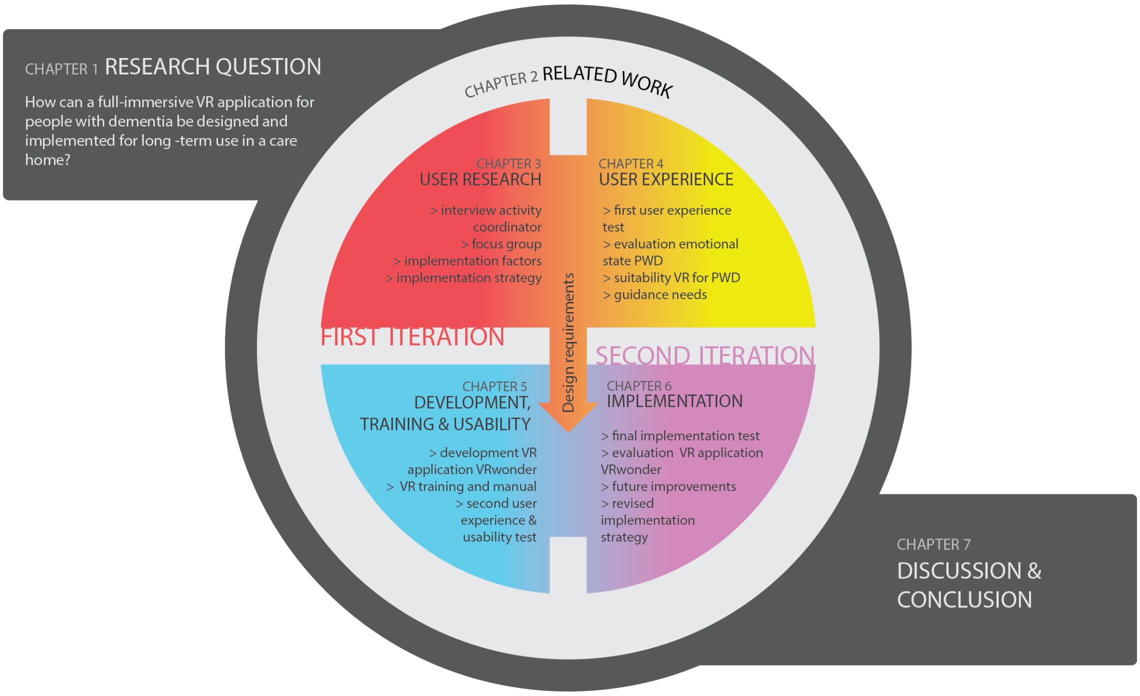


Figure 1.1. Overview of the components of the Final Project.

The chapter contents are summarized more extensively below.

Chapter 2: Related Work

In this chapter the available literature on the topic VR for PWD will be presented. The evaluation of emotional responses by PWD will also be discussed. This chapter serves as background for the remainder of the thesis.

Chapter 3: User-research: professionals' needs

Chapter 3 and 4 describe the first iteration of this Final Project, in which design requirements are formulated for the design of a Virtual Reality application for people with dementia. Chapter 3 begins with a literature review on implementation processes within the healthcare domain. Furthermore, this chapter comprises the user research carried out to gain insight into the use of technology in care-home Randerode and the implementation factors stated by staff. These findings will provide the answer to research question 1 (RQ1). Some first design requirements for the VR application for PWD will be derived from the findings of the user-research and an implementation strategy will be formulated.

Chapter 4: Evaluating the response of PWD to full-immersive VR experiences

Chapter 4 starts with an in-depth review of heart-rate variability analysis and galvanic skin response, and how these two can be used in evaluating emotional states. The remainder of the chapter will concern a first user experience test performed with five dementia patients at care-home Randerode of Zorggroep Apeldoorn. In this first test the feasibility of using full-immersive VR for PWD was researched. Both observed and physical reactions towards the VR experiences were analyzed and will be discussed. This chapter largely covers research question 2 (RQ2). The design requirements formulated in chapter 3 will be supplemented with the findings of this first user experience test.

Chapter 5: Development of the VR application for PWD

Chapter 5 and 6 include the second iteration of this Final Project. In chapter 5 the design of a VR application following the design requirements drawn up in Chapter 3 and 4 will be discussed. The development of a VR application and the creation of an accompanying manual and VR training will be illustrated. Chapter 5 closes with the results of a second user experience & usability test, in which care-givers guided PWD in the VR experience. This chapter complements the answer to research question 2 (RQ2) and largely covers research question 3 (RQ3).

Chapter 6: Implementation of VRwonder and the VR headset

Chapter 6 summarizes the results of an evaluation meeting with staff members of Zorggroep Apeldoorn about the VR application. Future improvements are drawn from this meeting and a new implementation strategy is suggested. This Chapter complements the answer on research question 3 (RQ3).

Chapter 7: Discussion and conclusion

In the discussion and conclusion a summary will be given on the answers of the sub-research questions. Shortcomings and possible improvements of the conducted research will be discussed. The contribution of this Final Project to the existing literature will be highlighted and ideas for future research are suggested. Finally, the answer to the main research question will be given.

Chapter 2

Related Work

In this chapter a more extensive overview will be given on the available literature in the field of Virtual Reality for people with dementia (PWD). First a small introduction is given into the individual topics of Virtual Reality and dementia, and next the two topics are combined. The chapter further highlights the gaps identified in the introduction of this Master Thesis.

2.1 On the topic of dementia

Dementia is a collective name for over fifty different diseases deteriorating the brain and causing a gradual decline of the mental health of patients (Alzheimer Nederland, 2019a).The most common types of dementia are Alzheimer's disease (AD), vascular dementia (VaD), frontotemporal dementia (FTD), and dementia with Lewy bodies (DLB). Each type of dementia is characterized by its own course of disease and specific symptoms, but in general all forms of dementia affect next to cognitive abilities also personality, behaviour, and mental state. As mentioned in the previous chapter, symptoms affecting these three characteristics are also known as behavioural and psychological symptoms. Behavioural and psychological symptoms (BPSD) that are most prevalent in people with dementia are agitation, apathy, depression, irritability, and aberrant motor behaviour (such as wandering) (Margallo-Lana et al., 2001; Lyketsos et al., 2002; Steinberg et al., 2008). Some of these symptoms are not only bothersome for the person with dementia, but can also cause stress amongst caregivers. Especially repetitive vocalizations, restlessness (both signs of agitation) and wandering are seen as stressful for caregivers (Kales, Gitlin, & Lyketsos, 2015). This can lead to ignorance of or impatient reactions towards the person expressing those symptoms or less time available for other patients. Alleviating symptoms of dementia is thus not only beneficial for the patients themselves but also for their caregivers and surroundings.

To be able to address certain symptoms of dementia it is important to know how they originate. There are several factors influencing the occurrence of BPSD, and these factors are either patient related, caregiver related or environmental related. Patient related factors include unmet needs, such as boredom, fear, pain, and loss of control or purpose. Caregiver related factors include stress, communication issues, and lack of knowledge. Environmental related factors include lack of activity and structure, and over- and understimulation. The interplay between these different factors and how they contribute to the occurrence of BPSD is depicted in Figure 2.1, retrieved from Kales et al. (2015).

As can be seen from Figure 2.1 the emergence of BPSD can be a vicious circle. A person with dementia can have sleep problems which causes him/her to leave the bed at night and wander around, the caregiver can experience stress due to this behaviour and reacts in a way that only reinforces the wandering behaviour by putting the patient back to bed immediately, while maybe the patient experiences sleep problems due to overstimulation (e.g., a blinking light in the room). Both patient, caregiver and environmental factors can continue to sustain each other leading again and again to the same

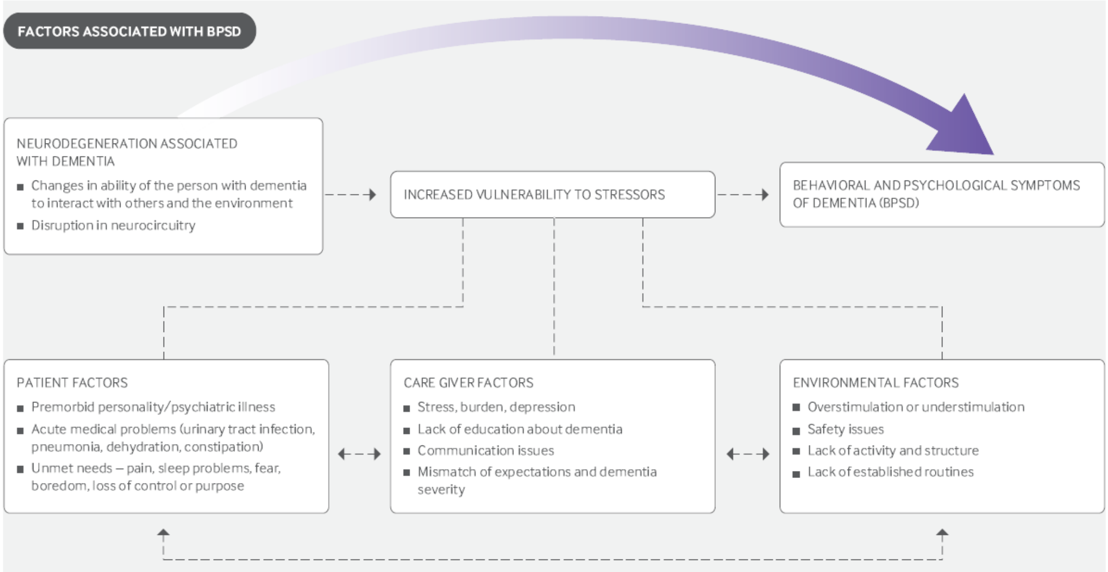


Figure 2.1. Interplay between patient related, caregiver related, and environmental related factors in the occurrence of behavioral and psychological symptoms in dementia (BPSD) (Kales et al., 2015).

behavioural and psychological symptoms. In alleviating BPSD it is thus important to address one or more of the factors likely influencing the occurrence of the symptoms.

The occurrence of BPSD is also often correlated with the time of day. For example, agitated behaviour is mostly seen in the afternoon. During the day the person with dementia encounters more and more stimuli or stressors, and this accumulates until a certain threshold is reached. To prevent or reduce the outburst of agitated behaviour, adaptations can be done in the daily schedule of the patient by adding resting moments or offering selective stimuli (Werken in de ouderengeneeskunde, 2019).

As this section illustrated, alleviating BPSD can improve the well-being of PWD and reduce stress on their surroundings. Offering selective stimuli can reduce the occurrences of BPSD, and technological applications such as Virtual Reality could be of value here.

2.2 On the topic of Virtual Reality

Virtual Reality (VR) is a technique that simulates a different reality, either based on the real world or a fictional world. A virtual reality environment is characterized by the fact that it is a 3D environment displaying 360 degrees of that environment. Virtual environments (VEs) can be 360° video recorded images, graphical computer generated worlds or a combination of the two. The most widespread view of a Virtual Reality environment assumes that the observer is "totally immersed, and able to interact with, a completely synthetic world" (Milgram & Kishino, 1994). This synthetic world can thus mimic properties of the real-world environment or be more fictional. An important aspect for Virtual Reality to be believable, is the sense of presence: the subjective feeling of being present in a simulated environment (Kim, 2011). Despite the widespread assumption that Virtual Reality must be immersive, there are also non-immersive VR environments. In a non-immersive VR environment the observer is situated in front of a large screen or PC monitor. For total immersion of a VR environment, the observer sees the environment

(a) Non-immersive VR. A 3D virtual environment is viewed on a computer screen. The viewer is not shielded from their surroundings and the VE is therefore not immersive.

(b) Semi-immersive VR. The viewer is surrounded by a large, half-round screen which increases the level of immersion and presence.

(c) Full-immersive VR. The viewer wears a head-mounted display in which the VE is displayed. The viewer is totally immersed in the VE and the level of presence is high.

Figure 2.2. Different ways of experiencing Virtual Reality. They differ in their level of immersion and presence.

through a head-mounted display (HMD), which blocks the view of the real-world (Kim, 2011). See Figure 2.2 for an illustration of these different types of VR.

The level of immersion contributes to the feeling of presence. However, presence is also dependent on user characteristics, like the user's perceptual, motor, and cognitive abilities. Next to that, also level of control, the amount of sensory information presented, and the real-time match between movements of the user and sensory information, play a role in perceived level of presence (IJsselsteijn, De Ridder, Freeman, & Avons, 2000; Riva, Davide, & IJsselsteijn, 2003).

2.3 VR for PWD

Virtual Reality is considered to be a promising technique in several domains of dementia research. As stated in the introduction Flynn et al. (2003) proposed several research domains for the topic of Virtual Reality for people with dementia. These domains were: VR as a cognitive assessment technique, VR as a cognitive rehabilitation technique, VR as a therapeutic activity, VR for indoor and outdoor design for dementia and VR for training caregivers. These research domains were adopted by others, and studies were conducted in these fields. García-Betances et al. (2015) reviewed research studies conducted from 2000 to 2014, and provided an overview of the work in each domain. This review showed that until 2014 the main focus of research into the field of VR & dementia was on cognitive assessment and rehabilitation techniques. Only few studies are named in the other categories. From the 28 studies reviewed by García-Betances et al. (2015), only three used a full immersive virtual environment (VE).

2.3.1 Feasibility of using VR for PWD

Early studies on Virtual Reality for people with dementia mostly focused on feasibility and theoretical frameworks. Flynn et al. (2003) researched the following feasibility issues: the experience of presence, navigating through a virtual environment (VE) with controllers, risk of simulator sickness and physiological and physical well-being, and performing functional tasks. The study was conducted with six participants, 3 male, 3 female, ranging in age between 52 and 91 years. All participants had a clinical diagnosis on probable Alzheimer's disease in its early stages. The participants reported a sense of being in the VE, indicating that a certain amount of presence was achieved. Almost all participants were able to control the joystick with which the VE was navigated. No symptoms of simulator sickness were reported by the participants, and also no decrease in psychological and physical well-being was seen.

Another feasibility study by Manera et al. (2016) tested the interest and satisfaction of PWD during an attentional task in both a VR and a paper condition. PWD were more interested and satisfied with the VR condition, even when the task was more difficult. Apathetic participants indicated a higher interest in the VR condition than non-apathetic patients. VR might thus be a good way to enthuse apathetic PWD. Above described studies demonstrate the feasibility of working with VR in PWD. However, caution in using VR for PWD remains necessary, as samples were small and dementia can take many forms, therefore asking for a person-centred view all the time. The feasibility studies also used non-immersive virtual environments, and it is unknown whether the results can be extended to full-immersive virtual environments.

As stated in the previous section about Virtual Reality (2.2) the credibility and immersion of a virtual environment is dependent on user characteristics, such as cognitive abilities. Since cognitive abilities decline gradually in PWD, it is questionable to which extent these persons can experience presence. Riva, Waterworth, and Waterworth (2004) defined three different layers of presence: proto presence, core presence, and extended presence. Proto presence involves the sense of how ones body moves in the environment. The study by Flynn et al. (2003) suggests that persons with early dementia are able to attain this layer of presence while navigating a virtual environment. Core presence involves the perception of what is real and what is not real based on perceived visual information. Garcia, Kartolo, and Méthot-Curtis (2012) hypothesize that PWD may experience a greater sense of core presence, because the cognitive ability of determining what is real or not may be impaired and these persons thus may assume that the environment they are in is real. This could possibly lead to confusion between the real and the virtual world, and is something to keep an eye on while testing VR experiences for PWD. The third layer, extended presence, comprises the understanding of and addressing meaning to the environment. This involves cognitive processing, which can be (partially) impaired in PWD. PWD can thus address a different meaning to an environment or object in the environment than was intended. Extended presence is therefore assumed to be present in a lesser or erroneous extent.

2.3.2 Full-immersive VR for PWD

The lack of studies on full-immersive VR for PWD continued from 2014 to the present. Only a handful of studies were available on this topic, which will be discussed more in-depth here. Two studies focused upon the feasibility and theoretical frameworks of full-immersive virtual environments. Huygelier, Schraepen, van Ee, Abeele, and Gillebert (2019) researched the acceptance of a head-mounted display by older adults. Seventy-six older adults participated of which forty-three displayed mild cognitive impairments, a pre-stage of dementia. Although the participants were not diagnosed with dementia this study is still included in this literature overview, since the results are thought to be transferable to dementia patients. The study used two conditions: a group experiencing the head-mounted VR display (HMD-VR) and a control group viewing nature videos on a television screen. The authors reported that the 76 participants which had no prior experience with HMD-VR had a neutral attitude towards this technology. In the HMD-VR group this attitude changed to positive after exposure of the HMD-VR. The attitude towards HMD-VR in the control group stayed the same. The change in attitude can thus truly be explained by the HMD-VR experience, and not merely by using any technology that provides a pleasurable experience. The authors confirmed that age influences the initial attitude towards technology negatively when not correcting for computer proficiency, global cognitive status, and years of formal education. They found that cognitive status did not mediate between age and initial attitude, when controlled for computer proficiency and years of formal education. This suggests that mildly cognitive impaired persons are equally willing to learn to use new technology as older adults of the same age with no cognitive impairment, despite the fact that they might experience difficulties in adopting the new technology.

A study by Hodge et al. (2018) attempted to create some guidelines for designing full-immersive virtual environments for PWD. Two workshops were organized to establish a set of guidelines. The first workshop was aimed at getting the participants acquainted with the term VR, and gave them the opportunity to try out different VR headsets (a head-mounted display or a handheld Google Cardboard with smartphone). Participants were asked about what they would like to experience in VR. In the second workshop, three tailored VEs were made for the participant group, inspired by the wishes expressed in the first workshop. Based on the opinions and experiences of the participants, five directions/guidelines for future design of VE for PWD were proposed:

1. Consider the physical design of the VR system
   A VR headset is an unfamiliar looking device which could result in reluctance to wear the headset. People with dementia might be concerned about how they look with such a device on their head, and do not want to be judged by their surroundings. Also the weight of the headset might play a role in the acceptance of wearing a VR headset. Therefore the physical design of the VR system should be taken into account to enlarge the acceptance of wearing it.

2. Stimulate shared experiences
   Virtual experiences could be used to establish meaningful interactions between the person with dementia and their carers or loved-ones. Possibilities of shared experiences with the PWD should be researched, however a sensible approach have to be taken in such a way that the shared interaction does not invite for cognitive testing purposes since this will reduce the pleasurable experience.

3. Address multiple senses
   Dementia can affect the ability to speak, and therefore other senses become more important such as sounds and physical touch. From the workshops it appeared that adding sound to a VE is appealing for PWD. Key is to make use of the strengths and abilities still preserved within the PWD when designing a VR experience.

4. Personalize the content of the VR experience
   Not every VE will be appealing to every PWD. Familiar elements are not all the same for everyone. Therefore it should be possible to offer personalized content.

5. Put the person with dementia at the center of the experience
   It is important that the person is positioned at the center of the VR experience,

and not as a bystander observing a scene. In this way the person with dementia feels as if he or she is really experiencing the environment.

As a last comment Hodge et al. (2018) stated that the focus on designing VE for PWD should not be on improving cognitive abilities, but on enriching the person by experiencing capabilities that they have lost and offer them the opportunity to forget their illness.

The study by Klein et al. (2018) mostly agreed with the proposed guidelines by Hodge et al. (2018). They conducted several focus groups with eighteen caregivers and seventeen relatives of people with dementia to inquire how technology could be used in reminiscence therapy. Four guidelines were proposed based on the information gathered during the focus groups. First, the content should be highly personal. Second, it should address several sensory modalities including touch. Third, the technology should be fitted to mental models and motor abilities of PWD. And lastly, social interaction should be encouraged by making use of the technology, making it both suitable for individual and group sessions. These proposed guidelines correspond to the first four guidelines of Hodge et al. (2018). Klein et al. (2018) did however not explicitly state the importance of putting the person with dementia at the center of the VR experience. The study by Klein et al. (2018) also tested their proposed guidelines in practice. The guidelines were amongst others used to develop a handheld VR experience, with the physical appearance of a binocular to fit the device to mental models of the PWD. The VR handheld experience was tested with 6 participants individually, of which 4 were officially diagnosed with forms of dementia and 2 showed similar cognitive impairments. It appeared that participants usually stopped looking into the VR device when conversing with the caregiver about the experience. A time-travel concept was used as the VR experience, in which the participants could control a zooming wheel to travel to different time-images. The zooming wheel concept was mostly understood but the operation of it was sometimes difficult: motoric disabilities to turn the wheel and high cautiousness were observed.

Two other studies concerning the use of full-immersive VR researched the suitability of using VR as a rehabilitative or therapeutic activity. Eisapour, Cao, Domenicucci, and Boger (2018) studied the potential of VR for increasing accessibility to physical exercise for people with dementia. Six persons with early dementia participated in the experiment. Two VEs were designed where physical exercise was possible: a farm scenario and a gym scenario. These scenarios were compared to actual physical human-guided exercises. No real differences were found between the VE exercise games and the human-guided exercises. However, this study demonstrated the ability of PWD in using controllers for reach and contact actions in VEs while wearing a head-mounted display (HMD). Another study by Benham, Kang, and Grampurohit (2019) studied whether VR could be used in pain management therapies. Although the twelve participants with a mean age of 70.2 years old participating in this study were not diagnosed with dementia it is still included in this overview because it is one of the few studies researching the use of full-immersive VR. The participants took part in 12 VR sessions in 6 weeks. In the VR sessions participants could choose from different games to play, no fixed program was followed and not every participant played the same games. Also the playing time differed per participant, a session lasted for at least 15 minutes but participants could play as long as they liked until 45 minutes. The authors reported that all participants experienced a reduction in pain levels after the VR intervention, probably due to the distraction of pain VR offers. No significant improvements were discovered in depression and quality of life (QOL) measures. The study showed a positive influence of VR intervention on pain management, however it is questionable if the results can be generalized, since the testing conditions differed greatly amongst participants (time of play, content of VE) and only participants who were interested in using VR were selected.

The available literature on full-immersive VR thus mainly focused on formulating guidelines for designing VR experiences and testing the acceptance and feasibility of VR for older adults/PWD. Little attention is paid to the challenges that might occur in evaluating the user experience of PWD due to their illness. The next section presents the possibilities in evaluating the responses of PWD.

2.4 Evaluation of the emotional response of PWD

As illustrated in the literature overview above, studies concerning full-immersive VR only researched participants with probable or early dementia. It is unknown how people with more moderate and advanced forms of dementia will respond to full-immersive VR experiences. Because the cognitive abilities of someone with dementia are affected the reliability of answering questions about their experience might be affected as well. Especially for people with moderate to advanced dementia other evaluation methods could be needed when recording their responses. Several evaluation techniques will be discussed which are developed or could be useful for evaluating the (VR) experience of PWD.

When dementia patients are not able to reliable answer questions about their experience, it can be useful to observe the emotions or moods of a person with dementia. It is good to first clarify the difference between the concepts of emotion and mood. Emotions are short-lived intense feelings that occur in response to a certain stimulus. Moods are less intense feeling states and are sustained longer over time. Moods and emotions are usually classified according their valence, which is indicated by the terms positive or negative affect (Tappen & Williams, 2008). Mood is usually the preferred measure in dementia research, because it is often desired to improve the emotional state of a dementia patient for a longer period of time by a certain intervention. However, in the evaluation of the reaction towards a full-immersive VR experience emotion is preferable. Several observational mood and emotion scales for PWD are available: the Dementia Mood Assessment Scale (DMAS), the Observed Emotion Rating Scale (OERS), the Apparent Emotion Rating Instrument (AER) and the Alzheimer's Disease and Related Dementia's Mood Scale (AD-RD Mood scale) (Sunderland & Minichiello, 1996; M. P. Lawton, Van Haitsma, Perkinson, & Ruckdeschel, 1999; Snyder et al., 1998; Tappen & Williams, 2008). The OERS seems most suitable for a direct observation of the response of someone with dementia. The other scales require an observation period of at least a week or rely on intensive training of the raters to obtain an acceptable reliability. The OERS (M. P. Lawton et al., 1999) measures the frequency of emotional expression of two positive emotions (pleasure and interest/general alertness) and three negative emotions (anger, anxiety/fear and sadness). The emotions are rated in a five-minute time period, making it a very fast way to evaluate the observed response of someone with dementia.

Another way to evaluate the response of someone with dementia towards a full-immersive virtual experience might be by physiological measures. The Observed Emotion Rating Scale is a subjective measure and the outcome is dependent on the interpretation of the observer. Physiological measures could provide a more objective measure in the evaluation of the emotional state of PWD. Emotional states are assumed to be

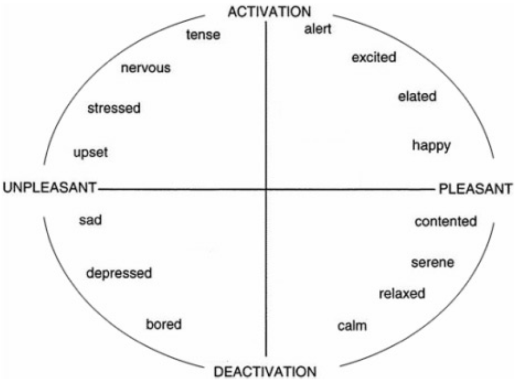


Figure 2.3. The Circumplex Model of Affect. The unpleasant-pleasant axis represents the valence dimension and the activation-deactivation axis represents the arousal dimension. Adopted from Posner, Russell, and Peterson (2005).

correlated to activation on two neuro-physiological dimensions: valence and arousal. Each emotion arises from a certain amount of activation in the neural systems related to valence and arousal (see Figure 2.3). These activation levels can be (partly) measured via physiological measures. Three physiological measures will be discussed which could possibly be used in the evaluation of the emotional response of PWD.

First of all, heart rate is known to increase with increasing levels of arousal (Posner et al., 2005). Emotions such as fear, anger and joy are all characterized by elevated heart rates (Neumann & Waldstein, 2001). A clear distinction between negative and positive emotions (valence) by means of heart rate is not possible. To distinguish between different emotions complementary (subjective) measures should be used. Heart rate can thus only be used in analyzing arousal levels.

A measure closely related to heart rate is heart rate variability. Heart rate variability (HRV) is the variation in time intervals between consecutive heartbeats (Nardelli, Valenza, Greco, Lanata, & Scilingo, 2015). The intervals between consecutive heartbeats are almost always measured as the temporal distance between the prominent waveforms which correspond to the contraction of the heart (R-spikes) (see Figure 2.4). These inter-beat-intervals (IBI) are often referred to as normal-to-normal (NN) intervals or RR intervals. The variation in the inter-beat-intervals are caused by the interplay of the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). The sympathetic nervous system is responsible for an increase in heart rate when facing physical or physiological stress. Due to this faster heartbeat, there is less room for variation in the inter-beat-intervals. Therefore, an active SNS is associated with a lower HRV. On the other hand, the parasympathetic nervous system is responsible for a decreased heart rate when a person is at rest. This means that an active PNS is associated with a higher HRV since the inter-beat-intervals have a longer duration, leaving more room for variations between the intervals. Low HRV is related to feelings of anxiety, stress, and depression (Appelhans & Luecken, 2006). HRV could therefore not only be used to detect emotional changes but also to detect stress levels.

The last physiological measure discussed here is the galvanic skin response (GSR). GSR measures the electricity conductance of the skin, and increases with arousal (Posner et al., 2005). High arousal emotions are thus represented by a higher skin conductivity. Discrimination between different emotions is sometimes even possible. Fear and disgust

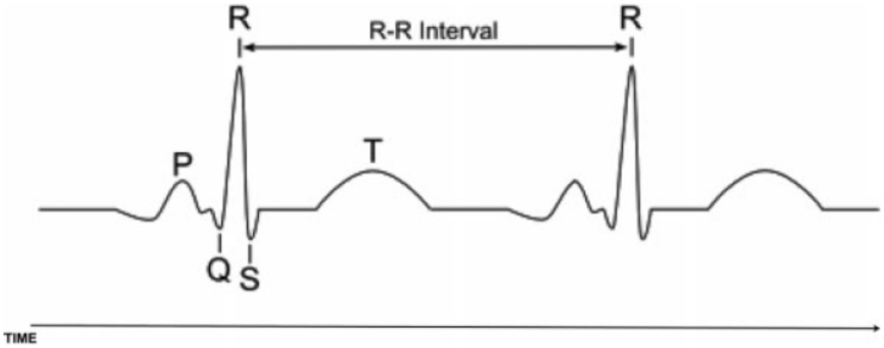


Figure 2.4. Example of the waveform of the heart, displaying the RR-interval between two consecutive heartbeats. Image obtained from Massaro and Pecchia (2019).

for example produced a larger skin conductance than happiness in a study by Ekman, Levenson, and Friesen (1983). Frustration is also characterized by a high GSR (Lisetti & Nasoz, 2004).

In conclusion, some physiological measures are closely linked to emotional states. Heart rate, heart rate variability and galvanic skin response measures could thus all potentially display information not only on physical but also on a psychological level. These physiological measures seem therefore promising to use in the evaluation of the emotional response of PWD.

2.5 Conclusion

The field of Virtual Reality for people with dementia is relatively new. The available literature focused mainly on defining opportunities for VR for PWD, hypothesizing on the suitability of VR for PWD, and on feasibility studies. Most studies concerned non-immersive virtual environments. Only a handful of studies concerned the use of full-immersive VR for PWD in early stages. The use of full-immersive VR for people with moderate to advanced dementia or how to evaluate their experience remains uncertain. Part of this Final Project is therefore used to gain more insight into the reactions of people with moderate dementia to full-immersive VR experiences.

Another aspect of this Final Project researches how VR for PWD can be stimulated for long-term use in care-homes. As stated earlier in the introduction, several small companies already sell full-immersive VR solutions for PWD. Widespread use of these solutions is however not reported and it seems therefore important to understand not only the reactions of PWD to VR but also those from everyone involved. The next chapter therefore focuses first on the professionals' needs of care-home Randerode to successfully implement VR for PWD, before we look into the reactions of PWD to VR.

Chapter 3

User-research: professionals' needs

To stimulate the long-term use of VR for PWD, it is important to understand which factors contribute to the implementation of a technological product in healthcare. This process of stimulating the use of a certain product is referred to as the implementation process. A literature overview on this topic was performed, in which several implementation models are discussed and examples of implementation strategies are given. To determine the most suitable implementation strategy of Virtual Reality for care-home Randerode, a one-on-one interview and a focus group were held with care professionals to gain insight into the current situation and the perspective on a successful implementation by staff of Zorggroep Apeldoorn. From these interviews the most important factors influencing the implementation process of VR were extracted. The goal of this chapter is to research how we can take into account the actual use of VR for PWD within care-home Randerode during the design process of a VR application. Therefore the implementation factors were evaluated on their suitability to be included during the design process of the VR application. Some first design requirements for the VR application were established based on this evaluation. This chapter focuses solely on the view of professionals on using VR for PWD, since they have a clear picture of the needs of their clients and colleagues to successfully use VR. In chapter 4 the focus will be on the end-user, where the design requirements will be completed with findings of a first user experience test with PWD. This chapter closes by formulating an implementation strategy which is designed to stimulate the use of VR within care-home Randerode.

3.1 Background

The study of introducing new innovations consists of two theoretical domains: technology adoption and implementation science. Technology adoption is mostly concerned with the acceptance and adoption of the new technology by the end users, while implementation science provides models and strategies describing variables influencing the diffusion of an innovation. Schoville and Titler (2015) specifically designed a framework for implementing healthcare technologies (see Figure 3.1). They combined theories of technology adoption and implementation science to provide a more complete model for successful implementation. The model (ITIM) addresses the key concepts involved in the adoption and implementation process, and divides them in internal and external context. The internal factors include the technology itself, interfacing systems interacting with the technology, workflow, users, leadership and communication. Accreditation/regulation, the economic environment, vendors and facilitators are mostly seen as external factors.

This ITIM models shows that there are a substantial amount of factors influencing the acceptance and actual adoption of a new technology. All these factors affect each other in a certain way, the one more strongly than the other. Most important is that the new technology will be accepted by the end-users.

Michel-Verkerke and Spil (2013) developed an adoption model for technological innovations in healthcare, the USE-IT model (see Figure 3.2). This model focuses on the reasons for adoption by end-users. The USE-IT model consists of four determinants for

Figure 3.1. The Integrated Technology Implementation Model (ITIM), representing the factors influencing the adoption and implementation of a new technology in healthcare. Adopted from Schoville and Titler (2015).

a successful innovation: relevance, requirements, resistance and resources. The success of an innovation can be predicted both on the macro- and micro-level, respectively the organizational or group level and the level of the individual end-user.

The relevance determinant is considered the most important factor for a successful adoption of a new technology. For an innovation to be relevant for the end-user it must provide certain benefits or solve a problem the end-user experiences. This relevance can be displayed in several forms: an innovation can be relevant if it supports a certain task, if it improves the quality of care, reduces the workload, or improves the patient satisfaction. The relevance of an innovation determines the requirements of that innovation. The requirements determinant is therefore defined as the degree to which the individual user needs are satisfied by the innovation. Information quality, accessibility, compatibility, interface satisfaction, and interoperability are seen as factors influencing the requirements determinant and all contribute to the level of adoption by the end-user. The third determinant, resources, determines whether the individual user is capable of using the innovation. Resources can both be internal and external factors. Internal factors are the inherent capabilities of the end-user on both a physical and a cognitive level, and the amount of experience and education someone has. External factors are the availability of training, support, and the quality of the hardware and software of the innovation. The last determinant, resistance, is mostly influenced by the perceived relevance of the end-user. Next to perceived relevance, resistance can originate from a lack of trust in the innovation or difficulties in using the innovation. Resistance also can originate from an inherent low tolerance of change of the end-user, or foreseen negative consequences the innovation might have.

Both the ITIM and USE-IT model provide us with a theoretical view of the factors influencing the adoption and implementation process of a healthcare innovation. On a more practical point of view, De Veer and Francke (2009) questioned 685 Dutch caregivers and nurses about their view on introducing new technologies in healthcare in order to gain insight into the acceptance of new technologies in care homes. Several topics were addressed: the desired goals and effects of new technologies, as well as the involvement of caregivers and nurses in the implementation process, and factors influencing the success or failure of a new technology. The majority of the caregivers and nurses indicated that the quality of care for the patient is the most important reason to adopt a new technology. Secondly, they are more positive towards a new technology if it will reduce physical- or overall workload. However, they do not want to lose personal

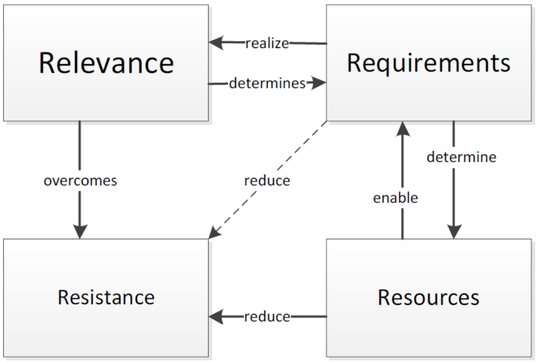


Figure 3.2. The USE-IT adoption model with the four determinants for a successful innovation: relevance, requirements, resources, and resistance. The font size shows the relative importance of each determinant. Adopted from Michel-Verkerke and Spil (2013).

contact with the patient due to the new technology. A healthy balance between reducing workload and maintaining personal contact thus has to be found. The involvement of caregivers in the implementation process was rated unsatisfactory by the caregivers. They would like to be involved earlier on in the implementation process. Currently they are only involved when the new technology is already implemented and has to be evaluated. According to the interviewed caregivers there are several factors influencing the success or failure of a new technology. First of all, the new technology should express noticeable benefits for the patient and carer. The technology should be robust, not sensitive for malfunctions, and easy to use. Second, the implementation strategy plays a big role. Caregivers and nurses want to be involved early on, and training and coaching sessions must be organized in order to gain enough confidence of working with the new technology. Third, the boundary conditions of using the new technology should be favorable. The infrastructure to facilitate the new technology should be well organized, e.g. there should be enough materials or computers to use the technology well. Also support should be available, since carers and nurses indicate that technologies usually not work as they are intended and knowledge and skills of technology might not be accordingly. These factors named by caregivers largely coincide with the factors of the ITIM model by Schoville and Titler (2015) and the USE-IT model by Michel-Verkerke and Spil (2013). The ITIM and the USE-IT therefore seem both useful models to take into account while designing an innovative product for healthcare. The factors displayed in both models will be used in this research to formulate questions targeting the acceptance and adoption of a new technology. The potential end-users (for example caregivers and activity coordinators) of the Virtual Reality application are involved early-on to determine the success factors for implementation.

