

# ADVISORY REPORT

*Enhancing VRelax: Optimizing Virtual Reality Integration  
in Elderly Care and Elevating Feedback Procedures*

VRELAX



## SUPERVISION

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28/06/2024

## Prologue

During the second year of my master's degree in biomedical sciences, I pursued the Science, Business, and Policy (SBP) track with the aim of becoming an independent science advisor, where I can integrate my biomedical knowledge into business and policy-related issues. As part of the curriculum of this track, in the second semester I took part in an internship at VRelax, specialized in using Virtual Reality to reduce stress in patients.

Throughout the course of my internship, I received guidance from three supervisors: a SBP supervisor for overall guidance with my project, a science supervisor, overseeing the scientific aspects of my project, and two daily supervisors guiding me in my internship and formulation of my project (Table 1).

I would like to express my gratitude to all my supervisors for all the opportunities and for promoting both my professional and personal development. Many thanks to my daily supervisors Jarib and Marieke for making it possible to get acquainted with all departments within a company and events and presentations at many companies, so that I could properly orient myself on career opportunities. Additionally, I want to thank them for giving me the freedom to explore my interest in elderly care within my project. I would also express my gratitude to Peter for his clear insights into the scientific knowledge that has been applied to my project. Finally, I am grateful to Mart for the overall steering and guidance to lead my project to a solid advisory report.

The objective of the internship within the context of the SBP specialization of the Master's program in Biomedical Sciences at the University of Groningen is to integrate scientific, business, and policy considerations, with the goal of providing a comprehensive recommendation addressing an issue in the biomedical field. The pursuit of this project is about 50% science and 50% business, and spans from the 8th of January to the 28th of June 2024, with a duration of 24 weeks.

**Table 1.** Supervisors of this project.

Name	Institute	Function	Role in supervision
MSc. M. P. C. (Marieke) Jongma	VRelax	Chief Operational Officer	Daily supervisor
MSc. J. E. (Jarib) Keasberry	VRelax	Operations & Customer Success	Daily supervisor
Prof. dr. P. (Peter) Meerlo	University of Groningen, GELIFES	Professor and researcher	Science supervisor
Drs. M. (Mart) van Genne and Drs. S. (Saskia) Grooters	University of Groningen, Science Business and Policy Master's track	Lecturers	SBP supervisors

### Disclaimer

This report has been produced in the framework of an educational program at the University of Groningen, Netherlands, Faculty of Science and Engineering, Science Business and Policy (SBP) Curriculum. No rights may be claimed based on this report, other than described in the formal internship contract. Citations are only possible with explicit reference to the status of the report as a student internship product and written permission of the SBP staff.

## Executive summary

### Advice

- Improve structure and communication within and between departments of VRelax.
- Implement an internal and external feedback form, user-friendly and accessible to both VRelax users and employees.
- Optimize feedback processes by the integration of all feedback input channels and Jira, so all feedback ends up in a central location and prioritization can then be done properly.
- Increase the focus on the specific needs of the elderly care sector, like content and implementation, to achieve a better alignment with this sector.

### Key Findings

- Lack of available feedback forms, PMS, and an efficient recording system and location of collection of all feedback.
- Within VRelax, the content does not always meet the needs of the care-dependent elderly.
- The HRV chest strap does not seem to be an optimal way to measure stress, but alternatives such as a wrist strap and HUME offer a good addition to this.

### Main Conclusion

To increase the efficiency of VRelax, improvements will need to be made in all four aspects of the customer feedback loop. In addition, better addressing the needs of elderly care is needed to be align with this sector. Both improvements are essential to enhance the position of VRelax.

### Background and Objective

The Dutch population is expected to keep aging significantly in the near foreseen future (Chapter 1). As a result of this increase in the number of elderly people, there will be a rise in common diseases. Even though the demand for care will increase enormously in the future, the number of people working in healthcare will decrease. The Dutch Healthcare Institute notes that the sustainability of healthcare is under pressure; if no action is taken, 1 out of 3 people will have to be working in healthcare within 40 years, while currently 1 out of 7 people are already needed in healthcare to sustain society. New healthcare technologies could alleviate this problem by relieving staff of labor-intensive tasks and possibly taking over secondary tasks. A form of healthcare technology to ultimately reduce the workload in (elderly) care is Virtual Reality (VR). An example of this application that is specifically used in the healthcare sector is developed by VRelax. The aim of this project is to enhance VRelax's efficiency by improving the customer feedback loop and optimizing the implementation of their product for care-dependent elderly users.

### Methodology

Firstly, a scientific literature study was conducted to examine the effects of VRelax as a solution to the problems faced by the care-dependent elderly. In addition, the findings from previous studies of VR in elderly care were retrieved (Chapter 2). Secondly, an internal analysis will look into the various bodies of VRelax and explain the communication between the different functions and departments. In addition, the VRIO examines the VRelax product and evaluates its position in the market. By looking at the position of VRelax in elderly care, it can be determined which aspects of the product can still be improved in order to best fit in with elderly care (Chapter 5). Thirdly, the current CFL has been mapped and looked at where the shortcomings lie (Chapter 6). Fourthly, an external analysis, using a PESTEL and Porter's Five Forces analysis, has been able to demonstrate VRelax's position on the market and what their opportunities and threats are (Chapter 7). Finally, interviews were held with several elderly care institutions that use VRelax to see what their findings and bottlenecks are (Chapter 8, Appendix).

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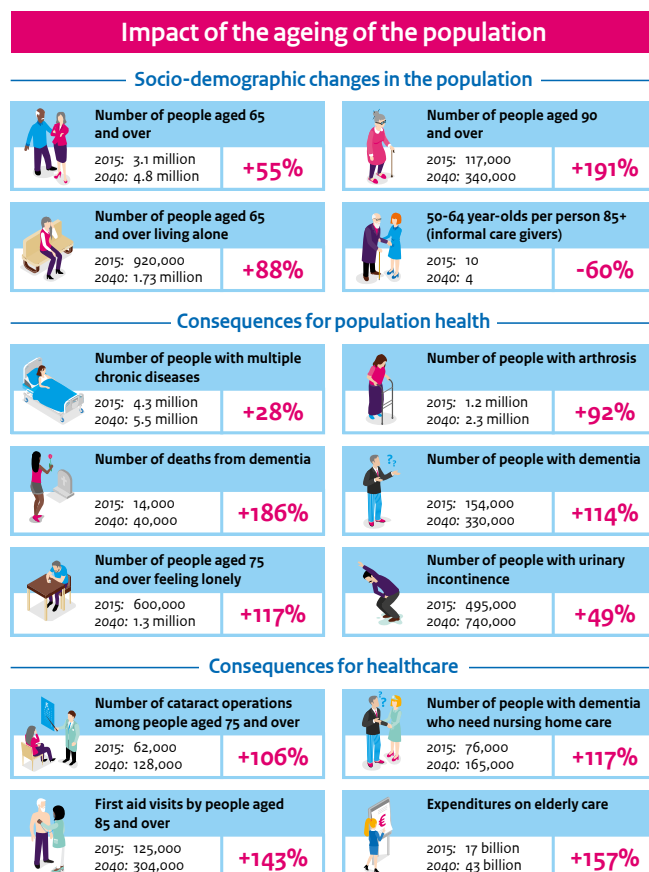
## Chapter 1. Introduction

### 1.1 The Aging Population and Increasing Pressure on Elderly Care

The Dutch population is expected to keep aging significantly in the near foreseen future (Figure 1). Due to improvements in healthcare, a decrease in the lethality of diseases is seen and thereby the share of people over 65 is expected to increase exponentially in the upcoming decades (Canoy et al., 2022). Currently, 20% of the Dutch population falls under this group, which is expected to increase by approximately 25% by 2050. In addition, the percentage of people aged over 80 is set to further increase from around 5% to over 10% in 2050. As a result of this increase in the number of elderly people, there will be a rise in common diseases. One of these is the disease dementia, which is present in a quarter of people over the age of 80. Dementia is the most expensive disease in the Netherlands. The fact that this group will grow and that the number of people with dementia will increase will lead to a significant increase in healthcare costs. Besides that, older people are more likely to suffer from chronic conditions, there will also be an increasing number of elderly people with multiple conditions at the same time, so-called multimorbidity (Idenburg & Philippens, 2020). Examples of these problems range from loneliness to limitations in daily functioning, which contribute to the vulnerability of the elderly. For these reasons, their satisfaction with their own lives will decrease enormously (RIVM, 2018).

The care needs of these elderly people with one condition, or even several, is great. Moreover, the share of elderly that end up alone due to the death of their significant other is also large (de Jong et al., 2022). Informal care is often assigned to people who are very old too, and therefore also develop their own problems. A legitimate question here is whether there is sufficient potential in the future to meet this high demand for care. The Oldest Old Support Ratio is an indicator of the number of people aged 50 to 75 compared to 85 or older (Robine et al., 2007). This value has decreased enormously in recent years and is estimated to be only 5 potential care providers in 2050, compared to 14 in 2021. As a result, this will mean that only a third of the current informal caregivers are available for every person over 85.

In addition to the decrease in available informal caregivers, which leads to higher costs for society (Brown et al., 2012), the complexity of problems where elderly have to deal with will place even greater demands on healthcare workers. The elderly will have the need for more care and especially more adapted care (Idenburg & Philippens, 2020). Even though the demand for care will increase enormously in the future, the number of people working in healthcare will decrease. The Dutch Healthcare Institute notes that the sustainability of healthcare is under pressure; if no action is taken, 1 out of 3 people will have to be working in healthcare within 40



**Figure 1.** The developments in aging for the coming decade and the additional effects on the health landscape (RIVM, 2018).

years, while currently 1 out of 7 people are already needed in healthcare to sustain the society (WWR, 2021). Due to the aging of the population, the percentage of people of working age will decrease by 5%, which will contribute to an increase in labor shortages. Additionally, the growing demand for more expensive technologies and medicines, driven by an aging population and the increase in chronic or multimorbidity diseases, is expected to cause healthcare costs to rise rapidly. The RIVM has found that healthcare expenditure in elderly care will increase from 17 billion euros to 70 billion in 2060 via the *Wet langdurige zorg (Wlz)* (RIVM, 2020). If no changes are made, it is expected that not everyone can receive appropriate care. These two major developments will increase the pressure on elderly care significantly.

Thus, it is important that this growing demand for care is taken into account so that everyone's care needs can be met. However, the demand for personnel in the healthcare sector has doubled in the past ten years and the number of vacancies in nursing and care, among other things, leads to a shortage of 22,000 employees (CBS, 2020). Research by ABF Research (2020) shows that in the future the demand for care will not be met with the available healthcare workers at the moment. New healthcare technologies could alleviate this problem by relieving staff of labor-intensive tasks and possibly taking over secondary tasks. This will probably result in a lower outflow of healthcare personnel. Currently, the technology used in healthcare is increasingly embraced, which offers positive prospects for the integration of further healthcare technologies. These positive effects of healthcare technology include increasing well-being and control and improving the quality of care (Ebbinge & Lintveld, 2020). Recently, there has been a positive development that will drive the adoption of healthcare technologies: the government has announced that it is making 108 million euros available for technology in healthcare (Rijksoverheid, 2024). However, there are still many steps to be taken to properly integrate it into current care. The present bottlenecks are the lack of knowledge and time, staff shortages, acceptance of healthcare technology by healthcare providers, and the lack of capacity to change (Strategy, 2019). However, research by Felder (2003) has shown that healthcare technology has many positive effects, such as addressing the current staff shortage.

A form of healthcare technology that may ultimately reduce the workload in (elderly) care is Virtual Reality (VR). This technology is an apparent reality that is realized through VR glasses (Rizzo & Bouchard, 2019). Several senses are stimulated, including sight and hearing, by being completely isolated from reality, and by seeing images and hearing sounds through the VR glasses. An example of this application that is specifically used in the healthcare sector is developed by VRelax. VRelax uses a unique 360-degree experience in natural environments with spatial audio. In addition, it is specifically aimed at relieving stress, anxiety, and sadness, resulting in improved mental well-being. An aging population brings more elderly people with more complex diseases, and the subsequent stress experienced from disease and care can further lead to various health problems in these elderly people (Seangpraw et al., 2020). With the use of VRelax, part of this stress could be relieved, which could result in fewer health problems, thereby contributing to reducing the workload in elderly care.

## 1.2 Ecosystem of VRelax

VRelax is a start-up software company, offering licenses of their VRelax app to healthcare organizations. All the software that is used for the VRelax experience is developed in-house. The product has been scientifically validated through their own research (Veling et al., 2021; Nijland et al., 2021). Furthermore, VRelax offers a whole eco-system, which in addition to the app consists of a biofeedback system, dashboard, and GRIP app. The VR glasses that are also offered by VRelax were not developed by VRelax, but are supplied by the external company VR Expert.

### VRelax app

The VRelax app is the main product, available for download onto the VR glasses exclusively through the purchase of a license. The app consists of about 60 different nature worlds, each with different themes, such as 'Calm Forest' or 'Sea Life'. The worlds vary from static and moving, to even interactive worlds where you have to blow away clouds or make stars twinkle, for example. Figure 2 shows the app's interface with a few examples of worlds. All content of the worlds is filmed and produced by VRelax itself. It is not possible to add images to the app yourself. With the current updates it is now also possible to indicate your favorites and select whether, for instance, you only want content visible without animals or that are static. Navigating through the app is possible without the use of external devices or operators, namely through the movement of the eyes, which makes the app easy to use for most target groups.



**Figure 2.** The latest version (v4.0) of the user interface of the VRelax app.

### GRIP app

In addition to the app on the glasses themselves, there is also a connecting app available for a tablet. By linking the app on the tablet to the glasses, you can use this app to view what the user of the glasses sees at that moment. Additionally, it is also possible to take control and decide what the user sees. For example, this would be a solution for a healthcare worker who works with clients having cognitive or physical impairments. Furthermore, immediate and accurate intervention can be taken if a client has an unpleasant experience with the VR session by leaving the specific world. Moreover, it is possible to perform biofeedback measurements using the GRIP app. This requires the client to wear a chest strap with which the heart rate variability (HRV) can be measured. This application allows HRV to be measured, which is an indicator of the stress level, which the healthcare worker can anticipate and act on. The use of this app comes into its own in elderly care, as the elderly often suffer from cognitive problems and assistance through the app is a good way to apply VRelax to this target group.

### Dashboard

The results of the measurements made with the HRV band can be seen in the dashboard. This shows the stress levels of a particular client during the VR session. Furthermore, the dashboard provides insights into content customization, language management, and role management for healthcare employees and clients in a user-friendly interface.

## 1.3 Customer Feedback Loop

Gathering feedback on a company's product is important to make the product as user-friendly as possible. This is equally applicable to VRelax. A recent study by Deniz-Garcia et al. (2023) on the implementation of mobile health apps indicates that the co-creation-based framework is the best method to tackle challenges such as usability and effectiveness. A key component of this co-creation is treating the end users as experts, identifying the main obstacles users encounter, and helping enhance goal setting. Currently, VRelax receives feedback in several ways. One of these is direct feedback from customers to VRelax employees, which is considered the most valuable.



This feedback is highly regarded since the fulfillment of VRelax content is based on these user insights. Additionally, there is an online page and a support mailbox where users can report any issues. The way of processing feedback in this way is not done efficiently very well at the moment. Feedback from customers and users currently comes in through several channels, resulting in a disorganized manner of feedback registration and processing. As a result, not all feedback is retained and adequate action cannot be taken.

In addition, VRelax has problems with prioritizing the received feedback. At the moment, the feedback is reviewed and then placed on the developers' priority list. The development team is currently experiencing difficulties with prioritizing all the various feedback that comes in through the different channels. By addressing these problems, the so-called customer feedback loop (CFL) of VRelax can be optimized. Advancing the CFL of VRelax involves evaluating customer feedback, presenting VRelax to customers, and validating whether the implemented improvements indeed enhance the product.

## 1.4 Goals and Research Questions

The goal of VRelax is to maximize the potential of their product for their customers, specifically the elderly in this context. The term “elderly” refers to those elderly who need care. This project will aim to investigate in which areas VRelax can be integrated to better suit elderly care. The end result will be advice on the points of attention of VRelax in elderly care and the possible method of validation of VRelax in elderly care. Furthermore, VRelax wishes to optimize its CFL, in order to improve integration of feedback into their current product. The aim of this project will be to map the current feedback process and explore its shortcomings. Finally, a piece of advice will be composed of improvements that can be made in order to optimize the CFL. With these aims in mind, it will be explored whether VRelax can serve as an effective tool for reducing stress in the elderly.

The main research question is: “How can VRelax improve its efficiency by advancing its customer feedback loop and optimizing its product for the care-dependent elderly?”

Sub-questions about stress and VR in care-dependent elderly:

- What is (a) stress (response)? – *Chapter 2*
  - What is the difference between acute and chronic stress?
  - What are stress determinants and its consequences?
- What is the prevalence and risk of stress manifestations in the elderly population? – *Chapter 2*
- What are the working mechanisms and effects of VR on the human body? – *Chapter 3*
- What measurements should be utilized for optimal implementation of VRelax in elderly care? – *Chapter 4 & 8*
- What is the external environment around VRelax like? – *Chapter 7*
- What interventions are needed to apply VRelax to the care-dependent elderly? – *Chapter 8*

Sub-questions advancing customer feedback loop:

- How is the organizational structure of the various sectors within VRelax designed? – *Chapter 5*
- How does VRelax position itself in the market given its capabilities and resources? – *Chapter 5*
- What is the current customer feedback loop of VRelax? – *Chapter 6*
  - What are the shortcomings?
- How can VRelax improve its customer feedback loop process? – *Chapter 6*
  - How can VRelax evaluate its updates as efficiently as possible?

## 1.5 Reading Guide

*Chapter 2* discusses the stress response, the difference between acute and chronic stress, the consequences of (chronic) stress, stress in the elderly, and multiple research where VRelax is used within elderly care. *Chapter 3* will discuss the potential mechanisms of action of VRelax. Here the effect of nature will be discussed, and the comparison between the simulated nature by VRelax. Furthermore, several theories, including the Attention Restoration Theory, Stress Reduction Theory, and the role of the Default Mode Network will be explained. *Chapter 4* will discuss various measurements to validate VRelax in elderly care. A distinction will be made between objective/physiological measurements and (self-)reporting questionnaires as measurements. *Chapter 5* provides an internal analysis of VRelax, in which the internal structure of VRelax is mapped and the capabilities and resources are elaborated. *Chapter 6* will cover all aspects of the CFL. Here we will discuss the definition of a CFL, the current state of the CFL at VRelax, the shortcomings of the feedback loop, and ways to improve the feedback process. *Chapter 7* shows what VRelax's external environment looks like in terms of market attractiveness and competition. *Chapter 8* provides recommendations for optimizing the alignment of VRelax into elderly care. *Chapter 9* will provide a piece of overall advice and tailored implementation for VRelax regarding the CFL and approach of elderly care. Finally, *chapter 10* provides a discussion that critically examines the advisory report, highlighting its strengths and identifying its limitations.

## Chapter 2. What is Stress

This chapter will discuss the biology of stress, the consequences of stress in the elderly, and the use of VRelax in this target group. Homeostasis, a regulatory process, maintains the internal environment in constant equilibrium by restoring it to changing conditions, ensuring the body's internal environment remains stable despite external fluctuations (Cannon, 1929). These external factors that disrupt homeostasis are caused by a stressor (Schneiderman, Ironson & Siegel, 2005). A stressor is defined as an actual perception of a threat. This stressor will then lead to a stress response. Although the perceived stress caused by the stressor may initially have a negative effect on homeostasis, the stress response ensures that the body is restored to its homeostatic state (Chovatiya & Medzhitov, 2014).

The stress response causes two physiological reactions in the body: a slow response, mediated by the hypothalamic-pituitary-adrenal (HPA) axis, and a fast response to the sympathetic part, mediated by the sympathetic adrenal medullary (SAM) axis (Figure 3). Both of these processes ensure the production of hormones that influence various body processes. However, the physiological response that is caused may not always actually be a sign of stress. The cognitive perception of uncontrollability and unpredictability will be included in the concept of stress (Koolhaas et al., 2011). These factors affect the actual stress response. Unpredictability is a characteristic of the stress stimulus, defined by the lack of an anticipatory response, which can result in an increased stressor. Similarly, uncontrollability is a feature of the stress situation, often leading to a delayed recovery and the presence of an adrenaline response (Koolhaas et al., 2011).

Moreover, earlier exposure to the particular stressor could provide greater controllability and predictability, which subsequently leads to a faster recovery time and therefore fewer negative consequences of the stress response. In addition to this qualitatively defined stimulus, the stressor also has a quantitative side. How a person interprets a situation varies from being completely in control to partially or completely losing control. This qualitative assessment, together with stressor intensity, forms the concept of stress, where controllability, predictability, and intensity collectively contribute to the overall stress experience.

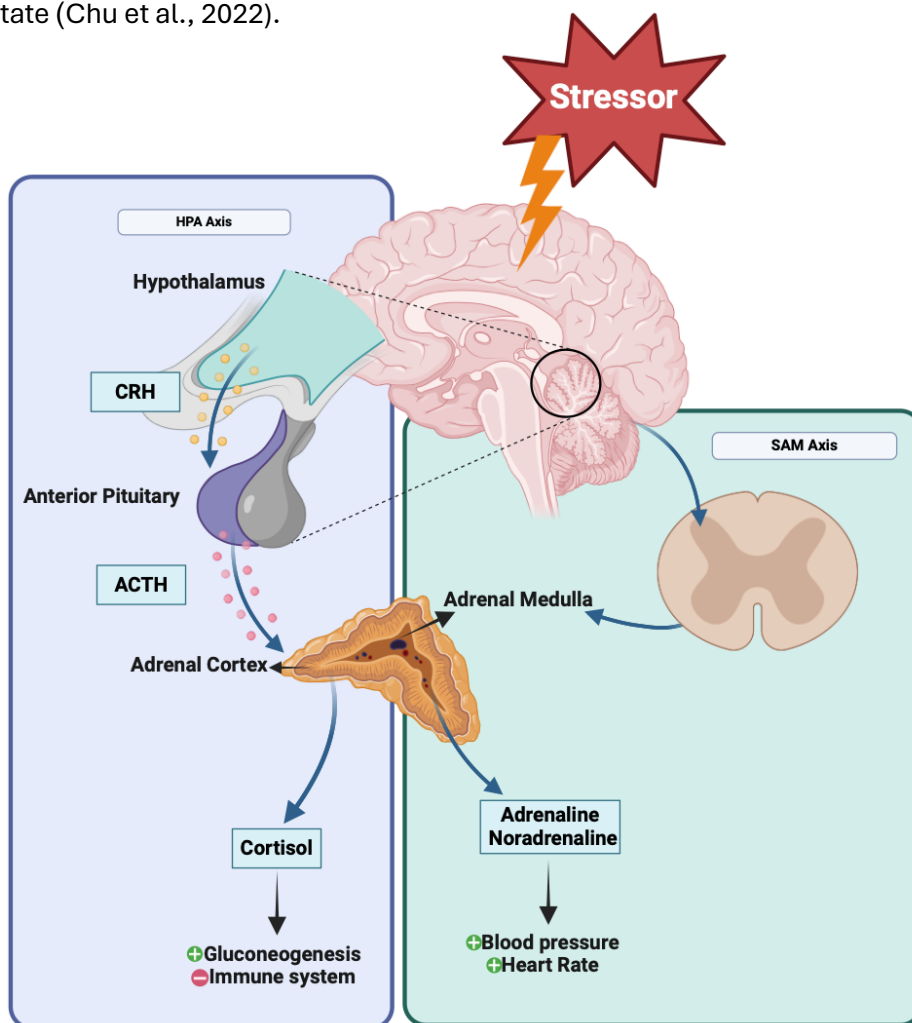
### 2.1 The Stress Response

The initiation of a stress response occurs when an individual perceives a particular stressor (Russell & Lightman, 2019; Figure 3). Firstly, the SAM axis responds as the sympathetic part of the autonomic nervous system is activated by the stressor. In response to the stressor, the sympathetic nervous system will release the hormones adrenaline and noradrenaline from the adrenal medulla (Gunnar & Quevedo, 2007). These two hormones will cause rapid reactions in the body, also known as the "fight or flight" response. Examples of this are higher blood pressure (BP) and heart rate (HR), and controlled blood flow to vital organs, to prepare the body to take action. The parasympathetic nervous system counteracts these effects and is therefore involved in the recovery and termination of the stress response (Chu et al., 2022).

Furthermore, noradrenaline is also an important neurotransmitter during a period of stress as it is involved in arousal (Berridge, 2008). The major source of NE production is the locus coeruleus and it has been shown that the locus coeruleus-noradrenergic system shows sensitivity to stressors (Berridge, 2005). From this, it could be concluded that this system is involved in the cause of the increased arousal levels during stress. As a result of this stimulation of arousal, it can have indirect consequences on affective and cognitive processes. Further actions involving

noradrenaline within affective and cognitive circuits will also impact these two affective and cognitive aspects of stress (Berridge, 2008).

On top of the activation of the fast-reacting SAM axis, the HPA axis is a slower-reacting system that restores homeostasis after the fast response. The area in the brain called the amygdala is important here and will recognize and interpret the stressor (Gunnar & Quevedo, 2007). Subsequently, it activates the hypothalamus, another area in the brain. As a result, the hypothalamus will release the hormone corticotropin-releasing hormone (CRH), one of the signaling molecules that starts the stress response. In response to the released CRH, the pituitary will release the hormone adrenocorticotropic hormone (ACTH) into the blood. ACTH then reaches the adrenal cortex via the blood, where it will trigger the release of glucocorticoids, such as cortisol. Cortisol gives the body an energy boost and suppresses processes that are not important during a stress response, including the immune system. This constant energy is generated because the blood glucose level increases through gluconeogenesis, sustaining the heightened energy state (Chu et al., 2022).



**Figure 3.** Visualization of stress response. A stressor enters the brain and activates two systems, the HPA axis and the SAM axis. In the HPA axis, CRH is produced by the hypothalamus, which then stimulates the anterior pituitary to produce ACTH. Subsequently, ACTH will activate the production of cortisol via the adrenal cortex. This will have effects on the body, including the stimulation of gluconeogenesis and inhibition of the immune system. On the other hand, in the SAM axis there will be a stimulation of the adrenal medulla via the autonomic nervous system and there will be a release of adrenaline and noradrenaline. In response to this, BP and HR, among other things, will increase.

## 2.2 From Acute to Chronic Stress

There may be times when the demands are high and require a lot of physical and psychological effort. This high tension and stress causes the body to activate all kinds of neuroendocrine circuits (via the SAM and HPA axis), in order to deal with it properly and return to homeostatic equilibrium (Mariotti, 2015). However, if an individual perceives a harmful stressor as overwhelming, or persisting for an extended period, proper handling may be compromised and will lead to maladaptation. As a result, internal balance will not be returned, neuroendocrine parameters will remain altered, and disease may eventually develop (Silverman & Sternberg, 2012).

As described in the article by Koolhaas et al. (2011), stress consists of a physical (objective) and psychological (subjective) part. The psychological experience of stress is linked to the individual's sense of control and predictability. The ability to anticipate and control a particular stressor determines how the stress response will proceed and how quickly it will be terminated. This implies that not all stimuli that evoke neuroendocrine responses are necessarily a real stressor, but only those where it falls outside the adaptive capacity of the individual.

A study by Yang et al. (2011) looked at the relationship between this controllability and predictability and stress. It was found that predictable and controllable stress (modeled by signaled, escapable shock) and predictable but uncontrollable stress (modeled by signaled, inescapable shock) produce distinct patterns and amounts of post-stress sleep. Secondly, it has been shown that stress can cause body temperature to rise. When exposed to signaled, escapable shock, as well as signaled inescapable shock, an increase in body temperature was measurable after stress exposure. Finally, the involvement of several neural substrates involved in the effects of both signaled escapable and signaled inescapable shock on several behavioral and physiological responses, including stress response and changes in sleep, was identified.

If a certain stressor persists, the HPA axis will be activated alongside the SAM axis. The hormones released by the HPA axis will restore homeostasis by initiating various stress-associated processes, including those involving the immune and cardiovascular systems (Black, 2002). The stress response is ultimately terminated because the HPA axis is inhibited by the negative feedback regulation of cortisol in the hypothalamus (Stephens & Wand, 2012). However, when the stressor is overwhelming and cannot be resolved by the body, the stress becomes chronic (Silverman & Sternberg, 2012). The negative feedback that should occur at the end of the stress response fails, the receptors for the hormones of the HPA axis become resistant, and too high systemic levels of molecular mediators of stress will occur. This will ultimately lead to negative consequences for the immune system and damage several organs and tissues in the long term (Mariotti, 2015). This transition from acute to chronic stress is more prevalent in the elderly compared to other age groups due to the combination of cumulative stressors and the natural aging process (Sun, 2019).

## 2.3 Consequences of Chronic Stress

Research has shown that chronic stress causes changes in certain areas of the brain. It affects both the size of the brain area and physical changes in the neuronal networks. Several studies have proven that the prefrontal cortex (PFC) is vulnerable to chronic stress. Lucassen et al. (2014) have shown that there are changes in neuronal plasticity, due to reduced spine density and dendritic atrophy, and the volume of the PFC and limbic system. Blix et al. (2013) also found a reduction in gray matter and atrophy in the PFC in individuals suffering from chronic stress. These

changes in this brain region could cause changes in other areas related to symptoms of chronic stress, thereby increasing vulnerability to psychiatric disorders.

The changes in brain areas due to chronic stress also affect the immune system. Specifically, psychological stress can evoke an acute phase response, which is often accompanied by an increased number of circulating cytokines and biomarkers of inflammation (Black, 2002). The increased cortisol level in response to acute stress will lead to temporary suppression of the immune system, which is known as stress-induced immune suppression, whereby the body is more susceptible to pathogens for a short period (McClelland et al., 1985). The relationship between the stress response and subsequent responses of the immune system can be explained from an evolutionary perspective, where the stress response leads to the activation of neuroimmune circuits to act as protective agents to limit damage and return to homeostasis (Maier & Watkins, 1998).

As individuals age, the immune system will deteriorate in effectiveness and reliability, increasing the risk of pathology in response to increased levels of inflammation, including Alzheimer's disease and cardiovascular disease (Baylis et al., 2013). This change in the immune system due to aging, also called autoimmunescence, is characterized by a reduction in the functionality of phagocytosis and superoxide production. Further research into these age-related changes in the immune system has led to the phenomenon of inflammaging (Franceschi et al., 2000). Inflammaging represents the upregulation of the inflammatory response during aging, leading to a low-grade chronic systemic proinflammatory state. This involves an increased level of proinflammatory cytokines, all of which have been shown to be increased in the elderly (Vasto et al., 2007) and are the cause of many age-related diseases (De Martinis et al., 2006).

Oxidative stress is another cause for the increase in inflammation. The aging process is generally associated with an increase in oxidative stress. Oxidative stress will arise if there is an imbalance in the production of reactive oxygen species and the defense capacity of antioxidants (Liguori et al., 2018). There are several factors that contribute to the increase in oxidative stress with advancing age. In addition to the weakening of the antioxidant system, mitochondrial dysfunction can also develop, resulting in even higher reactive oxygen species production. Low-grade inflammation will also occur as aging progresses, and cellular, DNA, and protein damage will accumulate as a result of stress (Maldonado et al., 2023). This increase in oxidative stress due to aging therefore affects both the immune and central nervous systems, exerting a significant impact on the emotional well-being of older individuals (Salim, 2016). Thus, aging causes an increase in oxidative stress and inflammation, which has negative effects on mental well-being and other facets of health.

In addition to aging, stress impacts the elderly's overall immune functioning (Glaser & Kiecolt-Glaser, 2005). Here, it can have a predominantly negative effect due to immunosenescence, an aging process that will lead to a decline in overall immune system functioning (Glaser & Kiecolt-Glaser, 1994). A theory that may explain the relationship between chronic stress and the functioning of the immune system is the glucocorticoid cascade hypothesis. This theory claims that chronic stress could have persistent negative effects on immune system functionality in the elderly and perhaps even accelerate immunosenescence (Conrad, 2008).

This hypothesis arises from the fact that glucocorticoids (GCs) released during stress downregulate the number of glucocorticoid receptors, thereby desensitizing the hippocampus to further GC exploration. Over time, downregulation of GRs will cause hypersecretion of glucocorticoid receptors, which will ultimately cause permanent cellular loss in the hippocampal pathway. The irreversible damage to the hippocampus renders the hippocampus insensitive to

further increases in GCs, resulting in a feed-forward cycle of increased levels of GCs and continued hippocampal destruction during aging.

There is sufficient evidence from previous studies that GCs are important for signaling between the endocrine, immune, and nervous systems to avoid harmful effects on the brain. For example, the GCs are involved in terminating the innate immune response in the central nervous system and the negative feedback mechanism (Herman et al., 2016). For the latter, aging will cause an increase in GC secretion because the GC negative feedback is lost due to the destruction of the hippocampus. As a result, there is overactivity in the HPA axis and persistent increases in cortisol levels. This will ultimately result in negative health effects, including immune suppression, memory problems (Li et al., 2006), anxiety disorders (Qin et al., 2015), and emotional dysregulation (Flores-Kanter et al., 2021).

## 2.4 Stress in the Elderly

Stress among the elderly is a common phenomenon. Older people are more vulnerable to psychological and general health problems. Most elderly people experience moderate levels of stress, with 15 percent suffering from mental disorders like anxiety and depression. (Issalillah & Aisyah, 2022). The stress in the elderly has drastic consequences for them, their quality of life is greatly reduced, and around 15 percent experience mental health problems. Symptoms that result from this include being unhappy, irritable, and feeling useless and lost. As a result of this feeling of stress among the elderly, it will also (negatively) affect the family and environment.

The stress that affects the elderly is mainly caused by two factors, namely individual and environmental factors (Sarafino, 1990). The individual factors depend on someone's personality, such as personality traits and motivation. On the other hand, environmental factors vary greatly from middle-aged to elderly and consist of physical and psychological conditions, called stressors. Examples of these stressors are reduced physical strength, social isolation, and financial insecurity. These stressors are interpreted differently by each individual, which also results in different responses (Feldman, 1989). The way stressors are interpreted is based on mental processes and own life experiences. For exactly this reason, stress is experienced differently in older people than in people of younger age. Stressful life experiences cause many comorbid mental health problems to occur in this group and are therefore also seen as predictors of deteriorating health.

Apart from contributing to illness, chronic diseases themselves serve as significant causes of stress and represent one of the primary stressors affecting the elderly. A recent study by Barrio-Cortes et al. (2021) showed that more than 85 percent of people over the age of 65 have a chronic condition. The fact that the vast majority of elderly people suffer from a chronic condition gives rise to an increase in stress in this group (Thongtang & Seesawang, 2014; Sulukananuruk et al., 2016). In addition to chronic diseases, family and the social environment are another cause of stress in the elderly. Contact with their family is very important for the elderly. The hectic nature or absence of family is interpreted by the elderly as not wanting to take care of them and small arguments can quickly become experienced as a major stressor (Issalillah & Aisyah, 2022). In addition, things such as adapting to a new environment, death of loved ones, physical defects, and noisy and crowded environments are also a source of stress in the group.

Conversely, the cumulative impact of various stressors can significantly influence the psychological and physiological well-being of the elderly, ultimately diminishing their quality of life (Cichy et al., 2016). High psychological anxiety is linked to a negative impact on the quality of

life in people over 60 years old. This effect on the quality of life has adverse consequences in terms of physical and psychological health, social interactions, and environment. Finally, it increases risk factors for morbidity and death (Post, 2014). These physical and psychological conditions that older people face are associated with stress. It is therefore important to limit stress in the elderly as much as possible in order to keep the quality of life as good as possible.

Moreover, research has shown that stress in the elderly, especially those with dementia, causes various behavioral changes (Schim van der Loeff-van Veen, R. J., 2012). For the vast majority of people living at home and elderly people in nursing homes, stress results in misunderstood behavior (Kromhout & Bruijtel, 2017). This behavior manifests itself in restlessness, aggression, wandering, and sadness, and is experienced as problematic among the elderly. Because this behavior is caused by stress, the elderly can develop problems such as fatigue, social isolation, and feelings of depression (Korten, 2015).

## 2.5 VRelax Studies in Elderly Care

VRelax has been scientifically validated by multiple studies conducted with their product (Veling et al., 2021; Nijland et al., 2021). In addition, several studies have been conducted in which VRelax has been applied in practice in elderly care. In these studies, detailed in the following sections, VRelax was used by one or more people who understand VRelax well and have applied it to the elderly within their organization.

### **GGZ Drenthe: effect of VRelax in elderly people with psychiatric problems**

A study by geriatric psychiatrist A. Lugtenberg conducted research on 120 clients in geriatric psychiatry, including elderly people with anxiety disorders and mood disorders (personal communication, 15-03). The aim of this research was to look at the effect of VRelax on this target group. Quantitatively, a VAS was used before and after the intervention, with a significantly higher VAS score measured after the use of VRelax. In addition, a PSS was administered as a baseline measurement, with the increase in the VAS being significant for the group with a moderate stress level. In addition, user-friendliness, experiences, motivation, and bottlenecks were examined qualitatively. This showed that VRelax could not be used independently in this target group. Furthermore, the experiences were very positive and examples of this are gaining memories, experiencing emotional and moving emotions, and feeling more cheerful. VRelax's motivation was often to find relaxation. The bottleneck is that no conclusions can be drawn for the long term, as VRelax is used here for a short period.

### **NNCZ: effect of VRelax in elderly people with neuropsychiatric symptoms**

Furthermore, a study led by a mental health psychologist in a healthcare specialist institution examined the effects of VRelax on neuropsychiatric symptoms in 11 residents of small-scale residential facilities (personal communication, 15-03). This included looking at the effects on well-being, side effects, and points of attention for the implementation of VRelax. For this purpose, the VAS, OERS, and NPI-Q were administered to map the effects on specific behavioral problems. This research found that VRelax contributes to an increase in pleasure and well-being in people with dementia. In terms of side effects, anxiety or dizziness was occasionally evoked, but this was short-lived due to adequate guidance.



**IJsselheem: VRelax in elderly people with dementia, reduction of stress and wandering behavior?**

The study looked at the factors that cause wandering behavior in the elderly (Remmerts, 2022). This showed that stress plays a major role in this and that VRelax may be a solution for the stress and the resulting wandering behavior. VRelax has been tested in combination with scent technology in elderly people with dementia over the age of 70. Literature research showed that the traffic light system is the most suitable instrument for observing misunderstood behavior. During the study, both qualitative and quantitative data were used. For example, BP and HR were measured, and emotions were observed using the Observed Emotion Rating Scale (OERS). Short-term effects included reduced BP and HR, and reduced misunderstood behavior. The key points were that it requires significant involvement from healthcare staff for individuals with dementia and that there is a need for specific content for the elderly.

## Chapter 3. The Potential Working Mechanisms of VRelax

In the previous chapter, the mechanisms of stress and its specific impact on the elderly were highlighted. Building on this, this chapter explores the several theories on how VRelax works. The use of natural environments appears to be an effective concept for stress reduction (Yao et al., 2021), offering potential benefits for relieving stress among the elderly. These natural environments must meet four core components which will be explained in the next section: seclusion, fascinating objects, sense of belonging, and intrinsic motivation to stay in the environment (Li et al., 2020). One of the theories that addresses the effect of these natural environments on reducing stress levels is the attention restoration theory (ART). The ART states that exposure to natural environments has positive effects on the recovery of attention and mental fatigue (Jimenez et al., 2021). According to this theory, attention can be focused more effectively towards important matters, thereby increasing concentration and promoting positive emotions.