In order to encourage the adoption and implementation of a new innovative product it is useful to determine an implementation strategy. An implementation strategy is defined as a "method or technique used to enhance the adoption, implementation and sustainability of a clinical program or practice" (Proctor, Powell, & McMillen, 2013). There are two types of implementation strategies, discrete and multi-faceted. A discrete implementation strategy comprises of a single component, while a multi-faceted strategy combines multiple strategies together. There are about 70 discrete implementation strategies described in literature, and they all can be combined into a multi-faceted strategy (Powell et al., 2017). Such discrete strategies are for example the distribution of educational materials, training, giving rewards, and providing feedback.

Due to the vast amount of implementation strategies and inconsistent use of referencing them there is a need for clear specifications of implementation strategies. Proctor et al. (2013) provide guidelines in how to specify and report implementation strategies in research. They developed a three step process of defining an implementation strategy: name it, define it, and specify it. The first two steps are concerned with appropriately describing and conceptualizing the strategy. The third step is used to make the strategy concrete such that other researchers can replicate it. In the third step the actor, action, action target, temporality, dose, implementation outcome, and justification of the implementation strategy are determined. These three steps will later on be used to determine a suitable implementation strategy for the introduction of a Virtual Reality application at care-home Randerode of Zorggroep Apeldoorn.

3.2 Current use of technology in care-home Randerode

This Final Project was conducted at care-home Randerode of Zorggroep Apeldoorn. To define a suitable implementation strategy it was important to first understand which role technology currently plays at this care institution. A semi-structured interview was held with the activity coordinator of one of the wards at Randerode.

3.2.1 Method

The activity coordinator (female, 63 years old) has a background in the field of creative therapy and is already working quite some time as an activity coordinator at Randerode. The nature of the interview was explained to the activity coordinator and informed consent was signed. The interview was recorded with the Zoom H6 audio recorder and had a duration of 36 minutes. There were 17 predefined questions that were discussed in a semi-structured manner. Interview questions were based on the ITIM model by Schoville and Titler (2015) and the USE-IT model by Michel-Verkerke and Spil (2013). The factors used of both models are listed below, with the subsequent questions underneath. Most questions could be covered by several factors. In this case the question was stated at the most relevant factor.

Workflow
To understand how a new technology could fit in, it was important to get a general impression of the workday of the activity coordinator. The following question was asked: *"Describe how your general workday looks like?"*.

Relevance
In order to deliver a relevant product it is necessary to understand what someone finds important in their job, and the product should be supporting those needs. To learn about these specific needs, the following questions were posed: *"What do you find important about your job as an activity coordinator? What services are most important for you to provide?"*, *"Are there certain things that make it hard to perform your job or job related tasks?"* and *"Which part of your job would you miss if it wasn't there anymore?"*. To gain insight in how relevant technological products currently were in the work of the activity coordinator, it was asked: *"Would you prefer an activity using a technological product or an activity without any technology, and why?"*.

Nature of the technology/requirements

Understanding whether current technologies support the users needs and how easy they can use current technologies could provide knowledge about possible improvements for a new technological product. Questions related to this topic were: *"Do you sometimes experience problems when you work with activity related technologies?"*, *"Do you also experience benefits when you work with activity related technologies?"*, *"Are the technological products that you use in activities easy to use? Why (not)?"*

Users

In the case of the Virtual Reality application there are actually two end-users: the patient/resident viewing the Virtual Reality experience, and the caregiver/activity coordinator guiding the Virtual Reality experience. Questions about the patients/residents were: *"Do you think that patients/residents are capable of using certain technologies independently?"* and *"Are patients/residents receptive of using technology during activities?"*.

Questions relevant to the caregivers/activity coordinators as an end-user are covered at other factors in this list.

Communication

It is important to know how the arrival of new technologies are usually communicated towards the end-users and if there are improvements possible in the way this happens. The following questions were asked: *"In which way were new technologies introduced?"* and *"Is there organizational support available when you want to learn about new technologies?"*.

Resistance

To get a sense of how receptive the activity coordinator was in using technology during her activities, this question was posed: *"Are you receptive of using technology in care/ for activity guidance? Do you think it brings some extra value?"*.

Resources

The resources questions concerned questions related to the activity-related technologies available at care-home Randerode and the extent to which they were used. Questions asked were: *"Which technologies are available for you to use in your activities?"*, *"How often do you use such technologies? What determines the extent in which you use these technological products?"*, *"If you want to use technological products during your activities do you have to reserve them beforehand? Or are you free to get them any time?"* and *"Are caregivers also involved in offering activities to the patients/residents? Do they help in bringing them to activities?"*.

3.2.2 Results

The interview is discussed by means of the same factors listed in the method section and is supported by quotes of the activity coordinator. The full interview (in Dutch) can be found in Appendix A.

Workflow

The activity coordinator works three days a week and provides activities for the residents in the communal rooms (in Dutch: 'huiskamers'). The days are very diverse, it is hard to plan something because she is dependent on how many residents are present in the communal rooms and how they are feeling. She also has to take into account the activities that take place outside the ward. She is then responsible for bringing and collecting the residents for the activity downstairs. Mostly she organizes group activities in the morning, and more individual activities in the afternoon. Group activities range from sports and games to watching nature movies and cooking. For individual activities she tries to focus on the people who receive less attention or have lesser activities to go to.

Relevance

According to the activity coordinator the most important aspect of her job is to find something that makes a resident happy again. That is another viewpoint than most activity coordinators have. She said:

> "What I find important is to understand why someone behaves in a certain way, and use that knowledge to find things that will make them feel happy and secure. That is different from other activity coordinators, because they just want to offer activities, make sure they [residents] have something to do. While I also try to accommodate a certain ambiance, security, and proximity."
>
> "Important is that I find something that suits the person, which make them feel happy again. And that's why I am broadly oriented, for this person I use this, and for another person I use something else."

This also is the thing she would miss the most in her job, the personal contact between her and the residents.

> "The individual contact, that is so important. Searching for the meaning of their behaviour, and having the opportunity to do so."

When asked about the things that make it hard to perform her job, she comes up with a list of things. Difficult is to find a suitable place to perform an (individual) activity, because you have to take into account the environmental stimuli present in the proximity. Quiet areas are mostly outside the ward, and that means she has to move the residents first before she can undertake an activity with them. She has also often big ideas for an activity which she cannot perform by herself alone. She needs to ask for help, but there is mostly no one available who has the time to help. She also experiences time issues herself. She has many ideas for activities but there is no time to evolve the idea into a real activity.

The activity coordinator did not had a strong preference for technological driven activities or activities without any technology. She indicated that she probably used technology more in individual contact, and in the group mostly not, with the use of DVD's excluded.

> "If I am organizing a group activity I usually do not make use of any technology, and individually I do."

Nature of the technology/requirements

Understanding how a technological product works is usually no problem for this activity coordinator. However, it should not be too complicated and it takes some time to get to know the product.

> "Because I have a technical understanding. I know others do not have it that much."
>
> "You must get to know how it works. That was the case with the MP3 player, with the Tovertafel. I am pretty quick, I understand things quickly. Also with that relaxing chair. It must not be too complicated."

One difficulty in working with technology and older adults is that it is usually not designed for older adults. This raises all kind of questions on how to use the technology in a suitable way. And if older adults are willing to use the technology.

> "I notice many problems with that [using an MP3 player]. The headphones are not working. People with hearing aids, how does that work exactly when using headphones?"
>
> "Yes, and also such glasses [referring to the VR headset], you never know. Are they able to handle it? It is something that must be put on their head, that looks funny, what is happening? Those are real questions."

The benefits that the activity coordinator experiences when using technology are the positive reactions of the residents. When she sees them enjoy themselves.

Users

The residents are able to enjoy certain technological activity-related products. This mostly also depends on how the product is introduced to a resident. The activity coordinator indicated:

> "If I make it very exciting: 'Look at what I have here!' And make a whole story of it. Then they most certainly want to try. Yes, people are very open. But it depends on how you introduce it."

However the acceptance of a technological product by residents is also very personal.

> "Look, someone who does not want to have something on their head or wants to keep in control, you will not be able to put such glasses [referring to the VR headset] on their head. It depends on the person, and also on how you introduce it, those two."

Residents using activity-related technological products independently is out of the question. However they are in some way still able to learn and master new things, but the act has to consist of one thing, and must be very simple and taught to the resident consistently.

> "Yes, one act is possible. I have followed a course or class about learning new behaviours or things to people with dementia. It is possible. However you need to have the whole team on board, they all have to teach it in the same manner to the person with dementia. The learning

> capacity is there, but it has to be simple and very clear. And every time in a similar way."

Communication

The activity coordinator is not very positive about the introduction of new technologies to use on the wards. The caregivers and activity coordinators are usually not involved in the process of choosing and giving feedback on a new technology. When a new product is introduced there are usually training opportunities, but the staff is badly informed about this. The staff of the wards is expected to use the new technologies, but they are not asked whether they think they would use it.

> "Someone thinks that we should have it and then we buy it, you get an introduction one time and then just go with the flow."
>
> "That truly sucks. It is conceived from above, and from us it is expected that we just do it. While we have no clue what to do with it."

She believes that the people that must use it must be involved much earlier in the process.

> "Look, what happens now, to involve the care staff at this research and ask them: 'Gosh, would this maybe be nice?'. You have so much more chance that you can introduce it properly. And if you can have input from the family before it [the product] is bought. Because that is how it works, in this way you create much more involvement, much more interest."

Resistance

The first answer when asked if the activity coordinator is receptive in using more technology in her activities is: No. Later on she adds that it depends on the technology. In her opinion you only must use technology when it offers you an opportunity to reach out to someone, and other ways are not as successful. But to use one technology on a large scale and for every purpose is not her thing. The diversity in offering activities is key. She sees a new technology as an extra tool in her toolkit, and not as a replacement for another activity.

Resources

There are quite a lot of technologies available at Randerode to use in activities. There are sensory technologies, such as the Tovertafel (Active Cues, 2019), CRDL (CRDL, 2019), Sona-arch (Yalp, 2019) and an automatic massage/relax chair. Then there are technologies available which can be used in reminiscence therapy or entertainment such as the Qwiek Up, and also the 'Belevenistafel' will be delivered in the coming months. The activity coordinator also uses a lot of DVDs and CDs, either on the television and stereo installation or on MP3 players. A therapeutic robot-cat and a Braintrainer game are two other technologies in the toolkit. Despite this large amount of available technologies, the extent to which she uses technology in her activities is variable, but on average one time a week. She mostly uses technology on an individual level, so her usage depends on the amount of residents she needs to offer an activity to. When it is quiet at the wards, e.g. when lots of residents are attending an activity elsewhere, she has the time to make use of technology individually. The mobility of the technology also influences the extent to which she uses a technology.

> “The Tovertafel a lot less, because you have to leave the ward for that. Sometimes that’s a drawback because you cannot keep an eye on what’s happening here [at the ward/the communal rooms].”
>
> “But then I have to move four people.. that’s the problem.”
>
> “That’s exactly why I put the Braintrainer on a mobile trolley.”

Next to mobility of the technology, the readiness to use the technology is sometimes a problem. To use for example the Qwiek Up she has to remove or replace several items in the room to make space for the projection.

There are no reservation systems to use specific technologies, she can just grab it when she needs it. In the rare occasion that someone else is already using the technology she has to come up with another activity. But that is part of the job, adjusting your plans for the day all the time. When we made a little round over the ward together there was something else worth noting. The technologies were not always put back in the same place, and therefore the activity coordinator had to sometimes locate the technology first before she could use it. There did not seem to be fixed places to keep certain products.

Other people that possibly make use of the technologies are caregivers. However this is very personal. Some caregivers do not think it is part of their job to undertake activities with residents, while others do take the time to play a game together.

> “Some of them [caregivers] really are like that, very task oriented towards washing and caring. But also some of them do play a game with them [the residents]. I find it quite difficult, to realise that some do not have that, that they are only task oriented, or for them at least. They say: ’I am not here for the activities.’ [Indignant] Come on, we are here for providing nice living, just like I also sometimes take someone to the toilet or give them a bath. But yeah, that is variable.”

Caregivers usually are also not involved in bringing residents to activities, they only help when they are asked by the activity coordinator.

3.2.3 Conclusion & Discussion

There are a lot of technological products available to use for activities with PWD within care-home Randerode. However not every technology is used that often. The activity coordinator indicated that she only made use of technology once a week on average. Factors that influence the use of technology are: mobility of the technological product, readiness to use the technological product, time, amount of people needing attention, lack of knowledge on how the technique works with older adults, a quiet space to undertake the activity, and acceptance of the residents to use the technology. These factors mostly coincide with the nature of the technology, users and workflow factors of the ITIM model (Schoville & Titler, 2015) and are for now seen as more relevant than the other factors of this model in this research. Another issue which influences the use of a new technology is that during the introduction of new technologies the staff at the wards is usually not involved in the process of picking and trying out a new technology. They are forced to use new technologies which sometimes are not seen as useful by the staff. This is in accordance with the relevance factor of the USE-IT model (Michel-Verkerke & Spil, 2013), which is also stated as the most important factor in the USE-IT model. The activity coordinator advocated early involvement of staff members using the technologies to ensure a more smooth implementation.

This information is a first step towards establishing design requirements for the Virtual Reality application and in formulating an appropriate implementation strategy. The input from this interview supported the wish to buy an Oculus Go as VR headset to use in this research. The Oculus Go is a stand-alone headset and has the advantage that it does not need to be hooked up onto a laptop or computer to use it (Oculus, 2019). This feature supports the mobility requirement stated in the interview with the activity coordinator. In the remainder of this thesis when there is referred to the VR headset, the reader can assume that this VR headset is the Oculus Go (see Figure 3.3), unless specified otherwise.

Figure 3.3. Oculus Go, a stand-alone VR headset.

3.3 Focus group

To gain insight into people's view upon a Virtual Reality application for people with dementia, it was decided to organize a focus group on the implementation of VR within care-home Randerode. While the interview with the activity coordinator addressed the general acceptance and adoption of a new technology, the focus group specifically focused upon the acceptance and adoption of Virtual Reality. The focus group was bringing staff members with different professions together to discuss the implementation of VR within Randerode.

3.3.1 Method

Six female participants attended the focus group: two psychologists, one doctor, one activity coordinator, and two nurses (in Dutch: Eerst Verantwoordelijke Verpleegkundige (EVV'er)). This number was in line with the recommendation of six to eight participants for a focus group by Krueger and Casey (2000). This amount of people allows for a lively discussion in which everyone can get a say. The age of the participants varied between 26 and 63 years old. All participants signed an informed consent form, thereby agreeing with the recording of audio and video during the session. Audio was recorded with the Zoom H6 and video was recorded with a Panasonic video recorder. The focus group had a duration of two hours. The main researcher acted as the moderator.
The focus group had the following structure:

1. **Introduction**
   The participants were informed about the collaboration between Zorggroep Apeldoorn and the University of Twente on this VR project and the goal of the focus group. A round the table introduction was performed in which every participant introduced themselves. They were asked about their familiarity with Virtual Reality and their opinion on using VR for people with dementia.

2. **First acquaintance with the VR headset**
   A short introduction was given on the topic of Virtual Reality. Then the Virtual Reality headset was shown and the functionalities were explained. The main researcher put on a 360° video and gave the headset to one of the participants to pass on. After every participant had experienced the VR headset they were asked to think of possible applications for which they could use Virtual Reality for people with dementia.

3. **Pre-conditions for using the VR headset for people with dementia**
   After discussing the possible applications for VR for people with dementia the participants were asked to name the factors that would influence their use of VR for people with dementia within Randerode. Participants were asked to think of both positive and negative options. Each participant first had the time to come up with factors individually. After that the suggestions were discussed with the entire group elaborately.

4. **Closing**
   Participants were thanked for their participation.

A focus group provides an extensive amount of data. For analyzing this amount of data the framework analysis approach described by Rabiee (2004) was used. This approach consisted of five key stages: familiarization with the data, identification of a thematic framework, indexing, charting, and finally mapping and interpreting. In the familiarization phase the audio data was transcribed and the transcription was read as a whole. Next, notes were added to parts of the transcript to identify emerging themes and categories. The third and fourth phases of indexing and charting were done simultaneously using the long table approach. The transcript was numbered first and cut apart into the defined categories and themes at step two. It was analyzed whether the participants answered a certain question the researcher had posed, and put under that corresponding question. In the final stage of mapping and interpretation, the categories were further deepened. Quotes were highlighted based on the profession of the participant, and it was stated who shared a certain opinion the most. When the topic was discussed more elaborately the topic was classified as more relevant to the participants. Finally a schematic overview was made of the factors influencing the use of a Virtual Reality application within care-home Randerode.

3.3.2 Results

At the beginning of the focus group the participants were asked about their familiarity with Virtual Reality and their opinion towards using VR for people with dementia. All participants expressed a positive attitude towards using Virtual Reality for people with dementia despite the fact that they all had no experience with Virtual Reality. They were all very curious about how residents would react to the VR headset. They also admitted that there could be certain risks in using the headset, such as fear when placed suddenly in another environment. But with proper guidance it could be very promising. They also pointed out that the VR headset would not be suitable for everyone, but they saw enough potential.

In the remainder of this results section the outcome of the framework analysis is presented. A full transcript of the focus group can be received on request, only small fragments will be cited in the upcoming pages. During the focus group two main questions were asked to the participants. These questions are discussed below.

To which end could Virtual Reality be used for people with dementia?
From the sorted transcripts several categories emerged for the possible application of VR for PWD (see Figure 3.4). These categories were:

1. **Alleviate symptoms of dementia**
   The most mentioned category was the alleviation of symptoms of dementia. Participants could see fit for the VR headset for all kind of symptoms. First, it might be helpful in combatting agitation. For agitation during the night a calm VR experience might help in relaxing the resident. In this case the VR headset would be used as a distraction from their agitation. This distraction method could also be useful for aggression.

   > Nurse: "... for agitation in the night or people expressing disruptive vocalizations. If you could maybe break that pattern by showing a [VR] movie and use it as a distraction."

   The VR experiences could also be used to relieve signs of apathy and depression. It could be a joyful activity which gives more meaning to their day.

   > Nurse: "Also for apathy, for people who are bored, to just experience some joy. Offer them pleasure in something they used to like, to relive that feeling again."

   Third, the VR headset could be used in reminiscence activities. This is suitable for people who for example experience a feeling of loss or sadness.

   > Nurse: "I also have written down grief, if you miss your home situation, to film the house."

In a more general way the participants agreed that the VR experiences could be used as a remedy against under- or over-stimulation of the environment. When someone is under-stimulated you could show images that stimulate or excite that person. When someone is overly stimulated you could offer calming and relaxing images.

2. **Offer a more personalized activity**
   The category of offering a more personalized activity was also mentioned a lot by the participants, especially by the nursing staff and the doctor. The VR headset could be used to show more personalized images which can be made by the family. In this way the PWD could feel in closer contact with the family if they might not visit much or the PWD keeps forgetting that they were visited. Another benefit named was the fact that the person then could have the feeling that he or she attended family gatherings such as weddings despite being able to be present physically.

   > Nurse: "And for example that you can bring your children in close proximity [without them really being there], or your grandchildren. And that you are sitting there with them."
   >
   > Doctor: "So, you should actually have a recording kit containing all those camera's. ... which could be very easily lend to the family, and then it is taken to a maternity visit or who knows what else."

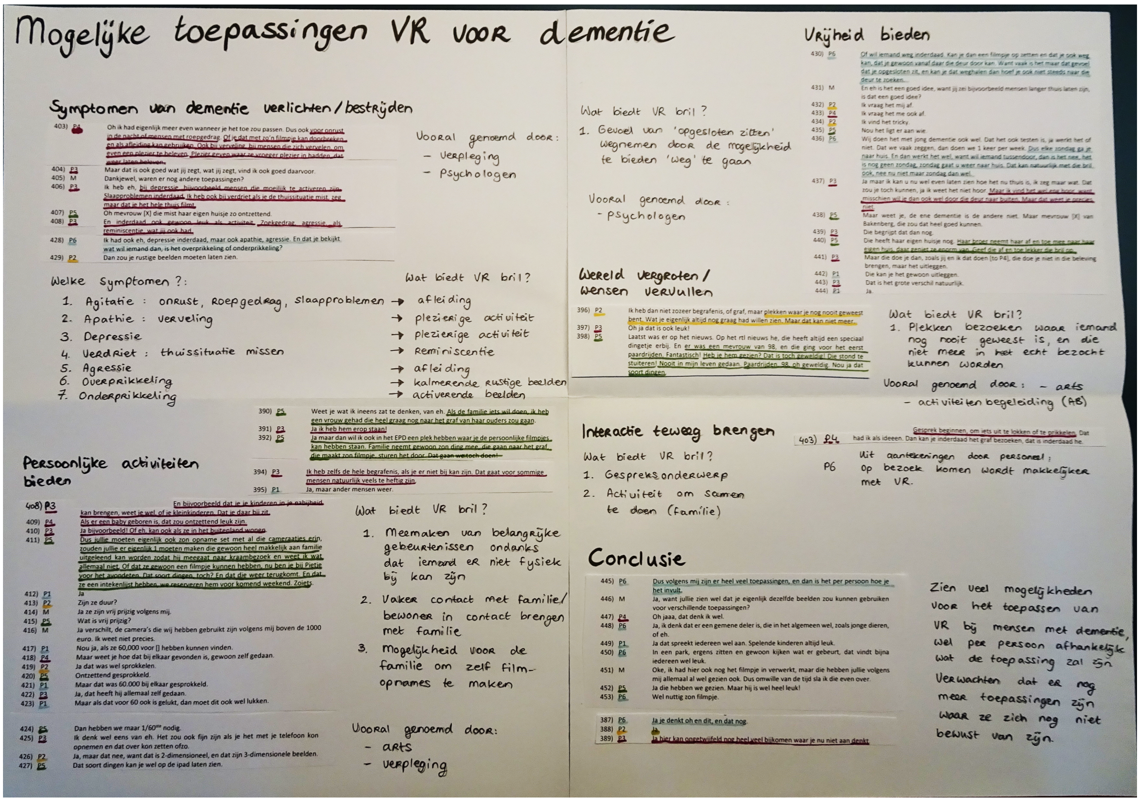
3. **Offer the sense of freedom**
   The VR headset could take away the sense of being locked away by offering the opportunity to "go" someplace else. This was especially pointed out by the psychologists.

   > Psychologist: "Or maybe someone wants to leave. You can put on a movie which makes it possible to leave, to go through that door over there. Because very often it is just the feeling that your are locked away, and if you are able to take that feeling away, then that person does not have to keep searching for that door anymore..."

4. **Enlarge the world/fulfilling wishes**
   With the help of Virtual Reality people could visit places where someone would still love to go once but due to their illness, this is not possible anymore.

5. **Stimulate interaction**
   A less discussed category was the stimulation of interaction. One of the nurses proposed that the VR experience could be used to start a conversation or to stimulate that person. One of the psychologists added that it could be an activity to do together with the family, it would maybe make it easier for the family to visit because it would bring them something to do.

In general the participants saw lots of opportunities for the application of Virtual Reality for people with dementia. They however did mention that the application would be very person dependent. They also expected that there were more possibilities out there which they could not think of at that moment.



Mogelijke toepassingen VR voor dementie

Symptomen van dementie verlichten / bestrijden

Vooral genoemd door:
- Verpleging
- Psychologen

Welke symptomen?:
1. Agitatie : onrust, roepgedrag, slaapproblemen → afleiding
2. Apathie : verveling → plezierige activiteit
3. Depressie → plezierige activiteit
4. Verdriet : thuissituatie missen → reminiscentie
5. Agressie → afleiding
6. Overprikkeling → kalmerende rustige beelden
7. Onderprikkeling → activerende beelden

Wat biedt VR bril?

Persoonlijke activiteiten bieden

Wat biedt VR bril?
1. Meemaken van belangrijke gebeurtenissen ondanks dat iemand er niet fysiek bij kan zijn
2. Vaker contact met familie/bewoner in contact brengen met familie
3. Mogelijkheid voor de familie om zelf filmopnames te maken

Vooral genoemd door:
- arts
- verpleging

Vrijheid bieden

Wat biedt VR bril?
1. Gevoel van 'opgesloten zitten' wegnemen door de mogelijkheid te bieden 'weg' te gaan

Vooral genoemd door:
- psychologen

Wereld vergroten / wensen vervullen

Wat biedt VR bril?
1. Plekken bezoeken waar iemand nog nooit geweest is, en die niet meer in het echt bezocht kunnen worden

Vooral genoemd door: - arts
- activiteitenbegeleiding (AB)

Interactie teweeg brengen

Wat biedt VR bril?
1. Gespreksonderwerp
2. Activiteit om samen te doen (familie)

403) P4

P6 Uit aantekeningen door personeel: op bezoek komen wordt makkelijker met VR.

Conclusie

Zien veel mogelijkheden voor het toepassen van VR bij mensen met dementie, wel per persoon afhankelijk wat de toepassing zal zijn. Verwachten dat er nog meer toepassingen zijn waar ze zich nog niet bewust van zijn.

Figure 3.4. Overview of categorized answers to the question about possible applications of VR for dementia.

Which factors influence your actual use of a VR headset within Randerode? The main goal of this focus group was to discover possible factors that could influence the implementation process of the VR headset within Randerode. When these factors are known, it is possible to discover whether these issues can be taken into account during the design process of the Virtual Reality application. The discussion about these factors was also grouped into several categories. After this grouping inter-dependencies between the categories were discovered. For each factor it was stated what aspects would influence that factor (see Figure 3.5). The discovered factors that influences the implementation process according to the participants are listed and discussed below.

1. **Usability VR headset**
   The usability of the VR headset seemed to be a self-evident fact for the participants. It should be simple to use, such that everyone could work with it.

   > Psychologist: "Positive would be that it can be used without a cord, so it is easy to use. Easy adjustable. It should work, be easy to handle. Easy for care staff to use, it should be transferable."

   The usability of the VR headset is assumed to be influenced by four aspects. First and foremost the usability is influenced by common knowledge about how to operate the VR headset. Having received information about how to operate the VR headset or not could make a difference in the perceived usability of the headset. Secondly, the perceived usability is influenced by the number of actions one has to remember and perform while using the VR headset. When the steps are easy to follow and perform the user would likely perceive the system as more user friendly. When the actions are numerous and hard to remember the system will be perceived as hard to use. From the quote it was seen that the usability is also dependent on whether the VR headset is mobile or not (attached to a cord or free to move). Lastly, the attitude of the staff members towards the VR headset influences the perceived usability. Someone with a negative attitude towards the VR headset will likely be more inclined to perceive the system as hard to use when he or she experiences some difficulty. Someone with a positive attitude will be less likely drawn back by an experienced difficulty and is more likely to try again.

2. **Positive effect VR headset**
   One of the main reasons to use a VR headset is if it has a positive effect on the residents. When negative effects are experienced it will be used less or they will stop using it altogether.

   > Psychologist: "If it has a positive effect it will be used more often. ... If something works well [for a resident] then it will be used, the same holds for such a VR headset." Nurse: "Yes, I agree. I wrote down that if it fosters well-being it would be a reason to use it [the VR headset]."

   Whether the VR headset is perceived to have a positive effect on residents is related to several things. First, to achieve an effect at all, the residents should be accepting of wearing the VR headset. Then, the resident has to respond in a positive way to the virtual experiences. This positive response will contribute to the idea that it promotes the well-being of the resident. Sometimes it is hard to determine whether a person with dementia responds positively or not. Therefore it is also important that the staff members notice any (positive) changes at the resident's behaviour during and after the use of the VR headset.

3. **Guidance via a second screen**
   To offer guidance during the VR experience it is necessary to see what the resident is seeing. All participants were agreeing on the fact that they should be in control and could be able to steer the experience in a certain direction. It would be most ideal if they could control the VR experiences via a second screen, such as a tablet. This tablet has to be multi-purpose such they could also use it for other activities.

   > Activity coordinator: "But that heavily relies on that you can see what is happening. If someone [a resident] wears the headset and that person needs to operate the controller themselves... I cannot see what they are doing, or where they are [in the VE]. That's the dealbreaker for me. Are you able to see what they are seeing."
   >
   > Doctor: "Yes, and that's why we need that Ipad that shows exactly the same image as in the VR headset. You can control it on the Ipad and then you also do not need the controller [of the VR headset] anymore."

   The guidance via a second screen will be only positively contributing to the implementation process when the VR headset and the second screen are communicating well with each other. The quality of guidance is also dependent on knowledge about the use of the second screen. If the staff does not know how to use it correctly it will not provide a smooth guiding process and the chance that it will be used becomes smaller. A second screen not only provides a way to guide the PWD, but also facilitates a shared experience between the PWD and the guider. This is in line with the proposed guideline of Hodge et al. (2018) to make virtual experiences for PWD a shared experience.

4. **Level of comfort of the VR headset**
   The level of comfort of the VR headset influences the implementation process. This factor is highly personal and will differ per person. If residents experience the VR headset as not comfortable they probably do not want to use it. Unless they can overcome the feeling of discomfort because they are distracted by the virtual experiences.

   > Nurse 1: "It fits quite tightly to your head, I wrote that down as well. That could possibly form a problem. ... I'm almost like, you have to put on that thing [the VR headset] as fast as possible, then they [the residents] could be distracted from their discomfort."

   The level of comfort of the VR headset will be influenced by three things. From the quote above it appeared that the level of comfort is influenced by the straps that are too tightly attached. However also straps that are attached too loose could cause discomfort. A second influence in the level of comfort is the weight of the VR headset. The VR headset is quite heavy (around 470 grams) and for some this will be too heavy to bear. Third, because the VR headset encloses the face almost completely warmth could build up and could cause condensation of the lenses. This warmth could make someone want to put down the headset. This factor corresponds to the design guideline of Hodge et al. (2018) to take into account the physical design of a VR headset for PWD. Since older adults, and especially PWD, are a fragile target group they might be more sensitive to the level of comfort of the VR headset.

5. **Acceptance of the resident to wear the VR headset**
   If the resident is not receptive to put on the VR headset in the first place, the whole implementation of VR within Randerode would be destined to fail. The acceptance of the resident is related to three factors. First, when the headset is experienced as uncomfortable the resident is likely to refuse to wear the headset. The unfamiliarity of the VR headset could also cause the resident to refuse to wear the headset. If the headset resembles something they know, or is introduced to them via a metaphor they know of it will be more likely that the resident is open to try the VR headset. Lastly certain habits of the resident could influence the acceptance of the headset. For example, when someone is very neatly about the way their hair looks or does not like to have something on their head this will likely result in a refusal of wearing the headset.

6. **Willingness of the caregivers and family to use the VR headset**
   The participants of the focus group agreed that the virtual experiences must be guided at all times. The resident would not be able to use the VR headset by themselves. This means that to introduce the VR headset properly at care-home Randerode it is necessary that the caregivers and family are willing to use the VR

headset. The participants do have trust that at least family will be willing to use it:

> Nurse 2: "But I think that this [watching virtual experiences] will be so much fun for the grandchildren to do with their grandpa or grandma. I personally would find it very enjoyable."
>
> Nurse 1: "Yes I agree. They [the grandchildren] enjoy it [using the VR headset] themselves as well, so you can give them something to do together. ... Like the Duo-bicycle, that's also comparable. That is so nice, that you can offer something they can do together."

Willingness to use the VR headset will be dependent on several things. If watching virtual experiences together also brings joy to the person who guides the resident, it will be more likely that this person is willing to use the VR headset. Also curiosity towards the headset will increase the willingness to try out the headset. And if the family sees it as an opportunity to do something together with their loved-one, they probably will be more willing to use it. For caregivers time could play a big role. They have usually little time to spare so therefore it is important that the set-up time of the VR headset is as short as possible. When this is the case the willingness of the caregivers to use it will increase.

7. **Accessibility of the VR headset**
   How easier it is to reach to the VR headset how likelier it is that it is used more often. The accessibility of the VR headset thus plays a role in the implementation success of the VR headset within Randerode.

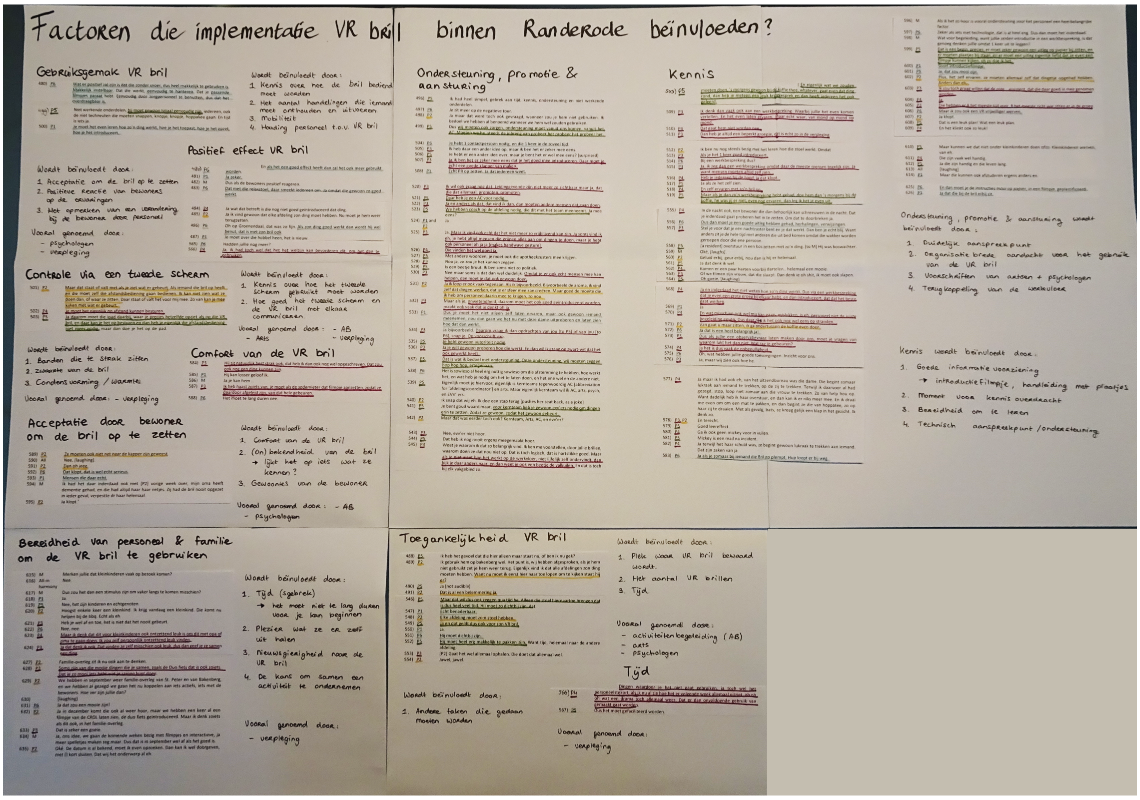
> Activity coordinator: "Now I first have to walk over there to check if it [a relaxing chair] is standing there. That's already an obstruction."
>
> Doctor: "But that implies also regarding time.. Just bringing that chair over here is a huge time investment. It has to be so close.."
>
> Psychologist 1: "Make it accessible."
>
> Activity coordinator: "Every ward needs to have such a chair."
>
> Doctor: "Yes and that also applies to the VR headset."
>
> Psychologist 2: "He [the VR headset] has to be in close proximity."
>
> Doctor: "He [the VR headset] should be very easy to grab."

The accessibility of the VR headset is influenced by the place where the VR headset is stored, the number of headsets available and the amount of time to collect the VR headset.

8. **Time**
   Time was mentioned by the nursing staff as a potential issue in the implementation process. The time pressure is very high on the nursing and caring staff these days, and there might be little time to calmly sit down with a resident to watch some virtual experiences together.

> Nurse 2: "Reasons why you won't use it. Yes, surely the staff shortage, if I already see how next week is going to look like, oh, oh, oh, what a nightmare. Yes, that this will result in insufficient use [of the VR headset]."

The time issue is mostly influenced by the amount of other tasks that needs to be done, the amount of staff working at that moment, and the attention other residents are asking at that moment.



Factoren die implementatie VR bril binnen Randerode beïnvloeden?