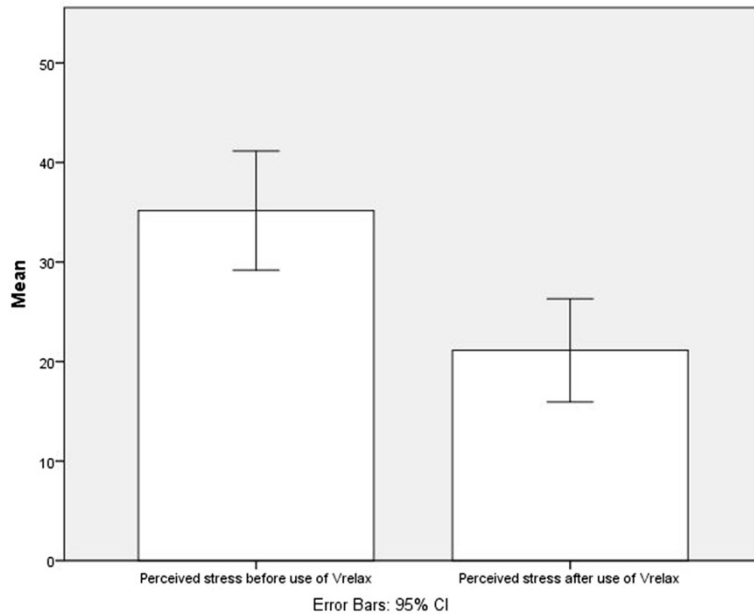
Secondly, another theory, called stress reduction theory (SRT), states that natural environments stimulate positive emotions through activation of the parasympathetic nervous system, predominantly via the visual sense, but potentially by the other non-visual senses (Franco et al., 2017), and thereby reduce stress (Ulrich et al., 1991). Finally, there is activation of the default mode network (DMN) during stress reduction in nature (Hopman et al., 2021). Activation of these brain areas is linked to low stress levels. Thus, both the ART and SRT propose a distinct theory about how VRelax reduces stress. The DMN, linked to these theories, offers an additional explanation for the underlying working mechanism of VRelax. Together, they ensure a restoration of attention, a balance of the nervous system, and an increase in positive emotions.

### 3.1 Nature Environment by VRelax

VRelax has developed an app that is used with Virtual Reality (VR). VR means a computer-generated simulation, such as certain images and sounds that represent a certain environment (Park et al., 2019). At VRelax, in this case, this means natural environments. By using both visual and auditory sensations through VR glasses and headphones, the person is completely isolated from reality and taken into the natural environment of VRelax. This environment consists of a 360-degree natural environment, ranging from stationary worlds such as on the beach, to more interactive environments such as a sleigh ride with huskies.

From studies by Li et al. (2020), among others, the term natural environment must meet several requirements: 1) “being away”, which means that you are completely psychologically removed from your current situation and concerns; (2) “soft fascination,” which means the fascinating objects that capture one's attention in a bottom-up manner and generate a minimal top-down response; (3) “extent”, which refers to the extent to which someone feels immersive and engaging; (4) “compatibility,” which refers to the intrinsic motivation to remain in the given environment.

Currently, a lot of attention is being paid to the applicability of VR in healthcare, especially mental and elderly care. For example, certain situations can be simulated using VR, providing educational and psychological training without causing harm and pain to the patient (Rothbaum et al., 1995). Partly because of this, it is already being used effectively as a solution for psychiatric disorders. VRelax uses its VR app to alleviate pain, stress, and burnout complaints. Research has shown that a ten-minute session would reduce stress levels by 40% (Nijland et al., 2021). Here, they used the level of perceived stress immediately before and after using VRelax, using a visual analogue scale (Figure 4). In addition, it was shown that negative affective states were reduced and positive affective states were improved (Veling et al., 2021).

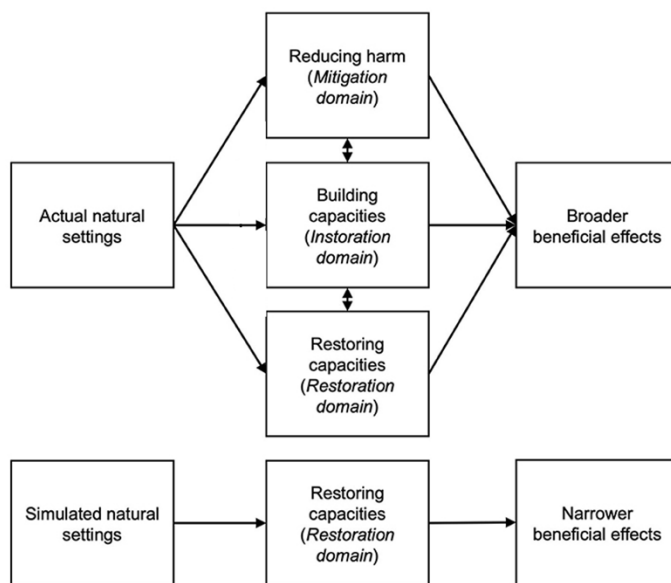


**Figure 4.** The perceived stress before and after a VRelax session. The mean perceived stress level was reduced by 39.9% after the use, compared to before the use of VRelax (Nijland et al., 2021).

However, it must be taken into account that the nature simulated by VRelax is not exactly the same as real nature. VRelax provides visual and auditory sensory inputs, but non-visual senses such as tactile and olfactory senses are not applied. The critical question is whether this lesser sensory input does justice to the exact effects that actual nature offers (Franco et al., 2017). Horiuchi et al. (2014) have shown that the effects of actual nature will have a more positive effect than nature images that have been simulated.

Moreover, a study by Browning et al. (2020) looked at the difference between actual nature and nature that is simulated, for example by VR. It has been found that actual nature has more beneficial effects on health than nature simulation. When going outside and using actual nature, three aspects of health can potentially be stimulated. These aspects are mitigation, instoration, and restoration. With mitigation, the natural setting will provide protection against heat, privacy intrusion, air pollution, visual blight, and other harmful aspects that will be present if time is spent in an urban environment instead of nature (Gopalakrishnan et al., 2019). In addition, instoration refers to the growth of capacities in the context of health-promoting behavior, such as social interactions, physical activity, and exposure to microbial diversity (Dobetsberger and Buchbauer, 2011; Rook et al., 2014; Łaszewska et al., 2018), which leads to modifying neurochemical pathways in the brain and stomach and thus contributes to stabilizing mood. Finally, the restoration aspect can be described as restoring adaptive resources, through attention restoration (ART; Kaplan, 1995) and stress reduction (SRT; Ulrich, 1983). These three domains will therefore be stimulated when actually going outside and will even reinforce each other, which cannot be achieved in simulated nature (Hartig et al., 2014). As a result, the positive effects of actual nature are expected to extend beyond the benefits of the effects due to the stimulation of only the visual and auditory input through simulation technologies, such as VRelax.

The first two domains mentioned, mitigation and instoration, are only stimulated by actual nature settings (Figure 5). However, the latter domain, the restoration domain, is stimulated by both the actual and the simulated natural setting (Browning et al., 2020). The restoring capacities, which are therefore activated in both settings, can be explained by the SRT and ART, which are elaborated in the following sections. Due to the fewer number of domains activated by the simulated natural setting, narrower beneficial effects will arise compared to the actual natural settings.



**Figure 5.** Actual natural settings stimulate three pathways, each contributing to broader beneficial effects, while simulated natural settings only stimulate one pathway, leading to narrower beneficial effects (Markevych et al., 2017).

Although this study shows that actual nature produces more positive effects than simulated nature, it is often difficult or impossible for many care-dependent elderly to go outside and experience actual nature. In addition, illnesses and other stressors can cause long-term stress in this group, making it difficult for this group to find the motivation to go outside. VRelax can be a solution for these elderly people, allowing them to experience the positive effects of nature, and even learn to deal with their stress so that they can eventually go outside again.

### 3.2 Attention Restoration Theory (ART)

The ART is one of the theories explaining the stress reduction by VRelax. It has to do with the interaction of the different types of attention. Firstly, there is directed or voluntary attention, where it is possible to keep attention fully controlled and applied to a task that requires effort (Kaplan & Kaplan, 1989). This skill is not infinite and therefore could become fatigued. Fatigue could occur when having to focus on a particular task with little intrinsic motivation while suppressing distracting stimuli that arouse more interest (Ohly et al., 2016). This increasing demand for directed attention would therefore cause attention to become exhausted.

ART states that an individual benefits from the four core components of nature. The combination of these four factors stimulates involuntary or indirect attention and ensures that voluntary or directed attention skills can be restored and recharged. In addition to the fact that relaxed circumstances such as popular locations or sleeping offer restorative opportunities, the ART emphasizes that nature is a useful factor (Kaplan & Kaplan, 1989). It is suggested that natural environments encourage people to think about unsolved problems and encourage reflection.

A meta-analysis by Ohly et al. (2016) demonstrates the relationship between natural environments and ART. It has been significantly shown that individuals who were exposed to nature had better attention scores than those who were not exposed to nature. Duvall (2011) discovered that attention recovery through nature is positively influenced by greater attentional involvement. For example, his study found that people who were actively focused on nature showed improved attentional functioning. Similarly, Pasanen et al. (2018) found that fewer errors were made on a cognitive test among those who were actively involved while being in the natural

environments. Thus, these findings suggest that voluntary attention and increased engagement in nature are effective for attention recovery.

### 3.3 Stress reduction theory (SRT)

In addition to the ART, the SRT provides another explanation for the stress-reducing effect of nature. The SRT includes both physiological and psychological aspects. During physiological recovery, the autonomic nervous system is more shifted towards the parasympathetic system to reduce stress and maintain healthy organ systems (Ulrich, 1984). As a result, physiological recovery occurs in which positive emotions become more activated and negative emotions are inhibited (Mitchell & Popham, 2008). Just like according to the ART, the SRT also works by restoring attention. According to Kaplan (1995) and Markevych et al. (2017), the concepts of both theories differ slightly, but they partly have similar processes that are connected to each other.

### 3.4 Default Mode Network (DMN)

The ART and SRT appear to be linked to the activity of the DMN, which refers to certain areas in the brain that are mainly activated in a resting situation (Buckner, 2013). This network consists of areas from the paralimbic regions and association cortex, and none from the motor and sensory cortex. The fact that nature shows positive effects in the field of stress has already been demonstrated in the aforementioned studies. According to ART, natural environments stimulate the recovery of attentional capacity. The study by Gould van Praag et al. (2017) shows that an area of the DMN (posterior cingulate cortex) is stimulated during a quiet setting. On the other hand, according to the SRT, an autonomic shift towards the parasympathetic system occurs. This was demonstrated, in the same study, where presenting natural environments showed a high-frequency peak of HRV, consistent with parasympathetic activity. Thus, natural environments restore attentional capacity and shift towards the parasympathetic system, which is supported by the activity of the DMN. In addition, the alterations in functional connectivity of the DMN lead to psychological stress, including depression (Lemogne et al., 2012) and anxiety (Zhao, et al. (2007).

### 3.5 Key Findings and Conclusion

- The number of elderly people in the Netherlands and the required workload in elderly care will increase significantly in the coming period, while the number of available caregivers will actually decrease. This larger percentage of elderly people will also have more diseases.
- The nature of this problem may partly arise from the stress that the elderly have to deal with. With the increasing symptoms among the elderly, acute stress can turn into chronic stress due to several factors. This chronic stress cannot be resolved by the body itself, which will lead to negative consequences in the immune system and various organs.
- Furthermore, aging will contribute to this increasing level of chronic stress, as this process, in addition to affecting areas in the brain, stimulates autoimmunescence and inflammaging, among other things. All this has negative consequences for the health and quality of life of the elderly, including mental well-being.
- VRelax is a healthcare technology developed to combat the above problems. The nature aspect appears to have an effective effect, in addition to meeting the four factors regarding immersion.

- The ART, which claims that there is a positive effect in terms of recovery from mental fatigue and attention, allows attention to be more focused on the things that matter. As a result, concentration will increase and there will be more room for positive emotions, such as happiness.
- In addition, the SRT focuses on the activation of the parasympathetic nervous system, so that the balance in the autonomic nervous system can be restored. This will ensure that positive emotions are stimulated here too.
- Finally, there may be activation of the DMN that reduces stress levels in the body.
- Thus, VRelax needs to know that if all four factors are present, these three positive effects can occur in the body. This must be taken into account for the successful effect and implementation of VRelax.

## Chapter 4. Validation of Measuring VRelax in Elderly Care

To demonstrate that VRelax can make a positive contribution to stress reduction in the elderly, its effectiveness must be tested. For the validation of VRelax in elderly care, it will be important to be able to measure stress parameters (biomarkers) and to map the course of stress surrounding VRelax through observation and questionnaires. Acute effects can be measured by assessing right before and after a session. However, by measuring daily over a longer period of several weeks, longer-term, chronic, effects could also be observed with VRelax sessions.

Given the high workload in elderly care, the user-friendliness of the measurements must be taken into account, and therefore the feasibility of VRelax. The upcoming parts of this chapter will analyze a few examples of stress parameters and questionnaires. After literature research and interviews, these stress parameters and questionnaires have proven to be suitable for use in elderly people requiring care. It will be necessary to examine which of these methods could best be integrated into VRelax, in order to achieve validation.

### 4.1 Objective/Physiological Evaluation VRelax

#### Heart rate (HR) & Heart Rate Variability (HRV)

One method to measure stress is through HR and HRV. A consequence of stress is an increase in HR (Schneider et al., 2021). The stress will activate the sympathetic nervous system and not the parasympathetic system, causing an increase in HR. In addition, stress also affects HRV. Where stress increases the HR, the HRV will actually be lowered. The HRV represents the capacity of the heart to deal with all kinds of internal and external stimuli (Kim et al., 2018). A low HRV represents a less well-functioning autonomic nervous system, which reduces the physical capacity to deal with stressors. Measuring HR and HRV can be done using different measuring methods. For example, a chest strap, wrist strap, and also the applications of the HUME platform (Hume, 2021) are methods to measure these parameters.

VRelax is currently using a chest strap to measure HRV. However, a study by Sartor et al. (2018) showed that a wristband has almost the same accuracy for measuring HR. Moreover, a study by Schuurmans et al. (2020) has proven that a wristband is a valid tool for measuring HR and HRV, among other things. Knowing that a wristband can also be used as a reliable measurement of HR and HRV, VRelax could consider this as an alternative to the chest strap.

The HUME app has been specially developed for elderly care. This stress-measuring method uses an emotion recognition platform based on two sensors, behavioral models and artificial intelligence. One sensor, called the SentiSock, measures skin conductance and movement, while the other sensor, a chest strap, measures HR and movement. All input that comes in via these sensors is translated into a stress level using a database of behavioral models. This information is then shown in the HUME app. By making this visible in the app at an early stage, an employee can take preventive action, which could prevent escalations. This method combines the HR with skin sound and movement, using the chest strap in combination with a sock.

The chest strap can be a hindering factor specifically for care-dependent elderly, as they are, for example, bedridden or have physical complaints or limitations. For this group, the wristband or HUME sock would be a solution, so that the stress level can still be measured, and thus the effect of VRelax can be validated and at the same time escalations in care-dependent elderly can be identified early and avoided.

There is no specific fixed value of HR or HRV that indicates that there is stress in a particular person. HR and HRV vary widely between individuals and depend on various external factors, including gender, age, and physical condition (Sammito & Böckelmann, 2016). It has been proven that stress causes an increase in HR and a decrease in HRV. The average value of HR in care-dependent elderly is higher than the average value of 60-100 bpm for healthy elderly people of the same age. In addition, this group has a reduction in HRV, by an average HRV of 20-40 milliseconds (Esselink, 2021). To determine whether stress is experienced by the person in question, it is important to measure HR and HRV for a longer period of time, like two weeks, so an average baseline value of the two parameters can be determined (Li et al., 2009). If a significant increase in HR or decrease in HRV is observed, this could indicate the presence of stress. To validate and measure whether VRelax can contribute to reducing acute stress and thus changing these parameters, the parameters will have to be measured before and after a VRelax session. Furthermore, the long-term effects can be assessed by monitoring HR and HRV at various time points, such as after two weeks and one month.

### **Blood pressure (BP)**

BP is another parameter that can be used to measure stress. Acute stress will cause the "flight or flight" response to be activated through the sympathetic part of the autonomic nervous system (Ayada et al., 2015). This response will, among other things, stimulate an increased HR and the production of adrenaline. As a result, hypertension will develop in the body. Persistent stressful situations can cause chronic stress, which then has negative effects on the body. BP can be measured using different measurements. A suitable method is the hybrid BP monitor, which uses both the features of an electronic and auscultatory device (Ogedegbe & Pickering, 2010).

The ideal location for measuring BP is the brachial artery, as this is where systolic and diastolic pressure vary the least. In the elderly, systolic hypertension should be taken into account, which is caused by the disappearing distensibility of the arteries with aging. In the worst case, this can result in loss of compressibility of the artery through the sphygmomanometer cuff, causing incorrect measurements (Spence et al., 1979). Furthermore, posture, position of the arm, cuff inflation hypertension, and cuff size must be taken into account. Regarding the person's posture, measuring BP while sitting is recommended. In addition, it is important to take the position of the arm into account. For example, there is an increase in BP of approximately 6 mmHg when the arm is held down compared to up. It is therefore recommended to always take the measurement in the same position. Third, hypertension can develop due to inflation of the cuff, which can cause an increase of 40 mmHg (Mejia et al., 1990). Finally, the cuff size must be taken into account. If the cuff size is too small, BP may be overestimated (King, 1963). In most cases, this problem can be minimized by using a slightly larger cuff size.

Furthermore, research by Tomitani et al. (2023) has shown that a wearable watch-type BP monitoring device is also suitable for BP measurement. The results of this study were consistent with other studies. Here they used ambulatory BP monitoring and it was shown that during periods of anger and fear BP increased and during periods of calm a decrease in BP was observed (James et al., 1986 & Schwartz et al., 1994). In conclusion, it can be said that the wearable watch-type BP monitoring device can detect emotional stress-induced BP changes as accurately as ambulatory BP monitoring.

However, in the elderly, other factors besides stress that can cause an increase in BP should also be taken into account. There are many causes of hypertension in the elderly, such as arterial stiffness, the aging kidney, and autonomic dysregulation (Oliveros et al., 2020). Most importantly, with aging there will be functional and structural changes in the arterial vasculature. Both systolic and diastolic BP will increase with aging, but after the age of 60, arterial stiffness will dominate, resulting in an even higher increase in systolic BP, but a decrease in diastolic BP.



At a healthy BP value, the upper pressure varies between 90 and 140, and the lower pressure between 60 and 90. A BP value higher than 140/90 is considered too high (Grundmeijer, 2014). It is important to realize that BP can vary during the day and can be influenced, in addition to stress, by various factors, including medication, physical activity, and diet (Pringle et al., 2003). For this reason, it is important to measure BP regularly so that a baseline value can be determined. If the person in question has a significant increase in BP, and the external factors are approximately the same as in the baseline measurements, it may indicate the presence of stress. A decrease in BP after a session of VRelax might indicate a relief of this acute stress, contributing to the validation. In addition, long-term effects can be measured by monitoring BP for multiple intervals, such as after two weeks and one month.

### **Cortisol**

A third method to measure the level of stress is via the stress hormone cortisol. As discussed in the previous chapter, a stressor will cause the body to produce cortisol, which gives it a good indication of the presence of stress (Tsigos & Chrousos, 2002). Cortisol can be measured in various ways, namely through urine, plasma, saliva, and more recently also through hair (Gow et al., 2010).

Measuring cortisol via hair, unlike blood and urine, is an indication of long-term stress, or chronic stress (Gow et al., 2010). Therefore, cortisol won't show direct effects from a VRelax session. Instead, measurable changes will only be evident after multiple samples a day for at least fourteen days (Luecken & Gallo, 2007). The advantages of measuring stress via hair are that it is a non-invasive and painless method compared to, for example, blood. In addition, it can be administered by a non-professional. However, a disadvantage is that there are several factors that can influence the measurement of cortisol in the hair. These are age, gender, hair growth rates, environmental exposures, and hair color (Uhart et al., 2006). Further research is needed to validate this method of hair cortisol as a biomarker of chronic stress.