Gebruiksgemak VR bril

Wordt beïnvloedt door:
1. Kennis over hoe de bril bediend moet worden
2. Het aantal handelingen die iemand moet onthouden en uitvoeren
3. Mobiliteit
4. Houding personeel t.o.v. VR bril

Positief effect VR bril

Wordt beïnvloedt door:
1. Acceptatie om de bril op te zetten
2. Positieve reactie van bewoners op de ervaringen
3. Het opmerken van een verandering bij de bewoner door personeel

Vooral genoemd door:
- psychologen
- verpleging

Controle via een tweede scherm

Wordt beïnvloedt door:
1. Kennis over hoe het tweede scherm gebruikt moet worden
2. Hoe goed het tweede scherm en de VR bril met elkaar communiceren

Vooral genoemd door: - AB
- Arts
- verpleging

Wordt beïnvloedt door:
1. Banden die te strak zitten
2. Zwaarte van de bril
3. Condens vorming / warmte

Vooral genoemd door: - verpleging

Comfort van de VR bril

Acceptatie door bewoner om de bril op te zetten

Wordt beïnvloedt door:
1. Comfort van de VR bril
2. (On) bekendheid van de bril
   → lijkt het op iets wat ze kennen?
3. Gewoontes van de bewoner

Vooral genoemd door: - AB
- psychologen

Ondersteuning, promotie & aansturing

Kennis

Ondersteuning, promotie & aansturing wordt beïnvloedt door:
1. Duidelijk aanspreekpunt
2. Organisatie brede aandacht voor het gebruik van de VR bril
3. Voorschriften van artsen + psychologen
4. Terugkoppeling van de werkvloer

Kennis wordt beïnvloedt door:
1. Goede informatie voorziening
   → introductiefilmpje, handleiding met plaatjes
2. Moment voor kennis overdracht
3. Bereidheid om te leren
4. Technisch aanspreekpunt / ondersteuning

Bereidheid van personeel & familie om de VR bril te gebruiken

Wordt beïnvloedt door:
1. Tijd (sgebrek)
   → het moet niet te lang duren voor je kan beginnen
2. Plezier wat ze er zelf uit halen
3. Nieuwsgierigheid naar de VR bril
4. De kans om samen een activiteit te ondernemen

Vooral genoemd door:
- verpleging

Toegankelijkheid VR bril

Wordt beïnvloedt door:
1. Plek waar VR bril bewaard wordt.
2. Het aantal VR brillen
3. Tijd

Vooral genoemd door:
- activiteiten begeleiding (AB)
- arts
- psychologen

Tijd

Wordt beïnvloedt door:
1. Andere taken die gedaan moeten worden

Vooral genoemd door:
- verpleging

Figure 3.5. Overview of categorized answers to the question about factors influencing the Virtual Reality implementation in care-home Randerode.

9. **Support, promotion and management**
   A much discussed topic during the focus group was the item of support, promotion and management. Without the constant promotion and encouragement to try to use the VR headset, the VR headset would not be used. The department coordinator has to support the use of VR and communicate this to the team. Everyone of the staff needs to be informed about the VR headset and why it could be useful. Prescriptions from doctors and psychologists are needed to oblige the caregivers to use it.

> Nurse 1: “Ignorance, that’s why it needs to be introduced properly, is often the problem.”
>
> Psychologist 1: “So you not only need them to experience it [the headset] themselves but also take that person along: ’Let’s try it with this lady’, and show them how it works.”
>
> Nurse 1: “That’s also why I ask for assignments of you [points to the doctor] or you [points to psychologist 2]. That it is done on prescription of.”
>
> Doctor: “You just need authority.”
>
> Nurse 1: “Yes, you just want to try how it works. And then I need a confirmation on paper that it truly has worked.”

From the focus group it appeared that there are four aspects needed to offer support, and promote and manage the implementation of VR within Randerode. First up, there needs to be a clear point of contact to address any questions about the VR headset to. Next, there has to be organization wide attention to the use of the VR headset such that everyone is up to date. To truly implement it at the wards you need prescriptions of doctors and psychologists on when to use the VR headset. Also feedback from the staff at the wards is needed to improve the deployment of the VR headset.

10. **Knowledge**

A topic closely related to support, promotion and management is the transfer of knowledge. To increase the success rate of implementing the VR headset people need to get trained in how to use it.

> Doctor: "What we should do, in the morning with coffee and tea, whatever, we need to pass round the VR headset. It yields a nice group conversation and everyone learns it at the same time!"
>
> Nurse 1: "I am also thinking of introducing it during a work meeting. That you come to tell how it works. And let it experience it. Truly, from mouth to mouth.."
>
> Nurse 2: "Yes, that's not working."

Transfer of knowledge is thus influenced by a suitable moment for the transfer. Key is to get as many people trained at the same time, so more people are involved at the same time.

Another issue is illustrated by the following piece of conversation:

> Nurse 2: "And maybe what could go wrong as well, if staff is not giving the proper guidance. That could be the downfall here."
>
> Activity coordinator: "Please sit down, in the meantime I am making the coffee, so to speak."
>
> Psychologist 2: "Yes, that is a very important comment!"
>
> Nurse 1: "So if you let us do an observation request you have to ask 'Why is it not working? What happened?' "
>
> Nurse 2: "Yes, it is often the laziness of someone."

The attitude and the willingness to learn and use a new skill of the staff members thus also influences the implementation. To make it easier to learn how to use the VR headset it is important to provide useful information via a suitable information channel.

> Doctor: "That's a start. There has to be an explanation on paper with pictures, and preferable a movie which they can watch on how to use it."
>
> Activity coordinator: "And in addition, let them experience it [the VR headset] themselves. They all have to wore it [the VR headset] themselves as well."

Lastly there should be a technical point of contact to which staff members can reach out when they are experiencing problems with the VR headset. One of the psychologists proposed the appointment of a VR volunteer for this role.

3.3.3 Conclusion & Discussion

The focus group provided great insight into the current attitude towards VR for dementia, the perceived opportunities for the VR headset and the perceived factors influencing the implementation process of the VR headset. Remarkable was that all participants did not have any experience with Virtual Reality but still were very enthusiastic about the deployment of it for people with dementia. The participants of the focus group saw lots of opportunities for which the VR headset could be used for people with dementia. It could offer a more personalized activity, the sense of freedom and enlarge the world of the person with dementia. It could also be a way to stimulate interaction between the person with dementia and the family/caregivers. The personalization and interaction possibilities of VR for PWD are also named by Hodge et al. (2018) in designing VR experiences, and their importance is confirmed here. The professionals participating in the focus group also expected that the use of the VR headset could help in alleviating symptoms of dementia, such as agitation, apathy, and under- and over-stimulation.

Ten possible factors influencing the implementation process of the VR headset within care-home Randerode were identified. A schematic overview was made to get an impression on how these factors influence one another (see Figure 3.6). All of the ten factors found in the focus group correspond to one or more factors identified in the ITIM- and USE-IT models (Schoville & Titler, 2015; Michel-Verkerke & Spil, 2013), which will be summarized here in bold.

1. The usability of the VR headset is both dependent on the **nature of the technology** as well as **the users**.

2. The positive effect of the VR headset is dependent on how the **users** respond to the headset, and a positive response will show the **relevance** in improving well-being.

3. Guidance via a second screen is part of an **interfacing system** communicating with the VR headset, and both a **resource** and **requirement** for using the VR headset successfully.

4. Level of comfort of the VR headset is partly defined by the **nature of the technology** (weight & heat distribution) and partly defined by how the **users** perceive and respond to these inherent characteristics of the headset.

5. The acceptance of the resident to wear the VR headset corresponds to the **resistance** one might have due to certain habits or unfamiliarity with the object, and **user characteristics** such as curiosity and ability to endure the weight of the headset.

6. The willingness of the caregivers and family to use the VR headset is also dependent on **resistance** and **user characteristics**. Also **internal resources**, such as education level, and **external resources** such as time, influence the willingness of caregivers and family to use the VR headset.

7. The accessibility of the VR headset corresponds to the factors **workflow** and **requirements** of the ITIM- and USE-IT model (Schoville & Titler, 2015; Michel-Verkerke & Spil, 2013). The accessibility of the VR headset will be increased when the VR headset fits the current workflow, which is at the same time a requirement to accomplish the use of the VR headset.

8. Time corresponds to the **workflow** factor. The use of the VR headset should fit the workflow in care-home Randerode. When this is not the case, the VR headset will not be used.

9. Support, promotion & management falls into the category of **leadership, facilitators, and available resources**. Without leaders and facilitators promoting the use of the VR headset, the implementation of the VR headset within care-home Randerode would be difficult. Resources available to support and promote the implementation of VR contribute to the success of leaders and facilitators.

10. Knowledge can be seen as the **communication** and **resources** factors of the ITIM- and USE-IT models (Schoville & Titler, 2015; Michel-Verkerke & Spil, 2013). The correct use of the VR headset for PWD has to be communicated via several resource channels, such as educational materials and training programs.

As can be seen from this list, the ten factors identified in this research mostly coincide with user characteristics influencing the implementation success. In the deployment of VR for PWD two types of end-users can be identified, the PWD and the caregiver/relative guiding the PWD. It is important to consider both in the design of the Virtual Reality application. Not all factors identified in the focus group can be included during the design process of the VR application. Therefore it was evaluated which of these factors could be taken into account during the design process. This will be discussed in the next section.

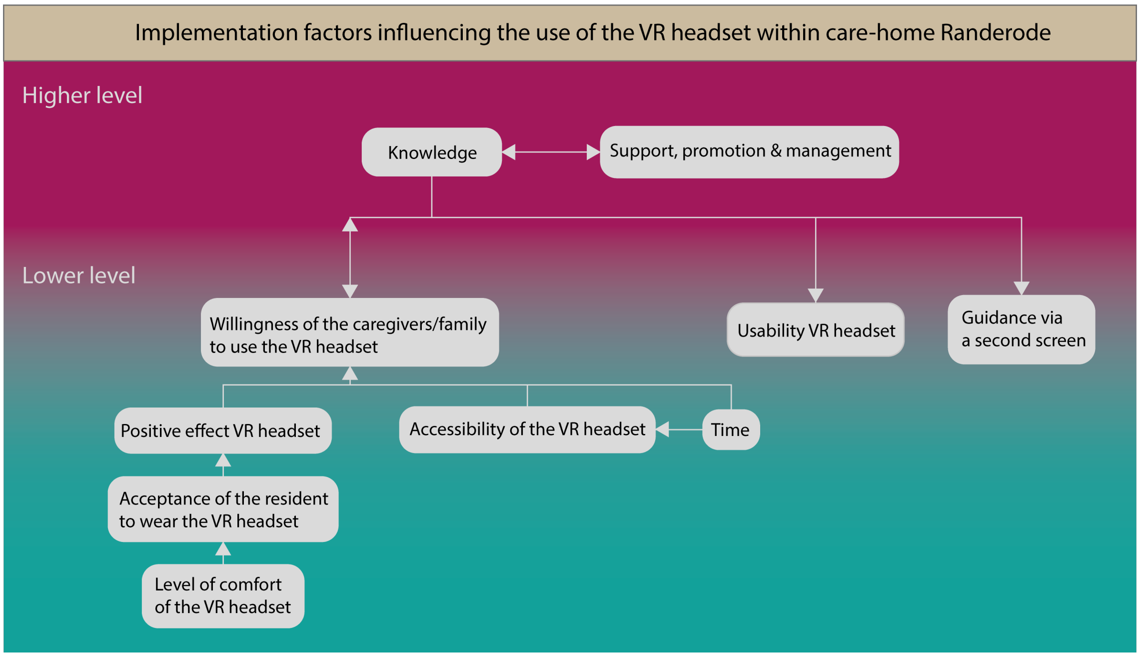


Figure 3.6. Schematic overview of the factors influencing the implementation process of the VR headset and the influence on each other.

3.4 Design requirements

From the ten factors influencing the implementation process several factors can already be included in the design process of the Virtual Reality application. These factors are knowledge, guidance via a second screen, usability, positive effect of the VR headset, the acceptance of the resident to wear the VR headset and the accessibility of the VR headset. For each factor it is highlighted how it could be taken into account during the design process below. This will eventually lead to a set of design requirements for the Virtual Reality application.

As described in the results section of the focus group knowledge can be influenced by the provision of useful information via suitable information channels. Therefore it is important to design easy to follow instructions on how to use the VR headset. There should also be a specific moment for transfer of knowledge, this could for example be in the form of a training session. The usability and guidance via a second screen are things to consider while designing the virtual reality application. The interface of the second screen should be very simple and easy to use for people with a non-technical background. There should only few options available to increase the memorability of the actions. The communication between the second screen and the VR headset should work (close to) flawlessly. The accessibility of the VR headset will influence the willingness of the caregivers to use the VR headset. The headset should be easy to grab and it should be possible to take the headset to a resident for use. During the design process the virtual experiences could be especially designed to fit people with dementia. This could foster the chance of a positive effect of the VR headset on PWD. The acceptance of wearing the VR headset plays a role here, it is therefore important to think about a way to introduce the VR headset to the resident.

By means of the information stated above and the information obtained during the interview session with the activity coordinator the following design requirements were formulated:

DR1 The virtual experiences have to be designed specifically for people with dementia.

DR2 A metaphor or analogy has to be formulated on how to introduce the VR headset to PWD.

DR3 The VR headset should be mobile and free of cords.

DR4 The VR headset should be readily usable, no complicated set-up.

DR5 To guide the resident in the virtual experience a second screen must be available on which one can see what the resident is seeing.

DR6 The interface of the second screen must be intuitive and easy to use.

DR7 The communication between the second screen and the VR headset must be (almost) real-time.

DR8 The VR headset must be accompanied with information on how to use it.

DR9 There must be a training moment for staff on how to use the VR headset.

3.5 Implementation strategy

Finally, to introduce the virtual reality application into care-home Randerode a first implementation strategy has to be formulated. This implementation strategy will help with developing activities supporting the implementation process. To formulate a suitable implementation strategy the three step approach of Proctor et al. (2013) is used.

1. Name it
   As we recall from section 3.1 discrete implementation strategies are used to enhance the implementation of a certain product and are characterized by one specific action. Different discrete implementation strategies will be set up to formulate one multi-faceted implementation strategy. The names of the discrete strategies are adopted from several papers describing specific implementation strategies (Powell et al., 2012, 2015). These names are used to make the strategy more consistent with names used in the literature. In the define and specify section these strategies will be more tailored to use at care-home Randerode. Because knowledge plays a big role in adopting the VR headset, the following educational strategies will be used: developing effective educational materials, distribute educational materials, conduct educational meetings and conduct educational outreach visits. To gain insight whether the VR headset could have a positive effect on PWD the following quality management strategies will be used: involve patients/consumers and family members, obtain and use patients/consumers and family feedback. The discrete strategies together form an implementation strategy focused on awareness of use of the VR headset.

2. Define it
   The educational strategies are meant to inform the caregivers on how to use the VR headset. This information will be provided both written and verbally. Key is that caregivers also can experience the VR headset themselves before using it at a resident. The quality management strategies will be used to test the reactions of the residents towards the VR experiences as well as obtaining information on how to guide the resident and use this information to improve the educational materials.

3. Specify it
   The implementation strategies that are intended to be used will now be more specified precisely. This will be done by means of specifying the actor, the action, the action target, the temporality and dose of the educational and quality management strategies.

   Educational strategies
   The educational materials will be developed by the main researcher in order to inform the people who are going to guide the VR experiences. These people will likely be caregivers, family, and activity coordinators. These end-users will receive a VR training session of around two hours in which they will learn to work with the VR headset. Several weeks after the training session they are asked to participate in a user experience & usability test where they can practice on using the VR headset with a resident. They will receive educational support from both a written manual as guidance of the main researcher when needed.

Quality management strategies
Family members will be involved in discovering topics for suitable virtual experiences for PWD. A first user experience test will be performed to learn how PWD react to the VR headset and the virtual experiences. These reactions will be analyzed and used to improve the virtual experiences and add new ones. Another round of input of the residents is gathered during a second user experience & usability test. Residents who responded positively to the VR headset in the first user experience test will be tested again to check whether their response is comparable.

In this chapter the input of an interview and a focus group led to the formulation of design requirements for the Virtual Reality application to be designed for Zorggroep Apeldoorn. An implementation strategy consisting of several discrete implementation strategies was proposed based on these design requirements. In the next chapter a start is made with this implementation strategy. It will be discussed how PWD reacted to the specifically developed virtual experiences in a first user experience test and additional design requirements will be proposed.

Chapter 4

Evaluating the response of PWD to full-immersive VR experiences

Because little is known about the reaction of people with dementia towards full-immersive VR experiences, a first user experience study was performed with people suffering from early to moderate forms of dementia. Full-immersive VR experiences were specifically developed for people with dementia based on information gathered during the focus group and interviews with relatives of PWD. It was researched how PWD responded to the virtual experiences and how their response could be interpreted and evaluated. Self-report, observation scales and physiological measures were used to this end. This chapter summarizes the results of this first user experience study and the findings were used to complement the design requirements formulated in the previous chapter.

4.1 Background

As stated in the related work chapter (section 2.4), heart-rate variability (HRV) can be used to detect arousal and stress levels in a person, and might therefore be an appropriate measure to detect emotional states in PWD. Also skin conductance can say something about the arousal dimension of a person. In this chapter it is researched whether HRV and GSR measures can detect changes in the mood of PWD. Before we can analyze whether HRV and GSR are suitable measures for evaluating the response of PWD, a little more background will be given on how these measures can be used to detect emotional states.

4.1.1 Heart-rate variability

As explained earlier heart rate variability is the variation in time between consecutive heartbeats (Nardelli et al., 2015). HRV is measured by calculating the inter-beat-intervals (IBI): the time between two consecutive peaks in the heart rate data. Changes in the IBI data are caused by changes in the sympathetic and parasympathetic nervous system. These two systems together form the autonomic nervous system which is responsible for regulating the activity of the heart (Nardelli et al., 2015). Emotions are influenced by the parasympathetic and sympathetic activity of the nervous system. Therefore it seems that emotions could be distinguished when these two systems are analyzed.

HRV analysis consists of several domains, of which the time-domain and the frequency-domain are of interest here. Time-domain measures say something about the variability of the inter-beat-interval (IBI) data, and can be used to determine whether HRV is high or low. Most time-domain measures require 24 hour recordings to be reliable. For short-term recordings only the time-domain measure pNN50 is assumed to be reliable, since it only requires two minutes of recording time. The pNN50 is a measure for the number of adjacent NN intervals that differ in time by more than 50 ms, and is given in percentages (Shaffer & Ginsberg, 2017). We recall from Chapter 2 that the normal-to-normal (NN) intervals are the same as the inter-beat-intervals. A higher value of pNN50 means a

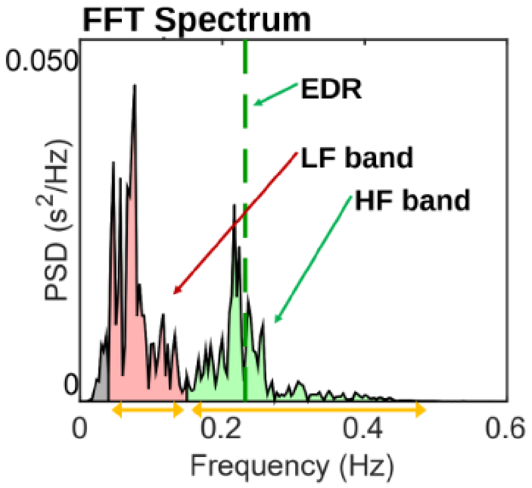


Figure 4.1. Example of a HRV frequency-domain power spectrum. The grey area represents the VLF band, the red area the LF band, and the green area the HF band. The EDR visible in this image represents the ECG derived respiration. As the name already implies this can only be measured during ECG measures, and is therefore not relevant for this research, where PPG measures will be used. Image obtained from Kubios (2016a).

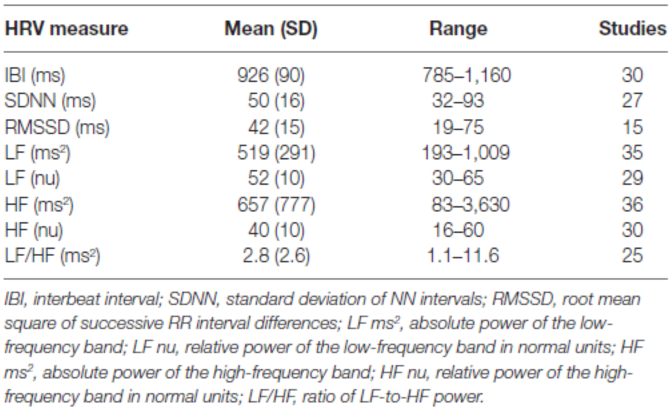
higher HRV, which symbolizes a relaxed state or the capability of the body to cope with stress (Castaldo et al., 2015).

The time-domain measures of HRV are thus indicative of whether the HRV is high or low. Frequency domain measures can provide a more in-depth view in the interplay of the sympathetic and parasympathetic nervous system. This can further illustrate the stress levels experienced by a person, and possibly also distinguish between different emotional states. The parasympathetic and sympathetic activity can be investigated by looking at the power density spectrum plots in the frequency domain of the HRV analysis. See Figure 4.1 for an example of a HRV power density spectrum plot. The power spectra for short-term recordings are divided into several frequency bands: the Very Low Frequency band (VLF, ranging from 0.003 to 0.04 Hz), the Low Frequency band (LF, 0.04-0.15 Hz), and the High Frequency band (HF, 0.15-0.40 Hz). The power displayed in the power density plots reflects the signal energy within one of these frequency bands. The LF and HF bands require only 1 to 2 minutes recording time for reliable analysis, while for the VLF band 24 hour recordings are preferred (Shaffer & Ginsberg, 2017).

In general it is assumed that the HF band represents parasympathetic activity and the LF band sympathetic activity (ChuDuc, NguyenPhan, & NguyenViet, 2013). Changes within these frequency bands can show whether someone is stressed. The power ratio between the two frequency bands, the LF/HF ratio, is an indication of the balance between sympathetic (SNS) and parasympathetic (PNS) activity. Simply stated this means that a low LF/HF ratio represents parasympathetic dominance, reflecting a relaxed state. A high LF/HF ratio represents a sympathetic dominance, reflecting an active state (Shaffer & Ginsberg, 2017). This is supported by a review of Castaldo et al. (2015) stating that the LF/HF ratio increases under stress. At the same time the HF power decreases when someone is stressed. However, this relationship between LF/HF and PNS and SNS activity is not that straightforward and is influenced by factors such as respiration and resting heart rate. Next to that, LF power is not solely determined by

SNS activity, also PNS activity plays a determining role (Shaffer & Ginsberg, 2017). The LF/HF ratio also does not display the order of magnitude of the LF and HF power, and therefore always must be complemented with other measures. The LF/HF ratio can thus be an indication for PNS and SNS activity but must be treated with caution.

One important aspect to take into consideration during HRV analysis is that HRV measures are influenced by age and gender. Values of time-domain measures generally decline with age (Shaffer & Ginsberg, 2017), maybe making the detection of differences due to emotions harder. Women generally have a higher mean HR and thus a lower HRV than men. Despite this finding, women displayed lower total and LF power, and higher HF power than men which is characteristic of a high HRV. Men thus display a relative SNS dominance, while women display a parasympathetic dominance (Shaffer & Ginsberg, 2017). There are no golden standards for heart rate and heart rate variability measures, every person has a different baseline. However, there are some norms available for short-term HRV measurements which can be used as a guideline for what is considered 'normal'. These norms are presented in Figure 4.2, and are based on 44 studies with 21,438 healthy adult participants with a large part of the participants above 40 years old. These norms are considered usable for a global impression in this research, but are cautiously treated because the testing population has a much higher age and is not considered healthy.



HRV measure	Mean (SD)	Range	Studies
IBI (ms)	926 (90)	785–1,160	30
SDNN (ms)	50 (16)	32–93	27
RMSSD (ms)	42 (15)	19–75	15
LF (ms^2)	519 (291)	193–1,009	35
LF (nu)	52 (10)	30–65	29
HF (ms^2)	657 (777)	83–3,630	36
HF (nu)	40 (10)	16–60	30
LF/HF (ms^2)	2.8 (2.6)	1.1–11.6	25

IBI, interbeat interval; SDNN, standard deviation of NN intervals; RMSSD, root mean square of successive RR interval differences; LF ms^2, absolute power of the low-frequency band; LF nu, relative power of the low-frequency band in normal units; HF ms^2, absolute power of the high-frequency band; HF nu, relative power of the high-frequency band in normal units; LF/HF, ratio of LF-to-HF power.

Figure 4.2. Short-term HRV norms. Adopted from Shaffer and Ginsberg (2017).

4.1.2 Galvanic Skin Response

Galvanic Skin Response (GSR), also referred to as Skin Conductance (SC) or Electrodermal Activity (EDA), is a measure for the electric conductivity of the skin. The electric conductivity of the skin is increased when the level of sweat production is increased, which is regulated by the sympathetic nervous system. High arousal emotions increase the sweat production and can therefore be distinguished in the GSR signal. The GSR signal can be divided into two parts: the tonic skin conductance level and the phasic skin conductance response. The tonic skin conductance level represents the baseline conductivity level of a person and can slowly vary over time due to changes in hydration, temperature and mood. Average skin conductance levels are usually in the range of 2-16 microsiemens (μS) (Braithwaite, Watson, Jones, & Rowe, 2013). The phasic skin conductance response is represented by peaks in the tonic skin conductance level. These peaks are caused by short-term events and discrete stimuli such as sight, sound, smell or cognitive processes as decision making. The skin conductance response (SCR) is therefore associated with emotional responses to certain stimuli, and will occur after 1 to 5 seconds after the emotional stimuli is presented. These peaks are also referred to as event-related SCR. Also non-specific SCR can occur in the GSR signal, these peaks are unrelated to any stimuli and happen at random at a rate of 1 to 3 per minute. A non-specific SCR has a much lower amplitude than an event-related SCR (iMotions, 2017).

Table 4.1

Overview of directional physiological measures for different emotions. Directions are based on the review by Kreibig (2010), and summarized in this table.

Emotions	Pos./ Neg.	Sympathetic activity	Parasympathetic activity	HR	HRV	LF	LF/HF	GSR
Anger	-	↑	↓	↑	↓	↑	↑	↑
Anxiety	-	↑	↓	↑	↓	↑	↑	↑
Embarrassment	-	↑	↓	↑	↓	unk.	unk.	↑
Fear	-	↑	unk.	↑	↓	NC	unk.	↑
Sadness	-	↕	↕	↕	↕	unk.	unk.	↕
Amusement	+	↓	↑	↕	↑	unk.	NC	↑
Contentment	+	↓	↑	↓	↕	↑	NC	↓
Happiness	+	↑	↓	↑	↓	NC	unk.	↑
Joy	+	↑	↑	↑	↑	unk.	unk.	↑
Relief	+	↓	↑	NC	unk.	unk.	unk.	↓

Note. ↑ refers to an increase with respect to the baseline, ↓ to a decrease, NC for no change. ↕ indicates conflicting results: changes were reported in both directions. Lastly where unk. is stated the direction of change is unknown.

4.1.3 Heart rate, HRV and GSR characteristics for emotions

The previous two sections elaborated on HRV and GSR measures. In this section it will be discussed how these measures could be possibly used in the evaluation of emotional states. Kreibig (2010) reviewed the physiological characteristics of several emotions. This review was used in summarizing some physiological characteristics relevant for this research. An overview of the directional physiological measures is displayed in Table 4.1. As can be seen from Table 4.1 some contradictory information is available in the literature about the direction in physiological measures of certain emotions. Kreibig (2010) for example stated different directional measures for sadness: different studies reported both increases as decreases for HR, HRV, and GSR. Disagreement also exists for amusement and contentment and the effect these emotions have on heart rate and HRV. The contradictory results on HR, HRV, and GSR measures for sadness seemed to be dependable on the type of sadness studied. The type of activating sadness or crying-sadness is related to an increase in sympathetic activity, and mostly resembles the characteristics of anxiety. The type of de-activating sadness or non-crying sadness is characterized by a sympathetic withdrawal and decrease in electrodermal (GSR) activity. The contradictions present in contentment and amusement might be, just like sadness, caused by the existence of different types of contentment and amusement. However this assumption is not confirmed in the literature. It is likely that different inducement methods for each emotion can cause differences within an emotion. Besides, it is also a

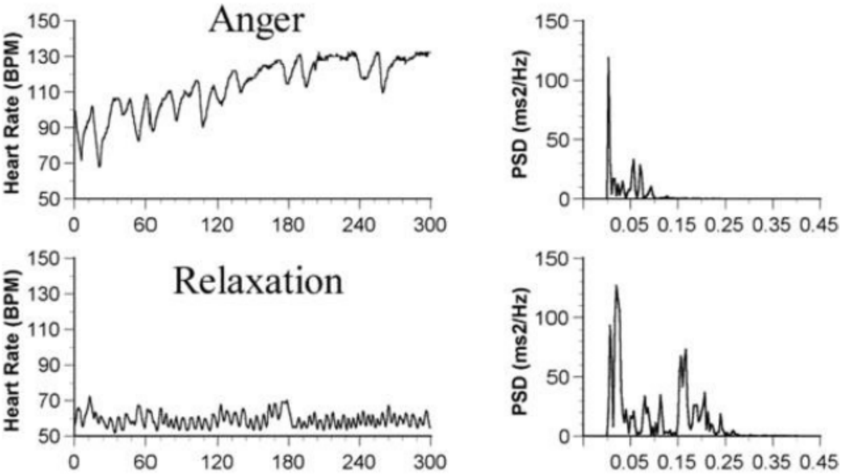


Figure 4.3. Power spectra density plots of the emotions anger and contentment/relaxation. The power spectra plots to the right show a sympathetically dominated spectrum for the emotion anger, and a more balanced spectrum with peaks in the LF and HF band for the emotion contentment/relaxation. Image obtained from ChuDuc et al. (2013).

possibility that in studies inducing emotions like contentment and amusement in reality a different emotion was measured (such as joy). The line between different emotions, especially subtle emotions which show resemblance to each other, can be very thin.

As can be seen from Table 4.1 little is known about the differences in frequency domain measures (LF and LF/HF) between emotions. An early study towards power spectral analysis of HRV found that the negative emotion anger produced a sympathetically dominated spectrum, with an increase in LF and no changes in HF and therefore also an increase in LF/HF ratio. The positive emotion appreciation was characterized by an increase in both LF and HF power, and therefore maintained a similar LF/HF ratio as in resting state (McCraty, Atkinson, Tiller, Rein, & Watkins, 1995). These findings are confirmed by ChuDuc et al. (2013) and illustrated in Figure 4.3, where relaxation is supposed to be similar to appreciation. This information was added to the overview in Table 4.1, where appreciation/relaxation is considered to be the same as contentment.

In conclusion, heart rate (HR), HRV and GSR measures could be useful in analyzing the emotional states and arousal/stress levels of a person. However little is known about differences between specific emotions and distinguishing between similar emotions could be difficult. The interpretation of these measures should therefore be treated cautiously. In the remainder of this chapter a first test with PWD watching full-immersive virtual experiences will be discussed. The HR, HRV, and GSR measures presented above will be used to analyze the applicability of physiological measures for evaluating the responses of PWD. The overview given in Table 4.1 will be used as a reference during the interpretation of the results.

4.2 First user experience test

4.2.1 Method

Study design

The purpose of this user experience test was to obtain a first impression on how dementia patients would respond to several specifically developed VR experiences. This study was of an explorative nature since little is known about the reactions of PWD to full-immersive virtual experiences. The content of the experiences was based on data gathered from interviews with family members and meetings with staff of care home Randerode at Apeldoorn. Several types of VR experiences were developed: passive experiences, a semi-interactive experience and an interactive experience. The passive experiences were 360° video recorded images of calm environments or environments assumed to slightly engage older adults. The semi-interactive experience was a computer generated environment, and offered the possibility to initiate a certain action. However, no real response was offered by the virtual environment to the action, and therefore this experience was not viewed as an interactive experience. The interactive experience was also a computer generated environment and offered the opportunity to interact with the virtual environment. An overview of the offered VR experiences during this first user experience test is summarized in Table 4.2 and snapshots of the experiences are displayed in Figure 4.4. In this first user experience test the feasibility of using physiological measures to evaluate the experience and emotional states of dementia patients was also tested.

Figure 4.4. Snapshots of the offered VR experiences during the first user experience test. From left to right, first row: Pond 1, Pond 2, Watch tower, Children's farm (passive experiences). From left to right, second row: Choir (passive), Fishing (semi-interactive), Painting (interactive).

Participants

Five dementia patients (two male, three female) residing in care home Randerode were recruited to participate in a first user experience test. They were selected by the medical doctor and psychologists of the nursing home, based on the following requirements: a) the participant does not have a history of motion sickness or epilepsy, b) the participant has a reasonable sight and hearing, and c) the participant is proficient in the Dutch language and can still express how he/she feels. The final selection of participants was based on the assumed suitability of the Virtual Reality experience for the dementia patient. Selection reasons varied from 'keen on technological products' to 'offering an

Table 4.2

Overview of the offered VR experiences during the first user experience test

VR experience	Description	Viewed by
Passive experiences		
Pond 1 (Enschede)	Calm experience in which you have an overview over a small pond located in Enschede. A goose and some ducks swim in the pond. Recorded from a one-point view.	P1, P4
Pond 2 (Park Berg & Bos, Apeldoorn)	Calm experience in which you have an overview over a pond with fountain located in Apeldoorn. The pond is situated in a well-known walking park, 'Park Berg & Bos'.	P4
Watch tower (Park Berg & Bos, Apeldoorn)	Slightly engaging experience. There is a one-point view from a watch tower overlooking the trees in Park Berg & Bos in Apeldoorn.	P2
Children's farm	Slightly engaging experience. Different views of donkeys, goats, pigs and sheep on a children's farm are presented in this video. Animal sounds are clearly audible.	P1, P2, P4
Choir	Slightly engaging experience. Two video's of two different choirs are presented in this video. The choirs are singing in an old castle. The first choir sings a more classic song, while the second choir sings a more upbeat and modern song.	P3, P5
Semi-interactive experience		
Fishing	Passive, slightly interactive experience in which a fishing rod can be thrown into a fishing pond. However, the fish did not bite in this experience.	P1
Interactive experience		
Painting	Active, interactive experience in which a white canvas can be painted via the controller in a virtual environment. Several different colours can be selected, and the canvas can be cleared when someone wants to start over.	P1, P2

opportunity to go outside' and 'trying to trigger someone'. Participants differed in their symptoms, one for example displayed depression and apathy, and another was frustrated and unrestrained.

Informed consent for each participant was obtained from the legal representative, usually a family member. Each participant experienced one or multiple VR experiences, this is summarized in Table 4.2.

Measures and materials

The Virtual Reality experiences were shown to the participant via a stand-alone VR headset, the Oculus Go. The controller provided with the Oculus Go was only used by the participants when the (semi-)interactive scenarios were tested. All sessions, but one, were video recorded. Participants were observed by the researchers and a caregiver or activity-coordinator on any signs of unpleasantness. The Observed Emotion Rating Scale (OERS) (M. P. Lawton et al., 1999) was used as a guide for this purpose and was later used more extensively to evaluate the emotions of the participant on the recorded video tapes. For a more objective evaluation of the experience, the peripheral measures Blood Volume Pulse (BVP) and Electrodermal Response (EDR) were recorded with an Empatica E4. These measures were used to calculate Heart Rate Variability measures.

Setting

The test sessions took place in the family room located at one of the wards. This room is normally used by the activity-coordinator to organise several activities for the residents. The family room provided a quiet testing environment, away from the other residents. A comfortable chair was present for the participants to sit in.

Procedure

The participant was accompanied by either a caregiver or the activity-coordinator. Two participants were also accompanied by one of their family members. The participant was welcomed by the researchers and asked to take place in the comfortable chair. The Empatica wristband was shown to the participant, and it was explained that it measured their heart rate and sweat in order to keep them safe. The researcher asked the participant if she was allowed to put on the wristband and informed the participant that they could indicate it when it was applied too tightly. Next, the VR headset was shown to the participant and explained in an understandable manner. One of the researchers prepared the VR headset, and set up the first experience. Then, the researcher asked the participant if she could put on the headset. After a confirmation, the headset was carefully placed on the head of the participant, with the first experience already playing. The participant was asked if the headset was comfortable, and adjustments were made when it was not. Each VR experience had a maximum duration of 5 minutes. Depending on the participant and their liking of the experience, the experience was either viewed fully or ended earlier when the participant indicated he/she wanted to stop. The participant was frequently asked whether he/she wanted to keep looking or not. After the VR experience, there was a VR break of about 5 minutes in which the researchers asked questions about the experience. The participant was then asked whether he/she wanted to see another experience. This cycle of viewing and evaluating was continued until the participant indicated he/she wanted to stop or when a maximum of four experiences was reached. At the end of the session, the Empatica wristband was removed and the participant was thanked for their participation. The caregivers and activity-coordinator were asked some questions related to the guidance of the VR session.

Data analysis

One of the aims of this user experience test was to discover whether physiological data could be used in evaluating the VR experience. Heart rate, heart rate variability (HRV) and galvanic skin response (GSR) were the chosen measures. Heart rate is affected by all sorts of factors such as physical activity, talking, and changes in breathing pattern (Shaffer & Ginsberg, 2017). Peaks and drops in heart rate are thus not solely attributable to mental arousal. However, psychological activation can be measured by using additional heart rate as a measure (Yang, Jia, Liu, & Sun, 2017). Additional heart rate is calculated as the difference between measured heart rate and predicted heart rate. The predicted heart rate is influenced by heart rate demand and cardiovascular condition. Heart rate demand is defined by the maximum and minimum HR of a person and the exercise intensity (Yang et al., 2017). Since no pre-measures were taken to obtain e.g. maximum and minimum HR of each person, and cardiovascular condition was not specified, the influence of physical activity on the heart rate measure could not be ruled out in this data analysis. Instead it was chosen to obtain a 'baseline' for heart rate by averaging the heart rate over the total sample time, and adding and subtracting the standard deviation of the sample to this average. In this way, a 'baseline' band was created resembling the predicted heart rate, which could then be compared to specific parts of the sample. Heart rate values above and below the 'baseline' band were then indicative of either over- or under-arousal of the participant. These arousal levels could both be caused by mental activity and physical activity, since no correction for physical activity was applied. However, indications of the origin of the arousal were obtained from the video and accelerometer data.

The physiological data obtained from the Empatica E4 was analyzed with software programs dedicated to analyze heart rate variability and galvanic skin response. For analyzing heart rate and heart rate variability the Kubios software (Kubios, 2016a) and the RHRV package for R (García et al., 2018) were used. The heart rate data was inspected first for each participant. Suspected artifacts, such as very low or very high heart rates, were removed from the data using R. The Kubios software automatically filters the data using a smoothness prior detrending method, resulting in a cleaner signal. The Kubios software provided results in the time- and frequency-domain. For each participant the PNS and SNS index values for each sample were inspected. The PNS index is characteristic of the parasympathetic nervous system activity and is computed based on measures of mean RR, RMSSD, and SD1. The SNS index is characteristic of the sympathetic nervous system activity and is computed based on mean HR, Baevsky's stress index, and SD2. Low PNS indexes and high SNS indexes are indicative of stress (Kubios, 2016b). For analyzing galvanic skin response Ledalab for Matlab (v.3.4.9) was used. This software package analyzes the GSR signal and divides it into tonic and phasic activity via continuous decomposition analysis (Benedek & Kaernbach, 2010).

4.2.2 Results

Observed reaction towards the VR experiences

In this section it is described how each participant reacted towards the different virtual environments, based on the video recordings. Emotional reactions were rated with reference to the Observed Emotion Rating Scale by M. Lawton, Van Haitsma, and Klapper (1999). Also both verbal and physical reactions towards the VR experiences and signs of discomfort were captured. More general observations about the reaction to the virtual environments are also described here.

Participant 1 experienced four VR experiences, in the following order: children's farm, painting, pond 1 and fishing. The participant was accompanied by his niece and the activity coordinator (AC) of Randerode, and was tested in the morning. Participant 1 expressed some depressive symptoms and naturally had his head slightly downwards. This head-position remained mostly the same when viewing the VR experiences, even when asked to lift his head some more. The first VR experience (children's farm) seemed to trigger this participant. He started to describe what he saw on his own initiative. However, his attitude was very indifferent during most VR experiences, and he was not easily impressed. His reactions towards the VR experiences were more negative than positive. He claimed that he had seen these things before (probably mentioning the content of the virtual environment, instead of the actual VR headset and the 360 experience). Despite this seemingly negative attitude, his niece indicated that she noticed a change, and that he talked more than usual.

> Niece: "It strikes me, he begins to talk now, normally he hardly says a word."

> AC: “So it does trigger him?”
>
> Niece: “Yes, it does, I really think so.”

Some confusion was seen by the participant between the semi-interactive experience and the interactive experience. For both experiences he needed the controller, but different actions were required from him. The first time, during the interactive experience, he had to press a button, and the second time, during the semi-interactive experience, he did not. Naturally he was pressing the button during the semi-interactive experience, however in this case he then returned to the home menu. It appeared that the interactive experience was too difficult for this participant, he was not able to put something on the canvas. The semi-interactive experience was more appealing to participant 1, although some help was needed with throwing out the fishing rod. His niece indicated the following:

> “He really liked this, yes, this was activating him. Nice.”

Also participant 1 expressed a more positive reaction towards the last VR experience, indicating that he thought it was amusing (Dutch: “geinig”).

Participant 2 viewed three VR experiences, respectively the children’s farm, the interactive painting scenario and the watch tower. Participant 2 was accompanied by the activity coordinator of Randerode, and was tested at the end of the morning. She had a defensive body posture throughout the whole experiment, having her arms crossed almost all of the time. However, this just seemed to be a comfortable position for her, since no defensive attitude was expressed towards the headset and she looked at ease. Participant 2 is still quite conscious about what is going on, but her short-term memory is quite heavily affected by the dementia. She knows the difference between being in the real world and being in the virtual world:

> “I’m present in two worlds, you suddenly put me in a forest or with animals, or here [meaning the real world]”.
>
> “I’m not scared, I know that I have that thing - *points towards headset* - on my head”.

Participant 2 thus not experienced a greater sense of core presence as was expected by Garcia et al. (2012) for people with dementia, and was not confused by what belonged to the real world and what belonged to the virtual world. Participant 2 was also capable of indicating when she wanted to stop: “I have seen it for now”, and “I think it is okay”.

Her general alertness was mostly good and she responded as if she understood the questions asked. Some questions were ignored though, possibly because she did not hear them or because they were formulated too difficult. The reliability of her answers seemed to be somewhat questionable when she first disconfirmed that she is scared of heights, and later indicated that she is a bit afraid of heights. Also after viewing the watch tower VR experience, she mentioned again that she is a bit afraid of heights.

Participant 2 looked around a lot when she had the headset on, and really explored everything that there was to see. She also naturally started to describe what she saw during the experience. She did had the tendency to repeat herself. She made the same comments about the same virtual environment several times. Outings of pleasure mostly occurred after the VR experiences or when a question was asked. At the third experience, pleasure also occurred during the VR experience, mostly after a ‘scary’ moment of looking down the watch tower. During and after the first and third experience she gave verbal indications that she liked the experiences, such as: "gorgeous, yes", "very nice view", "it is very pretty, truly, nice skies, nice trees". Occurrences of anxiety/fear and sadness appeared both during the explanation, viewing, and discussion of the second VR experience (painting). This experience seemed to cause confusion and a sense of inability for the participant. The participant even raised her voice a little during the painting experience, displaying her incomprehension of why the selection of a color did not work as she expected to. She thus seemed to be affected negatively by the painting experience. She still brought up the subject afterwards, she did not understand why she was not able to draw as she wanted too.

The occasional adjustments of the headset by the participant indicated temporary feelings of discomfort. The participant also indicated several times that it was warm in the room, likely the VR headset was also a source of heat for her, hence also the adjusting of the headset. It however did not seem to bother her too much.

It was hard for participant 2 to compare the three experiences afterwards. Even after naming the different experiences, she just indicated that she liked all experiences. However, her reaction during and after the second experience indicated that she did not liked this experience as much.

Participant 3 only viewed one VR experience, the choir. Participant 3 was accompanied by her husband and a caregiver of Randerode, and was tested after lunch. She immediately indicated that the headset was not comfortable when it was put on. Adjustments made to the headset straps did not relieve any discomfort. Eventually, one of the experimenters held the VR headset before the eyes of the participant, without it being placed on the head of the participant. The participant looked at the experience this way. She was not expressing real enthusiasm about the experience, the music was not her taste, it was 'just fine'. After the first experience her husband indicated that it would be better to stop. Due to a malfunction there was no video data for this participant.

Participant 4 experienced three VR experiences, namely pond 2, children's farm and pond 1. Participant 4 was accompanied by a caregiver of Randerode, and was tested in the early afternoon. He entered the experiment room frustrated about his personal situation, and spoke loudly. However, he was willing to put on the Empatica wristband and the VR headset. During the VR experiences it was necessary for the participant to bring the attention back to the virtual environment (VE), because he was easily distracted by his own thoughts. He often missed questions asked by the experimenters, general alertness was low for this participant. When he had the headset on his head, he was in his own little world. The VEs were engaging and activating. He actively started pointing out things he saw and described and counted them. Signs of pleasure were noticed when he was talking about the VE, laughter usually appeared right after removal of the headset. The participant indicated that he liked the VR experiences: "It is beautiful, really", "I like it", "Pleasant, yes". Signs of anger and sadness were visible in this participant when he was talking about his personal circumstances.

Participant 5 only viewed one VR experience, the choir. Participant 5 was accompanied by a caregiver of Randerode. She was tested in the afternoon, and just returned from a group activity. The first half of the experience seemed to grab the attention of this participant. She had one hand close to her mouth and when the choir stopped singing she started applauding and smiled. Then a second choir started singing, but she was distracted by the weight of the headset. She seemed to like this part less, and after a while she indicated that she wanted to stop looking ("I have seen it for now").

She rubbed her eyes extensively when the VR headset was removed. When asked if she liked the experience, she answered that there was a lot of movement, which distracted her from the singing. The image of the first choir was more still and was therefore also more liked by her. The feeling of more movement in the second part of the VR experience could also be caused by the instruction of the researcher to look around. She then repeatedly looked from left to right, maybe too fast. When asked if she wanted to try another VR experience with nature images she indicated that she would rather not. When she left the experiment room together with the caregiver, she expressed feeling a little bit dizzy.

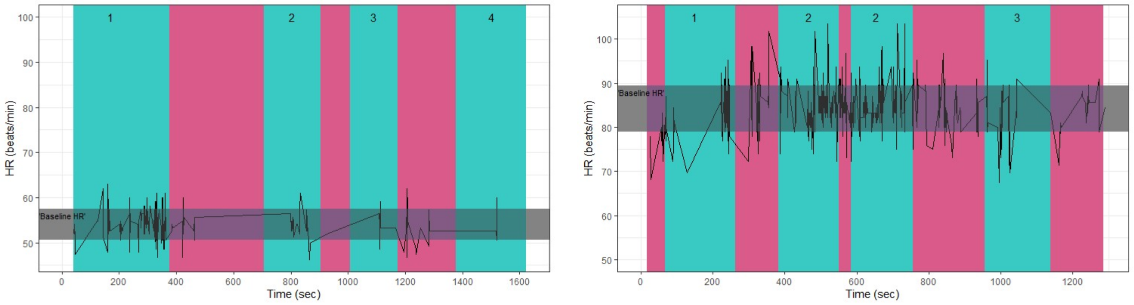
Heart rate and Heart Rate Variability analysis

For each participant the baseline heart rate band was calculated, visualized as the grey band in Figure 4.5. Participant 3 was left out of the analysis, since there was no video data present to compare the heart rate values to. The visualization of the heart rate per participant is divided into sections of the participant wearing the VR headset (the green/blue areas) and of the participant having a VR break (the red/pink areas) (see Figure 4.5). The numbering of the green/blue areas indicates the number of different VR experiences the participant saw. The heart rate data was obtained via the Inter-Beat-Interval points which are provided by the Empatica E4. As can be seen from the heart rate patterns there are some gaps in the data, especially for participant 1 and 5 (Figure 4.5a, respectively Figure 4.5d).

Participant 1 had an average heart beat of 53.9 beats/minute with a standard deviation of 3.5 beats/minute. The measured heart rate is very low, therefore it is questionable if the heart rate was measured correctly. However, a low heart rate could also be caused by medications for either heart diseases or psychosis (Mayo Clinic, 2011). No information about the medical condition of the participant was available, but it was known that the participant had depressive symptoms, and therefore the low heart rate might perhaps be caused by medication against these symptoms.

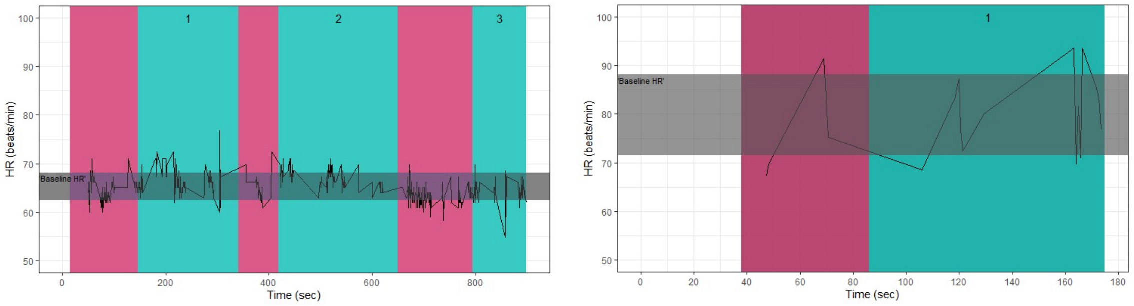
As indicated, there are some serious gaps in the data of this participant. In the first VR break and the beginning of the 2nd VR experience (from around 480 ms to 790 ms) there are no measurements. When looking into the video data, the participant received the Oculus Go controller around 530 ms, and tilts his hand where the Empatica E4 is situated and moves it up and down until 939 ms. A big part of the data loss seems to have occurred due to movement of the hand. However, the data signal was already lost before the controller was handed over to the participant, which might indicate that there was some air between the sensor of the Empatica E4 and the skin of the participant. Then again from around 870 ms to 1100 ms there is a gap in the heart rate data. There might be some missing data points again by movement of the arm where the Empatica was situated (the participant was adjusting the headset with his hands from around 990 ms to 1002 ms). However the rest of the missing data points in this timespan could not be explained by the video data, the hand of the participant is situated in his lap and in a horizontal position. It is possible that there was some air between the watch and the skin of the participant, but this could not be seen from the video data. The last gap from around 1300 ms to 1520 ms could be for the most part explained by the fact that the participant is holding the VR controller in the same hand as where the watch was situated and he was moving this arm frequently.

For participant 2 the recording seems most reliable, a more dense heart rate pattern is visible here. The average heart rate over the total sample was 84.2 beats/minute with



(a) Heart rate graph participant 1. Experienced 1) Children's farm, 2) Painting, 3) Pond 1, 4) Fishing.

(b) Heart rate graph participant 2. Experienced 1) Children's farm, 2) Painting, and 3) Watch Tower.



(c) Heart rate graph participant 4. Experienced 1) Pond 2, 2) Children's farm, 3) Pond 1.

(d) Heart rate graph participant 5. Viewed the Choir virtual experience.

Figure 4.5. Visualization of the heart rate per participant during the experiment. The blue/green belts indicate the VR experiences, and the reddish/pink belts indicate the VR breaks.

a standard deviation of 5.3 beats/minute. It can be seen from the graph that especially before, during, and after VR experience 2 (painting) this participant had a high arousal level. Before and during VR experience 1 (children's farm) and during and after VR experience 3 (watch tower) participant 2 had a low arousal level. No real difference in mean RR interval per sample was noticed (see Table 4.3a) for participant 2, however when looking at the pNN50 a much lower percentage of NN intervals are more than 50 ms apart from each other during the second VR experience compared to the first and third VR experience. This can be an indication of increased parasympathetic activity (Shaffer & Ginsberg, 2017), but if you look at the HR graph it seemed more likely that this difference occurred due to bigger gaps between two data-points (due to missing data) and less data-points in general during VR experience 1 and 3. From Table 4.3a it can be seen that during the 2nd VR experience much lower PNS and much higher SNS values were displayed in participant 2 compared to the other samples, both is an indication of stress. The 2nd VR experience was the interactive experience of painting. Although the participant understood the actions she had to perform, she was not able to complete them flawlessly. Therefore she got frustrated: "I don't get it", "that's not what I want to do", *when trying to select another colour:* "black again, how is that possible?". This frustration corresponds to the PNS and SNS values.

Also frequency domain measures were reviewed for participant 2 (see Figure 4.6). Since the difference between the 2nd and the 3rd VR experience seemed the most noticeable, it was chosen to only look at the power spectrum plots associated with these time samples. Because no real baseline is present, the changes in measures were compared between the 2nd and 3rd VR experience. A high increase in the LF region ($LF = 863ms^2, 85.41n.u.$) is visible in the VR break between the 2nd and 3rd VR experience ($LF = 251ms^2, 56.68n.u.$ and $LF = 317ms^2, 72.70n.u.$ respectively). Also a high LF/HF ratio is reported (5.928 compared to a mean of $2.8, (SD = 2.6)$ set by Shaffer and Ginsberg (2017)). In general, there is a shift in power noticeable from the HF region to the LF region during the 2nd VR experience and the VR-break afterwards, while this shift is reversed in the 3rd VR experience and post-measure.

Table 4.3

Selected HRV measures for analysis: mean RR, pNN50, PNS and SNS index values.

	Pre-measure	1st VR experience (Passive)	VR break	2nd VR experience (Interactive)	Pause	2nd VR experience (continued) (Interactive)	VR break	3rd VR experience (Passive)	Post-measure
mean RR (in ms)	758	718	708	708	712	707	710	733	705
pNN50 (in %)	64.71	56.60	55.88	24.39	28.95	30.95	42.03	54.05	22.58
PNS index	0.94	0.42	0.60	-0.30	0.09	-0.31	0.18	0.72	0.08
SNS index	0.79	0.95	1.23	1.55	1.56	1.28	1.11	0.72	1.18

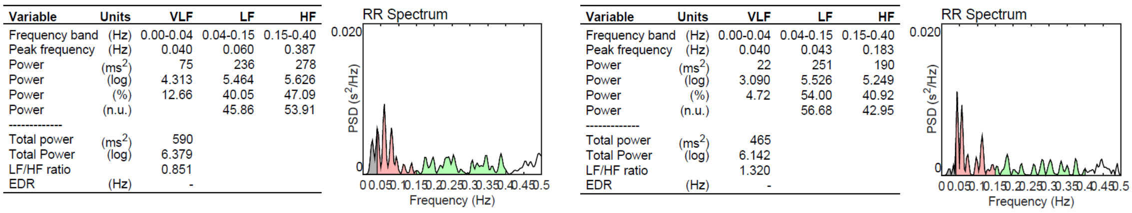
(a) *Participant 2*

	Pre-measure	1st VR experience (Passive)	VR break	2nd VR experience (Passive)	VR break	3rd VR experience (Passive)
mean RR (in ms)	922	901	921	894	945	937
pNN50 (in %)	18.46	24.00	4.76	14.46	27.78	30.00
PNS index	0.45	0.53	0.04	-0.03	0.66	0.91
SNS index	0.16	0.06	0.97	0.92	0.18	-0.29

(b) *Participant 4*

Participant 4 had an average heart rate of 65.2 beats/minute and a standard deviation of 2.8 beats/minute. During VR experience 1 and VR experience 2 a high arousal level can be seen, while the participant is under-aroused before and during VR experience 3. The PNS and SNS index values of participant 4 are in line with this finding (see Table 4.3b). They indicate some stress during the first VR break and the second VR experience (lower PNS values and higher SNS values), while the second VR break and the 3rd VR experience seems to be a relaxing experience for this participant (higher PNS values than SNS values). When these moments are compared to the video data, it is visible that during the first VR break and the second VR experience the participant was distracted by his own frustration about his personal situation. He was talking in a frustrated manner about this, and it was hard to keep his attention to the VR experience. This frustration likely caused stress in the participant. In the second VR break and during the 3rd VR experience the participant is more focused on the VR experience and shows less frustration. He actively describes what he sees in the virtual environment and seems to enjoy it. The higher PNS values and lower SNS values seem to be in line with this image. For participant 4 little difference is present between the mean RR of different samples (see Table 4.3b), however percentages of pNN50 are higher for VR experience 1 and 3 than for VR experience 2. This difference seemed not to be caused by differences in the amount of data-points present for all three samples, and therefore it is more likely that the difference is caused due to a change in parasympathetic activity. This is in line with the information described above.

For participant 4 part of the frequency domain measures are summarized in Figure 4.7. Three samples of the session were compared, the 2nd VR experience, the VR-break



Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.040	0.060	0.387
Power	(ms^2)	75	236	278
Power	(log)	4.313	5.464	5.626
Power	(%)	12.66	40.05	47.09
Power	(n.u.)		45.86	53.91

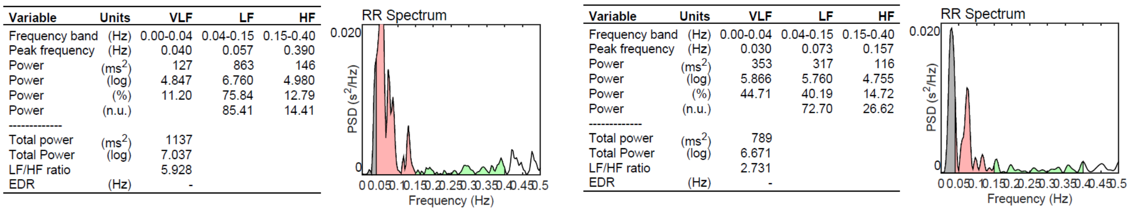
Total power	(ms^2)	590		
Total Power	(log)	6.379		
LF/HF ratio		0.851		
EDR	(Hz)	-		

Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.040	0.043	0.183
Power	(ms^2)	22	251	190
Power	(log)	3.090	5.526	5.249
Power	(%)	4.72	54.00	40.92
Power	(n.u.)		56.68	42.95

Total power	(ms^2)	465		
Total Power	(log)	6.142		
LF/HF ratio		1.320		
EDR	(Hz)	-		

(a) 2^{nd} VR experience, 1^{st} half

(b) 2^{nd} VR experience, 2^{nd} half



Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.040	0.057	0.390
Power	(ms^2)	127	863	146
Power	(log)	4.847	6.760	4.980
Power	(%)	11.20	75.84	12.79
Power	(n.u.)		85.41	14.41

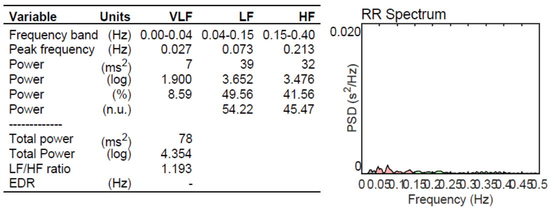
Total power	(ms^2)	1137		
Total Power	(log)	7.037		
LF/HF ratio		5.928		
EDR	(Hz)	-		

Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.030	0.073	0.157
Power	(ms^2)	353	317	116
Power	(log)	5.866	5.760	4.755
Power	(%)	44.71	40.19	14.72
Power	(n.u.)		72.70	26.62

Total power	(ms^2)	789		
Total Power	(log)	6.671		
LF/HF ratio		2.731		
EDR	(Hz)	-		

(c) VR-break

(d) 3^{rd} VR experience



Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.027	0.073	0.213
Power	(ms^2)	7	39	32
Power	(log)	1.900	3.652	3.476
Power	(%)	8.59	49.56	41.56
Power	(n.u.)		54.22	45.47

Total power	(ms^2)	78		
Total Power	(log)	4.354		
LF/HF ratio		1.193		
EDR	(Hz)	-		

(e) Post-measure

Figure 4.6. Power spectra plots and frequency domain measures from participant 2. Data obtained from part of the session.

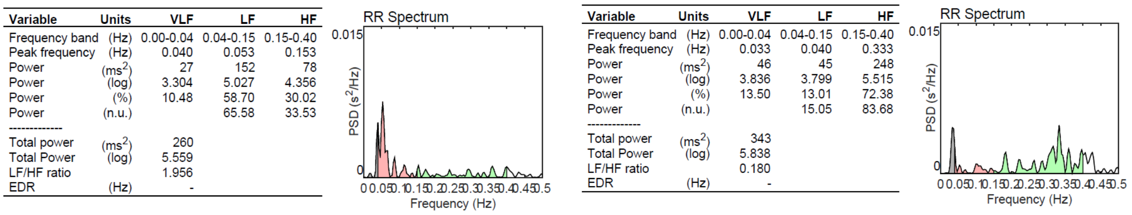
and the 3rd VR experience. For the 2nd VR experience a higher LF value and a lower HF value can be seen ($LF = 65.58 n.u., HF = 33.53 n.u.$ in comparison with $LF = 15.05 n.u., HF = 83.68 n.u.$ for the VR-break and $LF = 45.00 n.u., HF = 54.49 n.u.$ for the 3rd VR experience). This is also reflected in the LF/HF ratio (1.956 compared to 0.180 and 0.826).

There are only few data points for participant 5, therefore the quality of this recording is questionable. The average heart beat of this participant during the experiment was 79.8 beats/minute with a standard deviation of 8.4 beats/minute. The first half of the VR experience the participant seemed under-aroused while the second half she seemed aroused. This is in line with the observations in the video data, however, the reliability of these arousal levels is questionable due to the lack of data points.

A lower heart rate is observed for both males (participants 1 and 4) with respect to both females (participants 2 and 5), which is in line with the literature (Yang et al., 2017; Shaffer & Ginsberg, 2017).

GSR analysis

The skin conductance levels of participant 1, 2, 4 and 5 during their sessions are visualized in Figure 4.8. The skin conductance levels of participant 1 and 5 were extremely low (around 0.01 μS) and relatively flat, which makes the reliability of this data questionable. Participant 2 and 4 showed more normal skin conductance levels, although the SC of participant 4 was also quite low. Participant 2 showed an increase in tonic skin conductance level throughout the session. This could indicate a change of mood during the session, but the rise is more likely attributable to the rise in body temperature.



Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.040	0.053	0.153
Power	(ms^2)	27	152	78
Power	(log)	3.304	5.027	4.356
Power	(%)	10.48	58.70	30.02
Power	(n.u.)		65.58	33.53

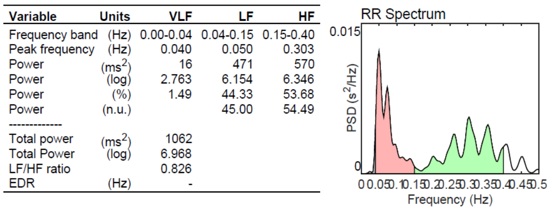
Total power	(ms^2)	260		
Total Power	(log)	5.559		
LF/HF ratio		1.956		
EDR	(Hz)	-		

Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.033	0.040	0.333
Power	(ms^2)	46	45	248
Power	(log)	3.836	3.799	5.515
Power	(%)	13.50	13.01	72.38
Power	(n.u.)		15.05	83.68

Total power	(ms^2)	343		
Total Power	(log)	5.838		
LF/HF ratio		0.180		
EDR	(Hz)	-		

(a) 2^{nd} VR experience

(b) VR-break



Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.040	0.050	0.303
Power	(ms^2)	16	471	570
Power	(log)	2.763	6.154	6.346
Power	(%)	1.49	44.33	53.68
Power	(n.u.)		45.00	54.49

Total power	(ms^2)	1062		
Total Power	(log)	6.968		
LF/HF ratio		0.826		
EDR	(Hz)	-		

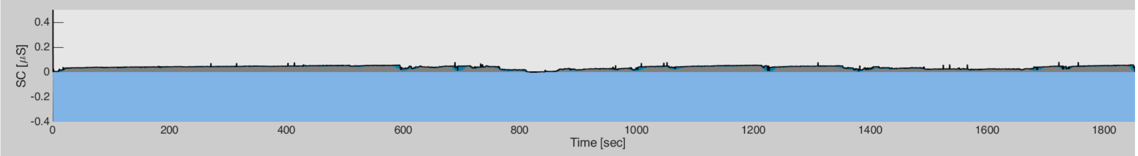
(c) 3^{rd} VR experience

Figure 4.7. Power spectra plots and frequency domain measures from participant 4. Data obtained from part of the session.

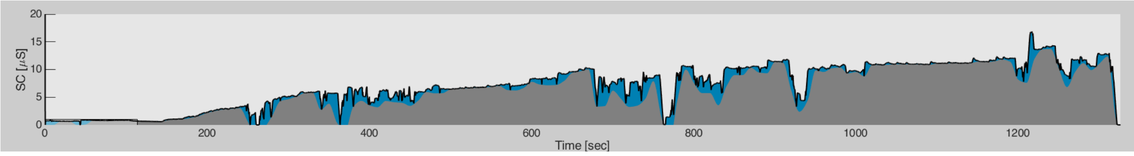
The room was quite warm at the moment of testing due to direct sunlight through the windows, and participant 2 indicated during the session that she was feeling hot. Also some low phasic activity is visible in the data (the blue areas), but this activity did not seem to be caused by emotional responses. Steep drops and increases in the signal were likely a consequence of lost contact between the skin and electrodes. This assumption is supported by the accelerometer data, drops mostly occurred at the same time as significant movement by the participant, leading to a bigger chance of lost contact by shifting of the E4 wristband. The smaller phasic peaks were most likely non-specific SCRs. Participant 4 showed a rather consistent tonic skin conductance level with a small increase at the end of the session. The most phasic activity is also visible towards the end of the session, however when looking into the accelerometer and video data participant 4 moved a lot with his arms which likely influenced the electrode measurement in that part of the recording.

Caregivers guidance

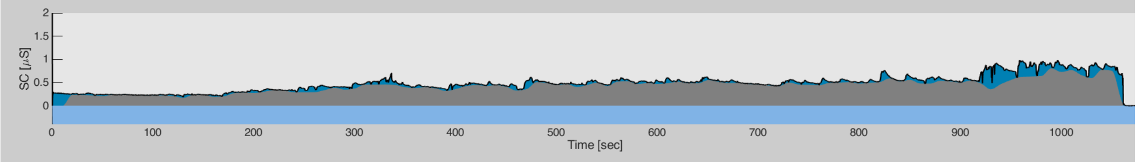
After the VR sessions with the PWD, some questions were asked to the caregivers in relation to the guidance they would offer when they had to perform such a VR session themselves and what they would need for it. Caregivers were not specifically instructed beforehand to give guidance in this user experience test, some offered it by themselves anyhow for some PWD. However, this is of course also dependent on the PWD, some needed more guidance than others. When asked what they would need if they had to guide the VR session themselves, they mostly responded that they would need instructions about the VR headset. One caregiver responded that she would have guided it in the same manner as the researchers did, by explaining to the PWD what to expect. However she thought it was unlikely that she would guide such a session in the future because it was more of a task for the activity-coordinator. When it was pointed out to her that the VR headset could possibly have a beneficial effect upon restlessness in the night, she replied that she never worked at night and that another caregiver would know better if there was time to use a VR headset during the night. Also the other



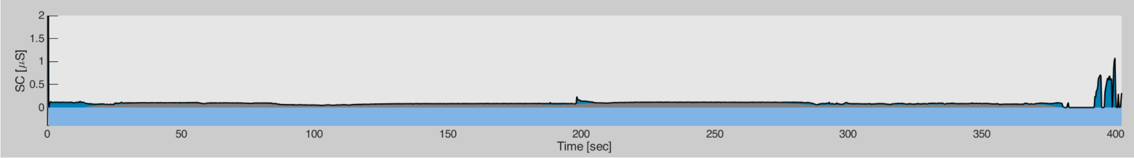
(a) Participant 1



(b) Participant 2



(c) Participant 4



(d) Participant 5

Figure 4.8. Skin conductance levels (in μS). The grey area indicate the tonic skin conductance level, the blue areas the phasic activity.

caregiver stated some concern about time to apply the VR headset because it requires the full presence of the caregiver during the VR experience, it is not possible to leave the PWD alone with the headset on. The activity coordinator indicated that, in order to give clear guidance, she must be able to see what the PWD is seeing. A second screen is needed on which the VR experiences can be viewed. In this way, the one who guides the PWD could ask more directed questions and would have a better insight into what the PWD is talking about and how they feel about the VR experience.

Also the ability to judge the mood or emotional state of the PWD was questioned. Both caregivers indicated that they could still easily judge the emotional state of the PWD despite the fact that part of the face was covered by the virtual headset. They mostly paid attention to verbal reactions by the participant to obtain an indication of his/her mood. And if the PWD would not have been able to express himself verbally, they would pay attention to body language, nervous movements, looking around more (although a caregiver admitted that this could also be the result of the VR experience itself). Also signs of trying to rise up from the chair would be indicative of agitation.

4.2.3 Conclusion and discussion

This user experience test yielded a first impression of how PWD with moderate dementia reacted to different passive and (semi-)interactive experiences. An overview of the findings are presented in Table 4.4. First, participants were open to try the VR-headset and willing to put it on their heads. For two of the five participants the headset was too heavy, but they still experienced one VR experience either because the headset was sup-

Table 4.4

Overview of the findings per participant on type of VR experience.

Participant	Passive experiences	Semi-interactive experience	Interactive experience
P1	Described the VE by own initiative, triggered him to talk more. Expressed himself somewhat negatively towards the VR experiences. Inconclusive arousal levels.	Challenging, but with help able to throw out the fishing rod. VE seemed to engage the participant.	Very challenging, not able to interact with the VE as intended.
P2	Expressed verbally her liking of the experiences. Described the VE by own initiative. Low arousal level. Comparable SNS and PNS indexes.	N.A.	Challenging, but managed to interact with the VE. Not able to perform all actions, which was frustrating for her. Expressed frustration verbally. High arousal level. High SNS indexes, low PNS indexes.
P3	Neutral about the experience. Headset was too heavy.	N.A.	N.A.
P4	Expressed verbally his liking of the experiences. Actively pointed out objects and described them when asked about the VE. High arousal level viewing the children's farm and pond 2, low arousal level viewing pond 1, corresponding PNS and SNS indexes.	N.A.	N.A.
P5	First part of the VR experience seemed to be appealing, but the second part was not received well, there was too much movement. Indicated that the headset was really heavy. Low arousal in the first part of the VR experience, high arousal in the second part. High PNS index, low SNS index.	N.A.	N.A.

ported by the researchers or was held before the face of the participant without placing it on her head.

Second, the passive VR experiences were received better by the participants than the interactive experience. During the sessions the interactive experience appeared to be too difficult for PWD. This led to frustration, which is also visible in the higher arousal level of participant 2 during this experience. The activity coordinator indicated that such an experience has a negative effect on the self-esteem of the PWD, they often experience an incapability of certain actions and this is an extra confronting experience. The VR experience should be rather used to enable the PWD to perform certain actions they are unable to perform in real-life and boost their self-esteem. From this first user experience test it seemed that the interactive experience is not suitable for PWD. However when the design would be adjusted and actions would be made more simple, an interactive experience might still be suitable. This could especially be the case for PWD who need a little bit more stimulation (e.g., PWD expressing apathy). This is also visible in the reaction towards the semi-interactive experience of fishing by participant 1, who displayed some depressive symptoms. Although the action he had to perform was challenging, he did like the experience when he finally succeeded. His reaction was more positive towards the semi-interactive experience than the passive experiences, which is likely caused by the higher threshold of stimulation needed for this participant.

The findings for the passive experiences were more positive, however they also differed in their level of appreciation. The images of the choirs singing for example were not received with full enthusiasm, while music is known as a medium able to invoke deep emotional feelings (Khalfa, Isabelle, Jean-Pierre, & Manon, 2002). However, music is also very sensitive to personal taste and the selected music did not appear to trigger the two participants tremendously (with one exception where participant 5 showed some appreciation during the VR experience, but indicated no joy afterwards). The other passive experiences seemed to trigger verbal responses and hand gestures by own initiative.