Furthermore, determining cortisol through saliva also has a number of advantages. This is also a non-invasive, painless method that causes almost no stress. In addition, it is not an expensive intervention and involves fewer ethical aspects than the more invasive methods (King & Hegadoren, 2002). Salivary cortisol also provides a direct picture of the amount of cortisol that is willing to bind with its receptors, whereby in plasma, corticosteroid-binding globulin, among other things, must be taken into account. However, research by Remmerts (2022) showed that the saliva of care-dependent elderly people was not reliable due to the unclean saliva. In addition, an expert from a hospital explained that salivary measurements are not reliable in elderly people with dementia, because the day and night rhythm of these elderly people is often disturbed.

In addition, it is also possible to measure the level of cortisol via the urine. Since cortisol is extensively metabolized in the liver, a large amount is excreted in urine (Baum & Grunberg 1997). Although it ends up in the urine, it is not possible to measure adrenal activity through this measurement, because it is dependent on the metabolism of cortisol and urine excretion. Due to the half-life of cortisol, the measurement of urinary cortisol after an intervention will reflect the level of cortisol for several hours. As a result, to get a completely accurate picture of the HPA activity, it is necessary to collect urine for 24 hours. Unfortunately, this is difficult to realize in many cases in elderly care (King & Hegadoren, 2002).

The measurement using plasma will not be the most suitable for this target group, as it is a more invasive method, a skilled person is needed to collect the sample, and the processing methods, e.g. in the lab, will cost a lot of time and money. Nevertheless, assessing cortisol in the blood has

the positive advantage of being able to measure acute changes in response to VR sessions (Boucher & Plusquellec, 2019).

## 4.2 (Self-)Reporting Effects VRelax

### **Perceived Stress Scale (PSS)**

The most widely used questionnaire worldwide to measure stress levels is the Perceived Stress Scale (PSS). This measurement can be used to determine how a certain situation or setting affects the stress level. This involves asking about various feelings in the past month, applied to how the respondents' lives are in terms of unpredictable, uncontrollable, and overloaded (Cohen and Williamson 1988). This questionnaire can have different variants, with 4 (PSS-4), 10 (PSS-10; Perceived Stress Scale, n.d.; Appendix A) or 14 (PSS-14) items. In the PSS-14, seven items are formulated positively, and the other seven negatively (Cohen et al. 1983). Each item is ranked on a scale from 0 (never) to 4 (very often). Finally, the total scores are calculated by, after reversing the positive item scores, adding all scores together, with a higher score equaling a higher level of stress.

It has been proven that the PSS is a suitable measure of stress level. First, a study has shown that higher levels of cortisol correspond to a higher PSS score, which aligns the PSS with the actual stress in the body (van Eck and Nicolson 1994). In addition, the PSS turned out to be a better predictor than life-event scores, and it is different and independent from a depressive symptomatology scale (Pbert, et al. 1992). Furthermore, research by Ezzati et al. (2014) showed that the PSS score corresponds to the estimated values of anxiety, depression, and affect, which strengthens the validation of the PSS. It was found that a higher PSS score corresponded to more depression and distress and a lower degree of coping. Finally, previous studies (Brajenović-Milić, et al. 2010; Chen, et al. 2012) have also shown that there is a significant relationship between the score of the PSS and the level of anxiety.

About the usage of PSS, it is important to complete the PSS prior to using VRelax in order to obtain a baseline measurement. Then, a measurement immediately after the VR session, to see the direct effect. Finally, follow-up measurements after two weeks and one month can be conducted to measure the longer-term effects.

To determine stress in an individual, compare the total score of the PSS prior to the intervention and compare it with the total score of the PSS after the intervention. A lower total score of the PSS after the intervention will indicate a reduction in the stress level of the individual in question. The average PSS score is higher in older people compared to younger and middle-aged people (González-Ramírez et al., 2013). An average PSS-13 of an older person, aged over 70 years, is 17.1, with the PSS-13 score being higher in the group with mild cognitive impairment (18.2), compared to the group without mild cognitive impairment (16.9; Ezzati et al., 2014).

### **Visual Analogue Scale (VAS)**

Another method of measuring stress is via the visual analogue scale (VAS). This is a non-specific measurement scale, often with a minimum score on the left side and a maximum score on the right side (Wu et al., 2021; Appendix A). The respondent can therefore indicate a point on the scale about how it was experienced in the past period, for example, last week. For example, for stress, this could be a scale from 0 to 10, where zero is no stress and 10 is the most severe stress.

The VAS is a commonly used measure of the effect of a specific intervention on stress levels. Validation of the VAS was also examined and compared with other measurement methods, such as the PSS. The study by Lesage & Berjot (2011) investigated this and showed that the VAS had a

slightly higher standard deviation than the PSS-14. However, this weakness is compensated by the qualities of the method as a clinical tool that can be used easily and quickly. In addition, a study by Begum & Hossain (2019) conducted a review in which ten studies were included in the validity and reliability of the VAS. It has been concluded that the VAS is a scientifically proven, valid, and reliable measurement method.

The VAS has already been widely used in studies of stress measurements, even in studies with VRelax. In all these studies, the VAS is often prior to and immediately after a measurement, and with VRelax this means a VR session. When using a VR session more often, it is important to complete the VAS each time, and also to complete the VAS after a period of use, like two weeks and a month, in order to be able to measure the longer-term effects.

To assess an individual's stress levels, compare the total VAS score before the intervention with the total VAS score after the intervention. A lower total VAS score after the intervention will indicate a reduction in the stress level of the specific individual.

### **Observed Emotion Rating Scale (OERS)**

Third, there is the observed emotion rating scale (OERS), which is an observational measurement method that assesses three negative emotions, anxiety/fear, sadness, and anger, and two positive emotions, general alertness, and pleasure (Lawton et al., 1999; Appendix A). When completing this method, the occurrence of these emotions in certain time intervals is examined (Moyle et al., 2018). For example, a score of 1 is entered if the emotion is not shown, a score of 3 if it is shown between 16-59 seconds, 5 points for the during interval >5 minutes, and 7 points for 'not visible', to indicate how long a certain emotion is displayed. When scoring these points, a list of corresponding characteristics and signs of certain emotions, drawn up by Lawton et al. (1999), is used. A higher score therefore represents a longer period of the specific emotion in the observation interval.

A study by Moyle et al. (2018) examines the effect of a virtual reality forest on elderly people with dementia. Although the results of the study were positive in terms of pleasure and alertness, there was a higher degree of fear/anxiety during the forest experience compared to a normative sample. For the target group of care-dependent elderly, this method can be a solution for measuring the effect of VRelax. Since care-dependent elderly may have difficulty assessing their feelings themselves, especially elderly people with psychiatric complaints, this measurement method can generate more reliable results.

The use of the OERS would ideally be a certain time before the intervention and the same time after the intervention. This measurement can also be measured again after a certain period after the intervention, like two weeks and one month, in order to measure the longer-term effects on the person's state of mind.

A higher OERS score may indicate a higher degree of emotional stress or distress. To determine whether there has been a reduction in stress in a specific individual, the values of the OERS before and after the intervention must be examined. If the OERS has a lower value after the intervention, the intervention could indicate a reduction in emotional stress or distress.

### **Measuring secondary outcomes**

Ultimately, secondary outcomes can also be measured to further elaborate the effect of VRelax. Firstly, the decrease in wandering or 'calling' behavior could be examined in elderly care institutions (Remmerts, 2022). By using VRelax for care-dependent elderly, the elderly could become calmer, causing them to exhibit less misunderstood behavior and ultimately less wandering or 'calling' behavior.

In addition, the decrease in medication can also be examined, for both soothing medication and pain medication. By using VRelax, care-dependent elderly could become calmer, which means they will have less interest in soothing medication. In addition, VRelax can also be used during medical procedures, resulting in a more relaxed experience during the procedure, meaning that less pain medication will be needed (personal communication, 20-03). As a positive effect of reducing medication, its side effects will decrease, which will also have a positive effect on the person's health.

The reduction in medication and medical procedures, along with the decrease in wandering and 'calling' behavior, can save valuable time for healthcare staff. This is a very positive development, especially considering the current high workload in elderly care.

### 4.3 Key Findings and Conclusion

- To validate VRelax in care-dependent elderly, it is important to measure stress parameters in addition to the questionnaires, in order to get a more accurate picture of the stress level.
- Measuring HRV using a chest strap does not seem to be a good option, due to problems with use in elderly people with physical problems.
- The HUME can measure HR and HRV, and skin conductance is used, among other things. Moreover, the HUME is a valuable addition to elderly care, especially with its integrated app enabling early intervention.
- BP can be measured with a wearable watch-type BP monitoring device and ambulatory BP monitoring, which could integrate with a wristband to measure BP, HR, and HRV simultaneously, to get an overall picture.
- So, as a quantitative method, a wristband in combination with HUME seems to be the best option, in order to measure HR, HRV, and BP and thus get a good idea of the stress level.
- Concerning the qualitative measurements, the PSS and VAS will fit well in somatic elderly care, and perhaps also in the psychogeriatric department. To ensure a good picture, the addition of the OERS is important, as the observations of the healthcare staff are added to their own interpretations regarding the stress level.
- To conclude, in order to validate stress reduction in the elderly as VRelax, a wristband will have to be used in combination with your own interpretation, using the PSS, and the interpretation of healthcare staff, using the OERS.

## Chapter 5. Internal Analysis of VRelax

This chapter will discuss the competencies and capabilities of VRelax itself. Firstly, the internal structure of VRelax will be mapped. This will clarify the various bodies of VRelax and explain the communication between the different functions and departments. These different functions and departments are each responsible for separate aspects of the CFL. By visualizing the relationships between these, advice on improving the CFL can be supported. In addition, the VRIO examines the VRelax product and evaluates their position in the market. By looking at the position of VRelax in elderly care, it can be determined which aspects of the product can still be improved in order to best fit in with elderly care.

### 5.1 Internal Organizational Structure of VRelax

VRelax has an organizational structure with several departments, all with a different function (Figure 6). The board of VRelax consists of the following functions: Chief Executive Officer (CEO), Chief Operational Officer (COO), Chief Financial Officer (CFO), and Chief Commercial Officer (CCO). A couple of functions that assist these key positions are the Chief Scientific Officer, Chief Content Officer, and Creative Audio Director. Additionally, VRelax is divided into various departments, like marketing, sales, customer success (CS), development, and content & design. Furthermore, there is an advisory board including an investor, a professor, and the CEO of an eye specialist company, among others.

As a small start-up with around 18 employees, VRelax falls under the category divisional organizational structure. Here, individual departments function as individual units, with an overarching strategy determined together (Mintzberg, 1985). Despite the presence of a board and heads of departments, there is a minimum hierarchy within VRelax, creating an inclusive working atmosphere. All employees within VRelax have diverse backgrounds, commonly in business or healthcare. The specific functions and communication between the different departments are detailed below.

STEFAN		SANDER			MARIEKE	CHRIS
CONTENT	DEVELOPMENT	SALES	MARKETING	CUSTOMER SUCCES	HR	FINANCE & IT
FABIAN	SIDO (TECHLEAD)	FRANK (AE)	SEBASTIAAN	GERBEN	COMPLIANCE	LEGAL
MYRTHE	JUSTIN	PETER (AE)	RICHARD	JARIB	RESEARCH	
JELMER	TOMMY	MAX (SDR)		JULIA	ACADEMY	
					PARTNERSHIPS	

**Figure 6.** Organizational chart VRelax. The organizational chart visualizes the layout of the various departments and the person in charge of the board. The CEO (Stefan) is responsible for the content and development departments. The CCO (Sander) is responsible for the sales, marketing, and customer success departments. And the COO (Marieke) and CFO (Chris) are responsible for their own tasks.

#### Board

In charge of VRelax, the CEO serves not only as a director but actively engages in the development and marketing of the company. Maintaining strong working relationships with department heads, the CEO collaborates with co-directors (COO, CFO, and CCO) and investors to develop the strategic course of VRelax. Beyond a leadership role, the CEO actively participates in the hands-on aspects of the company's growth and evolution.

The COO takes the lead in change management and operational oversight at VRelax. This involves spearheading and implementing strategic changes and business processes. By keeping close contact with all departments, the COO draws on a background in research and care, guaranteeing operational efficiency with broad business aims. Furthermore, there is a role played in the day-to-day functioning of VRelax, like HR, and involvement in compliance and networking.

The CFO is responsible for the financial aspects of VRelax, holding close ties with investors to ensure a strong financial basis. This financial stability is crucial for the ongoing development and progress of the company.

Finally, there is a new function within VRelax, the Chief Commercial Officer (CCO). This function is the director for the sales department and serves as an overarching responsible for, besides sales, the CS and marketing departments. Due to the wealth of his obtained experience, there will be more effective management of the aforementioned departments, and new insights will emerge for the vision and mission of VRelax. Lastly, tasks that were previously carried out collaboratively by the former board members, can now be managed independently, enabling each person to focus on their own responsibilities.

### **Co-founders**

The Chief Scientific Officer, currently a professor in psychiatry and head of the VR Mental Health Lab, providing VRelax insights and support in the scientific background. His expertise and research in VR and psychiatry ensures the scientific foundation of VRelax.

The Chief Content Officer is responsible for all content within VRelax. Next to capturing the content itself, the Chief Content Officer is involved in processing, creating the overall user experience of VRelax.

The Creative Audio Director is in the lead for the sound design of VRelax. This director uses spatial audio in order to enrich the VR experience, making an even deeper connection with the nature environment within the VR.

### **Sales department**

The account manager is in the lead of the sales department, providing coordination over the different sales employees. As a focus on managing and expanding customer relationships, the account manager has a key function in the effective deployment of VRelax to meet customer needs.

The sales & business development manager has the role geared toward informing and assisting interested parties while driving license sales. The manager often takes on the responsibility of maintaining customer relationships and developing sales strategies. Furthermore, he also has the task of developing new forms of business.

The junior account manager works closely with and supports fellow sales team members, the Junior Account Manager concentrates on approaching organizations to facilitate license sales.

### **Marketing department**

The marketing manager oversees VRelax's marketing campaigns and events, including tasks such as conducting market research and strategically planning marketing strategies. Supporting the marketing manager, the digital marketer plays a key role in setting up marketing campaigns and enhancing the visibility of VRelax. The position also encompasses online campaigns, social media management, and email marketing.

### **Development department**

In the lead of VRelax's development strategy is the head of software development, who not only contributes strategic planning but also brings programming expertise to the team. Collaborating with CS on customer feedback and desires, as well as with the CEO on the overall strategic direction, the head of software development plays a key role. The software developers, in turn, are

actively engaged in coding, programming, and visual aspects of the product. Additionally, they are involved in product testing and address bugs frequently reported by customers.

### Customer Success (CS) department

The two CS employees maintain close customer contact and are responsible for ensuring the effective use of VRelax within the organization. Their duties include providing kick-off and implementation training, offering solutions for content-related and technical problems, and engaging in regular meetings with other departments such as marketing, sales, and development.

### Content & Design department

For the department Content & Design, the content producer takes charge of processing and developing images created by the Chief Content Officer. This ensures an optimal integration into the VR experience of VRelax.

### Personalities within VRelax

The dynamics of the team are very important for the proper functioning of a company (Erikson, 2021). It is important that people complement each other and that there is a variation between personalities in the workplace. Four different personalities are distinguished, linked to a color; a red, yellow, green, and blue personality (Figure 7). Firstly, red personalities are people who are very energetic, goal-oriented, confident, and passionate about their work. In addition, they make choices quickly, regardless of the consequences, and do not handle criticism well. In collaboration, a red person likes to be told like it is. Secondly, yellow personalities are people who need a lot of stimulation through contact with others, they are very social and extrovert and are therefore often good leaders and team players. However, they are not good at taking responsibility, keeping deadlines, and having self-discipline. Although a yellow personality is very innovative and creative, when working together they need someone who can bring their ideas to reality. Third, green personalities are good listeners, observers, are available for others, and prefer to work individually or in small groups. When working with a green personality, it is important to know that they do not like making choices and that it is good to remind them of their actual tasks every now and then. Finally, there are the blue personalities, who are very precise, rigorous, and rational. Furthermore, they strive for perfectionism, they like efficiency and are critical, and they enjoy working with others but try to avoid risks. When working with a blue person, you must be well prepared and provide details, and also be careful with criticism.



**Figure 7.** The meaning of the different colors for personalities: dominant, influencing, cautious, and steady (Erikson, 2021).

Within VRelax there are many yellow and red personalities, and few blue ones (personal communication, 25-03; Appendix C). This is important to take into account, as this could conflict with collaborations. For example, a yellow personality talks on and on about a certain subject and forgets the essence of the story, while a blue personality only wants to hear the exact facts (Erikson, 2021). With a lot of red and yellow personalities you have a lot of extroverts on the team who want to be up front with their energy and ideas and this could clash between these individuals. However, you miss the green and blue personalities who view everything calmly and are strict on the rules and deadlines. It would be wise for VRelax employees to know the different personalities of their colleagues, in order to understand how others can react in collaboration and how you can best enter into collaboration. This is important, among other things, in the communication between the different departments for the CFL, as feedback comes in from multiple departments and the feedback process requires a lot of cooperation.

## 5.2 Resources and Capabilities of VRelax

A VRIO analysis is used to determine whether the VRelax product is actually of value, explicitly in elderly care in the context of this project (Table 2). This shows whether VRelax has competitive advantages with its product in elderly care. The four core factors will be looked at: Value, Rarity, Imitability, and Organizational support. By developing these four core components, it becomes clear what competitive position VRelax is in, and whether there is a competitive advantage or disadvantage. By going through the four core factors with regard to VRelax's product in elderly care, it will become clear whether there is a competitive advantage.

### Valuable

The 'valuable' factor examines whether the product in question has added value to customers compared to other products. For example, whether the product has unique functions and can be used as a relaxation method for care-dependent elderly. The product is a relaxation method that can also be used by the elderly, even if they are bedridden, and the use of the product results in positive effects in elderly care, including the increase in positive emotions in the elderly and possible time savings as a result. This means that there is a demand for the product, among other things to relieve stress among the elderly and the pressure in elderly care. All this makes the VRelax product 'valuable'.

### Rarity

The 'rarity' factor examines whether the properties of the product are rare in the market. The VRelax product has unique features, where all images are filmed themselves, there is a viewing function, and it has been scientifically validated. In addition, feedback from the user is taken into account and the VR environments are tailor-made for health purposes, which sets VRelax apart in the VR industry. Furthermore, the product can be used for multiple purposes, as in addition to healthcare purposes it can also be used for occupational health and safety purposes. However, there are a number of competitors that apply VR in elderly care, but each uses VR in a slightly different way (Table 3). All this means that the product meets the 'rarity' factor.

### Imitability

The 'imitability' factor looks at how easy it is for other companies to copy the product. If a product is easy to copy, its competitive position quickly decreases. On the other hand, if the product is difficult to imitate, the company can quickly increase its competitive position. Considering that all VRelax content is created manually and VRelax is innovative and continuously improving and developing, it makes it difficult to recreate it in this way, thus meeting the 'imitability' factor for several resources and capabilities.



### Organizational support

The 'organizational support' factor examines whether the company has the ability to effectively organize its internal resources and competencies to support the product. Examples of this include corporate culture, management, and technological infrastructure, among others. At VRelax there are skilled employees active in all different departments and this is monitored by the board. This provides leadership support and an innovative strategic focus, which ensures that VRelax remains at the forefront of the dynamic VR healthcare sector. This together ensures that the product meets the 'organizational support' factor on several levels.