Another finding was that during the sessions most participants asked if they had done everything right. This could be a sign of participation bias in the way that they expressed liking of the experiences because they thought it was desired. However, it is more likely to be a characteristic of dementia. Dementia patients sometimes do not know anymore what is normal or how to respond normally, which makes them insecure about their capabilities. This insecurity could lead to the need of confirmation by others. The need for guidance becomes apparent here as well. This was also acknowledged by the caregivers and activity coordinator present during the VR sessions. They indicated that the VR activity always has to be guided, PWD are not able to do it alone. In order to give proper guidance during the VR experiences, it is necessary that the caregiver or activity coordinator can see what the PWD is seeing through the VR headset. In this way specific questions about or pointers to the VE can be formulated. Despite the partly covered face of the PWD by the VR headset, caregivers indicated that they were still able to interpret the emotional state of the PWD by body posture and verbal comments, which enabled them to respond to their reactions accordingly.

This user experience test was also used to get a first grasp on whether physiological data could be used in the evaluation of a PWD's emotional state. Both HRV measures and GSR measures were analyzed. GSR measures seemed not suitable for the experimental setting and target group. Very low skin conductance levels (near 0) were reported for participant 1 and 5, which questioned the accuracy of the measurement. These low values could be caused by the fact that the electrodes were not in full contact with the skin or that maybe the participants had a very dry skin, which reduces the amount of conductivity. For participant 2 and 4 the GSR signal was mostly influenced by arm movements of the participant which caused loss of signal. Furthermore in the experimental setting the stimulus (the VR experience) was not a short term, strong stimulus. The VR experiences were viewed for several minutes and had a passive nature. The VR experiences are not likely to elicit strong emotions and therefore event-related peaks in the skin conductance level are unlikely to be expected.

HRV measures seemed more informative and in accordance with the video data. Elevated arousal levels in the heart rate data could be explained by the observed events. Participant 2 for example showed an increased arousal level during the second VR experience, in which she was frustrated about her inability to fully interact with the VE. The PNS and SNS index values were in line with the observations from the video data, showing a relaxing effect of some of the VR experiences. In general, the frequency domain measures between high arousal and low arousal samples showed corresponding increases and decreases in the LF region and decreases and increases in the HF region. However, these measures were not compared to baseline values of the LF and HF regions because these were not measured. It is therefore not known whether the fluctuations between LF and HF were really attributable to changes in emotional state or that the power spectra of either the high or low arousal samples closely resemble baseline measures.

Some improvements could be made in the data collection of the physiological measures. Due to either movements of the arm where the Empatica was situated or a loose attachment of the Empatica on the wrist, loss of contact between the skin and the watch caused missing data-points. Especially for participant 1 and 5 this resulted in an unreliable signal to interpret. More attention could be paid to the placement of the Empatica E4 on the non-dominant hand and the tightening of the Empatica E4. However, some participants already indicated that they thought the watch was applied too tightly when there was still some space left. Also when questioned about their dominant hand, reliability of the answer of a PWD is sometimes low. Participant 1 indicated that he was ambidextrous, however during the session he preferred to use his left hand, the hand where the Empatica E4 was situated. This sparks the idea that maybe the Empatica E4 is not the most suitable device for measuring HRV and GSR for this target group due to its sensitivity for movement. In a follow-up test other devices more robust for movement should be considered as a replacement for the Empatica E4. Such a device could be for example a fitness watch. It must also be taken into account that PPG measures (used in the Empatica E4) are naturally already less reliable than ECG measures (where sensors applied to the body are used) (Pietilä et al., 2017). This is a trade-off to be made between less reliable data and less hassle with measuring physiological data for a stimuli-sensitive target group.

Another improvement could be the addition of a baseline measure. In this first user experience test results could not be compared to a baseline resting measure, which makes it difficult to interpret real (emotional) changes from the data. The pre-measures before the VR headset was put on by the participants were mostly too short to obtain a baseline. Also this pre-measure may not represent the true resting state of the participant, since they just entered a new room and are not sure what to expect. Adding a baseline measure will make the results more reliable. This could for example be done by showing the participant a calming video (not in VR) before the VR session is started.

Lastly, the length of the samples differed quite a bit within and also between participants. These varying lengths also resulted in a variable amount of data-points present per sample. Some differences between samples might therefore also have arose due to the differences in sample length and data-point density. In the next experiment more controlled samples could be pursued, but the sample length is mostly dependent on the participant as they decide whether they want to continue viewing or not. Maybe VR experiences containing more of a story instead of a setting could minimize the differences in sample length within and per participant, because it consists of a clearer beginning and ending.

In conclusion, this first user experience test researched the observed and physiological reaction of PWD towards several VR experiences and showed positive reactions towards passive VR experiences by PWD with moderate forms of dementia. PWD were open towards the VR headset and mostly tolerated it on their head. HRV measures seemed to be useful in the evaluation of PWD's experience and emotional state, however the results should be handled with care due to large gaps in the data. Future experiments should consider using a different device for measuring physiological data and adding a baseline measure to obtain more reliable results. It is also necessary to add a second screen to the experiment setting to give better guidance to the PWD while they are viewing the VR experiences. Despite the lack of this second screen in this first user experience test and the coverage of the face by the VR headset, the caregivers indicated that they were still able to understand the PWD's mood. Although the HRV measures likely will not be used by caregivers in the evaluation of the mood of a PWD, physiological data might be a promising tool to support the observed effects of VR on PWD.

4.3 Updated design requirements

The first user experience test provided more insight into the reaction of PWD to virtual reality experiences. Based on the results of the user experience test some new design requirements for the Virtual Reality application were formulated, as well as additions to the previously stated design requirements. For the sake of completeness the design requirements stated in the previous chapter are repeated here as well. The new requirements and the additions to other requirements are represented in bold.

DR1 The virtual experiences have to be designed specifically for people with dementia, **representing general interests such as animals and familiar places.**

DR2 **The virtual experience should be passive.**

DR3 A metaphor or analogy has to be formulated on how to introduce the VR headset to PWD.

DR4 The VR headset should be mobile and free of cords.

DR5 The VR headset should be readily usable, no complicated set-up.

DR6 To guide the resident in the virtual experience a second screen must be available on which one can see what the resident is seeing.

DR7 **The second screen should enable the caregiver to control the VR experiences: e.g. the screen can be used to formulate specific questions about the environment or to switch between different VR experiences.**

DR8 The interface of the second screen must be intuitive and easy to use.

DR9 The communication between the second screen and the VR headset must be (almost) real-time.

DR10 The VR headset must be accompanied with information on how to use it.

DR11 There must be a training moment for staff on how to use the VR headset.

This chapter marks the end of the first iteration of this Final Project. User research and a first user experience test were conducted to understand the demands for a Virtual Reality application for PWD. The design requirements for the application were updated and lessons were drawn from the test to be used in the second iteration. The updated set of design requirements is used in the next chapter to develop a first prototype of the Virtual Reality application for people with dementia.

Chapter 5

Development of a Virtual Reality application for PWD

Chapter 3 and 4 provided us with a set of design requirements for the Virtual Reality application for people with dementia. In this chapter it is described how these design requirements were used in the development of the Virtual Reality application, and marks the start of the second iteration of this Final Project. First the focus will be on the application itself, subsequently the development of educational materials for the application will be presented. The chapter closes with the discussion of a second test, the user experience & usability test. In this test caregivers of care-home Randerode had to guide PWD through the VR experiences and made use of the developed VR application.

5.1 Development guidance screen

Both during the user research and the first user experience test phases the presence of a second screen appeared to be a big prerequisite for using a VR headset for PWD. Four of the eleven design requirements covered this second screen, which will be from now on referred to as *the guidance screen*. The further development of a Virtual Reality application for people with dementia therefore was marked by the development of a guidance screen. In this section the creation of this guidance screen will be discussed from two points of view, the technical design and the interface design.

5.1.1 Technical design

The wish for a guidance screen that could control the VR experiences in the headset appeared to be a challenging one. The Oculus Go is characterized as a stand-alone headset, which means that all control is originated in the headset itself. Just streaming the virtual experiences from the headset to a second screen did not seem to be the preferred option here. Leaving the control of the virtual experiences within the headset requires the caregiver to put on the headset first to select an experience. Choosing the right experience can take a while when the amount of options will increase, which will lead to a longer period in which the resident is left 'unattended' (the resident can not be watched when the caregiver is having the headset on). Furthermore when only streaming the image of the VR headset the caregiver would not be able to control the selection of other virtual experiences while the resident is wearing the headset or for example pause the experience to talk about something they see. When the resident does not respond well to a certain experience you might want to switch to a different experience fast without having to remove the headset first, selecting a different experience, and then put the headset on again. For these reasons it was desired to design an application in which the control of the virtual experiences was shifted from the headset itself to an external screen.

The application was eventually developed using UNET (Unity Networking) in the Unity 3D Game Engine (Unity, 2019), which is usually used to set up multiplayer games. The essence of a multiplayer game is that different players must be able to communicate with each other. This is done over a server or a host. For the Virtual Reality application, a communication channel between two different 'players' was also sought and thus had common ground with the basics of a multiplayer game. The application makes use of broadcasting and networking principles. The guidance screen (in this case a tablet) serves as a server and the VR headset as a client of that server. Two different versions of the application were installed on the guidance screen and the VR headset, respectively one for the server and one for the client. Before the two devices could communicate with each other a connection between the two had to be established. This was done via broadcasting. At the start-up of the application the guidance screen (server) initializes a broadcast which makes the server visible for the VR headset (client). At the same time the VR headset searches for available servers. When the VR headset finds the server (guidance screen) they automatically connect. See Figure 5.1 for a visualization of this process. When the two devices are connected the broadcasting process will stop as well. In order to set up a successful connection it is necessary that the two devices are connected to the same local network, otherwise the two devices would not be able to find each other.

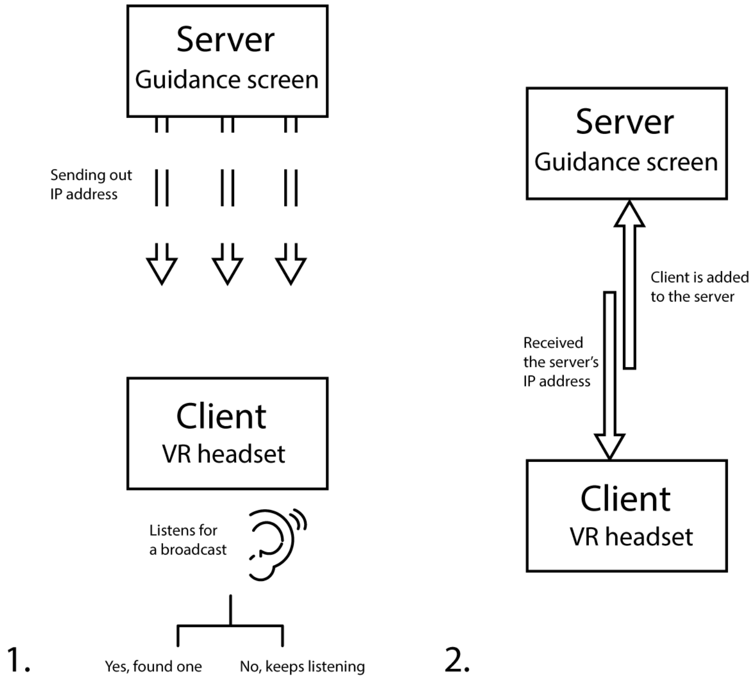


Figure 5.1. Broadcasting process visualized in two steps. The first step shows the initializing and searching process while the second step shows the connection process.

When the two devices are connected they are ready to communicate with each other. The VR headset will wait for input from the guidance screen. For the Virtual Reality application it was chosen to upload the virtual experiences to a private YouTube account. This provides an endless storage space for the tailored VR experiences and the opportunity to watch any other 360° YouTube video as well. To play the 360° video content in the Unity application the UnityYoutubePlayer package was installed (iBicha, 2019). In order to 'share' the view of one of the YouTube video's the guidance screen sends a YouTube url to the VR headset. They simultaneously play the same YouTube url which offers the same view without sending a whole video. This makes the communication much faster and makes sure the application also works with slower internet connections. The server side was also designed to control the video playback and is able to send commands to pause and play the video. The VR headset (client) thus receives a YouTube url and pause/play commands from the guidance screen (server). On the other hand the VR headset also sends information to the guidance screen. To ensure that the guidance screen mimics exactly what the person wearing the headset is seeing the VR headset sends its x,y,z rotation values to the server. These values are used to rotate the view of the video on the guidance screen in the same direction as the viewing direction of the VR headset. An overview of the communication between the guidance screen and the VR headset is displayed in Figure 5.2.

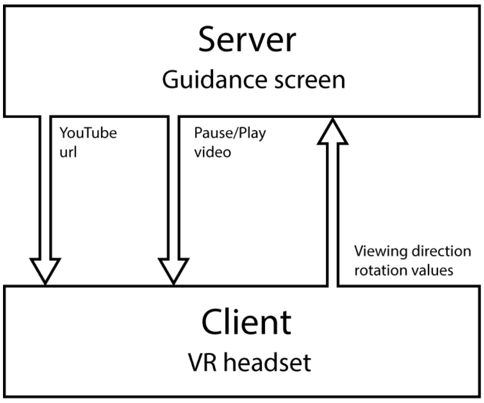
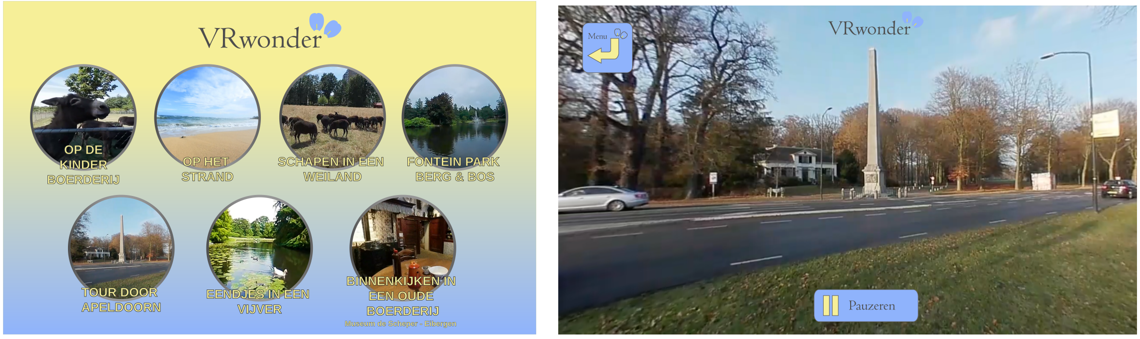


Figure 5.2. Simplified networkmodel of the communication between the tablet (server) and the VR headset (client).

5.1.2 Interface design

The name VRwonder was chosen for the developed Virtual Reality application. This name is based on the Dutch verb 'verwonderen', which means something like 'to marvel' or 'to wonder'. The idea is that the virtual experiences offer the possibility to explore a virtual environment which could surprise the viewer. They could wonder about this opportunity to see another world. In Dutch the name of the app would also be pronounced as the verb, so 'verwonder' with a silent e. The two petals in the logo of VRwonder are petals of the Forget Me Not flower. This flower is a symbol used by multiple dementia foundations which represent the fact that we do not forget about people with dementia. By adding these petals to the logo it distinctly says it is meant for PWD. The two petals also represent a little spark that hopefully the virtual experiences will bring about.

The Virtual Reality application VRwonder consists of two separate applications, one for the guidance screen and one for the VR headset. The interface of the VRwonder guidance screen had to be intuitive and easy to use by the caregivers. The set-up of the guidance screen is therefore fairly simple and consists of two main screens: a menu screen and an experience screen (see Figure 5.3). When the app launches the menu screen will be seen. In the menu screen an overview of the available virtual experiences is presented (Figure 5.3a). It was chosen to display the images in a round shape to resemble the idea of 'peeking inside another world through a peephole'. A virtual experience can be selected by clicking on the image. A loading pop-up will be visible until the virtual experience has loaded. While the guidance screen displays the main menu, the VRwonder app on the VR headset will display an image used frequently in learning how to read in the old days, the 'Aap-Noot-Mies' image. This prevents the PWD to look at a black screen while he or she is waiting for the caregiver to select a virtual experience, which is important because a black 'nothing' can cause feelings of fear or anxiety. At the same time the 'Aap-Noot-Mies' image can be used to test whether the headset is placed correctly on the head of the PWD. The PWD could be asked if he or she is able to read the words or describe the depicted images and could see them clearly.



(a) Main menu screen VRwonder

(b) Experience screen, displaying the virtual experience.

Figure 5.3. Overview of the interface design of VRwonder for the guidance screen.

The experience screen consists of several components (see Figure 5.3b). First of all the virtual experience itself is displayed full-screen. Then several buttons are present as an overlay on the virtual experience. In the left corner a return button is situated with which you can return to the main menu. At the bottom middle a pause button is displayed. The virtual experience can be paused at any time at the guidance screen, which also real-time pauses the virtual experience in the VR headset. By another click on the button the video can be resumed again. In the VRwonder app on the headset only the virtual experience will be seen. When the virtual experience ends or the caregiver returns to the main menu before that, the 'Aap-Noot-Mies' image will be displayed again.

By developing the guidance screen design requirements 6 and 7 are met, which stated the presence of a second screen (DR6) which controls the VR experiences (DR7). There is now a second screen available which enables the caregiver to select a virtual experience, follow the resident's head-movement, pause the virtual experience or choose another virtual experience. Design requirement 9 is also accomplished (concerning the communication between second screen and VR headset), the connection between the guidance screen and the VR headset is real-time. When the experience is paused on the guidance screen, this is immediately paused in the headset as well. The interface design is attempted to be designed as simple and intuitive as possible by offering only a few options. Whether this design requirement is met has to be proven in the second user experience & usability test.

5.2 New VR experiences for PWD

After the first user experience test also some new design requirements were formulated regarding the virtual experiences. The virtual experiences should represent general interests of PWD and should be passive. This means the interactive experiences were not used again in the VRwonder app, and only the passive experiences which received positive reactions by more than one person during the first user experience test were implemented in the VRwonder app. The passive experiences deemed suitable for PWD were the children's farm, pond 1 and pond 2. From the children's farm experience also one of the images was extracted to be a solo experience as well: the sheep in a field. It was decided to also add a virtual experience of the beach, because that was named during the focus group, and was considered to be a possibly very calming experience.

The existing passive experiences mostly focused on animals and nature. During the focus group it became apparent that also familiar places would probably be suitable for people with dementia. These images could for example be used for reminiscence purposes. It was therefore chosen to also develop some passive experiences specially intended for recognition. Some staff members of Randerode already expressed their wish to film places in Apeldoorn. Therefore a virtual experience of Apeldoorn was developed. Most PWD in care-home Randerode are supposed to have lived in the surroundings of Apeldoorn or are at least familiar with the city. This will make the experience appealing to many people.

Next to that it was expected that PWD would react well to a virtual experience displaying items of their childhood. It was also expected that quite some residents of Randerode had grown up on a farm, due to the area of the Netherlands where Apeldoorn is situated. Therefore another virtual experience was filmed at a reconstructed farmhouse at Museum de Scheper at Eibergen, which displayed the interior of an old farmhouse exhibiting many old-fashioned items. The images of the video were supported with familiar sounds of a household: a boiling kettle, a fire place, and a cuckoo clock. An old children's song was added to part of the experience, where two dolls of a mother and a child were visible. This could then maybe be perceived as the mother was singing to her child.

Whether the newly recorded passive experiences were indeed suitable for people with dementia was tested in the second user experience & usability test, which is discussed at the end of this chapter. In this second user experience & usability test seven passive virtual experiences were offered, of which the two virtual experiences described above were meant for recognition. An overview of the final virtual experiences can be found in Table 5.1 and snapshots of the virtual experiences are displayed in the main menu screen of VRwonder (Figure 5.3a).

5.3 Training the care professionals

One of the most important results from the focus group for a successful implementation was that there must be education available for the people who are eventually going to guide the residents in their VR experiences. To support the implementation process of the VR headset and VRwonder several educational materials were developed.

First, there must be a moment to transfer knowledge to the caregivers about the VR headset. To this end a VR training session was set up, which will be discussed in the following section. Next to providing training, it was also necessary that knowledge should be within reach when using the VR headset. A manual and safety instructions were developed for this purpose, which will be discussed in section 5.3.2.

5.3.1 VR training

Currently the caregivers (and other staff) of care-home Randerode have zero to little knowledge about Virtual Reality. They most likely do not have seen or wore a VR headset before. The older caregivers have little experience with technical products, the younger caregivers somewhat more. It might be unclear why Virtual Reality could be beneficial for people with dementia. A VR training was developed in order to change this situation.

The goal of this training was to create awareness about the possibilities of VR for PWD, and what to consider when using VR for PWD. Caregivers should learn how they could use the VR headset and it was important to let them experience the headset themselves. Overall the training should enthuse caregivers about using the VR headset with PWD. In order to realise those goals the following learning goals were set for the VR training session:

1. Teaching basic knowledge about Virtual Reality.
2. Making caregivers aware of the possibilities of VR for PWD.
3. Let caregivers experience the VR headset themselves.
4. Provide insight into the potential risks of VR and how VR could affect PWD.
5. Teaching basic controls of the VR headset.
6. Giving some tips about the guidance of a virtual reality experience for PWD.

The training session was estimated to take around one and a half hours time. Caregivers and other staff of care home Randerode were invited to join. Eventually six people participated, the activity coordinator, two people from the daycare, two psychologists and one caregiver. The caregiver was not able to stay for the full training session, but was alternated by another caregiver at the end of the training session. This however indicated that the time-span of the VR session was not manageable for the caregivers to attend. The activity coordinator and the staff from the daycare however were also likely to use the VR headset in the future, and were therefore also seen as part of the target group. The two psychologists are less likely to use the VR headset themselves, but they could maybe serve as facilitators or promotors.

The training session consisted of two parts: an exploratory and an in-depth phase. The training started with a general introduction into Virtual Reality and the possibilities of VR for PWD. Video's of the reaction of participants during the first user experience test were shown to the attendees to give them an impression on how people could react. Then the attendees could try the VR headset by watching one of the passive experiences. Before continuing learning how to control the headset, some pre-conditions to use the VR headset and safety warnings were discussed. At the end of the exploratory phase attendees had to complete several practical assignments (e.g. powering the headset on or off, using the controller) and had to practice with introducing and guiding a resident by acting this out in pairs. Some suggestions were given on how the VR headset could be introduced, and the analogy of a cardboard viewing box was used. This cardboard viewing box might be something the PWD is familiar with: a box with a small world inside it, which can be viewed from a little peep hole.

The second part of the training was a more in-depth part. Explanation was given about VRwonder and how this could be used with the guidance of the virtual experiences. VRwonder was not completely working yet, and could therefore not be tested during the training session. Information was given about the upcoming second user experience & usability test, and how the participants could bring their knowledge into practice at this test. The session was ended with a short evaluation of the training. The attendees were enthusiastic about the use of the VR headset for PWD and were very curious about VRwonder.

5.3.2 VRwonder manual and safety instructions

To ensure a safe use of the VR headset it was important to include some safety instructions and pre-conditions for using the VR headset for PWD. The safety instructions and pre-conditions were subtracted from the Oculus Go manual and reviewed on their applicability in the use situation of the care-home. Because caregivers are on a tight schedule and do not have the time to extensively study these type of instructions it was very important to provide some icons which could transfer the message as well. Caregivers could then quickly glance over the icons, and when more information is needed they could read the accompanying lines. These descriptions were kept short as well, and important words were printed in bold. The result of the safety instructions can be seen in Figure 5.4.

Belangrijk! Richtlijnen voor gebruik VR bril

Voorwaarden voor gebruik

Niet gebruiken bij gevoeligheid voor **wagenziekte** of **epilepsie.**

Niet gebruiken bij iemand met een **elektronisch implantaat of pacemaker** (of alleen op doktersvoorschrift).

Redelijk zicht en gehoor vereist. Heeft de gebruiker een bril? Deze kan gewoon worden opgehouden!

Veiligheidswaarschuwingen

Alleen **zittend** gebruik maken van VR bril. Zorg voor een comfortabele stoel met leuningen.

Bouw het gebruik van de VR bril rustig op, begin met enkele minuten per keer. Gebruik de bril tot een **maximum van 30 minuten** aan één stuk. Neem een pauze van minstens 10 tot 15 minuten na lang gebruik.

Medische apparaten zoals AED's kunnen het signaal van de VR bril verstoren (en vice versa). **Houd voldoende afstand** tot dit type apparaten.

Zorg voor **voldoende beweegruimte** voor de armen.

Gebruik de bril **nooit** wanneer deze nog aan het opladen is.

Technische problemen met de VR bril?
Neem contact op met Oculus Support via de site support.oculus.com

De VR bril is **niet waterbestendig**. Pas dus op met vloeistoffen! Deze kunnen de bril beschadigen.

Bril **te heet** om aan te raken? Gebruik de VR bril pas wanneer deze wat is afgekoeld.

Figure 5.4. Pre-conditions and safety instructions of the VR headset.

To support the caregivers during their use of the VR headset and VRwonder a step-by-step manual was written on how to set-up and use the headset and guidance screen. The written text was supported by images showing what to do. Important words were printed in bold here as well. The step-by-step manual is depicted in Figure 5.5.

5.4 Second user experience & usability test

To test whether care staff of Randerode was able to use VRwonder a second user experience & usability test was performed. The main focus of this test was on the usability of VRwonder. Another goal of the user experience & usability test was to get a second impression on how PWD reacted to the virtual experiences and whether heart rate could be used to evaluate the emotional state of PWD.

VR bril gebruiken

1 **Zet de bril aan.**
Druk hierbij de middelste knop bovenop de bril ( ) een aantal seconden in.

2 **Zet de tablet aan.**
Open de VRwonder app.

3 **Zet zelf de bril op** en pak de afstandsbediening in de hand.
Met de onderste knop (kiezen) kun je opties selecteren.

1. Kies nu in het onderste menu: **Navigeren** en dan **Bibliotheek**.
2. Kies dan in het menu aan de zijkant: **Onbekende bronnen**.
3. Kies in het middelste scherm de **VRwonder app**.

4 **De bril en de tablet zijn nu klaar voor gebruik!** Leg uit dat je met de VRwonder bril samen in een andere wereld gaat stappen. Zet vervolgens de bril op.
Pas de klittenbanden aan totdat de bewoner de aap-noot-mies afbeelding (min of meer) scherp ziet en de bril stevig op het hoofd zit.

5 **Pak de tablet erbij** en **kies een filmpje** uit het hoofdmenu om af te spelen.
Het kan even duren voordat het filmpje geladen is.

6 Jullie kunnen nu samen het filmpje bekijken! Vraag degene met de bril op wat hij of zij ziet. Als jullie iets interessants zien waar je langer over wilt praten kun je het filmpje altijd **pauzeren door op de "pauzeren" knop op het tablet scherm** te drukken.

7 Wil je liever een ander filmpje zien? Ga dan **terug naar het keuzemenu met de "Menu" knop linksbovenin** het tablet scherm.

8 Genoeg gezien voor vandaag?
Doe dan eerst de bril af. Laat de ander eerst nog eventjes rustig zitten om weer te wennen aan de echte wereld. Vraag hoe het met hem/haar gaat.

9 Ondertussen kunt u zelf de bril opzetten om de app af te sluiten.
Druk op de **Oculus knop** . Er verschijnt een scherm om de app af te sluiten. **Klik op afsluiten**. Zet de bril vervolgens helemaal uit door de knop ingedrukt te houden.
Vergeet de bril niet aan de oplader te leggen!

10 Sluit vervolgens de app af op de tablet en zet de tablet uit.
Leg de tablet indien nodig ook aan de oplader.

Figure 5.5. Step-by-step manual on how to set-up and use the VR headset and VRwonder.

5.4.1 Method

Study design

The second user experience & usability test had an exploratory and qualitative design and was a follow-up on the first user experience test described in chapter 4. It was of interest if PWD would react positively towards the virtual experiences for a second time. The set of offered virtual experiences was renewed and can be seen in Table 5.1. It was decided to only offer passive 360° recorded experiences because these were received most positively in the first user experience test. (Semi-)interactive experiences are assumed to be suitable for a smaller group of PWD and were therefore left out. The feasibility of using heart-rate to evaluate the emotional state and experience of dementia patients was also tested again. The main goal of the second user experience & usability test however was to check whether the caregivers were able to use VRwonder in offering Virtual Reality experiences to the participants. The main researcher therefore had a passive role and observed how the caregivers used VRwonder and the VR headset.

Participants

Six residents (two male, four female) of care home Randerode with an early to moderate form of dementia were selected to participate in the second user experience & usability test. Three of these six participants also had participated in the first user experience test. They were re-selected due to their positive reactions and tolerance of the VR headset during the first user experience test. During the first day of testing one of the participants had fallen ill and another refused to participate, resulting in four PWD participating (one

Table 5.1

Overview of the VR experiences available in the VRwonder app.

VR experience	**Description**	**Viewed by**
Pond 1 (Enschede)	Calm experience in which you have an overview over a small pond located in Enschede. A goose and some ducks swim in the pond. Recorded from a one-point view.	-
Pond 2 (Park Berg & Bos, Apeldoorn)	Calm experience in which you have an overview over a pond with a fountain located in Apeldoorn. The pond is situated in a well-known walking park, 'Park Berg & Bos'. Recorded from a one-point view.	P2
The Beach	Calm experience. Images of a quiet beach where you can see and hear the waves coming on shore.	P3
Sheep in a field	Calm experience in which you can see a herd of sheep graze in a field. Video is accompanied by the bleating sound of the sheep. Recorded from a one-point view.	P3
Children's farm	Slightly engaging experience. Different views of donkeys, goats, pigs and sheep on a children's farm are presented in this video. Animal sounds are clearly audible.	P3
City tour Apeldoorn	Slightly engaging experience. The experiences shows four landmarks of Apeldoorn: the monument 'De Naald', a Canadian war memorial, the church 'De Grote Kerk' and the walking park 'Oranjepark'. The experience is accompanied by repeating soothing music, and some sounds fitted to the images such as the church bells and whistling birds.	P2, P3, P4
Old farmhouse	Slightly engaging experience. The experience alternates several images of the interior of an old farmhouse. For example, the living room, kitchen and a clogs workshop can be seen. The images are supported with sounds associated with the rooms such as rumbling pots and pans, a boiling kettle and sawing. For the most part of the experience there is soothing music playing, alternated with an old Dutch children's song: 'Onder moeders paraplu'.	P1, P2, P4

male, three female) of two psycho-geriatric wards of the care home. For each of these wards, one caregiver participated in the second user experience & usability test. The caregiver of ward one was female, of middle-age and more experienced. The caregiver of ward two was male, young and working as an intern. Informed consent was obtained from both the caregivers as the residents. The residents' consent was acquired via their legal representatives, usually a family member.

Measures and materials

All sessions were video-recorded. Participants wore the stand-alone Oculus Go headset to view the virtual experiences. Caregivers guided the experience with the VRwonder app on a Samsung tablet. The controller of the Oculus Go was only used by the caregivers to set up the VR headset for the virtual experiences. During the rest of the VR session the controller was not needed. The heart rate of participants was measured with the Empatica E4. It was suggested in the discussion of the first user experience test to use another measuring device. Yet, for reasons of consistency and because this device was the only one able to measure inter-beat-intervals needed for heart rate variability analysis the Empatica E4 was used again. To possibly reduce the amount of data loss during measurement it was chosen not to use the Bluetooth function during this test.

For the observed evaluation of the reactions of PWD to the virtual experiences, the Observed Emotion Rating Scale was used again as a reference (M. P. Lawton et al., 1999). On instructions from two psychologists of Randerode, extra attention was paid to body posture and signs of confusion in the evaluation of the responses of PWD, and less attention to the expression of emotions since these can be hard to distinguish in PWD.

Setting

As for the first user experience test, the second user experience & usability test was held in the family room of one of the wards. The family room provided a quiet testing environment. Participants had to be collected from the wards and were brought to the family room by the caregivers. The participants were placed in a comfortable chair with armrests to sit in. The caregiver was seated next to the participant, and the main researcher took place opposite to the participant and caregiver.

Procedure

The caregiver collected the participant and briefly informed them that they were going to try something new. The participant was welcomed by the researcher and was asked to take place in a comfortable chair. The researcher explained the participant that they were about to enter a different world using the viewing box (in Dutch: kijkdoos) analogy. Next, the researcher showed the Empatica E4 to the participant and put the watch on the wrist of the participant. The Empatica was turned on immediately after the watch was applied. Then the caregiver was asked to set up the VRwonder app on both the tablet and the VR headset. After set-up the Oculus Go was carefully placed on the participant's head by the caregiver. Either the caregiver or the researcher asked the participant if the headset was applied correctly and if they could see the 'Aap-Noot-Mies' image displayed clearly. After confirmation by the participant the caregiver was asked to select a virtual experience. Each virtual experience had a maximum duration of 5 minutes. Just like the first user experience test there was a VR break scheduled after each virtual experience. However, the VR break was not used every time since the hassle of removing and putting on the headset was judged to be more confusing for the participant than watching two virtual experiences after each other. This was however only done for participants that participated in the first user experience test as well, who were known to react very well to the headset. The participants viewed a maximum of four virtual experiences, and the total VR session lasted at most 30 minutes. At the end of the session the Empatica wristband was removed and the participant was thanked for their participation. The caregiver guiding the session brought the participant back to their ward. The caregiver was interviewed after he or she had guided several VR sessions. The interview questions included questions about the usability of VRwonder, the level of information they had received and their impression of the reactions of the participants.

Data analysis

Heart rate and heart rate variability was measured to (re-)confirm that physiological data can be used in evaluating the VR experience. Since the first user experience test showed that GSR measures were not useful in evaluating the VR experience, this measure was left out in the data analysis of the second user experience & usability test. The same heart rate and HRV measures were used as in the first user experience test, namely the average heart rate during the test, PNS and SNS indexes, and power spectra plots. A baseline heart rate of each participant was obtained by measures of the care-institution in the past months. For analysis of the heart rate data the software packages Kubios (Kubios, 2016a) and RHRV for R (García et al., 2018) were used, which are the same as for the first user experience test.

5.4.2 Results

The results will be discussed in several parts. First the observed reactions of the participants towards the virtual experiences are presented. Then, these observed reactions are compared with the heart rate and heart rate variability measures of the participants. Lastly, it is discussed if VRwonder was useful for the caregivers in guiding the VR session.

Observed reaction towards the virtual experiences

Each video recording was annotated with the verbal and physical reactions of the participant. Special attention was given to occurrences of confusion and hand or arm motions indicative of restlessness or agitation. The Observed Emotion Rating Scale (M. P. Lawton et al., 1999) was used to record the general alertness and emotions of the participants. These factors together cover the observed reaction towards the virtual experiences. For each participant this observed reaction will be discussed separately.

Participant 1 viewed one virtual experience about the old farmhouse. Due to malfunctions with the VR headset at the beginning of her VR session, participant 1 had to wait for quite some time before she could view a virtual experience. Another headset was used and because this headset was not connected to the internal network of the testing location there was no guidance possible via the guidance screen. Participant 1 made a low-spirited impression from the beginning of the VR session. Her head was faced downwards and she was not expressing interest in her surroundings. Also during the viewing of the virtual experience her head was mostly kept downwards, she only minimally looked around her. Participant 1 did not start to describe the virtual environment on own initiative. However, after asking once "What do you see?" she kept on describing items until the end of the virtual experience, although in very short sentences. During the VR session she indicated that the VR headset was not comfortable and that it was pressing on her cheekbones. The researcher therefore supported the headset to relieve the pressure. At the end of the viewing experience participant 1 was asked about her experience. She indicated the following:

> "It is not the case that I think: Boy, that was fun."
>
> "I rather see it for real, than looking at it in this way."

The lack of expressions of pleasure during the virtual experience confirmed this attitude. The level of discomfort of the headset did not contribute to a pleasurable experience as well. No signs of confusion were noticeable for this participant.

Participant 2 was re-selected for the second user experience & usability test due to her positive reaction towards the virtual experiences in the first user experience test. This time she experienced three virtual experiences in the following order: a city tour of Apeldoorn, the old farmhouse, and pond 2. The caregiver that guided her indicated that participant 2 still remembered the first time that she participated, or at least had a memory of that she had enjoyed the VR headset. Participant 2 immediately started to describe what she saw when the headset was put on. This also included the picture of Aap-Noot-Mies, which she read aloud when she saw it every time in between the virtual experiences. During the first virtual experience of the city tour of Apeldoorn, she correctly recalled the year of an accident happening at one of the landmarks shown in the virtual experience. She frequently named the presence of the music in the background, as well as her liking of the images. After the first experience there was a short break in which the VR headset was removed and participant 2 was asked about her experience. She indicated that she really liked it, but that she likes almost everything. For the second experience she was asked to look at the guidance screen to see whether one of the VR experiences sparked her interest. She chose the old farmhouse experience. In this experience there is a lot to see and she immediately started to describe the items again. When the old children's song in this video started playing she directly started to sing along! When something else caught her eye she smoothly started describing again what she was seeing:

> *singing in Dutch* "... liepen eens twee kindjes, Hanneke en Janneke, dat waren dikke vriendjes, .. van tik tak tik, onder moeders paraplu, onder moeders paraplu." *something catches her eye* "That is a piano I think."

She also recognized an old closet, and described that she had a similar closet when she was young. She supports her descriptions with gestures (e.g., making a sawing gesture when she hears a sawing sound). The VR headset was not removed between the second and the third experience, since participant 2 reacted well to the virtual experiences and the removal and placing of the headset was thought to cause more disturbance for the participant than benefit. In consultation with the participant the caregiver chose the last virtual experience, pond 2. This video recalled memories of nice moments with her husband, as this was a place they had visited together often. It was seen that the caregiver and the participant were now more conversing about the memories related to the place than the physical elements visible in the virtual experience. During this virtual experience she indicated that it gave her relaxation, and that she really enjoyed the beautiful images. Instead of describing the virtual environment she is more indulged in the experience and the feeling it brings her.

No signs of confusion were seen at participant 2, she perfectly understood that she was wearing a VR headset, she indicated herself: "Very nice, such glasses". She also seemed to understand that the caregiver could see what she was seeing, because she asked: "Do you still see something I have not seen yet?". She sometimes could not come up with the right word for what she was seeing, but she mostly corrected herself afterwards. She indicated that she experienced the virtual experiences more consciously in comparison with images on a television screen. Enjoyment of the virtual experiences was also visible in her expressions of pleasure, she was laughing and singing along.

Participant 3 was also re-selected. He viewed four virtual experiences, however the first only briefly. The viewed experiences were: Sheep in a field, city tour Apeldoorn, Children's farm and the Beach. The caregiver selected the first experience but shortly decided afterwards that this experience might be too calm for participant 3, and therefore selected a more stimulating experience. When the city tour Apeldoorn experience started participant 3 immediately recognized the monument 'De Naald' and started to point and raise his voice. He remembered that an accident happened near that monument. However later on, he confused the location with Nijmegen, another Dutch city.

Participant 3 automatically started to describe what he saw in each experience. Looking around was also mostly on its own initiative. When viewing the third experience he started counting the number of animals that he saw. He however was not able to recall what type of animal he was seeing. During the fourth experience, the Beach, he was continuously describing the movement of the waves on the beach. The descriptions were somewhat in his own language, making it hard to follow if you would not know what he was viewing. He also viewed things which were not there, such as children passing through the water.

Participant 3 thus expressed some signs of confusion, however this is not due to the virtual experience. The participant suffers from aphasia which explains his mix up of words and strange sentences. He looked relaxed when viewing the virtual experiences, resting his arms mostly on the armrests or in his lap. When he recognized or described things he usually started pointing. He stayed approachable during the virtual experiences, since he was still responding to questions asked and turned his head towards the person who asked the question.

Participant 4 participated for the first time. She experienced two virtual experiences, respectively the city tour Apeldoorn and the old farmhouse. Right when she entered the test setting she already asked: "So I am a guinea pig?", and this attitude remained through the whole session. Mostly during the breaks in between she asked what the purpose was of her viewing these videos and what we had learned from it? When told that is was to see whether this could be a nice new activity, she still replied that she did not see the purpose of this activity. However when viewing the virtual experiences she did describe the virtual environments and displayed some signs of pleasure (laughing). She seemed to recognize places and objects in both the city tour Apeldoorn and old farmhouse experience. It took a while for her to understand that she could look around, but after that she did this on own initiative. The immersion in the virtual experience was alternated with comments about the height of the images:

> Participant 4: "But I am high up eh."
>
> Caregiver: "Yes, you are standing."
>
> Participant 4: *Confused* "No, I am sitting."
>
> Caregiver: "In the video you are standing."
>
> Participant 4: "Oh."

Participant 4 thus clearly perceived a mismatch between her sitting in the real world versus a more standing point of view in the virtual world. The participant was not able to experience a full sense of proto presence (the feeling of how ones body is situated in the environment) in the virtual environment. This seemed to have hold back the participant to completely immerse in the virtual environment. It was also noticeable that the participant needed some confirmation of the presence of the caregiver. She was afraid that he had left her behind.

> Participant 4: "Where did you go?"
>
> Caregiver: "I am still here next to you."
>
> Participant 4: "Oh.. I was already afraid that you have left me behind in this kitchen, this farmer's barn, no farmhouse kitchen."

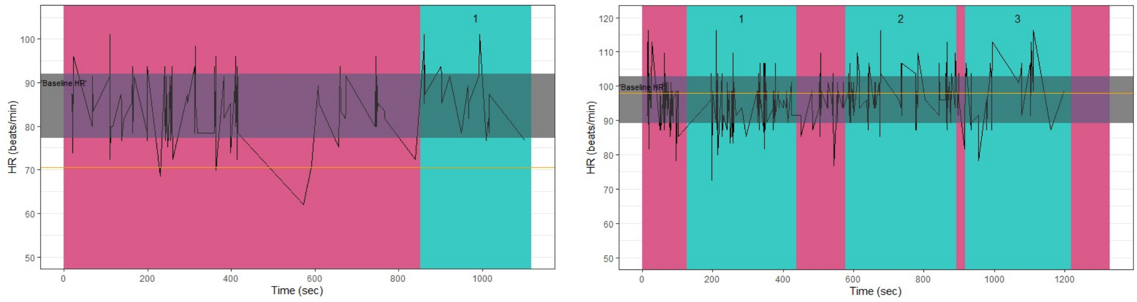
The mismatch between the standing position and her sitting position continued to cause some confusion for participant 4 after the virtual experiences. She indicated that she felt lost a bit. This could indeed point to a greater extent of experienced core presence in the virtual environment, which was hypothesized by Garcia et al. (2012), causing some confusion between both the real and virtual world. However, when asked about her confusion, she immediately denied that she had said this.

One of the psychologists had set out an observation request to the caregivers to report on the behaviour of the residents one week before and one week after the second user experience & usability test. These observations could then be used to check whether the use of the VR headset had brought about some positive or negative influence on the residents' behaviour. It was especially important to know that no (enduring) negative impact would follow from the virtual experiences. Nothing unusual was reported for participant 1 and 2. Participant 3 had viewed some other virtual experiences with the intern caregiver in the evening following the test. It was reported that participant 3 had enjoyed the VR session this time as well. Nothing special was reported about his behaviour in the following days. Participant 4 was a bit agitated and suspicious in the afternoon after she had viewed the virtual experiences. She was afraid that photo's were taken of her and would be spread without her permission, and this made her angry. The incident showed that her agitation was probably caused by the fact that she was tested and a camera was present in the room, rather than caused by the virtual experiences themselves. Apart from this incident no other particularities were reported.

Heart rate and Heart Rate Variability analysis

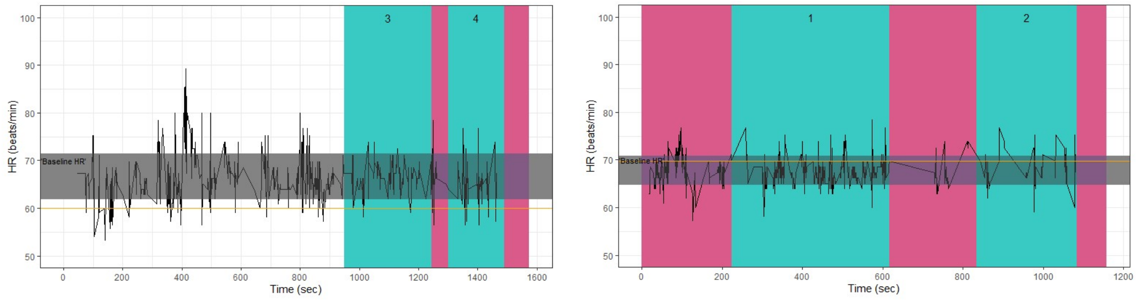
The observed reactions of each participant were compared to the heart rate and heart rate variability measures to see whether they were in accordance with each other. The heart rate data of each participant is visualized in Figure 5.6. The green areas indicate the time a participant is viewing a virtual experience, while the red areas indicate VR breaks or time before/after the VR session. The average heart rate during the VR session is represented by the grey belt. Peaks below or above this grey area are assumed to be indicative of either under- or over-stimulation. The orange line depicts the average heart rate value we received from the care-home for that participant. The heart rate and heart rate variability measures will be discussed per participant below.

Participant 1 had an average heart beat of 84.6 beats/minute with a standard deviation of 7.3 beats/minute during the VR session. As can be seen from Figure 5.6 this average is a lot higher than the baseline heart rate we received from care-institution Randerode, which was 70.5 beats/minute. This could be an indication of a raised overall stress level during the VR session. The increased stress level could be caused by the long waiting time before the participant experienced a virtual experience. Just when the caregiver wanted to start the VR session the VR headset malfunctioned and could not be used. The researcher had to prepare another VR headset and this took some time. The high peaks (above the grey area) in the heart rate graph can not be explained by the accelerometer data or the video data. However the reliability of these data points could be questioned because they are preceded or followed by very low peaks in heart rate. The difference in heart rate in a few seconds would then rise or drop with 15 to 30 beats/minute, which is possible but only when a gradual decline of heart rate is visible after such an increase. The PNS and SNS indexes of participant 1 also contradict each other. The PNS index for the pre-measure is 0.75 and the SNS index is 0.74, and respectively 1.28 and 1.04 during the virtual experience (see Table 5.2a). This would



(a) Heart rate graph participant 1. Viewed the old farmhouse virtual experience.

(b) Heart rate graph participant 2. Viewed 1) the City Tour Apeldoorn, 2) the old farmhouse, 3) Pond 2.



(c) Heart rate graph participant 3. Viewed 1) Sheep in a field, 2) City Tour Apeldoorn, 3) Children's farm, 4) The Beach.

(d) Heart rate graph participant 4. Viewed the City Tour Apeldoorn and Old farmhouse experiences.

Figure 5.6. Visualization of the heart rate per participant during the second user experience & usability test. The blue/green belts indicate the VR experiences, and the reddish/pink belts indicate the VR breaks. The orange line represents the average heart rate of the participant measured by the care institution.

mean that the participant is both stressed and relaxed. The heart rate data of this participant therefore does not seem fully reliable.

For participant 2 the average heart rate during the VR session was 96 beats/minute with a standard deviation of 6.8 beats/minute. The baseline heart rate received from Randerode of 98 beats/minute was in line with this finding. From the graph it seems that the first virtual experience (city tour Apeldoorn) is more relaxing (under stimulation) than stressful (over stimulation). Participant 2 also mentioned a lot that she liked the VR experience while viewing the first experience. The second experience is more stimulating, the heart rate spikes more above the average grey belt here. When looking at the video the experience does not seem to be stressful for the participant. The raise in heart rate could probably be explained by the recognition of objects in this virtual experience. The third experience seemed to start relaxing for the participant and ends more stressful. This is not in line with the video data, in which the participant indicated that she felt at peace during the high peaks in the graph. The lower heart rate in the beginning of the third experience could possibly have been caused by feelings of grief or sorrow, because the experience reminded the participant of memories with her husband. The PNS and SNS index values (see Table 5.2b) support the assumption that the first VR experience is more relaxing, participant 2 has a lower SNS index during the first virtual experience than during the second and third experience. However the differences between the virtual experiences remain very small.

Table 5.2

Short-term time-domain HRV measures for each participant.

	Pre-measure	**1st VR experience**
mean RR (in ms)	704	679
pNN50 (in %)	62.75	63.64
PNS index	0.75	1.28
SNS index	0.74	1.04

(a) *Participant 1*

	Pre-measure	**1st VR experience**	**VR-break**	**2nd VR experience**	**Pause**	**3rd VR experience**
mean RR (in ms)	627	634	627	612	615	616
pNN50 (in %)	35.37	42.11	39.29	38.53	37.51	54
PNS index	-0.63	-0.33	-0.04	-0.49	0.01	-0.08
SNS index	2.46	1.79	1.96	2.35	2.50	2.04

(b) *Participant 2*

	3rd VR experience	**Pause**	**4th VR experience**
mean RR (in ms)	891	899	916
pNN50 (in %)	32.62	42.31	51.35
PNS index	0.97	1.95	1.80
SNS index	-0.16	-0.42	-0.56

(c) *Participant 3*

	Pre-measure	**1st VR experience**	**VR-break**	**2nd VR experience**
mean RR (in ms)	882	888	886	881
pNN50 (in %)	31.45	19.69	12.90	34.33
PNS index	0.58	0.46	0.00	1.20
SNS index	0.05	-0.24	0.74	-0.01

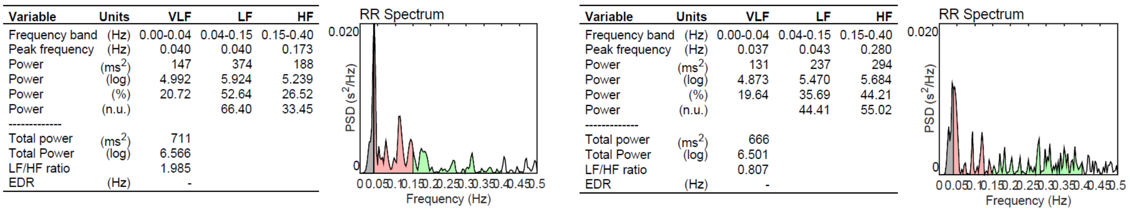
(d) *Participant 4*

Participant 3 had an average heart rate of 66.6 beats/minute with a standard deviation of 4.8 beats/minute. The baseline heart rate obtained from care-home Randerode was slightly below this average, namely 60 beats/minute. Unfortunately there was only video data from the 3rd VR experience onwards, so the correct time frames of the first and second experience could not be displayed in the heart rate graph. However, it is assumed that the large peak after 400 ms is caused by the recognition of the monument 'De Naald' in the city tour of Apeldoorn experience. The virtual experience must have started around that time, and participant 3 immediately started pointing, shifted forward in his seat and raised his voice when he saw these images. The first, third and fourth experiences are characterized by a lower heart rate than the second experience. This is likely due to the fact that these experiences did not produce any memories, while the second virtual experience did. From the PNS and SNS index values (Table 5.2c) it can also be seen that the fourth experience was more relaxing for participant 3 than the third experience. The pNN50 value is much higher for the fourth experience than for the third experience, which resembles a higher heart rate variability during the fourth experience. Besides, the PNS index almost doubles (0.97 for the third experience versus 1.80 for the fourth experience), and the SNS index drops as well (from -0.16 to -0.56). This reflects an increase in parasympathetic activity and a decrease in sympathetic activity. The video data illustrates a possible reason for this effect as well. During the third experience the participant is more frequently asked about the virtual environment, and he has some difficulty in answering the questions. This could be a tiny stressor for the participant. During the fourth experience the participant is less questioned about the actual virtual environment, which gives the participant the opportunity to more indulge in the experience. He also indicated that he thinks "it is beautiful" during this experience.

For participant 4 an average heart rate of 67.8 beats/minute was measured, with a standard deviation of 3.1 beats/minute. The measured baseline heart rate provided by care-home Randerode was 69.7 beats/minute, thus falling within this range. The heart rate of participant 4 was mostly around this average or below. The higher peaks visible in the heart rate graph are mostly caused by movements of the arm: the peaks coincide with peaks in the accelerometer data. No real difference between the first and second virtual experience and the breaks in between can be seen from the heart rate graph. However when we look at the HRV measures some distinctions become visible (Table 5.2d). The mean RR interval stays roughly the same throughout the VR session, which explains why we can not detect any differences when looking at the graph. The PNS and SNS indexes do show a difference between the different parts of the session. The PNS index is higher for the first and second experience compared to the VR-break. On the other hand the SNS index is lower for the first and second virtual experience in comparison to the VR-break. This indicates that the virtual experiences do seem to be slightly relaxing to participant 4. This finding is supported by the video data: during the virtual experiences participant 4 is mostly occupied with the virtual environment, while in the VR-break she asks herself why she has to participate and what the purpose is. When we look at the frequency domain measures this slightly relaxing effect of the virtual experiences can be seen here as well. The plots of the first and second virtual experience show more activity in the HF region compared to the pre-measure and VR-break ($HF = 294ms^2, 55.02n.u.$ and $HF = 217ms^2, 48.19n.u.$ respectively $HF = 188ms^2, 33.45n.u.$ and $HF = 73ms^2, 56.77n.u.$). The big drop in power during the VR-break could however partly be caused by a lower number of data-points, so this has to be interpreted cautiously.

Caregiver guidance with VRwonder

Both caregivers were interviewed about their experiences with VRwonder. The initial set-up of the VRwonder app in the VR headset was perceived a bit difficult by the older caregiver, but she indicated that it probably was a matter of practice. She eventually managed to set-up the app herself. The younger caregiver had less trouble with this, and needed less explanation. He indicated that he already had wore a VR headset once, which made him more familiar with the technology. The use of the VRwonder app on the guidance screen was perceived as really easy. The interface was intuitive and it was easy to understand what the purpose of the buttons was. They both emphasized the use-fullness of the guidance screen during the virtual experiences. It enabled them to start a conversation with the participant or to steer them in a certain direction. The younger caregiver also stated that the guidance screen enabled him to understand what participant 3 was talking about. Without the ability of seeing what the participant is



Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.040	0.040	0.173
Power	(ms^2)	147	374	188
Power	(log)	4.992	5.924	5.239
Power	(%)	20.72	52.64	26.52
Power	(n.u.)		66.40	33.45

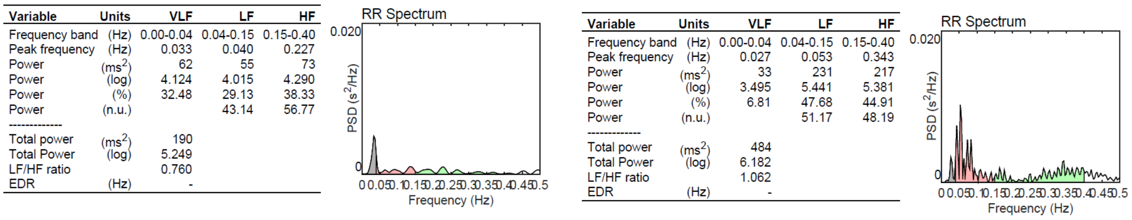
Total power	(ms^2)	711		
Total Power	(log)	6.566		
LF/HF ratio		1.985		
EDR	(Hz)	-		

Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.037	0.043	0.280
Power	(ms^2)	131	237	294
Power	(log)	4.873	5.470	5.684
Power	(%)	19.64	35.69	44.21
Power	(n.u.)		44.41	55.02

Total power	(ms^2)	666		
Total Power	(log)	6.501		
LF/HF ratio		0.807		
EDR	(Hz)	-		

(a) Pre-measure

(b) 1^{st} *VR experience*



Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.033	0.040	0.227
Power	(ms^2)	62	55	73
Power	(log)	4.124	4.015	4.290
Power	(%)	32.48	29.13	38.33
Power	(n.u.)		43.14	56.77

Total power	(ms^2)	190		
Total Power	(log)	5.249		
LF/HF ratio		0.760		
EDR	(Hz)	-		

Variable	Units	VLF	LF	HF
Frequency band	(Hz)	0.00-0.04	0.04-0.15	0.15-0.40
Peak frequency	(Hz)	0.027	0.053	0.343
Power	(ms^2)	33	231	217
Power	(log)	3.495	5.441	5.381
Power	(%)	6.81	47.68	44.91
Power	(n.u.)		51.17	48.19

Total power	(ms^2)	484		
Total Power	(log)	6.182		
LF/HF ratio		1.062		
EDR	(Hz)	-		

(c) VR-break

(d) 2^{nd} *VR experience*

Figure 5.7. Power spectra plots and frequency domain measures from participant 4 during the second user experience & usability test.

seeing it is much harder to know what a person with aphasia is talking about. With the help of the guidance screen more of a conversation can be started with people suffering from aphasia.

The accompanying manual was not used during the VR sessions, and assumed to be only needed during initial set-up or if any problems would occur. Both caregivers found that they had sufficient prior knowledge to work with the VR headset and the guidance screen efficiently.

Both caregivers were positive towards future use. They would definitely see themselves use the VR headset because it could not only be an enjoyable activity for residents but also for themselves. The female caregiver was impressed by the impact it had on participant 2, and enjoyed the enthusiasm of the participant. She also thought the VR headset could possibly recall certain emotions, which she perceived as a positive feature. Both caregivers indicated that their future use of the VR headset was dependent of the reaction of the residents and the available time. They expected to use the VR headset mostly in the afternoon, when the wards are usually somewhat calmer due to residents visiting activities downstairs.

5.4.3 Conclusion and discussion

The second user experience & usability test provided us with a second impression on whether Virtual Reality experiences could be used for people with early to moderate dementia. The first user experience test had shown that the passive virtual experiences were more likely to be received positively by participants. Therefore only passive virtual experiences were used in this test, however they varied in the amount of stimulation.

Two passive experiences were specifically developed to stimulate recognition. These videos indeed seemed to trigger recognition by all participants, they actively described things they recognized, and even recalled specific events related to a place (e.g., the accident at monument 'De Naald'), made a comparison to items they had owned (e.g., an old closet) and even remembered the lyrics of an old children's song. Also one re-used passive experience from the first user experience test recalled some memories for one of the participants. When this happens the virtual environment can be used more as a conversation starter about certain life events, instead of only describing the environment. This possibly has more effect on the person viewing the experience, because it establishes a more valuable interaction, something dementia patients often seem to loose more and more.

The second user experience & usability test showed again that the participants were willing to try the VR headset and put it on their heads. It also reconfirmed that the suitability of the VR headset differs strongly per person. Although there is thus an initial openness to the VR headset by PWD, the liking of it is very personal. It seems that mostly the weight of the VR headset influences a positive experience. Just as in the first user experience test, one of the participants expressed discomfort of the VR headset caused by the weight of it. I assume that the discomfort was partially caused by the head-position of the participant. This participant naturally faced her head downwards, also when viewing the virtual experience. The headset probably feels more heavy when looking downwards due to the force of gravity. The VR headset was probably not tightened enough as well, increasing the pressure on the cheekbones of this participant when looking down. However, when putting on the headset the participant had indicated that the headset should not be tightened more, and this was respected by the researcher. This results in a difficult conflict: do you tighten the VR headset more because you know this will likely lead to improved comfort, or do you respect the wishes of the participant? I think the caregiver should be able to make this consideration dependent on the person. Because the caregiver knows the person well, they should be able to estimate how the person would react if you ignore their wishes. The caregivers however need to be informed on how the VR headset can be worn as comfortable as possible.

Another reason seen for rejecting the VR headset is the feeling of participants that they were partaking in a test and the incomprehension of why they had to wear the VR headset. This feeling might hinder these participants in immersing in the virtual experience. However, it is seen that these participants mostly seem to enjoy the virtual experience when viewing it, and when the headset is removed they are expressing themselves more negatively. A better introduction into the activity might change this negative attitude. Of course changes in comfort and introduction of the VR headset to PWD will not make it an activity for everyone. Some persons just prefer to see real environments opposed to virtual environments, or are getting a little bit confused by wearing it.

Two participants were re-selected due to their positive reactions during the first user experience test, and participated again in the second user experience & usability test (participant nr. 2 and 4 in the first test, 2 and 3 in the second test). Also in this test the reactions were positive. This is an indication that the acceptance and positive experience are repeatable, and that the positive reaction during the first user experience test was not just a lucky shot. Observations of each participant one week before and one week after the second user experience & usability test showed that there were no negative behavioural events related to the virtual experiences. The only incident reported had more to do with the nature of the test (being recorded on camera) than with the virtual experiences themselves. This finding is another indication that Virtual Reality can be used safely with PWD.

Just as for the first user experience test heart rate data was analyzed to see whether this could provide extra information on the emotions and stress levels of the PWD during the VR session. There seemed to be less fluctuations in the heart rate data per participant. This could be explained by the smaller differences in the virtual experiences. During the first user experience test the participants experienced passive and interactive experiences, while during the second user experience & usability test only passive experiences were offered. The interactive experiences were causing higher increases in heart rate and stress level, while the differences in heart rate between the passive experiences in the second user experience & usability test were much smaller. The heart rate remained quite stable for most participants during the whole VR session. However, still some small differences could be perceived. Virtual experiences which recalled some memories at the participant were characterized by a (slightly) higher heart rate and lower heart rate variability. This change is assumed to be just caused by the fact that the participant recognized parts of the environment and is not assumed to be stressful for the participant. The virtual experience seemed also more relaxing to a participant when the participant is not continuously asked questions about the virtual environment. Questions about the virtual environment could increase the stress level of the participant when he or she does not know the answer to the question. The key is to find a suitable approach in which you can talk about the virtual environment, without the person feeling tested about his understanding of that environment.

Next to obtaining a better understanding of the suitability of the VR headset for PWD, the second user experience & usability test was meant to study the guidance of the caregivers with VRwonder. Although initial set-up of the VR headset was slightly difficult, both caregivers were able to set it up themselves by following the verbal instructions of the researcher. The use of VRwonder itself was perceived to be very easy and intuitive, and no real explanation of the researcher was needed here. The ability to watch along with the participant wearing the headset proved to be a very valuable asset. Both caregivers indicated that it helped them in the guiding process. It enabled them to steer the person in a certain direction or start a conversation about something they could see on the guidance screen. In case of PWD who are harder to understand (e.g. due to mix up of words) the guidance screen helped in understanding what the person was talking about. When asked about the applicability and future use of the VR headset and VRwonder, both caregivers responded enthusiastically. They saw themselves use the VR headset in the future, because it is not only fun for the residents but also for the caregivers. Their use however would be dependent on the amount of time available and the reaction of the residents. They indicated that they would probably use the VR headset at a quiet moment on the wards, when they would have the time to sit individually with someone.

This intention to use the VR headset and VRwonder in the future will be tested during an implementation period, in which the VR headset can be used without guidance of the researcher. The results of this implementation test will be discussed in the next chapter.

Chapter 6

Implementing VR for PWD in a care home

In this chapter the use of VRwonder and the VR headset at care home Randerode will be evaluated. It will be discussed if the design requirements were met and if this supported the possible implementation of the VR headset at care home Randerode. The chosen implementation strategies will be discussed and evaluated. Conclusions will be drawn on what is still needed for a successful implementation, and which implementation strategies would be used next.

6.1 Meeting the design requirements

In chapter 3 and 4 a set of design requirements was formulated for the design of a virtual reality application for PWD. This set of design requirements was meant to support the implementation process of the virtual reality application. In this section it is discussed whether each design requirement was met. For ease of discussion, the design requirements are listed here again first, and discussed consecutively.

DR1 The virtual experiences have to be designed specifically for people with dementia, representing general interests such as animals and familiar places.

To meet the first design requirement (DR1) input was used of both family members and the participants of the focus group to develop a few virtual experiences suitable for people with dementia. The first user experience test and second user experience & usability test provided me with several insights on the types of virtual experiences suitable for PWD. It appeared that virtual experiences displaying music performances were not received well, despite the fact that music is assumed to invoke emotional feelings (Khalfa et al., 2002). However, music did work well in the background of virtual experiences. Furthermore, virtual experiences designed for recognition purposes elicited quite some responses from the participants.

DR2 The virtual experience should be passive.

Following the results from the first user experience test, it was decided that the virtual experiences should be passive to appeal to more PWD. Interactive experiences could be frustrating due to the feeling of incapability by the residents. The final virtual experiences therefore were all passive, according to design requirement two (DR2).

DR3 A metaphor or analogy has to be formulated on how to introduce the VR headset to PWD.

To meet design requirement three (DR3) an analogy of a viewing box (Dutch: 'kijkdoos') was created. According to Klein et al. (2018) it is necessary to make use of technology metaphors familiar to PWD in order for them to be more accepting of the new technology. The VR headset is an odd looking device which itself does not really has a resemblance to a familiar object. Making a comparison to something they know will increase their understanding of what the object does. Klein et al. (2018) used the analogy of a binocular to introduce the VR headset to PWD. I did not think this analogy was very suitable, since it implies that you enlarge a certain image to view up close, and that you would hold the VR headset in your hands. Some people of the age around 50 suggested the analogy of the View Master to me, a toy available in the late 1950s to 1990s (Sell, 2017) to view some stereoscopic images, so actually 3D images. However, the key of the View Master was also to hold it in your hands and change the virtual image by clicking a wheel at the side of the device. This analogy thus would imply control by the viewer itself. I also assumed that most residents of care-home Randerode would not be familiar with the toy since their childhood would most likely have taken place during the 1930s and 1940s. Therefore I decided to use a much older analogy, namely the one of the viewing box. The principle of a viewing box is that you can peek through a little hole and see a little world that is created within the viewing box. In my opinion this resembles the principle of the VR headset quite well, here you also put on this weird box and you are surprised by the images found within. The analogy of the viewing box was introduced in the VR training session and used during the second user experience & usability test, and therefore design requirement three has been met.

DR4 The VR headset should be mobile and free of cords.

To meet design requirement four (DR4), it was decided to use the Oculus Go for a VR headset. This headset is a stand-alone headset and is therefore free of cords and easy to move around.

DR5 The VR headset should be readily usable, no complicated set-up.

The Oculus Go requires a one time set-up with the Oculus app via a phone or tablet, before you can use the headset. After that the headset is readily usable when the headset is turned on, and therefore design requirement 5 (DR5) is assumed to be met as well.

DR6 To guide the resident in the virtual experience a second screen must be available on which one can see what the resident is seeing.

In order to meet design requirement six (DR6) VRwonder was developed, which enabled the caregiver to watch along with the resident wearing the VR headset. VRwonder was installed on a tablet, and could then serve as a second screen for guidance.

DR7 The second screen should enable the caregiver to control the VR experiences: e.g. the screen can be used to formulate specific questions about the environment or to switch between different VR experiences.

VRwonder enables the caregiver to switch between different virtual experiences on the second screen, and to control the experience by offering the option to pause the experience. This pause function enables the caregiver to ask specific questions or have a conversation about a specific point of interest in the experience. VRwonder thus complies with design requirement seven (DR7).

DR8 The interface of the second screen must be intuitive and easy to use.

From the second user experience & usability test described in chapter 5 it was concluded that the VRwonder app was intuitive and easy to use, meaning that design requirement eight (DR8) was successfully implemented.

DR9 The communication between the second screen and the VR headset must be (almost) real-time.

Playing the virtual experience on the VR headset and on the second screen happens almost simultaneously (a one second delay can appear). Pausing the virtual experience happens real-time. Communication between the two devices thus happens almost always real-time, and design requirement nine (DR9) is thus met.

DR10 The VR headset must be accompanied with information on how to use it.

The safety instructions and manual were specifically developed to meet design requirement ten (DR10).

DR11 There must be a training moment for staff on how to use the VR headset.

A VR training session was organized to transfer knowledge about how to use the VR headset, meeting design requirement eleven (DR11).

The above illustrates that all eleven design requirements were met during the design of the virtual reality application. The question now is if these design requirements actually supported the implementation process of the virtual reality application within care home Randerode.

6.2 Final implementation test

To discover whether the design of the virtual reality application supported the implementation process of the VR headset within care-home Randerode, the VR headset and tablet were left at Randerode for 3 weeks after the second user experience & usability test. In these weeks, staff had the opportunity to try the VR headset and VRwonder app with residents. After this final implementation test staff was asked to fill in a questionnaire about the use of the VR headset and VRwonder. Questions concerned their technical pre-knowledge, amount of use of the VR headset, user friendliness of the headset and VRwonder, the use-fullness of the provided information and their general impression about the VR headset and VRwonder. During an evaluation meeting in which the results were presented of the second user experience & usability test, some information was also gathered on whether staff had used the VR headset and VRwonder app or not, and for which reasons.

It appeared that the VR headset and VRwonder app was only used by one person in these three weeks, whom was the intern caregiver who also had participated in the second user experience & usability test. Unfortunately the timing of the final implementation test had been very poor. The VR headset was left behind just before Christmas and New Year, a period in which a lot of temporary workers are deployed. They do not have knowledge about the residents' behaviours and whether or not it would be suitable to try out a VR headset. The permanent employees did not have the time to try out the VR headset because they had to guide the temporary workers. On top of that there was an outbreak of the norovirus on one of the wards. They had to close the passage between the wards to prevent further spreading of the virus, which eliminated the opportunity to exchange the headset between the wards. Therefore only one of the wards had access to the headset. Another reason named by one of the caregivers why she did not use the VR headset was the fact that only one caregiver on their ward knew how to use the headset, and that this caregiver did not had the time to explain it to the others. It appeared that the threshold was too high to grab the headset and try it out by themselves. The caregiver indicated that they would rather receive some small demonstration first on how to use the VR headset, for example during a work meeting, before using it. Initially the VR training session was designed for this purpose, but this was a too large time investment for the caregivers to make. Therefore it might be better to divide the information into smaller sections and use several work meetings to inform the caregivers about the VR headset. However, this approach would still be hard to organize since schedules change all the time, and different people are assumed to be present during different work meetings. Getting everyone informed is therefore a very challenging task.

Three persons eventually filled in the questionnaire, the intern caregiver and two psychologists. The questionnaire can be found in Appendix B. Only the intern caregiver actually used the VR headset a few times, because he had liked the reaction of one of the residents he had guided during the second user experience & usability test. He therefore decided to use it with this resident again, and reported that the resident responded again positively and the resident recalled some memories. The caregiver reported that he found himself skillful in using technological products, this was also visible during the second user experience & usability test. In his opinion the VR headset and VRwonder were really easy to use. He expected that most people probably would have a little bit more difficulty with the VR headset, but that it would be still quick to learn. He expected that VRwonder would be readily understandable to use for most people. The caregiver reported that he had only briefly looked at the safety instructions and manual, but that he did use the manual quite often during his use of the VR headset and VRwonder. He found the manual easy to follow, but missed some information about the direction he had to set-up the headset in (this was initially indeed forgotten in the manual but was added to the manual in handwriting. The information was thus present, but maybe not in a logical position). To the final manual this information still need to be added. Overall the caregiver liked to use the VR headset and especially the reactions of the residents to the VR headset.

Two psychologists filled in the questionnaire as well. They had not used the VR headset because they had not thought about the fact that they could use it as well. They were too focused on the caregivers using it, while they actually had liked to try it as well. I showed them how the VRwonder app looked like and how it worked during the evaluation meeting, and therefore they had some impression on how easily they thought they could use it. They both expressed a positive attitude towards the VR headset and VRwonder, and thought it seemed simple to use. One of them stated the following about what she liked about the VR headset and VRwonder: "I like the fact that something so seemingly small and simple can open a whole new world for you". In the future both psychologists hoped to use the VR headset and VRwonder often. The safety instructions and manual seemed mostly clear to them. One of the psychologists suggested that the change between devices in the manual maybe could be made even more clear. It was also a bit unclear where to look for which menu in the VR headset. However, this would become clear after trying it out. She also added that maybe some more information should be available on what to do when things do not work properly. If any problems occur now (e.g., a non-responding headset), the current manual does not provide you with any help.

Despite the not really successful implementation test period, the implementation of VR within care home Randerode is within reach. Zorggroep Apeldoorn has already ordered several VR headsets and tablets and truly expresses the wish to use VR in the future. The activity coordinator told us that she had really liked to use the VR headset, but that she simply did not had the time during the implementation testing weeks. The will and enthusiasm for using VR is thus still very alive. In the next section some suggestions and recommendations will be given on how to continue the road to a successful implementation of VR in care home Randerode.

6.3 Suggested improvements and recommended implementation strategies

At the end of chapter 3 an implementation strategy was formulated for the use of a virtual reality application for PWD within care home Randerode. This implementation strategy implied the use of both educational and quality management strategies. The quality management strategies focused on involving the residents of care home Randerode in the question whether VR could be suitable for PWD. The responses of the residents towards the virtual experiences seemed promising. Next, the aim was to involve caregivers during the testing period of the virtual reality application. In this way I could see whether the caregivers were able to use the VR headset and VR application independently or not, and where improvements could be made. To prepare and guide the caregivers before and during the testing period some educational materials were developed. The educational materials consisted of the VR training session and the manual and safety instructions of the VR headset.