**Table 2.** VRIO analysis for VRelax,

Resource/capability	Valuable	Rare	Inimitable	Organization	Competitive position
<b>Content</b>	✓	✓	X		Temporary competitive advantage
<b>User interface</b>	✓	✓	✓	✓	Sustained competitive advantage
<b>Spatial audio</b>	✓	✓	✓	X	Unused competitive advantage
<b>Scientifically validated</b>	✓	✓	X		Temporary competitive advantage
<b>Expertise employees</b>	✓	X			Competitive parity
<b>Biofeedback measurements</b>	✓	✓	X		Temporary competitive advantage
<b>Customer co-creation</b>	✓	✓	X		Temporary competitive advantage
<b>Financial resources (investors)</b>	✓	X			Competitive parity
<b>Partnerships with organizations</b>	✓	X			Competitive parity
<b>Collaboration with research institutes</b>	✓	✓	X		Temporary competitive advantage
<b>MDR-certification</b>	✓	X			Competitive parity
<b>GRIP app</b>	✓	✓	X		Temporary competitive advantage

#### *Content – temporary competitive advantage*

VRelax currently offers approximately 80 different nature images in the app, which have been presented in 6K since the new update. VRelax also uses interactive exercises. The 'rare' aspect is fulfilled as all images are filmed and edited by VRelax itself.

#### *User interface – sustained competitive advantage*

The VRelax interface allows you to navigate through the entire VRelax app without the use of external devices, such as remote controls. This makes it easy to use and all functions can be used

by moving the head. The specific interface is, in addition to being valuable and rare, inimitable because of the unique expertise with which everything is built up, which makes it very difficult for competitors to imitate. There is also organizational support, as this interface is continuously improved by being in close contact with customers.

*Spatial audio – unused competitive advantage*

VRelax has a specialist (CAD) involved in the field of spatial audio. With his expertise, it is possible to observe the sound from all angles in addition to the 360-degree content. Synchronizing this spatial audio with the self-made images makes the content and experience of VRelax even more unique and therefore inimitable. However, organizational support is not met, given that the headphones are rarely used by customers and ignorance about the importance of the sound for the effect. The headphones make the actual spatial audio possible and this contributes 50% to the immersion, and therefore the effectiveness of VRelax.

*Scientifically validated – temporary competitive advantage*

VRelax's product has been scientifically validated by researchers (CSO and COO), demonstrating that the product shows significant positive effects in practice. This is a unique point about VRelax, as many competitors do not comply with this. On the other hand, it is not inimitable, as these competitors could also conduct scientific research with their own products.

*Expertise employees – competitive parity*

VRelax employees have a broad knowledge, the majority of which have experience in healthcare. The healthcare technology product is a fairly unique and emerging sector. However, it does not fall under the 'rare' factor, because VRelax has the general departments of a company.

*Biofeedback measurements – temporary competitive advantage*

The VRelax app is integrated with biofeedback measurements using an HRV chest strap. By using this HRV band, the user's HRV can be measured during a VRelax session, giving an indication of the stress level of that particular person. This measurement can be performed and the HRV values can be read by using the GRIP app on a tablet. This data can also be transferred to the computer, to have an overview of all values of all clients. This integration of VR with simultaneously measuring the stress level falls under 'rare'. However, it would be possible for other companies to imitate this functionality.

*Customer co-creation – temporary competitive advantage*

This concept includes the relationship that VRelax has with their customers. VRelax is in close contact with their customers and tries to meet their wishes as fully as possible. VRelax listens carefully to their customers and they influence the content that will be filmed and therefore available in the app. These close customer relationships are very valuable to VRelax's success, as they know what is most effective for the app and their target groups. In addition, the relationships are unique, but not inimitable, as other companies could imitate the same way of working with their customers.

*Financial resources (investors) – competitive parity*

In addition to VRelax making their revenue from selling the licenses of their app, attracting investors is the other side of their revenue. Several large investors have recently joined, each of whom has a lot of knowledge about similar companies in the same industry. This allows them, in addition to receiving money to invest in the company, to gain a lot of knowledge about VRelax's strategies and future plans. So it is certainly very valuable for VRelax to have these investors. Furthermore, financial resources are not rare, as many companies have investors available.

#### *Partnerships with organizations – competitive parity*

This includes the relationships that VRelax has with all kinds of organizations and institutes.

#### *Collaborations with research institutes – temporary competitive advantage*

VRelax has several collaborations with companies and institutes that are conducting research on VRelax's product. These results contribute to the scientific validation of VRelax and can subsequently be used, among other things, to sell the product in a specific sector. However, more can be gained from this, since all these new results are not actively used within VRelax. This certainly falls under 'rare', as this collaboration is unique on the market.

#### *MDR certification – competitive parity*

Since the VRelax product can be used to treat a client, it is considered a medical device, which means it must meet the requirements of the Medical Device Regulations (MDR). It is positive for VRelax for their external environment if they can demonstrate that they meet the MDR certification, which makes this 'valuable'. However, there are many other companies that meet the requirements of the MDR, which does not make this resource rare.

#### *GRIP app – temporary competitive advantage*

The GRIP app is an application that can be used in addition to using the app on the VR glasses. This allows you to take control and see what the person wearing the VR glasses sees. This is very valuable for many target groups and therefore organizations because it provides support in selecting the appropriate content and provides insight into which images evoke negative experiences in clients. It is possible for competitors to integrate a similar viewing function into their product, which means that it does not meet the 'imitable' factor.

### 5.3 Key Findings and Conclusion

- Most departments have weekly or biweekly meetings with their own department and there are regular meetings with other departments, including CS with development or CS with marketing. However, this can be designed even better and there is no clear structure yet.
- The integration of Slack with different channels of individual departments and departments together could increase communication and work processes within VRelax.
- The different personalities within VRelax must also be taken into account. Due to the large proportion of yellow and red personalities and few blue ones, conflicts can arise and new projects cannot be completed. Ideally, VRelax would find a nice balance in personalities, in order to optimize the work processes and performance of the team as much as possible.
- The fact that VRelax has a sustained competitive advantage in terms of user interface means that in addition to having a user-friendly and very effective interface, it is also difficult to replicate by competitors. This advantage gives VRelax a unique position in the market, making their product easier to use and more attractive compared to what competitors offer.
- If new incumbents enter the VRelax market, they could do this through innovative features or improvements that come close to the VRelax interface. In addition, competitors could invest heavily in research and development or rapid improvements in technology could help them reach the level of VRelax's capabilities.
- To maintain or even enhance their competitive advantage, VRelax can focus on several key strategies. This entails continuous improvement by investing in research and development, increasing customer engagement, investing in employee training and development, and monitoring competitors to stay ahead of market trends.

## Chapter 6. Improvements Customer Feedback Loop

This chapter will discuss the CFL within VRelax. The CFL briefly includes collecting, registering, evaluating, prioritizing, and verifying improvements. The collection is done by different departments, especially during customer contact moments, such as telephone calls, emails, and events. Further, the registration is mainly in Salesforce, communicated verbally to the relevant department, or in the specific feedback channel in Slack. The registered feedback is then evaluated and prioritized based on importance and safety, after which VRelax will take action. The final aspect of the CFL is to determine whether the improvements implemented have actually helped. However, this step has not yet been integrated into VRelax. The following headings will list several aspects that can contribute to optimizing this feedback process. These include further integration of Slack, making a feedback form accessible, a better application of PMS, and other aspects to improve the CFL.

### 6.1 Definition of Customer Feedback Loop

It is very important for VRelax that they continuously remain in close contact with their customers in order to collect their findings and feedback. Based on this user input, VRelax can improve its product by collecting the feedback provided, then recording it and taking subsequent actions so that the final improvements reach the customer. This process of product improvement through feedback is also called the CFL. This CFL therefore roughly consists of four parts: collecting, registering, evaluating/prioritizing, and implementing improvements to the customer. This is a circular process, where each time all steps are completed, the product will be improved.

Firstly, collecting the feedback is important. This customer feedback can be provided in various ways, such as through customer conversations, telephone conversations, email contact, etc. It is essential for VRelax to receive feedback in all areas, both technical and experience, from all different types of customers, from elderly care to disability care, and on several moments in the process to gather feedback. In this way, a complete picture can be created and insights can be gained on which points the product needs to be refined.

Secondly, the registration of feedback is an issue that must be done carefully to ensure that the CFL runs smoothly. It is important that the feedback received through the various employees and channels is properly recorded in a system. There are various systems or databases for this to clearly organize everything in one place so that it is accessible to everyone and easily traceable. When registering, it is very important that all information is noted, such as name of the organization and contact person, date, and the actual qualitative feedback in clear formulation.

Further, it is important to analyze the collected and registered feedback. When evaluating the feedback, the frequency, urgency, feasibility and importance of the company can be taken into account. After all received feedback has been evaluated, a prioritization can be made based on the analysis, enabling VRelax to identify key areas for improvement and allocate resources effectively. In this way, VRelax will be able to make the right decisions and thus increase their customer satisfaction and business results as optimally as possible.

Finally, implementing the improvements to the customer is important to close the CFL. It is essential to show that the customer feels heard and valued and that the improvements made are therefore clearly communicated to the customer. In addition, it is important to ask the customer whether the updates provided are actually improvements for the customer.

## 6.2 Current Feedback Loop; Shortcomings

At VRelax, the feedback process is a dynamic and essential link in their efforts to improve the sustainable development of the VR environment. By talking to all relevant departments within VRelax, a clear picture can be sketched of the current approach to the four parts of the CFL (Figure 8) and their shortcomings (Table 3).

### **Collection**

Collecting feedback at VRelax takes several channels and affects almost all employees. Feedback comes in through various avenues, including emails to the support mailbox, telephone conversations, contact forms on the website, internal feedback and input at events. The sales and CS departments have a lot of customer contact, as they provide kick-off presentation and implementation training to customers. In addition, these departments, but CS in particular, are also mainly involved in receiving feedback and registering and resolving it (Appendix C). For example, small, often technical, problems are often resolved directly by telephone or email via these departments. A feedback form is available for software bugs. However, this form is only available to employees and is hardly used yet. Although there were initial plans to extend this to customers, the idea has taken a back seat as it is hardly used by VRelax employees. CS contacts the customer every two, six and nine months to discuss the current state of affairs with the use of VRelax. Although points of feedback are collected during these conversations, these moments are not sufficient to delve deeply into all points of feedback.

### *Shortcomings*

The process of collecting feedback within VRelax has several significant shortcomings. While there are scheduled touch points with customers after certain periods, these touch points are not primarily focused on collecting overall feedback, which limits the effectiveness of collecting feedback. Furthermore, these contact moments are not long enough to thoroughly discuss all feedback. In addition, despite being accessible to employees, the bug form is not used by employees and is not accessible to customers. Additionally, there is a lack of a general feedback form that is easily accessible, which limits users' ability to easily report feedback. All these issues hinder the thorough collection and resolution of customer feedback, which is ultimately essential for continuous improvement.

### **Registration**

Feedback is mainly registered in Salesforce, via a 'Case' (Appendix C). Here, all contact moments with a customer are registered with the relevant information, including the points of feedback. Complaints have priority over feedback, which means that not all feedback, which may also be positive feedback, is registered. There is currently no direct link between Salesforce and Jira, the program used by the development department to prioritize tasks. However, if something critical or serious is going on, it will be sent to the development department by email. In addition, feedback is reported internally via Slack in the special feedback channel. This will happen if employees encounter issues themselves, for example in consultation with a user, or if new applications are tested internally by the team.

### *Shortcomings*

The feedback registration process has a number of shortcomings. Feedback is mainly registered in Salesforce in a 'case', which most employees have access to. However, it turned out that many employees did not know that this option for registering feedback was available. In addition, the 'case' is not specifically aimed at reporting feedback, which may result in valuable information being lost. Furthermore, there is no direct link between Salesforce and Jira, which means that the development department misses information about the feedback provided, such as which

organization has provided which specific feedback and how often certain feedback is reported. Finally, not all feedback is recorded. Frequently, only the most important points of feedback are recorded, and the less important or positive points are barely registered, which distorts the overall view of the feedback. All these issues hinder the thorough and effective registration of customer feedback, impacting VRelax's ability to leverage this information for continuous improvement.

### **Evaluate & Prioritize**

Evaluating the recorded feedback is the next step in the CFL. This process is mainly carried out by the development department (Appendix C). The CS department also support with this, and mainly looks at the safety aspect of the feedback. If something occurs that has adverse consequences for the health of the users, this will be given priority and will be passed on to development. Currently, prioritizing the evaluated feedback is mainly done based on things that are very critical, whether they are explicitly addressed by CS or the CEO. However, the type of customer, number of licenses of the customer in question and the frequency are not clear to the development team, so prioritization cannot be done on this basis.

#### *Shortcomings*

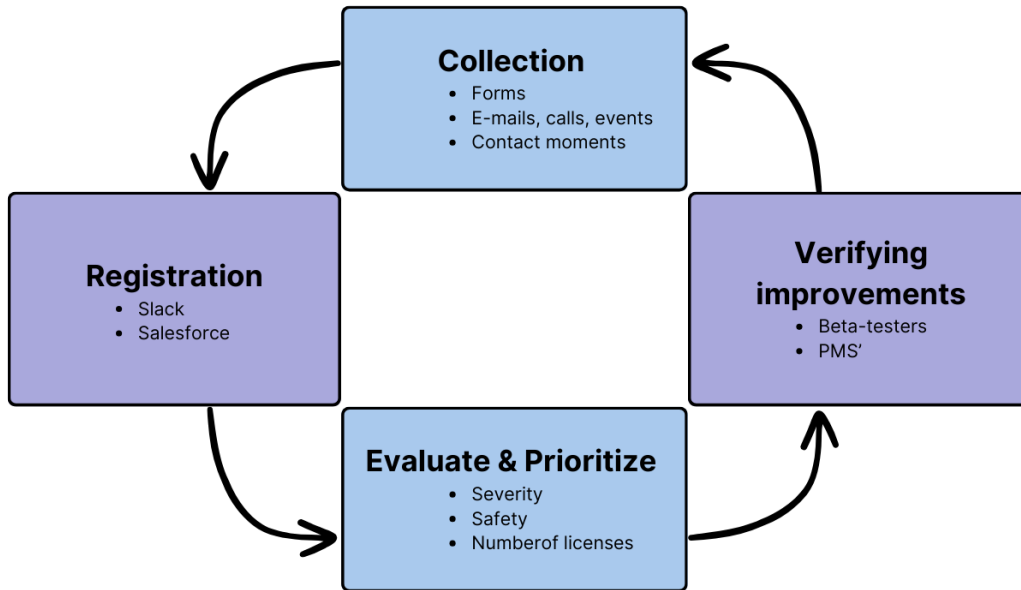
A significant shortcoming is the lack of information for the development department about the particular customer, such as the branch, the number of licenses, the urgency and frequency of the feedback provided. Because this data is missing, the evaluation and prioritization cannot be carried out thoroughly and accurately, which may lead to inefficiencies in the approach to feedback.

### **Verifying of improvements**

Finally, it is important for VRelax to know whether the updates or improvements implemented are actually a solution to the customer's problem. It is currently broadly assumed that the customer has been helped with the improvements or updates provided from VRelax, in other words, the customer is not checked whether it is actually an appropriate solution. VRelax has recently formed a small group of organizations that will be closely involved in VRelax's updates and will provide feedback on them (Appendix C). This ensures short lines of communication so that you can immediately hear whether the updates implemented are actually improvements or contribute to the quality and user-friendliness of VRelax.

#### *Shortcomings*

Firstly, there is no system in place to check whether the implemented improvements actually contribute to solving customer problems, which indicates a lack of PMS. In addition, there is no insightful list of fixed bugs for customers, which limits their ability to understand certain updates.



**Figure 8.** Current customer feedback loop of VRelax. The CFL is a continuous process in which the different parts follow each other. First, feedback is collected through forms, emails, etc. after which it is registered in Slack and Salesforce, among others. An evaluation can then take place based on this registered feedback and it can be prioritized based on severity, safety and impact on the number of users. Finally, it must be examined whether the improvements implemented have actually contributed to solving the feedback through the beta testers and PMS. After this, feedback will have to be collected again and the run will continue.

**Table 3.** Shortcomings in VRelax’s customer feedback loop.

Part of CFL	Description shortcoming
<b>Collection</b>	Scheduled touch points with customers are too short and not primarily focused on collecting overall feedback, which limits the effectiveness of collecting feedback.
<b>Collection</b>	Lack of a general feedback form that is easily accessible, which limits users' ability to easily report feedback.
<b>Registration</b>	Registration in Salesforce in a 'case' is not being used optimally and some feedback is being lost.
<b>Registration</b>	No direct link between Salesforce and Jira, which means that the development department misses information about the feedback provided.
<b>Registration</b>	Not all feedback is recorded, but only the most important points of feedback and the less important or positive points are barely registered.
<b>Evaluate &amp; prioritize</b>	The development department lacks crucial information about customers, such as the branch, the number of licenses, the urgency and frequency of the feedback provided. This makes it difficult to evaluate and prioritize effectively.
<b>Verifying improvements</b>	No system in place to check whether the implemented improvements actually contribute to solving customer problems.
<b>Verifying improvements</b>	No insightful list of fixed bugs for customers, which limits their ability to understand certain updates.

## 6.3 Optimization Feedback Management

### Integration of Slack

Searchable Log of All Communication and Knowledge (Slack) has been the new communication tool within VRelax since the end of April 2024, and will therefore often replace the other communication channels. It will take over all internal communication, replacing e-mail and WhatsApp. If there is external communication, to customers for example, email will still be used. In addition, files can be uploaded, Google Drive can be linked and action lists can be maintained live. Slack makes communication within a department and between departments much more streamlined.

In terms of feedback management within VRelax, Slack would be a good way to collect everyone's feedback in a central place. A separate 'product feedback' channel could be created on Slack, on which internal feedback on the product can be given, but also feedback obtained from customers can be entered directly via the Slack channel. A distinction will therefore be made between continuous internal testing of the product and externally obtained feedback. Within the internal and external, a distinction will be made between software and hardware.

### Creating feedback forms

Since VRelax does not currently have a customer feedback form, this will be created. This will also improve the feedback collection component. Two separate (internal and external) feedback forms will be created for this based on the requirements that will be mentioned later. One of these will be placed in the dashboard, which will be referred to on the website, among other things. This will be used for external parties, i.e. customers and end users who have experience with VRelax. It is important that all feedback is registered, and the threshold for registering it must be as low as possible. For this reason, the requirements of the form have been drawn up as compactly as possible. As a follow-up to the completed feedback form, a confirmation email will be sent to the person concerned with a possible indication that further contact will be made by email or telephone.

This **external feedback form** will have the following requirements:

- Customer contact details: e-mail address and optional phone number
- Nature of problem
  - Categorize
    - Product (app/GRIP/dashboard)
    - Version
    - Software (WiFi/update/etc.) or hardware (glasses/lenses)
    - Content
    - Bugs
    - Recommendations
- Description of feedback or issue
- Points of improvement, suggestions (ideas for new content) or recommendations

In addition, a second feedback form will be prepared for internal use. This will be used for internal testing by staff, but also if someone within VRelax receives an issue or feedback. The input of this form will be somewhat larger, to gain a better insight into which feedback comes from which organization and how much influence this has, in order to then make correct prioritization.

This **internal feedback form** will have the following requirements:

- Customer contact details: e-mail address and optional phone number
- Version
- Software or hardware



- Priority
  - Severity
  - Number of licenses affected
- Categories of topic (content, update, user-friendliness, etc.)
- Description of feedback or issue
- Source (event/e-mail/call/etc.)
- Notes

In addition to being used for internal testing, it would also be used if employees encounter feedback or complaints, for example at an event or receiving an email or telephone call. The (most important) aspects can then easily be entered into this internal form in Slack. During these customer contact moments, the VRelax employee then emphasizes that the complaint or feedback can then be provided directly via the dashboard. The data from both forms will then be collected centrally together in Jira. In addition, a questionnaire (Google Forms) has been shared with the Beta testers, a group of current customers who regularly evaluate updates, from which continuous feedback will be received on new functionalities. The data from this questionnaire will then also be linked to Jira.