Especially involving the caregivers during the testing phase of the virtual reality application appeared to be challenging. Only two caregivers were partly present during the VR training session. Also during the second user experience & usability test and implementation test caregivers hardly participated. The biggest issue appeared to be time, and therefore any information transfer should be kept to a minimum amount of time. However, the knowledge should be spread more widely. Only a few caregivers did know how to use the VR headset and application, and others were not likely to figure out the use of the headset by themselves. These issues have to be taken into account in formulating a new implementation strategy.

Improvements could also be made to the available educational materials. The manual and safety instructions mainly focus on starting with and setting up the VR headset. There should also be information available on possible issues which could arise during use of the VR headset. As was mentioned before the VR training session was too lengthy, and should be revised into several shorter training sessions. It could also be an idea to only teach the full training to a few caregivers and that they will transfer their knowledge to their colleagues.

From the second user experience & usability test and final implementation test it appeared that the VRwonder app was easy to use. No significant improvements have to be made for further implementation. Some more difficulties were experienced with the VR headset itself, however caregivers indicated that with proper guidance this will be learned quickly as well. The above described issues asked for an adjustment in the implementation strategy described in Chapter 3.5 that could be followed for further implementation of the virtual reality application. To advise an upcoming implementation strategy the three step approach of (Proctor et al., 2013) was used again.

1. Name it
   While the implementation strategy used during this Final Project focused on bringing awareness on how to use the VR headset, the adjusted implementation strategy focuses on spreading this awareness. Next to educational and quality management strategies, some planning and restructuring strategies are advised. In formulating these strategies, the standardized names proposed by Powell et al. (2012, 2015) are used for consistency across the literature. The following discrete planning strategies are considered to be useful: *identify and prepare champions* and *recruit, designate and train for leadership*. As a restructure strategy the *change of physical structure and equipment* might be considered. The meaning of these strategies will be discussed under the heading 'Define it'. The educational and quality management strategies should be shifted towards reaching more people and evaluating the user experience. Educational strategies that could be considered are: use *train-the-trainer strategies*, further *develop educational materials* and *make training dynamic*. For the quality management strategies the following discrete strategies are possible: *provide local technical assistance* and *organize implementation team meetings*.

2. Define it
   The planning strategies constitute of appointing leaders or facilitators within the care-team who will become responsible for spreading awareness on how to use the VR headset. One of the main educational strategies is to train these leaders/facilitators in using the VR headset such that they can explain it to others. Quality management strategies should support the use of the VR headset on a bigger scale, by providing technical support and evaluating on improvements which could promote the widespread use of the VR headset. To stimulate the use of the VR headset a clear repository has to be assigned where people can collect the VR headset. This might ask for a restructuring strategy of changing the lay-out of a certain room.

3. Specify it
   Each of the proposed strategies will be specified on the actor, action, action target, temporality and dose.

   Planning strategies
   The coordinators of each ward should identify and select caregivers or other staff members who are enthusiastically about the use of the VR headset and are willing to promote the use of it on their wards. Important is that these caregivers are respectable members of the care-team and are often present. The selection of facilitators or leaders will be a one time assignment, however informing and training the leaders will happen more frequently, especially in the beginning of the implementation phase.

Educational strategies
To assure the appointed leaders are able to spread awareness on the use of the VR headset, these leaders need to be trained and informed first. The leaders should be trained to inform their colleagues on the working of the VR headset and should get a more extensive training. The training sessions should be given by an expert who knows how to use the VR headset and the virtual reality application. Introductory training should be given multiple times, and each session should be kept at a maximum duration of 30 minutes. Refresher courses should be given after two months of practice. This time span allows the caregivers to get the hang of it first, and the refresher training then could help in fine-tuning their guidance. The available educational materials should be updated to the needs of the caregivers. A help guide should be made which caregivers can consult when any technical problems are encountered with the VR headset.

Quality management strategies
In the beginning monthly implementation team meetings could be held with the appointed leaders to check how the implementation is progressing. The leaders can discuss tactics on how to promote the use of the VR headset on their wards. Next to implementation team meetings it is important that a technical support team is available when any technical problems occur with the VR headset. This task could be performed by staff members of the IT department or by technically minded volunteers.

Restructuring strategy
The appointed leaders should in consultation with the coordinators of each ward decide on a suitable repository for the VR headset and guidance screen. It should be easy accessible for each caregiver, activity coordinator or family member but not for the residents themselves. Several repositories might be tried first before a suitable one is found.

The above described discrete strategies together form the advised implementation strategy to spread awareness on the use of the VR headset within care home Randerode. This awareness will likely contribute to a positive attitude to adopt the VR headset on a more widespread level. As seen from the final implementation test the enthusiasm and will to implement the VR headset is mostly present, but the widespread knowledge on how to use it stays behind. The suggested implementation strategy aims to change this fact. This chapter focused on the evaluation and implementation of Virtual Reality for PWD within care home Randerode. In the final chapter of this thesis a more broad conclusion will be drawn on the suitability of VR for PWD and how it can be used effectively.

Chapter 7

Discussion and conclusion

This final chapter presents the main findings of this research and provides the conclusion to the main research question. The findings of each sub-research question will be presented separately and improvements will be discussed. The contribution of this research to the current literature will be highlighted and some suggestions for future research will be done. The chapter concludes with the answer to the main research question.

7.1 Design based factors influencing the implementation process

The first sub-research question posed the question of which design-based factors influence the implementation process of Virtual Reality in a care home. In order to determine factors influencing the implementation process within care home Randerode user research was conducted. An one-on-one interview was held with the activity coordinator and a focus group was organized with staff members from different professions. Ten factors influencing the implementation process were identified during these sessions: *usability of the VR headset, positive effect of the VR headset, guidance via a second screen, level of comfort of the VR headset, acceptance of the resident to wear the VR headset, willingness of the caregivers and family to use the VR headset, accessibility of the VR headset, time, support, promotion & management*, and *knowledge*. I supposed six of the ten factors could be taken into account during the design process of the virtual reality application. These six factors were:

1. Knowledge
2. Guidance via a second screen
3. Usability of the VR headset
4. Positive effect of the VR headset
5. Acceptance of the resident to wear the VR headset
6. Accessibility of the VR headset

From the remaining factors time and the level of comfort of the VR headset were seen as fixed factors. The available time caregivers had could not be influenced by me, and also the level of comfort of the VR headset was rather fixed since the weight of the headset could not be adjusted. These factors could be seen as limitations of this research, as the level of comfort for some participants heavily influenced their acceptance of the VR headset and the usability of VRwonder was only tested by few caregivers due to time constraints. Willingness of the caregivers and family to use the VR headset seemed to be a factor mostly influenced by other factors. I assumed this factor could not be seen as a factor that could be influenced directly during the design process. But indirectly other factors such as a positive effect of the VR headset, usability, and acceptance of the resident wearing the headset will contribute to the willingness to use the VR headset. Therefore I assumed that focusing on these last three factors during the design process would result in a positive attitude towards the VR headset. The support, promotion &

management factor covered organisation wide attention for the use of the VR headset and the widespread use by the caregivers. This factor would become more relevant in a later stage of the implementation process, and since it focuses more on organizational processes it was not assumed to be applicable during the design process of the virtual reality application.

It is important to keep in mind that the determination of the factors influencing the implementation process was the result of two moments in time (the interview and the focus group). It is possible that there are still other factors influencing the implementation process which where not thought of at that time. Also the participants might not be aware of other factors influencing the process, as they might be specific for the implementation of virtual reality and have not been encountered before. However I believe that the diversity in the focus group resulted in a varied range of factors. It was often mentioned by someone of one profession that she did not think of a factor named by someone of another profession. Therefore I had the feeling that the proposed implementation factors were reliable and were useful to consider during the design and implementation process.

7.2 Evaluation of the VR experience

Little is known about the responses of people with dementia towards virtual experiences. The research that is available mostly focused on non-immersive and semi-immersive virtual environments (Flynn et al., 2003; Manera et al., 2016; García-Betances et al., 2015). The coverage of the face by a full-immersive VR headset and the disease of dementia makes it difficult to evaluate the response of PWD towards Virtual Reality. Therefore the second sub-research question was: *"How can the experience and emotional state of a PWD wearing a full-immersive VR headset be evaluated?"*

Since the verbal responses by someone with dementia might be influenced by their disease, it seemed to be unreliable to only rely on subjective responses while evaluating the reaction to the virtual experiences. I hypothesized that an objective measure, such as heart rate and galvanic skin response might be helpful in evaluating the VR experience and could serve as a control measure on the subjective responses. Heart rate and GSR were measured during the first user experience test. The GSR measures were not found useful for the target group and experimental setting. Very low skin conductance levels were reported, possibly caused by dry skin, something not unusual for older adults. Also the lack of a short-term strong stimulus reduced the chance for detecting changes in emotional state, as is usually needed to detect event-related peaks in the GSR signal.

The heart rate data however did seem to support the verbal and observed physical responses of the PWD. As well during the first user experience test as the second user experience & usability test peaks or drops in the heart rate data could be explained by video images of the participants. The first user experience test showed more variance in the heart rate data per person than during the second user experience & usability test, where no large differences were observed during the VR session of one person. This could be explained by the fact that there were larger differences between the offered VR experiences at the first user experience test than at the second user experience & usability test. At the first user experience test both passive as (semi-)interactive experiences were offered. The (semi-)interactive experiences resulted in a higher heart rate than the passive experiences because these were perceived to be frustrating for the participants. The PNS and SNS indexes showed these differences in stress level as well.

The skill-level needed to interact with the interactive experiences was set too high.

Despite the fact that differences in heart rate during the second user experience & usability test were smaller, the heart rate data still often supported the observed video data. Virtual experiences that recalled some memories seemed to be associated with a slightly higher heart rate, which is expected to be caused by recognition rather than stress related to that memory. The virtual experiences also seemed to be more relaxing when the participant has the change to indulge in the experience completely. It should be avoided to test the participant on his knowledge about the virtual environment, when someone can not find the correct word to describe something this should not be enlarged by the person guiding the VR session.

In conclusion, the first user experience test and second user experience & usability test showed that the measurement of heart rate and heart rate variability is promising in evaluating the emotional state of PWD. Some caution is advised however on the reliability of these results. The device used for measuring heart rate and heart rate variability made use of PPG measures to determine these values. PPG measures are assumed to be less reliable than ECG measures (Pietilä et al., 2017), but for a general impression PPG measures are good enough. The baseline measures obtained from care home Randerode which were used in the second user experience & usability test mostly supported the reliability of the PPG measures with the Empatica E4 wristband. Another thing to take in mind when evaluating heart rate data from the Empatica E4 is the sensitivity to movement. Movement can cause the wristband to shift a little bit and leaves room for space between the wrist and measuring diode of the E4. However, unreliable peaks and drops in heart rate data could mostly be eliminated when looking at the accelerometer data.

7.3 User friendliness of the VR headset

One of the conditions for successfully implementing VR for PWD is to make the VR headset and experiences user friendly for both PWD as for their guiders. The third sub-research question therefore addressed how the VR experience could be made easily accessible and user-friendly for residents and staff.

From the user research conducted in the first phase of the project it appeared that the presence of a guidance screen was necessary to provide proper guidance and was a prerequisite for using the VR headset. A guidance screen would provide more control to the person guiding a VR session, and would make the use of the VR headset more accessible. To this end VRwonder was developed, a virtual reality application that shifts the control from the VR headset mostly towards a tablet or guidance screen. By shifting the control it becomes possible for the guider to focus more on choosing a suitable VR experience and guiding the viewer, instead of spending too much time in the VR headset to set up the VR experience. The interface of VRwonder was kept very simple, with only a limited number of available actions, contributing to a user-friendly experience. The user-friendliness of the application was confirmed by two caregivers participating in the second user experience & usability test.

Little is known in literature about what type of VR experiences are suitable for PWD. The following guidelines were proposed in designing VR experiences by Hodge et al. (2018): consider the physical design of the VR system, stimulate shared experiences, address multiple senses, personalize the content of the VR experience and put the person with dementia at the center of the experience. Most of these guidelines were applied to the developed virtual experiences. Shared experiences were stimulated by the presence of the guidance screen, enabling the guider to more easily interact with the resident about the virtual environment. Multiple senses were addressed by the sounds and music added to the virtual experiences. The content of the virtual experiences was kept general, but were chosen on their capability to be compelling to many people. This research pointed out that passive virtual experiences displaying calm images were most suitable for most PWD, and could offer relaxation to participants. Virtual experiences focused on recognition could be used for reminiscence purposes. Interactive experiences were found to be too difficult for people with moderate dementia, since they were not able to fully learn how to control the environment. The PWD was put in the center of the experience by using a central viewpoint offering points of interest in different directions.

Whether or not participants truly feel in the center of the experience relates to the feeling of presence, as was explained in chapter 2. Due to the cognitive decline of people with dementia, the extent of feeling present can be affected. Therefore, in the available literature the three types of presence, proto presence, core presence and extended presence, are assumed to be in a lesser or higher extent visible in people with dementia (Riva et al., 2004). Proto presence, which relates to the feeling of how the body moves and is situated in the virtual environment, is assumed to be preserved in people with dementia (Flynn et al., 2003). This assumption is confirmed by the results of the first user experience and second user experience & usability test. Participants understood the relation between looking in a certain direction in the real world and the shift of the camera to that same direction in the virtual world. Some participants noted some small differences between the real and virtual world (e.g. the height of the camera view differed from their sitting position), indicating awareness of their body position.

The assumption of Garcia et al. (2012) that PWD may experience a greater sense of core presence was not directly visible during this research. Core presence relates to the distinction between the real and the virtual world. Because the cognitive ability of PWD is declined they could experience difficulty in distinguishing between the real and virtual world and get them mixed up. Most participants were still aware of the difference between the real and virtual world, indicating things like: "I know I am wearing this headset" and "I have seen it for now". However one of the participants of the second user experience & usability test indicated that she felt lost a bit after the VR session, which could be a sign of a greater core presence. I assume that the greater sense of core presence will be more prevalent in people with moderate to advanced dementia, compared to the early to moderate people with dementia tested in this research.

The last type of presence, extended presence, corresponds to the extent one understands and addresses meaning to the virtual environment (Riva et al., 2004). Extended presence is assumed to be in a lesser or more erroneous extent present in PWD (Garcia et al., 2012). In general this seemed not to be the case, participants correctly identified their virtual surroundings. However, some participants wrongly addressed certain objects, giving another meaning to these objects. This could be caused by a decline in cognitive ability, but could also be caused by the haziness of the objects in the virtual experience. Despite the fact of giving some objects another meaning the general idea of the virtual environment was always understood by the participants. Therefore extended presence was not seen to be in a lesser extent present, and did not affect the feeling of presence in a negative way.

In terms of guiding someone with dementia during their VR experience it is important to remember that you are not testing their knowledge or memory of the virtual environment. Caregivers should try to focus on having more of a conversation than asking closed questions. It is also necessary to create a safe VR experiencing environment. Because the resident is not able to see the real world, it could be good to remind the resident of your presence. This is most obviously done by guiding the resident with your voice, but when someone has a strong need for safety, you could touch the person on their arm or leg to provide this safe feeling. Most important in terms of guiding the VR experience is to respect the wishes of the resident. When the caregiver only receives the subtlest hint that the resident is not enjoying the VR experience anymore the headset should be removed.

7.4 Contribution and future research

This research has contributed to expanding the knowledge in the field of Virtual Reality for people with dementia. The two user experience tests indicate the suitability of full-immersive passive virtual experiences for people with an early to moderate form of dementia. It also showed the potential of using virtual environments for reminiscence purposes.

During this Final Project a very similar research project was conducted by Tabbaa et al. (2019). They also researched the feasibility of full-immersive 360-video recorded virtual environments on PWD. Their sample of participants consisted of people that showed challenging behaviour (i.e. behavioural and psychological symptoms), and concerned people with moderate to advanced dementia. However, they also reported recruiting a participant with early cognitive decline and that most of their participants provided consent themselves, suggesting that their sample was not exclusively characterized by moderate to advanced PWD. Just as in this Final Project calm passive experiences were used, mostly of nature. Positive responses were found in this study as well, as the virtual environments seemed to spark the interest of PWD and displayed increases in pleasure of PWD. The study by Tabbaa et al. (2019) also showed the potential of VE for reminiscence purposes, although they did not explicitly designed VEs for recognition. Tabbaa et al. (2019) stated the potential of VR in alleviating aggressive symptoms, since aggressive symptoms were seemed to be reduced during and post VR-exposure. This potentially calming effect of VR was also seen during this Final Project: participants often expressed their enjoyment and feeling of relaxation. However no differences in behaviour were noted before and after VR-exposure. The findings of this research thus largely coincides with the findings of Tabbaa et al. (2019), which strengthens the suitability of VR for PWD.

One thing different from previous research in the field of VR for PWD is the use of physiological measures in the evaluation of the VR experience. This Final Project showed the potential of using physiological measures to this end. Heart rate data seemed to be useful in providing a richer image on the emotional state and response to the virtual experience. Measuring heart rate could especially be beneficial for people with dementia who are losing or have lost their way of expressing their emotions verbally.

Only small samples were used during this exploratory research, making the results still to be treated cautiously. Follow-up research should try to gather more participants to confirm these first results, however this is a challenging task since PWD are a very fragile target group and legal representatives might be hesitant to provide consent. Also not every PWD would qualify for participation, since the use of VR requires a lack of epilepsy or motion sickness, lack of electronic implants and reasonable sight and hearing abilities. Mostly these last two requirements could be hard to fulfill with PWD.

For future research it might be interesting to explore the field of interactive virtual experiences a little more. Despite the negative results of interactive experiences during this research, I believe that it could be still beneficial to some PWD. The interactive experiences used in this research were way too hard for PWD to interact with. They had to learn several ways of control and were given too many options in the virtual environment. By offering only one action which stays the same for different virtual environments, and an exaggerated effect in the virtual environment upon their action I think an interactive virtual experience can offer a self-esteem boost. With a more simplified approach I think interactive virtual experiences could especially be beneficial for PWD who suffer from apathy and depression.

Another direction for future research would be the use of full-immersive VR as an intervention or therapy. The virtual experiences designed for recognition purposes during this research showed the potential of using VR for reminiscence purposes. VR experiences could possibly be used during reminiscence therapy, which entails conversations about past activities, events, and experiences with another person or group (Meyer & O'Keefe, 2018). Reminiscence therapy is used to improve cognition and mood, and could also relieve behavioural and psychological symptoms such as agitation. BPSD are often caused by the lack of or abundance of stimuli in the environment. The immersion VR offers could provide a controlled stimulating environment. Depending on the type of BPSD present a more or less stimulating VE could be offered.

This research addressed only direct responses towards the virtual reality experiences. Longitudinal studies could provide more insight into the enduring effects of full-immersive VR on people with dementia. It would be interesting to know whether positive or negative responses to the virtual experience are only short-lived or might endure for a longer period of time. Longitudinal studies could also investigate the potential of VR for alleviating behavioural and psychological symptoms. VR for PWD could in the future possibly be used as an intervention for combatting restlessness during the night, calming someone down or maybe even prevent wandering behaviour. This could potentially relieve the stress and workload caregivers experience due to these behavioural and psychological symptoms, while being able to provide more quality care for PWD.

7.5 Main conclusion

As stated in the introduction of this thesis it is important to find ways to alleviate symptoms of dementia, and offer relaxation and distraction to people suffering from dementia. No cure is found yet for dementia, and therefore care institutions are highly interested in improving their care for PWD. There is very little known on the topic of Virtual Reality for people with dementia, and even less about using full-immersive VR headsets. This Final Project aimed to contribute to the knowledge in the existing literature. At the same time a gap was identified between the scientific and commercial world. Several small companies already market VR for people with dementia, despite the lack of evidence on the responses of PWD to VR. This Final Project bridged that gap by scientifically researching the suitability of VR for PWD and simultaneously looking at the possible use of VR within a care home. The main research question therefore was: *"How can a full-immersive VR application for people with dementia be designed and implemented for long-term use in a care home?"*

The main research question consists of several parts. First, we focused on whether full-immersive VR is suitable for PWD. The first user experience and second user experience & usability test showed the suitability of full-immersive VR for PWD with early to moderate dementia. Most PWD responded positively to the VR headset and enjoyed the experience. A sense of presence was achieved in the virtual experiences, some PWD truly indulged in the experience. Heart rate data supported verbal reactions to the virtual experiences, and substantiates the positive reactions of PWD towards VR even more. However, it also illustrated that VR is not for everyone. PWD showing a more negative attitude towards the VR headset complained about the weight of the headset or preferred the normal world to a virtual world. Despite their negative comments, these PWD did seem to have moments in which they enjoyed the virtual experiences.

Another part of the main research question addressed the need of determining preconditions for designing and using a full-immersive VR application for PWD. It was important to understand why a virtual reality application for people with dementia would or would not be used in a care home. Both professionals and end-users were involved early on to formulate several implementation factors and design requirements for the virtual reality application. Factors influencing the implementation process mostly were associated with the reaction of both PWD and caregivers to the VR headset, knowledge on how to use the VR headset, and guidance of the PWD wearing the VR headset. Next to the design requirements, educational and quality management implementation strategies were formulated to help shape the design process.

Lastly, it was asked whether the full-immersive VR application for PWD could be implemented in a care home. The most important prerequisite for using VR for PWD in a care home setting appeared to be the presence of a guidance screen. This guidance screen enables the caregiver to support the PWD in their viewing experience. Without the presence of a guidance screen successful implementation of VR for PWD in a care home would not be possible. The VRwonder application was developed serving as a guidance screen for caregivers, activity coordinators and family members. During the testing phases the focus was put on the caregivers as guides, because they could possibly benefit from any positive effects due to the VR experience as well. VRwonder was received positively by the caregivers who used it, and they were enthusiastic to use it in the future.

Overall the choices during the design process based on the established implementation factors seemed to have contributed to the positive response of both residents and staff members of care home Randerode. I assume that the results obtained in this care home could be extended to other care homes in the Netherlands since the care of PWD is organized quite similar.

In conclusion, this research confirmed the suitability of using full-immersive VR for people with early to moderate dementia, not only by subjective reactions of the PWD but also by the objective measures heart rate and heart rate variability. Most PWD responded positively to the passive virtual experiences and showed signs of pleasure and relaxation. Even memories were sometimes triggered by the virtual environments, which illustrates the potential of using VR for reminiscence therapy. For successful use of VR for PWD in a care home, the presence of a guidance screen is necessary. Caregivers and other staff members should be aware of the opportunities of using VR for PWD, and be trained and stimulated in using the VR headset. Virtual Reality truly seems to be a promising technology to use with PWD and could possibly offer them a form of relaxation, reminiscence and the sense of being themselves.

References

Active Cues. (2019). *Tovertafel: De zorginnovatie die geluksmomenten creëert voor mensen met een cognitieve uitdaging en iedereen om hen heen.* Retrieved from `https://tovertafel.nl/`

Alzheimer Nederland. (2019, May 27). *Factsheet cijfers en feiten over dementie.* Retrieved from `https://www.alzheimer-nederland.nl/factsheet-cijfers-en-feiten-over-dementie`

Alzheimer Nederland. (2019a). *Soorten dementie.* Retrieved from `https://www.alzheimer-nederland.nl/dementie/soorten-vormen`

Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review of general psychology*, *10*(3), 229–240.

Benedek, M., & Kaernbach, C. (2010). A continuous measure of phasic electrodermal activity. *Journal of neuroscience methods*, *190*(1), 80–91.

Benham, S., Kang, M., & Grampurohit, N. (2019). Immersive virtual reality for the management of pain in community-dwelling older adults. *OTJR: occupation, participation and health*, *39*(2), 90-96.

Braithwaite, J. J., Watson, D. G., Jones, R., & Rowe, M. (2013). A guide for analysing electrodermal activity (eda) & skin conductance responses (scrs) for psychological experiments. *Psychophysiology*, *49*(1), 1017–1034.

Castaldo, R., Melillo, P., Bracale, U., Caserta, M., Triassi, M., & Pecchia, L. (2015). Acute mental stress assessment via short term hrv analysis in healthy adults: A systematic review with meta-analysis. *Biomedical Signal Processing and Control*, *18*, 370–377.

ChuDuc, H., NguyenPhan, K., & NguyenViet, D. (2013). A review of heart rate variability and its applications. *APCBEE procedia*, *7*, 80–85.

CRDL. (2019). *Contact door aanraking.* Retrieved from `https://crdlt.com/`

De Veer, A., & Francke, A. (2009). *Ervaringen van verpleegkundigen en verzorgenden met nieuwe technologieën in de zorg. Resultaten van de peiling onder de leden van het panel Verpleging en Verzorging.* Utrecht: NIVEL.

Eisapour, M., Cao, S., Domenicucci, L., & Boger, J. (2018). Virtual reality exergames for people living with dementia based on exercise therapy best practices. In *Proceedings of the human factors and ergonomics society annual meeting* (Vol. 62, pp. 528–532).

Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science*, *221*(4616), 1208–1210.

Flynn, D., Van Schaik, P., Blackman, T., Femcott, C., Hobbs, B., & Calderon, C. (2003). Developing a virtual reality–based methodology for people with dementia: a feasibility study. *CyberPsychology & Behavior*, *6*(6), 591–611.

Garcia, L., Kartolo, A., & Méthot-Curtis, E. (2012). A discussion of the use of virtual reality in dementia. In *Virtual reality in psychological, medical and pedagogical applications* (p. 123-136). IntechOpen. doi: http://dx.doi.org/10.5772/46412

García-Betances, R. I., Arredondo Waldmeyer, M. T., Fico, G., & Cabrera-Umpiérrez, M. F. (2015). A succinct overview of virtual reality technology use in alzheimer's disease. *Frontiers in aging neuroscience*, *7*(80), 1-8.

García, C., Lado, M., Méndez, A., Otero, A., Rodríguez-Liñares, L., & Vila, X. (2018). *RHRV Project.* Retrieved from `http://rhrv.r-forge.r-project.org/`

Hodge, J., Balaam, M., Hastings, S., & Morrissey, K. (2018). Exploring the design of tailored virtual reality experiences for people with dementia. In *Proceedings of the 2018 chi conference on human factors in computing systems* (p. 514).

HumanXR. (2019). *Virtuele verwondering.* Retrieved from `http://humanxr.com/designed-to-sparkle/`

Huygelier, H., Schraepen, B., van Ee, R., Abeele, V. V., & Gillebert, C. R. (2019). Acceptance of immersive head-mounted virtual reality in older adults. *Scientific reports*, *9*(1), 4519.

iBicha. (2019, February 22). *Unityyoutubeplayer.* Retrieved from `https://github.com/iBicha/UnityYoutubePlayer`

IJsselsteijn, W. A., De Ridder, H., Freeman, J., & Avons, S. E. (2000). Presence: concept, determinants, and measurement. In *Human vision and electronic imaging v* (Vol. 3959, pp. 520–530).

ImmersiCare. (2019). *[website of immersicare].* Retrieved from `https://www.immersicare.com/`

iMotions. (2017). *Galvanic skin response. The Complete Pocket Guide.* iMotions, Biometric Research platform.

Kales, H. C., Gitlin, L. N., & Lyketsos, C. G. (2015). Assessment and management of behavioral and psychological symptoms of dementia. *Bmj*, *350*, h369.

Khalfa, S., Isabelle, P., Jean-Pierre, B., & Manon, R. (2002). Event-related skin conductance responses to musical emotions in humans. *Neuroscience letters*, *328*(2), 145–149.

Kim, J.-J. (2011). *Virtual reality*. InTech.

Klein, P., Uhlig, M., & Will, H. (2018). The touch and feel of the past—using haptic and vr artefacts to enrich reminiscence therapy for people with dementia. *Technologies*, *6*(4), 104.

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological psychology*, *84*(3), 394–421.

Krueger, R., & Casey, M. (2000). *Focus groups: A practical guide for applied research* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Kubios. (2016a). *Kubios HRV standard.* Retrieved from `https://www.kubios.com/hrv-standard/`

Kubios. (2016b). *PNS and SNS indexes.* Retrieved from `https://www.kubios.com/about-hrv/#PNS_and_SNS_indexes`

Lawton, M., Van Haitsma, K., & Klapper, J. (1999). *Observed emotion rating scale.* Retrieved from `www.abrahamsoncenter.org/PRI`

Lawton, M. P., Van Haitsma, K., Perkinson, M., & Ruckdeschel, K. (1999). Observed affect and quality of life in dementia: Further affirmations and problems. *Journal of mental Health and Aging*.

Lisetti, C. L., & Nasoz, F. (2004). Using noninvasive wearable computers to recognize human emotions from physiological signals. *EURASIP journal on applied signal processing*, *2004*, 1672–1687.

LookBack. (2019). *Lookback: virtual therapy for dementia.* Retrieved from `https://www.virtue.io/lookback/`

Lyketsos, C. G., Lopez, O., Jones, B., Fitzpatrick, A. L., Breitner, J., & DeKosky, S. (2002). Prevalence of neuropsychiatric symptoms in dementia and mild cognitive impairment: results from the cardiovascular health study. *Jama*, *288*(12), 1475–1483.

Manera, V., Chapoulie, E., Bourgeois, J., Guerchouche, R., David, R., Ondrej, J., ... Robert, P. (2016). A feasibility study with image-based rendered virtual reality in patients with mild cognitive impairment and dementia. *PloS one*, *11*(3), e0151487.

Margallo-Lana, M., Swann, A., O'Brien, J., Fairbairn, A., Reichelt, K., Potkins, D., ... Ballard, C. (2001). Prevalence and pharmacological management of behavioural and psychological symptoms amongst dementia sufferers living in care environments. *International journal of geriatric psychiatry*, *16*(1), 39–44.

Massaro, S., & Pecchia, L. (2019). Heart rate variability (hrv) analysis: A methodology for organizational neuroscience. *Organizational Research Methods*, *22*(1), 354–393.

Mayo Clinic. (2011, June). *Bradycardia.* Retrieved from `https://www.mayoclinic.org/diseases-conditions/bradycardia/symptoms-causes/syc-20355474`

McCraty, R., Atkinson, M., Tiller, W. A., Rein, G., & Watkins, A. D. (1995). The effects of emotions on short-term power spectrum analysis of heart rate variability. *The American journal of cardiology*, *76*(14), 1089–1093.

Meyer, C., & O'Keefe, F. (2018). Non-pharmacological interventions for people with dementia: A review of reviews. *Dementia*, 1471301218813234.

Michel-Verkerke, M. B., & Spil, T. A. (2013). The use it-adoption-model to predict and evaluate adoption of information and communication technology in healthcare. *Methods in Medicine*, *52*, 475-483.

Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE TRANSACTIONS on Information and Systems*, *77*(12), 1321–1329.

Nardelli, M., Valenza, G., Greco, A., Lanata, A., & Scilingo, E. P. (2015). Recognizing emotions induced by affective sounds through heart rate variability. *IEEE Transactions on Affective Computing*, *6*(4), 385–394.

Neumann, S. A., & Waldstein, S. R. (2001). Similar patterns of cardiovascular response during emotional activation as a function of affective valence and arousal and gender. *Journal of psychosomatic research*, *50*(5), 245–253.

North, M., North, S., & Coble, J. (1998). Virtual reality therapy: an effective treatment for phobias. *Virtual environments in clinical psychology and neuroscience: Methods and techniques in advanced patient-therapist interaction*, *58*, 112–119.

Oculus. (2019). *Our all-in-one headset made for entertainment.* Retrieved from `https://www.oculus.com/go/`

Pietilä, J., Mehrang, S., Tolonen, J., Helander, E., Jimison, H., Pavel, M., & Korhonen, I. (2017). Evaluation of the accuracy and reliability for photoplethysmography based heart rate and beat-to-beat detection during daily activities. In *Embec & nbc 2017* (pp. 145–148). Springer.

Posner, J., Russell, J. A., & Peterson, B. S. (2005). The circumplex model of affect: An integrative approach to affective neuroscience, cognitive development, and psychopathology. *Development and psychopathology*, *17*(3), 715–734.

Powell, B. J., Beidas, R. S., Lewis, C. C., Aarons, G. A., McMillen, J. C., Proctor, E. K., & Mandell, D. S. (2017). Methods to improve the selection and tailoring of implementation strategies. *The journal of behavioral health services & research*, *44*(2), 177–194.

Powell, B. J., McMillen, J. C., Proctor, E. K., Carpenter, C. R., Griffey, R. T., Bunger, A. C., ... York, J. L. (2012). A compilation of strategies for implementing clinical innovations in health and mental health. *Medical care research and review*, *69*(2), 123–157.

Powell, B. J., Waltz, T. J., Chinman, M. J., Damschroder, L. J., Smith, J. L., Matthieu, M. M., ... Kirchner, J. E. (2015). A refined compilation of implementation strategies: results from the expert recommendations for implementing change (eric) project. *Implementation Science*, *10*(1), 21.

Proctor, E. K., Powell, B. J., & McMillen, J. C. (2013). Implementation strategies: recommendations for specifying and reporting. *Implementation Science*, *8*(1), 139.

Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the nutrition society*, *63*(4), 655–660.

Rendever. (2019). *[website of rendever].* Retrieved from `https://rendever.com/`

Riva, G., Davide, F., & IJsselsteijn, W. (2003). Being there: The experience of presence in mediated environments. *Being there: Concepts, effects and measurement of user presence in synthetic environments*, *5*.

Riva, G., Waterworth, J. A., & Waterworth, E. L. (2004). The layers of presence: a biocultural approach to understanding presence in natural and mediated environments. *CyberPsychology & Behavior*, *7*(4), 402–416.

Schoville, R. R., & Titler, M. G. (2015). Guiding healthcare technology implementation: a new integrated technology implementation model. *CIN: Computers, Informatics, Nursing*, *33*(3), 99–107.

Sell, M. A. (2017, November 10). *Focusing on view-master history and value.* Retrieved from `https://www.antiquetrader.com/collectibles/focusing-view-master-history-value`

Shaffer, F., & Ginsberg, J. (2017). An overview of heart rate variability metrics and norms. *Frontiers in public health*, *5*, 258.

Snyder, M., Ryden, M. B., Shaver, P., Wang, J.-J., Savik, K., Gross, C. R., & Pearson, V. (1998). The apparent emotion rating instrument: assessing affect in cognitively impaired elders. *Clinical gerontologist*, *18*(4), 17–29.

Steinberg, M., Shao, H., Zandi, P., Lyketsos, C. G., Welsh-Bohmer, K. A., Norton, M. C., ... Tschanz, J. T. (2008). Point and 5-year period prevalence of neuropsychiatric symptoms in dementia: the cache county study. *International Journal of Geriatric Psychiatry: A journal of the psychiatry of late life and allied sciences*, *23*(2), 170–177.

Sunderland, T., & Minichiello, M. (1996). Dementia mood assessment scale. *International Psychogeriatrics*, *8*(S3), 329–331.

Tabbaa, L., Ang, C. S., Rose, V., Siriaraya, P., Stewart, I., Jenkins, K. G., & Matsangidou, M. (2019). Bring the outside in: Providing accessible experiences through vr for people with dementia in locked psychiatric hospitals. In *Proceedings of the 2019 chi conference on human factors in computing systems* (pp. 1–15).

Tappen, R. M., & Williams, C. L. (2008). Development and testing of the alzheimer's disease and related dementias mood scale. *Nursing research*, *57*(6), 426.

The Wayback. (2019). *The wayback is a virtual reality film series designed for those living with dementia and their carers.* Retrieved from `https://thewaybackvr.com/`

Unity. (2019). *Unity for all.* Retrieved from `https://unity.com/`

Werken in de ouderengeneeskunde. (2019). *Probleemgedrag bij dementie.* Retrieved from `https://www.werkenindeouderengeneeskunde.nl/specials/probleemgedrag-bij-dementie/`

Yalp. (2019). *Yalp sona play arch.* Retrieved from `https://www.yalp.com/sona-play-arch-2/`

Yang, Z., Jia, W., Liu, G., & Sun, M. (2017). Quantifying mental arousal levels in daily living using additional heart rate. *Biomedical Signal Processing and Control*, *33*, 368–378.

Appendix A

Interview activity coordinator

This appendix includes the written version of the interview which was held with the activity coordinator of care home Randerode, on June 18, 2019. The interview was conducted in Dutch. The statements of the interviewer are abbreviated with an ‘I’, and the statements of the activity coordinator with ‘AC’.

I Zoals je ook in het formulier hebt kunnen lezen, wil ik graag een wat algemener beeld hebben van hoe jouw werkdag eruit ziet en hoe techniek daar in een rol speelt, hoe dat naar voren komt. Dus ik vroeg me af of je eerst een algemene schets kan geven van hoe jouw werkdag er normaal gesproken uitziet? Hoe begin het en wat voor activiteiten.

AC Ik werk drie dagen in de week hier op de afdeling, in de huiskamers. Elke dag is anders. Ik kan een heleboel plannen maken van tevoren, maar afhankelijk van wie er in de huiskamer zijn en hoe de stemming is, kan ik mijn dagindeling zeg maar maken. En dan is het per dag ook nog verschillend, omdat er ook andere activiteiten buiten de huiskamer plaatsvinden, waar ik zelf weinig mee van doen heb. Maar wel de voorbereiding dat mensen er naar toe gaan. Dat is op maandagochtend buiten de afdeling het wandelen, op dinsdagochtend hebben ze niet buiten de afdeling iets, maar wel binnen. Dan hebben ze de ene keer peuters op bezoek, en de andere keer de aaihond op bezoek. Dus dan doe je ook alweer andere dingen. Vrijdagochtend heb ik de zaak vrij aan mezelf. Dan ga ik wel eens aan de gang met de groene wand, 1 keer in de veertien dagen, en de andere keer maar net wat er speelt, dat kan een spel zijn of sport achtige dingen zijn, kan ook zijn dat ik rustig een mooie muziekfilm opzet op tv. Ja de qwiek die gebruik ik niet zo vaak, omdat ik dan de hele wand vrij moet pakken. Dat vind ik er het nadeel van, van de qwiek zeg maar. De middagen zijn vaak individueler omdat er dan weer veel mensen weg zijn, of naar een zangactiviteit, of zoals vanmiddag een soos activiteit.

I En door wie worden dan de grotere activiteiten georganiseerd?

AC Dat zijn weer andere AB’ ers die voor het verenigingswerk bezig zijn. Op vrijdagmiddag heb ik gewoon mijn handen vrij, dan heb ik ook de mensen op de afdeling, doe ik vaak spel, ik doe ook vaak iets met koken en bakken. Ja gewoon rond gezelligheid. En dat zijn dan meer de groepsactiviteiten. En voor de rest vul ik mijn tijd echt individueel, individuele aandacht.

I En dan loop je ook een beetje rond over de afdeling om te zien wie er behoefte heeft?

AC Ja, ja. Wat er is. Ik probeer ook altijd een beetje een verdeling te maken. Die hebben wel al veel dingen, die hebben wat minder aandacht, laat ik daar me focussen. En ja Afhankelijk van met wie ik wat doe, gebruik ik wel of niet wat. de CRDL heb ik laten zien, daar werk ik wel mee. De Tovertafel wel minder, omdat je dan ook de afdeling af moet. Vind ik wel een bezwaar soms, want dan heb je toch weer geen feeling met wat er hier gebeurt. De dvd's, cd spelers gebruik ik. De belevenistafel moet dus nog komen, dus dat weet ik nog niet. Maar dat is het zo'n beetje.

I En het wandelen bijvoorbeeld, is dat een vaste activiteit iedere week?

AC Ja maandagochtend is er een groep vrijwilligers die komen voor de mensen. Ik heb een stuk of 5 mensen van mijn afdeling die meekunnen. En op donderdag is er ook nog een andere groep, dan kan er eentje van mijn afdeling mee. Dat is zeg maar georganiseerd elke week met vrijwilligers van buitenaf. En zelf individueel ga ik wel eens wandelen als ik denk van nou die moet er even uit, er is zon onrust. Of er is genoeg op de afdeling, ik kan hier wel weg. Dan ga ik ook wel wandelen. En dan is het of in het parkje hier, beetje afhankelijk van de stemming van die persoon. Want aan de overkant hier heb je ook een klein bosje. En nou ja dan kan ik ook wel het bos in gaan.

I Maar als ik het goed begrijp is het vooral 's ochtends groepsactiviteiten en 's middags individueel?

AC Ja, ja. Wat meer individueler. En ik maak zelf echt hoor, veel gebruik van de TV met een DVD. Omdat dat toch een beeld geeft. Je kan geluid erbij geven, hoeft niet. Maar er gebeurt tenminste iets. Want heel vaak kom ik ook wel in huiskamers en dan denk ik mijn god, wat een stilte, wat een niksigheid.

I Zit iedereen een beetje voor zich uit te staren.

AC Vreselijk. Ja bij rustige beelden, ik wil dus geen drukke beelden, geen tv geluid. Aquarium of vogeltjes. Mooie natuur, zwanen op het water. Vul maar in. Dat soort beelden ja die kan je gewoon veilig aanbieden. Is er in ieder geval wat. [Laughs]

I Wat vind je vooral belangrijk aan je werk als activiteitenbegeleidster?

AC Moet ik 1 ding zeggen, ik ben niet opgeleid tot activiteitenbegeleidster. Wat ik belangrijk vind is om mensen te snappen in hun gedrag en zodanig dingen te vinden waardoor ze zich happy voelen, waardoor ze zich veilig voelen. Dat is anders dan activiteitenbegeleiders, want die willen graag activiteiten bieden, he, dingen doen. Terwijl ik het ook vaak meer zoek in sfeerdingen of geborgenheid, of nabijheid.

I Meer een gevoel creëren dan per se een activiteit.

AC Ja dat was ook het conflict, ik heb heel veel afdelingswerk, opgeheven. Ze waren er niet meer. Dus toen heb ik een tijd activiteiten moeten doen. Verenigingswerk is leuk, is heel belangrijk, maar past niet bij mij. Ik kan het hoor, ik zet zo een ding op en ik doe mijn kunstje. Maar zo voelt het voor mij, ik doe mijn kunstje, en dan komt er een volgende groep en doe ik mijn andere kunstje. Belangrijk in mijn werk is dat ik iets vind wat past bij diegene waardoor die zich weer happy voelt. En daarom ben ik ook zo breed zeg maar, bij die zet ik dit in, bij die zet ik dat in.

I Mooi.

AC Ja het is mooi, maar in die zin conflictueus met het vak activiteitenbegeleiding. Maar ik heb gewoon een andere achtergrond.

I Want wat heeft u gedaan?

AC Creatieve therapie. Beeldend. Daar heb ik jaren in gezeten, maar dat wou ik niet meer. En dit past gewoon beter. Tref je een andere ab' er die zal het belangrijker vinden dat ze wat te doen hebben of nou ja..

I Ja of actief mee doen?

AC Ja, en ik probeer wel, zoals die meneer daar ook. Die had vanochtend echt geen zin om wat te doen en die heb ik uiteindelijk wel meegekregen in de bezigheid. En ik had hem ook meegekregen naar de muziek als ik het zelf helemaal had kunnen regelen. En dan merk je gewoon, als je niet goed weet hoe je iemand moet benaderen, dan krijg je hem niet mee. Blijft hij in zijn eentje hier in de tuin. Nou lijkt hij op dit moment, nu valt het wel mee want hij kijkt nog een beetje.

I Zijn er dingen die het uitvoeren van je werk lastig maken?

AC Ja, [laughing], heb je even? Lastig is welke plek, de prikkels in de omgeving, maar ook ik heb vaak grotere plannen dan dat ik in mijn eentje kan uitvoeren. En dan heb ik hulp nodig van de zorg of van een vrijwilliger of weet ik veel wat. Dat is sowieso een grote beperking.

I En kan je die hulp wel krijgen?

AC Die kan ik wel vragen, maar ja op zo'n dag als vandaag, als ze met tekorten zitten, en met invallers, ja dan kan je het schudden. En dan moet ik ook gewoon mijn dingen aanpassen, en dan moet ik ook mijn dingen kleiner maken. En dat vind ik heel heel jammer ja.

En er is ook een beperking wat plek, wat ruimte betreft. Wil ik al rustig gaan zitten, dan moet ik bijvoorbeeld iets op de gang kiezen, en dan loopt ook weer iedereen langs. Of ik ga dus hier zitten, dan ben je echt helemaal buiten de afdeling. Of je pakt de zintuigruimte. Ja dus dat is een stukje ruimte, wat een beperking is.

I En komt u ook wel eens bij bewoners op de kamer als activiteitenbegeleider?

AC Ja hoor, ja. Maar over het algemeen, we hebben hier een actief huiskamer leven. Mensen mogen best op hun kamer zitten hoor, dat mag. Maar als je alleen op je kamer zit, dan krijg je te weinig prikkels. Cognitief nog vrij goed bent. Maar deze mensen worden steeds inactiever omdat ze het niet meer kunnen, omdat ze het niet meer kunnen overzien. Blijf je dan alleen maar op de kamer, dan vereenzaam je. Tenminste ik vind dit systeem, dat je toch een huiskamer hebt, waar je mensen betrekt, waar je gezamenlijk eet met zijn allen. Beter dan alleen maar op je eigen kamer zitten. Dus ja ik doe wel dingen op de kamer, als iemand dan op bed ligt. Maar je zag ook wel, die mevrouw die lag de hele dag op bed, die heeft een bad gehad van een collega. Dan is ze te moe om zeg maar aangekleed in de rolstoel de hele dag in de kamer te zitten dus die ligt dan in bed, maar ja de hele dag alleen in bed op je kamer. Dan halen we haar toch weer bij, in de huiskamer. Maar goed het gebeurt wel activiteiten op de kamer.

I Maar vooral dus in de huiskamers?

AC Ja huiskamer, of daarbuiten. Op de gang of kleinere ruimtes.

I Welk aspect zou u missen als het er niet meer was in uw werk?

AC [laughing] Ja. Ehm. Nee gewoon, het individuele contact, vind ik heel belangrijk. Het zoeken naar betekenis van gedrag, die ruimte daarvoor hebben. En ja het contact, het individueel contact. Ik ben niet van de groepsdingen alleen maar. Ik ben juist van het zoeken, ja.

I Kijken wat past bij iemand.

AC Ja, en van wat is er aan de hand. Want ja, dat moet je eerst weten voordat je kan vinden wat past.

I Je gaf net aan dat je soms bij activiteiten ook hulp nodig hebt van vrijwilligers of verpleegkundigen, betrek je die er op het moment bij, en zijn ze bijvoorbeeld ook betrokken bij het halen en brengen van bewoners?

AC Nee, nee, zelf haal ik ze op. Zelf breng ik ze ook. Nee ik vraag ook wel eens personeel. Dat ik zeg ik heb even hulp nodig met halen en brengen. Dan vraag ik ook degenen die in de huiskamer werkt zo van eh, help even. Vanmorgen ook, help even de boel klaar zetten. Nou die vond dat zo leuk dat ze ook nog meedeed, dus dat was dubbelop.

I Nemen verpleegkundigen ook zelf initiatief om activiteiten te ondernemen met bewoners?

AC Wisselend. Is heel erg persoonsgebonden, ja welke blik ze hebben naar het werk wat ze doen. voor sommigen is het geen werk. Dan moeten ze bijvoorbeeld als ze in de huiskamer zijn tijdens de koffiepauze van een ander. Als je weet wat zo'n uitspraak inhoudt dat eh, bij de mensen zijn is geen werk. Dat hebben een aantal echt, die zijn heel taakgericht naar het wassen, het zorgen. Naar het pappen en nathouden zeg maar. Er zijn er ook weer bij die wel een spelletje met ze doen. Een aantal doet dat wel, een aantal niet. Ik vind dat zelf heel moeilijk, om te beseffen dat een aantal dat echt niet heeft, dat is alleen maar taakgericht, of voor hun taakgericht. Ja ik ben er niet voor de activiteiten. Ja doei doei, we zijn er voor het wonen, net zoals ik wel eens iemand naar de wc breng of in bad doe. Maar dat is wisselend.

I De rest van de vragen gaan meer over de technologie die hier beschikbaar is, heb je net al wel even wat over verteld. Hoe vaak maak je gebruik van techniek in activiteiten?

AC Ja heel wisselend, maar gemiddeld 1 keer in de week. Laten we het zo zeggen. Het is maar net wie er op dat moment achterblijven. Wat ik wel of niet kan met ze.

I En dan grijp je toch vaak terug op filmpjes?

AC Ja ik ben sowieso van de filmpjes. Ja maar dat vind ik meer een soort sfeer maken. Er zijn altijd een aantal mensen waar je echt niks mee kan op dat moment. Nou dan bied ik daar een filmpje aan, en ondertussen ga ik iets anders doen met de ander. Dus zo moet je dat zien dan. Ik ga er niet echt bijzitten, filmpje kijken. Voor een aantal mensen biedt ik dat als achtergrond, ja als levend decor. Zoiets ja.

I Wat beïnvloedt de mate waarin je bepaalde technologie gebruikt?

AC Ehhh.. De hoeveelheid bewoners die ik wat te bieden moet hebben. Want 1 op 1 doe ik wel, maar als het heel rustig is, als de rest al wat activiteiten te doen heeft. Dan ga ik meer 1 op 1, en kan je ook bijvoorbeeld met masseren of alleen een praatje maken of wat dan ook.

I En bijvoorbeeld zoiets als de tovertafel, gebruik je dat wel in een groep?

AC Te weinig. Ik heb het wel gedaan, met vier mensen. Maar niet structureel. Dat is meer incidenteel, zo van als ik een paar mensen van de andere huiskamer, die toch wel verder weg gaan, een keer iets anders wil bieden. Maar dan moet ik dus al vier mensen verplaatsen he, dat is het probleem. Dan moet je weer iemand hebben die meehelpt met dat verplaatsen. Maar dan moet je nog een paar keer op en neer want dat zijn allemaal rolstoelbewoners.

I Dus iets van techniek wat je overal mee kan nemen is eigenlijk eh

AC Ja dat is heel fijn. Daarom heb ik ook op een gegeven moment de braintrainer op een verrijdbaar karretje gezet. Je kan hem even meetrekken.

I Wat houdt die braintrainer precies in?

AC Dat is een soort spelcomputer, dat is een computer waar je rekensommetjes mee kan doen. Het lijkt een beetje op de tovertafel, maar dan op een computer en een beetje uitgebreider. Waar je ook foto's op kan zetten, waar ook quizjes opstaan. Ik vind het beeldscherm dus te klein om in een grote groep te doen.

I Dat kan je niet nog projecteren?

AC Nee, nee. Wat ik toch wel eens doe is de braintrainer daar neer zetten met een groepje eromheen. Maar dan zet ik het geluid uit, want dan kan ik zelf het geluid maken. Dan kan je het toch ook weer regelen, hoeveel extra vragen je dan stelt.

I Je hebt hier dus bijvoorbeeld de braintrainer liggen, maar de qwiek stond bijvoorbeeld weer in een andere ruimte.

AC Ja op kantoor inderdaad.

I Heb jij daar vrij toegang tot?

AC Ja, die kan ik zo pakken. Ik zou daar meer mee moeten doen. Maar op dit moment heb ik zo iets ik wil eerst die groene muur. En als je vraagt, beperkingen, nou dat is toch ook wel tijd. Ik heb nog zoveel dingen die uitgewerkt moeten worden.

I Doe je dat wel nog buiten werktijd?

AC Ja tuurlijk. Anders gaat dat weer van je bewonerstijd af. Ja ik doe veel buiten werktijd. Dat is ook een stuk passie wat ik heb. Mijn werk is mijn hobby hoor.

I Zijn er meerdere activiteitenbegeleiders ook hier op de afdeling?

AC Op mijn afdeling loopt nog 1 activiteitenbegeleidster die mensen in bad doet. Op groenendaal zit ook een activiteitenbegeleidster. Die heeft een kleinere afdeling, maar daar doet zij dus activiteiten. Verder hebben we ook een hoop activiteitenbegeleiders beneden die het verenigingswerk leveren, het amusement. En dan hebben we zorggroep breed ook nog een muziektherapeut, die ook wel eens op de afdeling komt, maar niet structureel. Ja zo een beetje.

I Maar moet je dan ook afstemmen met de andere activiteitenbegeleiders wat je gaat doen?

AC Nee op de afdelingen niet. Wat ik wel doe, Die groene wand is samen met St. Peter. Dat ik in ieder geval die boswachter ook betrek, bij mijn groene activiteit. En evelyn deed dus een reminiscentie groep waar ze mensen van mijn afdeling bijhad. Maar goed zij is nu weg, en ik moet maar afwachten wat er komt.

I Maar je hebt niet vaak dat er net iets in gebruikt is wat jij wilt gebruiken? Er is genoeg voor iedereen?

AC Nee hoor. En anders verzin je wat anders. Ja. Een AB'er staat nooit voor een eh [laughs]

I Nee, je moet sowieso meerdere opties hebben natuurlijk.

AC Zo, nou. Ja je kan hier echt komen met de wildste plannen maar eh.

I Wat ik me afvroeg, de tovertafel is nog vrij nieuw, en de qwiek ook nog wel, hoe werden dat soort technologieën geïntroduceerd op de afdeling aan jullie?

AC Ehm, hoe gaat dat. Iemand verzint dat dat er moet komen en dat komt er, en dan krijg je een keer een introductie, en dan zoek het maar uit. De sonaboog, heb je daar wel eens van gehoord?

I Ik heb het op jullie site gezien, dat jullie dat hadden wel ja.

AC Nee, de sonaboog hadden ze van boven bedacht, dat is hartstikke mooi voor onze mensen, allemachtig prachtig. Werd ik in 1 keer gevraagd om de volgende dag in Zeeland een introductiecursus te volgen. Om maar voor te zorgen dat die geïmplementeerd werd, in eh Randerode, in weet ik veel wat. Nou dat is echt waardeloos, Wordt van bovenaf bedacht, en wordt er van ons verwacht dat wij het maar even doen. Terwijl wij zoiets hebben van wat moet je er mee. Maar die sonaboog staat buiten. Je moet weten hoe je er mee om moet gaan. Of de mensen dat wel leuk vinden. Nou ja zo gaat dat hier. Het wordt ergens bedacht, en wij mogen het uitzoeken.

I Er is niet echt ondersteuning vanuit de zorggroep om dat aan te leren?

AC Nee. We mochten wel een cursus volgen. En dat heb ik wel gedaan. Maar het is niet geweest zo van hè wat vinden jullie van de sonaboog, lijkt jullie dat wat voor jullie doelgroep? Nu heb ik echt hemel en aarde moeten bewegen om hem in te passen. Maar hij is nog niet ingepast in onze bezigheden, hij zit gewoon te ver weg. Er zijn teveel mitsen en maren. Hij staat er hartstikke leuk hoor, voor het kinderdagverblijf, en voor de mensen uit Ugchelen. En wij komen wel eens een keertje kijken als we toevallig wandelen.

I Het liefst zou je meer betrokken zijn bij het proces om te beslissen wat er gekocht wordt?

AC Kijk wat nu gebeurt, dat we nu zorg al betrekken bij zon onderzoek van goh zal dat wat zijn. Dan heb je ook veel meer kans dat je het goed kan introduceren. En als je inbreng hebt vanuit familie, dus voordat dat er is. Want zo werkt dat, Zo kweek je veel meer betrokkenheid, veel meer interesse.

I Ook leuk als jullie zelf een beetje mee kunnen denken lijkt me?

AC Ja toch!

I Sta jij open voor meer gebruik van techniek in de activiteitenbegeleiding?

AC Neuhh. Nou ligt eraan wat. Zo'n zora bijvoorbeeld vind ik wel leuk als ik dat heel specifiek bij 1 bewoner als contactmiddel. Maar om nou te zeggen zora dat is het, en we gaan hem overal inzitten, dan denk ik nee.

I Specifiek voor bepaalde doeleinden sta je ervoor open?

AC Specifiek heel gericht.

I Ervaar je wel eens problemen als je met een technologisch apparaat moet werken?

AC Ik zou graag willen dat mensen muziek gaan luisteren dat echt bij hen past. Wat dan ook wel zo gepromoot wordt ,met een mp3 speler en een koptelefoon op. Ik merk gewoon heel veel problemen daarbinnen. Dat de koptelefoon niet werkt. Mensen met gehoorapparaten, hoe werkt dat met geluid?

I Je merkt eigenlijk dat de technologie niet goed is afgestemd op de oudere mens?

AC Ja en ook zon bril is echt maar de vraag, kunnen ze dat hebben. Het is wel iets wat je op je hoofd zet, wat er gek uitziet, wat gebeurt er. Dat zijn echt vragen hoor.

I Ervaar je zelf ook wel eens problemen met het aan de praat krijgen van zo'n apparaat?

AC Je moet dingen leren kennen. Dat was ook met die mp3 speler, met de tovertafel. Ik ben wel vrij snel, dat ik dingen snel doorheb. Ook met zo'n relaxstoel. Het moet niet te moeilijk zijn.

I Ervaar je ook voordelen van het gebruik van technologie?

AC [laughs] Jawel. Kijk om zon meneer even neer te kunnen leggen en rust ervaart, dat is toch super. En ik heb ook wel mensen meegemaakt met zo'n koptelefoon Die dat heerlijk vonden, en dan eigen muziek. Tuurlijk ja.

I Zou je eerder kiezen voor een activiteit met technologie of zonder technologie en waarom?

AC Ehm. Weet ik niet. Ik denk dat ik technologie zelfs vaker inzet individueel, en in de groep zonder. Als je dat eh, als je dvd film even buiten beschouwing. Als ik echt een groepsactiviteit doe, dan gebruik ik geen technologie, en individueel wel.

I Zijn de technologieën die je gebruikt makkelijk te gebruiken voor je?

AC Ja, deze die ik nu allemaal ter beschikking heb wel.

I Allemaal makkelijk onder de knie te krijgen? Hoe komt dit denk je?

AC Omdat ik wel een technisch inzicht heb. Ik weet dat anderen dat niet zo hebben. Als je dan een oven hebt, dan moest ik wel eens een oven aanschaffen voor de afdeling. een simpel aan/uit knopje en een draaiknop om de temperatuur in te stellen, zodat iedereen dat kan bedienen. Iets anders kan ik niet zeggen, Ik snap dingen iets sneller, met de computer ben ik toch wel vaardig. Enigzins Ik zou niet zeggen dat ik alles weet. Maar ik kan me heel goed redden, en dat ik ook wel andere toepassingen vind zeg maar.

I Voor andere minder vaardige, niet technische mensen zou het dus handig zijn om het zo simpel mogelijk te hebben. Denk je dat bewoners in staat zijn om bepaalde technologieën zelfstandig te gebruiken? Dus bijvoorbeeld zon mp3 speler kunnen ze dat zelf opzetten?

AC Nee. Mp3, nee. Dat ligt sowieso buiten hun belevingswereld, dat is iets van onze generatie, of in ieder geval veel later. Bewoners kunnen best wel nieuwe dingen leren. Als je ook ziet dat mensen kunnen lopen met een rollator, betekent dat ze best nieuwe dingen kunnen leren. Ze kwamen hier lopend binnen en nu gaan ze toch met een rollator aan de gang. Dus het kan wel. Het heeft een bepaalde aanpak nodig. Koptelefoon aan en uitzetten wel. Maar dan komt er de volgende handeling, het moet ook nog wat doen. Het moet aan, je moet dingen kunnen selecteren. Hoeveel handelingen wil je nog dat mensen kunnen aanleren.

I Maar 1 handeling zou nog kunnen?

AC	Ja 1 handeling kan. Ik heb ook wel een opleiding of cursus gehad over nieuw gedrag of dingen aanleren met dementie. Dat is mogelijk. Maar je moet dan wel het hele team meehebben, dat ze het allemaal op dezelfde manier aanleren. Het lerend vermogen is er wel, maar het moet simpel zijn en heel duidelijk. En iedere keer op dezelfde manier.
I	Denk je dat bewoners ook open staan voor technologie tijdens activiteiten?
AC	Jawel, ze vinden het wel leuk. En het Ligt er ook maar aan hoe je het brengt.
I	Ook als ze het totaal niet kennen?
AC	Ja ligt eraan hoe je het brengt, als ik het heel spannend breng, van moet je nou toch kijken wat ik heb. En daar een heel verhaal omheen bouw. Dan willen ze best wel proberen. Jawel hoor, mensen willen best wel. Maar het ligt er aan hoe je het brengt. [laughs]
I	Het is dus niet zozeer hoe het eruit ziet, dat dat per se afschrikt?
AC	Het kan afschrikken. Ja, het kan. En kijk, iemand die niks aan zijn gezicht wil hebben, of heel graag de controle wil houden, die zal je niet gauw zon bril op de neus kunnen zetten. Het is maar net wie je hebt, en ook hoe je het brengt, die beiden ja.
I	Oké, duidelijk. Dat waren mijn vragen, bedankt voor alle informatie en je tijd.

Appendix B

Evaluation questionnaire VR headset & VRwonder

zorggroep Apeldoorn en omstreken UNIVERSITY OF TWENTE.

ONDERZOEK VIRTUAL REALITY VOOR MENSEN MET
DEMENTIE

In samenwerking met de Universiteit Twente onderzoekt Zorggroep Apeldoorn of Virtual Reality ingezet kan worden bij ouderen met dementie. Er wordt gekeken naar de reactie van de bewoners op Virtual Reality. Daarnaast wordt gekeken hoe de ervaring begeleid kan worden. Dit evaluatieformulier gaat voornamelijk over de begeleiding van bewoners bij het bekijken van virtuele ervaringen.

Evaluatieformulier Virtual Reality bril & VRwonder app

In de afgelopen weken heeft u vrij gebruik kunnen maken van de Virtual Reality bril en de VRwonder app op de tablet. Om erachter te komen hoe u het gebruik hiervan heeft ervaren vragen wij u om dit evaluatieformulier in te vullen. Met uw feedback kunnen er eventuele aanpassingen worden gedaan en de haalbaarheid worden geëvalueerd.

Het formulier is ingedeeld in verschillende thema's. Deze worden kort toegelicht waar nodig.

Probeer niet te lang na te denken over uw antwoorden, er zijn geen goede of foute antwoorden!

Alvast hartelijk dank voor uw deelname!

Algemeen

1. Wat is je functie binnen of je relatie tot Randerode (bijv. verzorgende, familielid etc.)?

   ----

2. Hoe lang ben je al werkzaam bij Randerode? (indien van toepassing)

   ----

3. Hoe oud ben je?

Voorkennis

De volgende vragen gaan over uw voorkennis wat betreft het gebruik van technische producten.

4. Ik vind mezelf vaardig in het gebruik van tablets.

Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens
○	○	○	○	○

5. Ik heb het omgaan met een technisch product snel onder de knie.

Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens
○	○	○	○	○

6. Ik heb zelf wel eens eerder een Virtual Reality bril gebruikt.

Ja	Nee
○	○

Mate van gebruik

7. In de afgelopen weken heb ik de VRwonder app en VR bril:
   - ○ Niet gebruikt
   - ○ 1 keer gebruikt
   - ○ 2 tot 5 keer gebruikt
   - ○ Meer dan 5 keer gebruikt

8. Waarom heb je de VRwonder app en VR bril wel/niet gebruikt? En wat beïnvloedde de mate waarin je de VRwonder app en VR bril hebt gebruikt?

Gebruiksvriendelijkheid van de VR bril en de VRwonder app

De volgende vragen gaan over het gebruiksgemak van de VR bril en de VRwonder app. Vraag 7 t/m 16 gaan specifiek over de Virtual Reality bril. Dezelfde vragen zullen daarna gesteld worden over de VRwonder app op de tablet (vraag 17 t/m 26).

Probeer de vragen zo vlot mogelijk in te vullen. Vul het antwoord in dat het eerste bij u opkomt. Probeer de vragen ook in te vullen als u de VR bril of VRwonder app (nog) niet heeft gebruikt.

De volgende vragen gaan over uw indruk van de **Virtual Reality bril**:

	Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens	Niet van toepassing
7. Ik denk dat ik de VR bril vaak zal gebruiken.	○	○	○	○	○	○
8. Ik vind de VR bril onnodig complex.	○	○	○	○	○	○
9. Ik vond de VR bril makkelijk te gebruiken.	○	○	○	○	○	○

		Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens	Niet van toepassing
10	Ik denk dat ik technische support nodig heb om de VR bril te kunnen gebruiken.	○	○	○	○	○	○
11	Ik vind de verschillende functies van de VR bril goed geïntegreerd.	○	○	○	○	○	○
12	Ik vind dat er teveel inconsistentie in de VR bril zit.	○	○	○	○	○	○
13	Ik kan me voorstellen dat de meeste mensen snel door hebben hoe ze de VR bril moeten gebruiken.	○	○	○	○	○	○
14	Ik vond de VR bril erg omslachtig te gebruiken.	○	○	○	○	○	○
15	Ik voelde me zelfverzekerd toen ik de VR bril gebruikte.	○	○	○	○	○	○
16	Ik moet veel leren over de VR bril voordat ik het goed kan gebruiken.	○	○	○	○	○	○

Vul nu dezelfde vragen in over de **VRwonder app op de tablet**:

		Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens	Niet van toepassing
17	Ik denk dat ik de VRwonder app vaak zal gebruiken.	○	○	○	○	○	○
18	Ik vind de VRwonder app onnodig complex.	○	○	○	○	○	○
19	Ik vond de VRwonder app makkelijk te gebruiken.	○	○	○	○	○	○
20	Ik denk dat ik technische support nodig heb om de VRwonder app te kunnen gebruiken.	○	○	○	○	○	○

	Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens	Niet van toepassing
21 Ik vind de verschillende functies van de VRwonder app goed geïntegreerd.	○	○	○	○	○	○
22 Ik vind dat er teveel inconsistentie in de VRwonder app zit.	○	○	○	○	○	○
23 Ik kan me voorstellen dat de meeste mensen snel door hebben hoe ze de VRwonder app moeten gebruiken.	○	○	○	○	○	○
24 Ik vond de VRwonder app erg omslachtig te gebruiken.	○	○	○	○	○	○
25 Ik voelde me zelfverzekerd toen ik de VRwonder app gebruikte.	○	○	○	○	○	○
26 Ik moet veel leren over de VRwonder app voordat ik het goed kan gebruiken.	○	○	○	○	○	○

Handleiding en informatievoorziening

Bij de VR bril zat een A4 met veiligheidswaarschuwingen (zie hieronder). Beantwoord nu de vragen over deze richtlijnen voor gebruik.

Belangrijk! Richtlijnen voor gebruik VR bril

Voorwaarden voor gebruik

Niet gebruiken bij gevoeligheid voor **wagenziekte** of **epilepsie.**

Niet gebruiken bij iemand met een **elektronisch implantaat of pacemaker** (of alleen op doktersvoorschrift).

Redelijk zicht en gehoor vereist. Heeft de gebruiker een bril? Deze kan gewoon worden opgehouden!

Veiligheidswaarschuwingen

Alleen zittend gebruik maken van VR bril. Zorg voor een comfortabele stoel met leuningen.

Bouw het gebruik van de VR bril rustig op, begin met enkele minuten per keer. Gebruik de bril tot een **maximum van 30 minuten** aan één stuk. Neem een pauze van minstens 10 tot 15 minuten na lang gebruik.

Zorg voor **voldoende bewegruimte** voor de armen.

Gebruik de bril **nooit** wanneer deze nog aan het opladen is.

Medische apparaten zoals AED's kunnen het signaal van de VR bril verstoren (en vice versa). **Houd voldoende afstand** tot dit type apparaten.

De VR bril is **niet waterbestendig.** Pas dus op met vloeistoffen! Deze kunnen de bril beschadigen.

Bril **te heet** om aan te raken? Gebruik de VR bril pas wanneer deze wat is afgekoeld.

Technische problemen met de VR bril?
Neem contact op met Oculus Support via de site support.oculus.com

27. Heeft u het blad met veiligheidswaarschuwingen doorgenomen voor gebruik van de VR bril?
    - ○ Blad met veiligheidswaarschuwingen? Niet gezien!
    - ○ Vluchtig, ik heb even snel de plaatjes bekeken.
    - ○ Jazeker, ik heb het nauwkeurig doorgelezen.

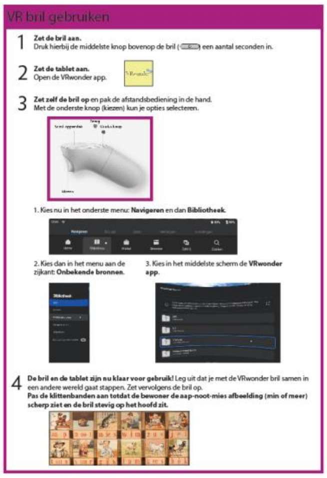
28. De richtlijnen voor gebruik van de VR bril waren helder.

Totaal onduidelijk	Veelal onduidelijk	Neutraal	Voor het grootste deel duidelijk	Heel erg duidelijk
○	○	○	○	○

29. De plaatjes bij de veiligheidsvoorschriften waren goed te begrijpen, ik kon in één oogopslag zien wat er werd bedoeld.

Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens
○	○	○	○	○

Naast de veiligheidsvoorschriften was er ook een handleiding (stappenplan) te vinden in het VR koffertje.



VR bril gebruiken

1 **Zet de bril aan.**
Druk hierbij de middelste knop bovenop de bril ( ) een aantal seconden in.

2 **Zet de tablet aan.**
Open de VRwonder app.

3 **Zet zelf de bril op** en pak de afstandsbediening in de hand.
Met de onderste knop (kiezen) kun je opties selecteren.

1. Kies nu in het onderste menu: **Navigeren** en dan **Bibliotheek**.

2. Kies dan in het menu aan de zijkant: **Onbekende bronnen**.

3. Kies in het middelste scherm de **VRwonder app**.

4 **De bril en de tablet zijn nu klaar voor gebruik!** Leg uit dat je met de VRwonder bril samen in een andere wereld gaat stappen. Zet vervolgens de bril op.
Pas de klittenbanden aan totdat de bewoner de aap-noot-mies afbeelding (min of meer) scherp ziet en de bril stevig op het hoofd zit.

5 **Pak de tablet erbij** en **kies een filmpje** uit het hoofdmenu om af te spelen.
Het kan even duren voordat het filmpje geladen is.

6 Jullie kunnen nu samen het filmpje bekijken! Vraag degene met de bril op wat hij of zij ziet. Als jullie iets interessants zien waar je langer over wilt praten kun je het filmpje altijd **pauzeren door op de "pauzeren" knop op het tablet scherm** te drukken.

7 Wil je liever een ander filmpje zien? Ga dan **terug naar het keuzemenu met de "Menu" knop linksbovenin** het tablet scherm.

8 Genoeg gezien voor vandaag?
Doe dan eerst de bril af. Laat de ander eerst nog eventjes rustig zitten om weer te wennen aan de echte wereld. Vraag hoe het met hem/haar gaat.

9 Ondertussen kunt u zelf de bril opzetten om de app af te sluiten.
Druk op de **Oculus knop** . Er verschijnt een scherm om de app af te sluiten. **Klik op afsluiten.** Zet de bril vervolgens helemaal uit door de knop ingedrukt te houden.
Vergeet de bril niet aan de oplader te leggen!

10 Sluit vervolgens de app af op de tablet en zet de tablet uit.
Leg de tablet indien nodig ook aan de oplader.

Beantwoord nu de vragen over de handleiding.

30. Heeft u de handleiding doorgenomen voor gebruik van de VRwonder app en VR bril?
    - ○ Nee, ik ben gelijk aan de slag gegaan met de bril en de tablet!
    - ○ Nee, maar ik heb uitleg gehad van een collega (of iemand anders) over de bril en de app.
    - ○ Ja, ik heb hem vluchtig doorgenomen.
    - ○ Ja, ik heb de handleiding stap voor stap gelezen voordat ik aan de slag ging met de bril en de tablet.

31. Ik heb de handleiding nodig gehad tijdens het gebruik van de VRwonder app en VR bril.

Helemaal niet	Eén keer, maar daarna wist ik hoe ik het moest doen	Af en toe	Vaak	Bij iedere stap
○	○	○	○	○

32. De handleiding was gemakkelijk te volgen.

Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens
○	○	○	○	○

33. De handleiding was volledig.

Helemaal mee oneens	Oneens	Neutraal	Eens	Helemaal mee eens
○	○	○	○	○

Zo nee, wat miste er aan de handleiding?

Afsluiting

34. Wat was je algemene indruk van de VRwonder app en VR bril?

----

35. Wat vond je leuk aan de VRwonder app en de VR bril?

----

36. Wat kan er beter aan de VRwonder app en de VR bril?

Dit is het einde van het evaluatieformulier. Hartelijk dank voor het invullen!