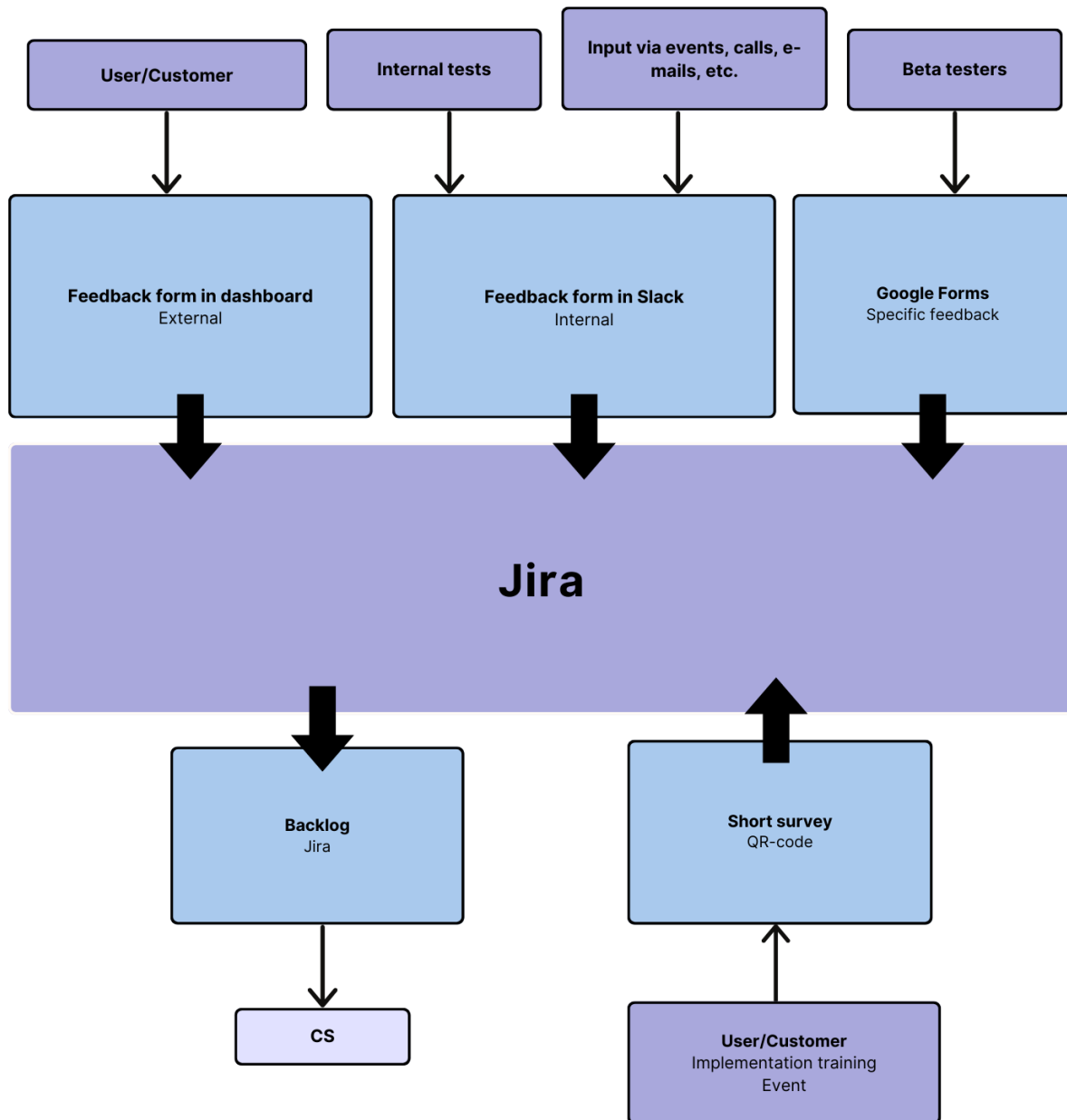
### Short survey

Finally, it is useful for VRelax to have a short survey available for implementation training, kick-offs or events, among other things, with which they can easily obtain information. These can be presented after an implementation training or during an event to allow participants to complete short questions on various aspects. This response will contribute to the collection of feedback and will be linked to the central collection point Jira, so that it is included in the prioritization. In addition, training and events can be improved using this information.

The **short survey** could contain the following questions:

- Did the training meet your expectations?
- Did you find the content of this training valuable?
- What do you think of our service?
- Did this event help you form a clear picture of VRelax?

A possible initial sorting will then be possible using AI, where everything is sorted by category and by priority. This will be very desirable for the development department as it can save a lot of time. All information from Slack from both forms will then be linked to Jira in a backlog, with which development can carry out prioritization based on the most complete picture possible. It is also important for CS to have insight into the feedback or complaints given by customers, which is why they will also have access to this backlog and will have to look at it weekly to stay informed of the current state of affairs.



**Figure 9.** A new approach for VRelax’s customer feedback loop. User or customer can report feedback themselves by completing an external feedback form in the dashboard. Users can also report feedback to VRelax itself at events or via e-mail or telephone by approaching the relevant person. They will then put it in the internal feedback form in Slack. In addition, the input from the internal tests by VRelax employees will also be entered in this internal form. The group of beta testers uses a questionnaire in the form of Google Forms to ask specific questions about certain matters that VRelax wants to obtain information about. Furthermore, users can complete a short survey at implementation training or events, for example, to obtain valuable feedback and improve these services. The input from the four collection points will all come together in Jira, the central point of all feedback. Development will then place this in a backlog in Jira, on which basis can be prioritized and will become transparent to other departments, such as CS.

### Points for implementation:

- CS (Gerben):
  - Create the final content for the short survey.
- Marketing (Richard):
  - Organization and integration of the internal feedback form in Slack.
  - Placing (the link to) the feedback form on the website.
  - Communication to the entire team about new form of feedback process.
- Development (Tommy):
  - Ensure that both feedback forms are created, and place the external one in the dashboard.
  - Ensure that both feedback forms, the Google Forms, and the short survey can be transferred to Jira.
  - Make backlog in Jira available for CS.

### **Post Market Surveillance (PMS)**

The role of the CFL is closely intertwined with the post market surveillance (PMS) process. PMS means that after the product has been put on the market, there is continuous evaluation of the product with regard to expectations, safety, operation, among other things. Important parts of the PMS are collecting data, such as feedback, analyzing this data and updating the risk assessment. The PMS is also a mandatory component of the medical device regulation (MDR), which VRelax must adhere to. The purpose of this is to ensure the safety and best possible care of medical devices, such as VRelax, for users. The medical devices can be divided into different types, with the VRelax product falling under type 1. A type 1 product has a low risk for the user. Within VRelax, these requirements of the MDR are met, including drawing up the aspects of the PMS. Important aspects here are, for example, the clinical evaluation plan and the analysis and processing of this data. However, within VRelax this is not yet adhered to as closely as described. A clinical assessment will be an important input into the PMS, allowing continuous evaluation and improvement of user safety and experience. All in all, the CFL is an important input for the PMS. For example, incidents can be reported by the CFL, which in turn helps identify trends, potential risks and the need for corrective actions. Thus, the CFL and PMS work closely together to ensure that VRelax takes the interests of their customers into account, ensuring the safety and effectiveness of their product and meeting medical device requirements.

The PMS must be actively maintained and the CFL can provide support in this regard. There are a number of questions that VRelax must continuously ask itself, which customers can gain insight into by providing feedback. Important questions are:

- Are there any risks that VRelax itself is not aware of? Have any unexpected side effects arisen that have not previously been revealed by evaluations?
- Is the performance and usability still correct?
- Has the context in which the product is used changed? Should new legislation and regulations still be taken into account?

By continuing to ask these questions regularly, and therefore carrying out PMS, as VRelax, you keep track of whether the product still has the desired purpose. The difference between the intention of the product and the experience of the user, and the difference between the requirements of the MDR and the actual safety of the product will become clear, which is of great importance to VRelax.

## 6.4 Key Findings and Conclusion

- To collect feedback, a feedback form must be made available to all users, as well as a feedback form in Slack in which everyone can record feedback collected within VRelax.
- In addition, more attention will have to be paid to collecting feedback during customer contact, possibly separate feedback sessions with multiple customers.
- All types of feedback must be registered, including smaller points of criticism or attention and positive feedback, in one of the feedback registration platforms.
- Integration between Slack, together with the other feedback collection channels, and Jira is needed for optimization of prioritization. All feedback received must be arranged in a Jira backlog and accessible to other departments within VRelax.
- The verifying improvements part must be entered within VRelax. For this, the beta testers must be deployed properly and PMS must be implemented, guaranteeing the interests of and safety for users.
- Thus, by making improvements to all four aspects of the CFL, VRelax's overall feedback process will be optimized and the product will better meet user needs.

## Chapter 7. External Analysis of VRelax

The external environment in which VRelax operates is mapped by means of an external analysis. This makes it clear which capabilities of VRelax can be well reflected in this, the opportunities, and which are still missing and which can therefore create threats. The purpose of conducting this analysis will be to answer the sub-question: “What is the external environment around VRelax like?”. The analyses that will be utilized for this purpose are the PESTEL and Porter's Five Forces.

### 7.1 External Factors Influencing VRelax

A PESTEL analysis provides insight into the various external factors that can influence the company. The name PESTEL stands for Political, Economical, Social-cultural, Technological, Ecological/Ethical and Legal factors. For each factor, possible external opportunities or threats are examined. This project specifically examines the use of VRelax in elderly care, and which external factors are involved. By gathering this knowledge, VRelax can gain a better understanding of the external environment in which they operate and, based on this, develop strategies to adapt to the developments and trends that are taking place. Ultimately, this will lead to better company performance and strengthen their competitive position.

#### **Political**

The 'political' factor will look at government policy, political stability, and legislation and regulations, and their influence on business operations. Firstly, VRelax will have to take into account and stay abreast of current laws and regulations regarding VR in healthcare. These laws and regulations that VRelax must take into account with their medical product are the MDR and the Dutch Medical Devices Act. In addition, the laws in force in elderly care include the Long-term Care Act (Wlz), the Social Support Act (Wmo), the Health Insurance Act (Zvw), and the Care and Coercion Act (Wzd). Possible changes in the political field could be towards a greater focus on technology integration, which could be interesting for VRelax in terms of being able to claim subsidies to integrate their form of healthcare technology. In addition, the high workload in (elderly) care will increase the possibility that the government will provide incentives for new care technologies, for example with financial support or subsidies. Examples of organizations that are in charge of providing subsidies are ZonMW, SNN, EIT Health, and VWS. VRelax will also have to take into account data protection and privacy, such as the GDPR, as health data of care-dependent elderly may be used. In addition, an amount of 345 million will be allocated in 2024 for the Housing, Support and Care for the elderly program, which should increase the self-reliance of the elderly, encouraging the use of care technology, which is also a positive development for VRelax. Thus, threats could include regulatory changes in healthcare that impose new restrictions or reductions in governmental funding cuts. On the other hand, there are possible opportunities such as supportive policies, which will stimulate new techniques such as VR in healthcare, and research grants, which promote scientific validation and thus the position of VRelax.

#### **Economical**

The 'economic' factor analyzes indicators such as inflation and growth to understand how they can influence the financial health of the company. Firstly, the budgets for healthcare and healthcare innovation (within an elderly care organization) play a role. An increase in these budgets could translate to greater investment in technological solutions for elderly care, potentially including VRelax. In the Dutch healthcare system, budgets are based on several factors, namely regional needs, specific healthcare requirements and agreements with healthcare providers. Hence, the aging population and the resulting increasing demand for care will have a positive effect on this.

In addition, it would be a positive development if the VRelax product were included in health insurance so that it could be used much more widely, including for private individuals such as the elderly, who suffer from isolation or other mental complaints. An option to include the integration of new healthcare technologies, such as VRelax, in insurance is through the Healthcare Institute of the Netherlands (ZIN). This institute assesses and decides whether the particular technology can be covered by insurance. It is important that VRelax can demonstrate that the product is effective and cost-effective, by demonstrating this through the thorough research that is currently being conducted. Broader coverage for the product could create greater demand from elderly care institutions, which will be positive for VRelax financially. Finally, general economic growth is of course positive. This could, among other things, ensure that elderly care institutions have more budget to embrace new care technologies and, as a result, become VRelax customers.

However, there will be threats. On the other hand, an economic recession would of course also be possible, which would not contribute positively to the budgets and investments for VRelax's product. Factors that play a role in the willingness to invest in start-ups are economic growth, interest rates, healthcare demand, government policies and incentives, and investor confidence. Furthermore, the pressure on elderly care is currently increasing and there is a high demand for care. As a result, budgets will be severely tightened and there is a significant chance that there will be little money left for new healthcare technologies, especially since a lot of time, and therefore money must first be invested in them. Finally, VRelax is currently not reimbursed by insurance. This will hinder the adoption of VRelax (in elderly care).

### **Social-cultural**

The 'social-cultural' factor mainly looks at the social norms and values, cultural factors and lifestyles that can influence the demand for the product. One of these points in this case is the aging population. This increasing percentage of elderly people may create greater demand for healthcare innovations in elderly care. A significantly larger number of healthcare workers will be needed in the coming years due to this aging population, and since this number will be difficult to achieve, the use of healthcare technology is crucial, which will have a positive effect on the use of VRelax in elderly care. Secondly, the growing awareness of mental health plays a role in this. This translates into an increasing demand for relaxation exercises. VRelax offers an excellent solution, especially among the elderly, who are often less mobile and therefore limited in their ability to walk outside or participate in other forms of relaxation. Finally, technology adoption is essential. Since VRelax is a technological product, the degree to which older people are familiar with technology influences its successful use. Although there is an increasing acceptance of technology among older people, there still remains a group that has difficulty understanding it, which can be an obstacle. Reasons for this misunderstanding may include incomprehension of technology, deterioration of cognitive and physical functioning and fear. Addressing these barriers could be done by fostering a supportive environment for older adults to learn and engage with new technologies.

In addition to the elderly themselves, caregivers and care staff will also have to embrace the new care technology. If there is resistance from the caregivers, the use of VRelax will be difficult, also because some cannot use it independently. This resistance can arise from lack of awareness, lack of time, doubts about effectiveness and technical problems. To combat this resistance, extensive training, providing ongoing support and clear communication about the benefits would be beneficial and increase the adoption of VRelax. All in all, the aging population and the growing attention to mental health offer opportunities for VRelax. At the same time, technological acceptance represents both an opportunity and a threat to the implementation of VRelax in elderly care.

### **Technological**

The 'technological' factor looks at technological developments and innovations that can change the way companies operate. Firstly, VRelax's innovative technologies are part of this. VRelax's high quality makes it a pioneer in the use of VR in healthcare. There is continuously being worked on new and high-quality content, which increases the immersive effects and thus increases the positive effects of VRelax.

Current developments in the field of VR that VRelax could perhaps integrate into their product are AI, haptic feedback, augmented reality and remote monitoring and telehealth integration. By integrating AI, the VR experience would become more personalized by analyzing user data. Haptic feedback would make the VR experience even more realistic, which increases the immersion and thus the effect of VRelax. Adding augmented reality could be useful in therapeutic settings and integrating telehealth allows caregivers to better meet the client's needs. Making the product more intuitive and user-friendly in the future will also positively contribute to its use by the elderly.

Therefore, the accessibility of VR, especially for care-dependent elderly, is of great importance. User-friendliness is essential for the optimal use of VRelax in the elderly. For example, the VRelax interface will have to be easy to use for the elderly, so that those who have physical limitations, among other things, can also easily navigate through VRelax, which will improve the adoption of VRelax in elderly care. Furthermore, the integration of voice commands, gesture-based controls, and an ergonomic design, which makes the VR glasses lighter and more comfortable for the elderly, would contribute to greater accessibility and usability.

Technological infrastructure also plays a role. It is important to apply suitable VR hardware and software in elderly care and also to keep an eye on technological trends in VR to stay at the forefront of innovation. The technological infrastructure in elderly care institutions includes various medical equipment and technologies to increase effectiveness and quality in elderly care. Examples include electronic health records, telehealth systems, and wearable health monitors. Finally, problems may arise when integrating technology into the current form of care. VR in elderly care is a new area, where it still needs to be examined how this can be used optimally. Therefore, institutions should integrate VR systems that are compatible with existing technologies and infrastructure, ensuring seamless data exchange and support.

To conclude, the main opportunity here is the current quality and usability of VRelax, which is at the forefront of VR innovations in healthcare. A possible threat would be integration into the current healthcare system, where VR is a new healthcare innovation that is still searching for its optimal use in the current form of elderly care.

### **Environmental/Ethical**

The 'environmental/ethical' factor identifies environmental considerations, such as the sustainability and ecological impact of business activities, and ethical aspects. Sustainability plays an important role in VRelax's considerations, despite the company only developing the VR app. However, using VRelax requires VR glasses, which are usually purchased by VRelax and delivered to the customer at the same price. If a customer decides to stop using VRelax, the VR glasses remain fully recyclable, as long as the current version of the app is supported by the glasses. In addition, ethical considerations are crucial when implementing VR in elderly care. This includes ensuring the protection of user data privacy, especially since VRelax may collect medical data. In addition, VRelax must comply with all relevant laws and regulations regarding elderly care and the use of technology in the healthcare sector. This includes complying with privacy laws, medical regulations, and other legal requirements applicable to the development of the product. Finally, it is important that VRelax is accessible to all target groups, there is no discrimination and the product can be used easily by the elderly. To ensure the inclusion of care-dependent elderly, VRelax must take into account any limitations they may bring.

## Legal

In terms of 'legal' factors, the law and regulations will be divided, as well as the legal issues that may affect the business. First of all, VRelax must comply with all relevant laws and regulations regarding elderly care and technology use in healthcare, including privacy regulations and medical standards. Also, protecting the user data comes through maintaining rules and regulations. This will implement and pursue security measures to eliminate the disappointment and integration of user data. In addition, it is important that VRelax protects the intellectual property rights associated with its VR app and any proprietary technologies used. Most importantly, VRelax is aware of the potential liability issues that may arise from the use of the product in aged care. This will concern the responsibilities and obligations of VRelax, as there is a potential for damage to be caused by the use of VRelax.

## 7.2 Competition Landscape and Market Attractiveness of VRelax

The competitive landscape and market attractiveness are assessed through a comprehensive analysis using Porter's Five Forces framework. This tool will delve into VRelax's application in elderly care, examining pertinent factors such as competitors, buyers, and substitutes. By delving into these dynamics, we gain insights into the potential profitability and avenues for growth for VRelax in the elderly care sector. Armed with this understanding, VRelax can refine its strategy to bolster its standing within this market. The two components suppliers and new entrants are not included in this analysis because they are not relevant in this case. The supplier is not relevant for VRelax, as there are several companies that offer VR glasses, and this is not the essence of VRelax's product. In addition, there will likely be a small probability for new entrants that will specifically have the same formula as VRelax entering the market.

The VRIO analysis assesses the internal resources and capabilities to subsequently determine the strategic position. As an example, evaluating the content creation capability and the effectiveness and uniqueness of VRelax's technology (resources) helps determine the competitive edge. In addition, identifying the ability to innovate and adapt (capabilities) in response to technological developments and market forces is important. In addition, matters such as brand reputation and how VRelax maintains its customer relationships (organizational) will provide insights into the sustaining competitive advantage. By integrating the VRIO into Porter's Five Forces, VRelax can sharpen its strategic approach and increase its position in the elderly care market.

### Competitors (moderate to high power)

Firstly, the competition for the use of VRelax in elderly care will be mapped out. By gaining insight into the intensity of competition, it can be understood how it compares to rival companies in the same industry. It is important for VRelax to make it as user-friendly as possible for the elderly. Currently, VRelax is not specialized in the use of their product in elderly care. VR applications in healthcare are currently growing in popularity, which means that VRelax will have to continue to innovate and listen carefully to the recommendations of the care-dependent elderly. Possible competitors for VRelax that also apply VR in elderly care include EldersVR, Virtuele Dromen, RendeVer, SiVR Adventures, and Mynd Immersive, with the first two based in the Netherlands and the others operating internationally (Table 4). Since EldersVR and Virtuele Dromen are located in the Netherlands, they are direct competitors for VRelax, particularly since they are specified in the elderly care domain and can focus entirely on this target group. VRelax differentiate itself from its competitors through its user interface. However, VRelax must divide its attention across the different target groups, potentially diluting its efforts in the elderly care sector, which is a



weakness. Therefore, it is important to stay ahead of this competition by continuously applying updates and improvements to maintain the competitive advantage.

**Table 4.** Competitors using VR in elderly care.

Company	Characteristics
<b>EldersVR</b> (EldersVR., n.d.)	<ul style="list-style-type: none"> <li>• The Netherlands</li> <li>• Offering three themes: 'relaxing', 'experiencing excursions' and 'exercise and activities'.</li> <li>• Let people live happier lives so that they need less care, thus relieving the burden of care.</li> <li>• Up to 6 people at the same time in 1 session, increasing social connection between elderly people.</li> </ul>
<b>Virtuele Dromen</b> (Virtuele Dromen, n.d.)	<ul style="list-style-type: none"> <li>• The Netherlands</li> <li>• 10 films with themes such as nature, city trips, safaris and excursions.</li> <li>• The aim is to make elderly people mobile with key words: re-experiencing, cognitive development and connecting.</li> </ul>
<b>Rendever</b> (Rendever, n.d.)	<ul style="list-style-type: none"> <li>• United States</li> <li>• The VR application makes it possible to go anywhere to reminisce and combat social isolation and depression.</li> <li>• You can talk to others in a virtual world and play games (together).</li> </ul>
<b>SilVR Adventures</b> (SilVR Adventures, n.d.)	<ul style="list-style-type: none"> <li>• Australia</li> <li>• Offering group virtual tours of up to 40 people that bring older people together with shared experiences, such as a virtual cafe and theater.</li> <li>• It can be used in the memory care program.</li> <li>• Through the content and activities, unique experiences can be created based on the user's personality.</li> </ul>
<b>Mynd Immersive</b> (Mynd Immersive, n.d.)	<ul style="list-style-type: none"> <li>• United States</li> <li>• A library consisting of 250 immersive and interactive experiences, designed to enhance recreational, reminiscence and distraction therapy for older adults.</li> <li>• Empowering licensed therapists with groundbreaking tools to seamlessly integrate immersive technologies into therapeutic interventions.</li> </ul>

#### Buyers (moderate to high power)

In addition, it is essential to understand the various buyers involved in this context. In this case, this will specifically concern the organizations in which care-dependent elderly are involved, such as nursing homes, care homes, rehabilitation centers and home care institutions. Given the aging population and the associated increasing demand for care needs in elderly care, this group can exert a great influence on VRelax's position. Despite the high workload in elderly care and the additional time investment required to deploy VRelax, new technologies will have to be developed to meet the rising demand for care. Furthermore, the fact that there are multiple technologies available to adopt (substitutes), and other companies offering similar products (competitors), it is crucial for VRelax to differentiate itself and align closely with the needs of the elderly care sector. By creating unique features, like making it possible to travel back in time or bike rides in their birthplace, and demonstrating effectiveness while ensuring acceptance, VRelax can strengthen its bargaining power in the market.

**Substitutes (moderate power)**

By mapping the substitutes of VRelax in elderly care, it is possible to examine its position on the market and whether buyers will easily opt for other solutions. Currently, VRelax is mainly used in this target group as a relaxation method to combat restlessness and agitation, and the resulting misunderstood behavior, among the elderly. Various alternatives are available, both digitally and non-digitally, for using VRelax in this way. Examples of digital substitutes are music therapy, meditation and mindfulness apps, aromatherapy, and new specific technology for the elderly such as Qwiek.up, an audiovisual aid, BeleefTV, positive stimulation for elderly people with dementia, and white noise, a relaxation agent through sound stimulation. In addition, there are also non-digital relaxation methods for the elderly, such as group activities, a walk or a bike ride on a duo bike or wheelchair bike, among others. However, these relaxation methods are not accessible to all elderly people, for example, due to physical or mental limitations. For this group, VRelax would be an ideal outcome, which will contribute to the superior effect of VRelax, provided it is suitable for use, compared to alternative relaxation methods. However, switching from current relaxation methods to VRelax will involve the so-called 'cost of change', as the elderly care institution in question will have to invest time and money for the use of VRelax.

### 7.3 Key Findings and Conclusion

- Politically, there is a positive development given the increased focus on technological integration. As a result, there is the possibility to claim subsidies, among other things, to finance VRelax and thus increase its use and deployment.
- Increasing budgets for healthcare innovations through rising demand for care, could translate to greater investments in technological solutions for elderly care, like VRelax.
- VRelax must be able to clearly demonstrate that they are effective and cost-effective, in order to convince ZIN that they can be covered by the insurance.
- VRelax's product must remain user-friendly for the target group, be sustainable, properly secure medical data, and continue to contribute positively to mental well-being, in order to maintain a good position on the market in the sector.
- VRelax itself is not specialized in elderly care, but if it wants to continue to serve the elderly care sector, it will have to respond more and better to the demand from elderly care in order to remain successful and at the forefront in this sector.
- Given the aging and demand for care, this group of buyers will become significantly larger, giving VRelax opportunities to expand in this sector if it continues to differentiate and innovate in relation to other relaxation methods.

## 7.4 Integration of Internal and External Analyses

By integrating the internal analysis (VRIO) and the external analyses (PESTEL and Porter's Five Forces), a summary is visualized by a SWOT analysis (Figure 10). Based on this integration, VRelax can determine a strategy that leverages the competencies, addresses potential risks, and capitalizes on market opportunities. This approach will ensure that VRelax continues to improve its competitive edge. The strengths must be used properly to realize opportunities. For this purpose, the sustained competitive advantage of the user interface and the high quality of the content can be used to capitalize on the governmental focus on technology integration and supportive policies. In addition, the fact that VRelax has been scientifically validated can be used to attract subsidies and inclusion in health insurance. Furthermore, weaknesses will have to be addressed to minimize threats. For example, the CFL will have to be improved in order to gain insight into the desires of the users and to continue improving the product. In addition, the accessibility and user-friendliness of the product for the elderly will have to be improved to overcome challenges in elderly care. Additionally, VRelax should monitor regulatory changes, economic conditions, and technological trends to anticipate and adapt to potential threats. Finally, continuous innovation is essential. This involves investing in research and development, as well as increasing customer engagement through additional support and training for staff, to better align with the elderly care sector.



**Figure 10.** Integration of internal analysis (VRIO) with external analyses (PESTEL and Porter's Five Forces) into a SWOT analysis.

## Chapter 8. Recommendations for Improved Alignment with Elderly Care

For the optimal alignment of VRelax with elderly care, various areas must be examined. The VR session itself will have to be looked at, which includes the duration, the moment, and the content. In addition, the time-saving factor will be examined, where independence and the role of employees in an elderly care organization are important. Thirdly, the specification within the care-dependent elderly will be examined, whether there are certain diagnoses or risk groups to which VRelax is most compatible. Finally, stress measurement in the elderly will have to be examined and what appropriate qualitative, such as questionnaires, and quantitative, such as biomarkers, are. All these aspects will be approached through an integration of scientific literature and knowledge gained from interviews with experienced users in practice and studies of organizations that use VRelax.

### 8.1 The Arrangements of a VRelax Session

#### **Duration and regularity of a VRelax session**

The research by Veling et al. (2021) shows an effect of a 40% reduction in stress in a ten-minute session. Other studies specifically in the elderly also conducted a ten-minute session (NNCZ). For this reason I would recommend a minimum of a ten minute session. However, the optimal duration will differ per individual, but it will therefore be necessary to carefully consider the optimal period of a session per individual. With the psychiatric target group, I will advise that the session should not last longer than twenty minutes, as the elderly person must still be able to distinguish between reality and the VR environment, a point that some of the interviewees also raised. Also with regard to the application and guidance in elderly care, in combination with the high workload (Idenburg & Philippens, 2020), it is not ideal to have to do sessions that are too long, as guidance is always needed for the care-dependent elderly.

The interviews conducted also often revealed that this period is a suitable period for care-dependent elderly. However, the elderly person's state of mind must be taken into account. Research by Remmerts (2022) has shown that if an elderly person is already struggling with stress or aggression, for example, they do not want to wear their glasses for longer than ten minutes. To initiate a session effectively, it is important to choose a suitable moment for the elderly to avoid any deterioration in mood.

For the regularity of using VRelax, I will recommend using it with some regularity, like once a day for two weeks, to actually see (long-term) effects. For example, VRelax studies show an increase in positive emotions and a decrease in negative emotions after a longer period of daily use.

#### **Use of headphones during a VRelax session**

To maximize the effect of a VRelax session, the client must experience the greatest possible sense of immersion. In addition to the images on the glasses, the sound is also important for this immersion. Research by Potter et al. (2022) has shown that spatial audio makes a significant contribution to the effect of a VR session. Since the spatial audio is not fully achieved due to the sound from the glasses, headphones would be recommended to optimize the effect of the immersion, and therefore of the VRelax session.

During each interview, it emerged that the headphones were not used during deployment with care-dependent elderly. When asking further questions, it also emerged that this is not ideal for this target group, as it means they have to place even more relatively heavy equipment on their heads. They are also isolated even more from their environment, which, among other things,

makes communication with healthcare staff or someone else supervising the session more difficult, which would make it less possible to take adequate action in the event of an escalation, for example.

As a recommendation, it should be assessed individually whether the elderly person is suitable for wearing headphones during the session. When introducing VRelax, I would not recommend the glasses, but after becoming well acquainted with the glasses, the headphones could be tried to see if they can increase their effects and if the person does not experience any hindrances. In addition, I would not recommend a VR session during the transition from a green to an orange state (Table 5), when someone is in the process of losing control in a situation, in order to maintain good communication with the elderly and to be able to intervene if necessary.

### **Method for integrating VRelax into elderly care work processes**

Research by IJsselheem (Remmerts, 2022) showed that the 'traffic light system' is the most suitable method to demonstrate a deterioration in mood (Figure 11). This will also allow the moment of deployment to be in line with this, as the transition from a 'green', stable situation, to an 'orange', loss of control, is a suitable moment to optimally deploy VRelax. This would prevent an escalation, which would be the desired result for the healthcare staff and the client himself.

At Zorggroep Meander (Appendix D) it became clear that the sessions were mainly used in the 'green' phase, because during this period communication with the elderly runs well and they can maintain attention on the session. In addition, this can prevent the transition to the 'orange' phase, because it is sometimes difficult to carry out the session in this phase in elderly people.

An important aspect of this method is ensuring that it is well received by all healthcare staff, so everyone adheres to it in the same manner. If all employees apply it properly, it becomes clear what the state of mind of each client is, and when VRelax can be used at the right time. If this is not yet the case in an organization, training must be provided in which everyone learns to work with this method.

Furthermore, an evaluation of the research by Remmerts (2022) also showed that the staff shortage and high workload in elderly care may cause problems with consistently properly implementing this method. A solution to this would be the involvement of the older person's network, where this family could support them during the sessions and identify the (change in) state of mind. It will also be in line with social developments to promote family participation (Van Halem, 2015).

Stable situation	
There's nothing wrong. The situation is stable. The client has a grip on the situation and is relaxed.	Reinforce the client's situation by giving positive attention and compliments.
Loss of control	
The client's anxiety increases. This can manifest itself in: restlessness, looking differently (alert), slamming doors, etc. The sense of reality is still present and the client is (still) reasonably easy to reach.	The attitude of the care provider here is supportive. It is important to let the client know that you have noticed the change in behavior and that you are offering help. The attitude is not aimed at taking control.
The situation can derail due to increasing loss of control. The fear or anger is so great that there is little to no sense of reality anymore. Behavioral changes may include; threatening, motor restlessness, disinhibition.	The healthcare provider must be directive here and take control. The care provider determines what will happen and how. The healthcare provider pays attention to the intonation and body language that suit the situation.
Escalation	
In this phase the client shows aggressive or transgressive behavior such as shouting, hitting, kicking and spitting.	The care provider uses learned (defense) techniques or chooses a low-stimulus environment to stop this behavior.

**Figure 11.** The ‘traffic light system’. This method distinguishes three different states of mind: stable situation, loss of control, and escalation (Btsg, 2023).

### The range of content offered

The interviews yielded varying stories about the distinction between static and moving images. For example, during the interview with NNCZ (Appendix D), it was mentioned that there was a preference for moving images, as the static images were experienced as boring, which caused the elderly to quickly take off their glasses. On the other hand, during the interview with Zonnehuisgroep Noord (Appendix D), it was mentioned that many images were experienced as busy, and that more static images were chosen.

During all interviews, it became clear that there was a lack of content aimed at the elderly target group. Examples of images that were missed were mainly images from the past, a bicycle ride through their own village, etc. For the care-dependent elderly target group, it is advisable to use these images and other images with nostalgic elements such as walks, bike rides, boat trips, and famous landmarks to evoke memories. Another suggestion, from the interview with Zorggroep Groningen, was to integrate Google Maps, for example, in order to go to places of your choice. This would be greatly appreciated by this target group, as many memories can be made here and positive emotions will arise. The company Rendeever has a similar application for their product (Table 4).

The conclusion is that the images that resonate well are very personal. Gaining insights into the preferences and most liked content of the elderly, VRelax can respond to this and take into account what new content could be created to suit this target group. This information can guide the creation of new content and allows VRelax to provide appropriate advice on what will appeal to care-dependent older people.

## 8.2 Time-Saving Aspects of VRelax Integrated in Elderly Care

### **Assistance during a VRelax session for care-dependent elderly**

Literature shows that care-dependent elderly have a high likelihood of experiencing stress and therefore developing physical and psychological problems. These limitations can make it difficult for elderly people to use VRelax independently. In addition, the technical aspect can also be difficult to understand by people with psychiatric problems. In conclusion, it follows that VRelax is difficult to use independently, and therefore an employee will be present to supervise the session.

The interviews revealed that in all institutions the VR session was not done individually, but always accompanied by an individual from the healthcare institution. VRelax cannot be used independently for care-dependent elderly. This would have a negative effect on the time-saving aspects. However, over time, certain elderly people may be able to use VRelax independently, although this must always be monitored by healthcare staff, for example, to take action to prevent an escalation or loss of control. A family member would also not be able to play a role in this, which would put less pressure on the staff.

### **Possibilities for time-saving in elderly care**

During interviews, it was often mentioned that educating people about how VRelax works is often an obstacle. Often only a few people are familiar with the use of VRelax, which makes it difficult to use it widely and sufficiently. In the absence of this person, use is no longer possible. At first, it will be a time investment to make VRelax known to all staff. Once everyone knows how to use it in a targeted manner, it can save time.

If the elderly show less calling and misunderstood behavior, they will experience fewer problems and therefore require less care from healthcare workers, which could reduce the workload and thus save time. Furthermore, it may be less necessary to administer medication, which in addition to the time a call would take, also costs less time for the staff, which will contribute positively to the time savings. In addition, the duration of a VRelax session and the positive effects the session has on the environment and atmosphere in the elderly care institution should be taken into account.

In addition, the interview with GGZ Drenthe (Appendix D) revealed that replacing VRelax with medication is also much better for the health of the residents, since the pain and rest medications have many side effects, like becoming drowsy and weakened.

## 8.3 Specification of Target Group within Elderly Care

### **Specification within the target group of care-dependent elderly**

Literature has often conducted studies with elderly people who suffer from psychological problems and a few with somatic problems. The interviews were conducted specifically to gain more insight into the effect of VRelax on elderly individuals with somatic problems. Several stories about the effects emerged from these visits to elderly care institutions. I was told that in addition to having positive effects on elderly people with psychological complaints, it also has positive effects on people with somatic problems, including reduction of anxiety and stress problems, but also as a daytime activity by retrieving memories and evoking positive emotions.

Interviews with various elderly care institutions, each with different target groups, have shown that it can be used successfully for somatic, psychological, and rehabilitating elderly people.

Although VRelax can contribute to solving misunderstood behavior and restless behavior, it can also have positive effects for people who do not directly suffer from these problems.

It is important for healthcare staff to know someone's history well, so they can avoid possible triggers or traumas with the use of VRelax, as became clear during the interview with NNCZ (Appendix D). The healthcare professionals have access to the background information and interests of the elderly person, allowing them to select images for the elderly person, for example with the help of the GRIP app.

## 8.4 Stress Measurements for VRelax in Elderly Care

### **Validation of VRelax in elderly care: combining quantitative and qualitative measurements**

It emerged from the previous chapter that it is important to have a combination of quantitative and qualitative measurements. As a quantitative measurement, VRelax should use a wristband, with integration of HUME. This would allow HR, HRV, and BP to be determined simultaneously. In addition, they should use the PSS-10 and the OERS as qualitative measurements, to include both the client's feelings and the observations of the healthcare staff. It is important for VRelax to support and guide elderly care organizations in starting up and properly carrying out the various measurements, and in understanding their interpretation and usefulness.

## 8.5 Points for Implementation VRelax in Elderly Care

### **Investing time and effort**

Healthcare staff need sufficient intrinsic motivation to invest time and effort to work with VRelax (Kouijzer et al., 2024). Interviews have shown that not every healthcare worker has confidence in the use of VRelax. This trust is essential to successfully transfer and deploy VRelax. This will require support from management or organization to encourage the use of VR, by offering them tools and solutions when they encounter problems. Furthermore, it is crucial to provide adequate time for staff to learn how to use VRelax properly. Elderly care is already very demanding, and if this has to be done in their regular shift besides all the other responsibilities, it is quickly put aside.

### **Introduction of VR and support during using VR of patients**

Healthcare staff must introduce the new form of therapy appropriately (Kouijzer et al., 2024). It is very important for the elderly to calmly explain what VRelax entails and how everything works. It is often a very new modern method, which means that it must be made clear how everything works and what the positive effects can be for themselves. The staff can use various techniques and resources to get the elderly enthusiastic to see whether VRelax can be of added value for them. Both VRelax and the management of the elderly care organization should provide guidelines to the healthcare staff, for example in the form of a suitable approach per diagnosis, to offer VRelax as suitable as possible.

### **Integration of VR in routines**

VRelax is not a solution or treatment in itself, but an extension of an existing treatment. It is important that the care worker specifically examines for each elderly person whether VRelax can be a contribution, and how exactly this can fit in with the current treatment plan. It is important that in addition to the kick-off, during which all background information about the positive operation and effect of VR is explained, VRelax provides a clear implementation training that specifically addresses how the elderly target group can best be addressed. It is important for both healthcare staff and the elderly themselves to have a positive and motivated attitude towards the



use of VRelax. Establishing VR-specific protocols would facilitate integration and give staff confidence to work with VRelax and use it successfully (Kip et al., 2023).

### **Educational level & psychosocial situation**

The older person must have enough cognitive capabilities and provide input to achieve the desired effect with the use of VRelax. The mental state must be stable for the use of VRelax, which can be monitored with the traffic light system (Kip et al., 2023).

### **Ease of use & content**

The software and hardware of VRelax are easy to use by healthcare staff in elderly care. The person responsible within the organization must be in close contact with VRelax in order to be able to immediately resolve any problems that arise and to implement continuous improvements to continue to meet the wishes of the elderly. The needs of the elderly must be taken into account with regard to the content that is presented. In the absence of suitable content, VRelax should include this in the CFL and evaluate whether there should be more content specifically for the elderly.

## 8.6 Key Findings and Conclusion

- The duration of a VRelax session must be at least ten minutes, and a maximum of twenty minutes, for visible results.
- The mental state and state of mind must be taken into account before starting a session for it to be successful.
- VRelax will have to be used several times to achieve lasting effects, preferably once a day for a minimum of two weeks.
- Although the use of headphones increases the immersion and the effect, it is not always wise to use them for care-dependent elderly, because of the loss of communication.
- The ‘traffic light system’ would be an ideal system to link the use of VRelax.
- Content specifically for the elderly care sector is missing.
- Given the high degree of physical and psychosocial problems in the elderly, it is necessary that the elderly are guided during a VRelax session.
- It is important that all employees have knowledge about the use of VRelax. Appointing a limited group makes the overall effort difficult and contributes to the neglect of the product.
- In addition to the proven effect in the psychiatric group, the interviews conducted also made it clear that it also has a significant effect in the somatic group.
- A wristband could be suitable alternative for measuring HR, HRV and BP. In addition, the application of HUME could perhaps be integrated, which is a valuable addition in elderly care.
- The best way to determine stress levels through cortisol is via hair. However, multiple samples will have to be taken per day for a period of longer than fourteen days, and there is a chance that other factors will have an effect on the cortisol level during this long period. This makes measuring stress levels using cortisol not an optimal method.
- The most suitable qualitative methods are the PSS-10 and the OERS.
- There must be sufficient space for healthcare workers to learn to work with VRelax and create intrinsic motivation.

## Chapter 9. Advice & Implementation

### Internal Analysis

- Clarification of structure in consultation and communication within and between different departments.
  - Integrate Slack into this as much as possible, to always keep all discussed information in a central place and to place the minutes of meetings.
  - Create a clear structure, including fixed times for meetings, to work efficiently within and between different departments
  - Improve transparency and communication for the entire team through physical weekly updates for the entire team at a fixed time of the week.
- Consider personalities and group dynamics when hiring new employees. A balanced mix of personalities will contribute positively to the group atmosphere and performance.
  - Take the current group of VRelax employees and the relevant department into account when hiring new staff.
- Further optimize resources and capabilities.
  - Spatial audio will have to be better appreciated by end users through organizational support.
  - In addition, continuing to improve the user interface and scientific validation of the product in order to stay ahead of the competition and maintain a good position on the market.

### Customer Feedback Loop

- Implement an internal and external feedback form.
  - The development department will have to create these two feedback forms in the dashboard and ensure that these forms can be linked from Slack to Jira.
  - Marketing has to integrate the internal feedback form in Slack and ensure that it is also user-friendly for employees to submit after receiving feedback.
  - The established external feedback form should be easily made accessible, by marketing, to all customers and employees to optimize feedback collection, like on the website and dashboard.
  - These forms should clearly distinguish between the different categories types of feedback, such as negative, positive, complaints, and suggestions, which will lead to the proper recording of all feedback so that it can be properly followed up.
- Ensure that all feedback inputs from various channels, such as Slack, external forms, Google Forms, and surveys, are consolidated in Jira.
  - By realizing an integration between all these feedback collection input channels and Jira, the development department has an immediate overview of how often certain feedback is given by which customer. This will help this department enormously with the evaluation and prioritization of the feedback given.
- Organizing regular feedback sessions with customers.
  - These can be meetings once a quarter, organized by CS, with a specific focus on collecting extensive feedback. This will make more feedback available and implementing this will improve the CFL's overall customer satisfaction. The co-creation with the formed group of customers will contribute to this.
- Conduct regular clinical evaluations to monitor the safety and effectiveness of VRelax. These must be documented and analyzed to meet the requirements of the MDR.

### External Analysis

- The sales department has to encourage companies to apply for subsidies (STOZ, among others) so that they have money available for VRelax, by an information e-mail or contact moments.
- Calculate how much time VRelax can save in elderly care. If concrete values can be provided, such as what percentage of the workload will decrease or how many minutes it will save healthcare, it will contribute to the inclusion of VRelax in health insurance.
  - Initiate a study, potentially in collaboration with an intern, to see how this time saving can be quantified. Examples of where healthcare technologies relieve the workload for healthcare staff and improve the efficiency of care are the studies by Kwint (2023) and Moore et al., (2020).
- Increase the focus on the specific needs of the elderly care sector.
  - This can be achieved by working closely with elderly care facilities to gather feedback, and investing in R&D so VRelax can continue to grow and innovate in this sector.
  - Possible competitors specialized in elderly care could otherwise assume a higher position in the market. However, on the other hand, lessons can be learned from certain applications that they use in elderly care.

### Alignment with Elderly Care

- Use the information from the literature and interviews for a better connection with the elderly care sector and apply it, among other things, to implementation training. Guide the organizations on how to implement a VRelax session, how they can best measure its effects, which target groups they can approach, and what time-saving factors can be when using VRelax. The following points of advice apply:
  - The duration of a VRelax session must be between ten and twenty minutes.
  - The mental state and state of mind must be taken into account before starting a session for it to be successful.
  - VRelax will have to be used repeatedly to continue to see the effects
  - Start VRelax without headphones. If it seems suitable for the person, it can be tried to increase immersion and effects.
  - The 'traffic light system' is a suitable system to connect VRelax for use at the right times.
  - Provide guidance and support while using VRelax, such as putting on the glasses and selecting suitable content.
  - Use a qualitative measure in combination with a quantitative measure to get a clear insight into the effect of VRelax.
- The content department has to add more content that is appropriate or focused on elderly care.
  - Choose a number of elderly care institutions with different target groups within elderly care, with which the current form of VRelax can be evaluated and how VRelax can better meet the needs of the elderly.
- To validate stress reduction in the elderly as VRelax, replace the chest with a wristband and use it in combination with the elderly's own interpretation, using the PSS-10, and the interpretation of healthcare personnel, using the OERS.
  - Start a project to investigate the best alternative for the HRV chest strap and what the possibilities are, conducted by a research intern.

## Chapter 10. Discussion

This advisory report discusses how to enhance VRelax's market presence by improving the aspects of the CFL and the alignment within the elderly care sector. By applying the new form of the CFL, VRelax could work more specifically on the desires of the end user, which could significantly improve the product. This will contribute to the ultimate goal in which the end user will determine what VRelax will create. Improving communication between the various departments and the structure of the meetings results in improved problem-solving and collaboration and facilitates the implementation of innovations, such as the new form of CFL.

Moreover, VRelax could also contribute to the high workload in healthcare that currently exists, particularly in elderly care. By exchanging all the findings from this report on how VRelax could be integrated into elderly care as optimally as possible with current VRelax customers, they could use VRelax more appropriately and possibly achieve better effects for the elderly. In addition, it can help VRelax to better approach and connect potential new elderly care institutions as customers.

Additionally, it is recommended to switch from the chest strap to a wrist strap with possible integration of the HUME applications. However, the recommendation is based on previous research and own insights following interviews. Therefore, the effectiveness of this new method will still have to be evaluated. Furthermore, the data from the interviews used for advice were from only a few elderly care institutions located in the same region, and no analysis was applied to them. To obtain more significant and reliable data, VRelax should gather field data from multiple customers in different regions. In addition, there was limited literature available on the effect of VR on care-dependent elderly, which weakens the scientific robustness of the report's conclusions. Finally, a bias may have arisen in the internal analysis due to the assumptions made.

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## Appendix A. (Self-)reporting questionnaires

### I. Perceived Stress Scale (PSS-10)

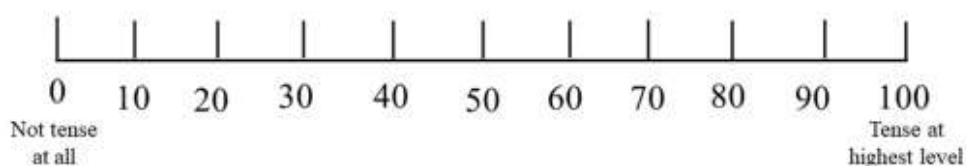
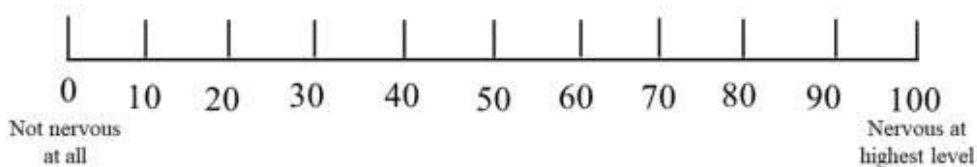
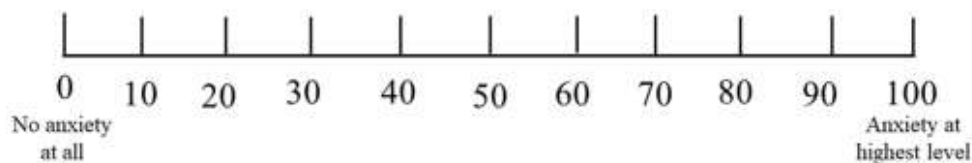
**For each question choose from the following alternatives:**

**0 - never 1 - almost never 2 - sometimes 3 - fairly often 4 - very often**

- \_\_\_\_\_ 1. In the last month, how often have you been upset because of something that happened unexpectedly?
- \_\_\_\_\_ 2. In the last month, how often have you felt that you were unable to control the important things in your life?
- \_\_\_\_\_ 3. In the last month, how often have you felt nervous and stressed?
- \_\_\_\_\_ 4. In the last month, how often have you felt confident about your ability to handle your personal problems?
- \_\_\_\_\_ 5. In the last month, how often have you felt that things were going your way?
- \_\_\_\_\_ 6. In the last month, how often have you found that you could not cope with all the things that you had to do?
- \_\_\_\_\_ 7. In the last month, how often have you been able to control irritations in your life?
- \_\_\_\_\_ 8. In the last month, how often have you felt that you were on top of things?
- \_\_\_\_\_ 9. In the last month, how often have you been angered because of things that happened that were outside of your control?
- \_\_\_\_\_ 10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

### II. Visual Analogue Scale (VAS)

#### *Visual Analogue Scale*



III. Observed Emotion Rating Scale (OERS)

Resident's Name: \_\_\_\_\_ Unit: \_\_\_\_\_ Observer's Name: \_\_\_\_\_  
 Date: \_\_\_\_\_ Time: \_\_\_\_\_

		9	1	2	3	4	5
		Can't tell	Never	less than 16 secs	16-59 secs	1-2 mins	more than 2 mins
<p><b>Pleasure</b>                      Signs: Laughing; singing; smiling; kissing; stroking or gently touching other; reaching out warmly to other; responding to music (only counts as pleasure if in combination with another sign). Statements of pleasure.</p>							
<p><b>Anger</b>                      Signs: Physical aggression; yelling; cursing, berating; shaking fist; drawing eyebrows together; clenching teeth; pursing lips; narrowing eyes; making distancing gesture. Statements of anger.</p>							
<p><b>Anxiety/Fear</b>                      Signs: Shrieking; repetitive calling out; restlessness; wincing/grimacing; repeated or agitated movement; line between eyebrows; lines across forehead; hand wringing; tremor; leg jiggling; rapid breathing; eyes wide; tight facial muscles. Statements of anxiety/fear.</p>							
<p><b>Depression/Sadness</b>                      Signs: Cry, frowning; eyes drooping; moaning; sighing; head in hand; eyes/head turned down and face expressionless (only counts as sadness if paired with another sign). Statements of sadness.</p>							
<p><b>Interest</b>                      Signs: Participating in a task; maintaining eye contact; eyes following object or person; looking around room; responding by moving or saying something; turning body or moving toward person or object.</p>							

## Appendix B. Feedback questionnaire Beta-testers

*“This evaluation form is intended to collect valuable feedback about VRelax's new menu. It takes approximately 10 to 20 minutes to complete the questionnaire. This is not a knowledge test and there are no wrong answers. All information provided will be treated confidentially.*

*To access the new menu, log into the VRelax app as usual. In the old menu go to 'Options' and there you will find the new menu under 'Menu V2'. In some places you will encounter a yellow bar, this means that the part is still under development. You can judge it based on what is available now. The sounds used are not yet the final sounds. No feedback is required on this.*

*If you have any questions or comments about this questionnaire, please contact us via {telephone number} or {email address}.*

*Thank you for your cooperation on behalf of VRelax!*

1. What do you think of the menu?
2. What do you think of the menu compared to the previous menu?
3. How would you rate the overall layout and design of the menu?
4. How easy did you find it to navigate the menu?
5. How do you experience the breadth of the menu? Wat is jouw mening over de nieuwe functionaliteiten?
  - a) Filters
  - b) Volume system
  - c) Preferences
  - d) Downloading images
6. How do you rate the speed of the cursor while navigating the menu?
7. How do you rate the responsiveness of the menu when selecting options?
8. Can you easily find the settings screen?
9. Are the icons in the settings screen clear?
10. Is it clear how to leave the app and switch users?
11. Are there any specific elements of the menu that you found confusing or difficult to understand?
12. Have you encountered any problems while using the menu? If so, can you specify these?
13. Did you find what you were looking for easily?
14. Are there any features you missed in the menu or would like to see added?
15. How would you rate the user-friendliness of the menu on a scale of 1 to 10?

## Appendix C. Internal interviews customer feedback loop

To gain a better understanding of how the customer feedback loop is currently organized within VRelax, I conducted interviews with the relevant departments within VRelax. Firstly, the Chief Operational Officer (COO), as she is involved in operational matters within VRelax, including the proper coordination of the feedback process. In addition, the CS department, because they have a lot of contact with customers and usually have the most to do with the input, registering and processing of feedback and any follow-up steps. Finally, also with development, as they are mainly responsible for prioritizing the received feedback and processing a significant portion of the feedback, such as feedback about the experience and the dashboard.

### I. Chief Operational Officer (COO)

#### **Marieke**

The COO indicated that Confluence contains guidelines for the feedback loop, but that these do not fully correspond to current practice. It is essential to identify and address these irregularities to resolve the shortcomings and improve the feedback process. Although registration usually runs smoothly, filtering important information proves to be a challenge. The translation and distribution of feedback within the team also appear to be stumbling blocks. To ensure that the feedback loop runs efficiently, attention to team dynamics is also required. Although all departments communicate with each other, it is unclear whether all relevant topics are discussed during these meetings and whether notes are taken. It is recommended to establish a connection between Confluence and Jira. In this way, feedback received from CS, for example, can be channeled directly to development, which benefits the prioritization of tasks. It is also emphasized that more feedback needs to be collected on users' preferences regarding content. This would give users more influence over the images VRelax offers.

### II. Customer Success (CS)

#### **Jarib**

One of the important aspects is increasing the accessibility for customers to provide feedback, possibly by implementing a specific feedback register. This allows customers to share their input in a structured way. Another point concerns the labeling of specialists within the client base, which allows VRelax to test ongoing changes and receive feedback from selected users identified as specialists. To enable more direct interaction with users, a user day is being considered. During these days, users can be guided and informed about the entire VRelax process. In addition, regular update meetings with customers are sometimes perceived as too short to discuss all feedback received. To address this, consideration is being given to processing feedback directly through the dashboard, so that all input is collected in one central location and linked to the relevant customer. Another option for collecting feedback is through an online form, which allows for the collection and analysis of qualitative data. It is further emphasized that communication between Salesforce and Jira is not yet optimal, which can slow down the process. It would be more efficient if these systems communicated better with each other. Finally, there is a difference in perspective between development and customer service when reviewing feedback. While the development team looks at the importance to the business and the time investment required, the customer service team focuses mainly on the aspects of safety and severity.

#### **Gerben**

An essential aspect is the accessibility of the feedback mechanism. It is crucial that customers can provide feedback in different ways, and that all these forms of input are captured and labeled



with the correct customer data and channel used. This makes it possible to directly assign feedback to the right person within the team, who can then work specifically on the insights received. An efficient way to collect feedback is via the dashboard. This eliminates the need to contact VRelax directly and provides an organized place to collect all feedback. Adding a status feature to the dashboard would also be helpful so that team members can see if feedback has already been processed and if further action is required. Currently, feedback is often documented in Salesforce, but retrieving this information can be difficult because it is sometimes lost in the text. To ensure feedback is continuously discussed and addressed, it is suggested to share key insights during monthly team meetings. In this way, the entire organization is involved in the improvement process and everyone can contribute to the pursuit of optimal customer satisfaction.

### III. Development

#### **Sido**

At this time, notifications of new feedback from Salesforce are not sent to us unless there is a very critical situation. This is an area that deserves attention as it would help us respond more proactively to customer feedback. Although Salesforce is linked to our development email, a link to Jira is missing. It is essential that these systems are integrated with each other to ensure seamless communication and the most efficient handling possible. Another challenge is that we often do not know from which organization specific feedback comes, nor how often this feedback has been given. Gaining these insights would help us better understand which issues are common and which organizations are most involved in providing feedback. Furthermore, the current prioritization of feedback is not always strictly followed based on customer, number of licenses, urgency and frequency. Understanding this data is crucial so we can align our priorities with our customers' needs and respond more effectively to their feedback.

## Appendix D. Interviews with elderly care institutions

- I. Organization: **NNCZ**  
Profession: Nurse

*Which target group did you test? Or was it general?*

No, we tested it in the PG department, so people with dementia.

*Would you also recommend using it for dementia, for example?*

Yes, and also on sleep problems. I also had someone who, for example, was in a lot of pain, chronic pain. That lady had a hard time falling asleep. Or she woke up very early with the pain. And then I used those VR glasses. And then I came back, and the glasses were on the table, and the lady was asleep. So she could do that herself. So that was, yes, it did work. But not everyone is open to it. I notice that too.

*Can VRelax be used independently by the elderly?*

Well, we basically set everything. And then I put it on when the video is ready.

*In conversation with the client, did you mainly look at what kind of world the client prefers?*

Not really talking to the client. You are really dependent on information you have. But you know that someone with a trauma for almost drowning, you're not going to swim with dolphins. And I sometimes ask a family member. And sometimes it's just a matter of trial and error. Only now I don't have a viewing function anymore, because I think it's gone. And I do notice that when someone is startled, but then I don't know why exactly.

*Did you have a content map?*

No, I didn't.

*Do some people find the static content boring?*

Some, for example, really want to join the huskies. But that is dependent on what form of dementia, and what stage of dementia it is. One requires just that movement, and the other a more static content.

*In people with dementia, it sometimes seems quite difficult to use it?*

Yes, that is difficult sometimes. For example, they are in another world, plus there are the big glasses themselves. So I often try to put the glasses in front of their eyes and let the client come to the glasses themselves. So first without straps, let's see how someone experiences it. We do notice that some find it scary. And it's too heavy for some clients. In addition, the star at the bottom is very distracting.

*Did you use the VRelax with or without headphones?*

Without. You have less contact with the person, of course. Then you're even more frightened. And you also have a bit of hearing problems with the elderly.

*Do you support a VRelax session?*

Yes, because it is still difficult to use independently in terms of navigating to the menu, with people with dementia. For somatical patients, perhaps without support. Maybe there are also older people who could do it.

*You had used different measurements. Observing emotions and also on a scale of 0 to 10?*

Yes, or observe if the stress was reduced. On certain items we have restlessness or emotional.

*Did that go well? Or was it difficult sometimes?*

Yes, sometimes difficult to estimate. In addition to implementation back then, I didn't use that list anymore. But you do have to report properly, for example how someone experienced during the session with VR glasses and later as well. And you can also see it in the posture. And sometimes you have people who are very apathetic, so you can't see on their faces, so that's difficult.

*Do you think there are any long-term effects that are possible with VRelax as well?*

That's also a bit dependent. In people with dementia, the short term is affected. For example, yesterday I had someone who got very emotional. He has always swum with his wife among dolphins. But the first time, he was crying. Last time he really liked it and then he tells all kinds of stories about what they have done. And yesterday he got very emotional and then he can get stuck in something for a while. So in the long run, I'm curious about that too. But not everyone is open to it.

*Are there specific moments when you can use it optimally?*

I really try to look when someone needs it. Preferably preventively, before I see something or think that someone is getting restless.

*Do you work with a traffic light system?*

Yes, sometimes. That's different per client.

*Were there any content missing from VRelax?*

There was always a world that did catch on, but it doesn't work for two people. They often turn it off immediately after a minute, but can't figure out why. They are in the advanced stages of dementia. And some have a lot of walking behavior, which makes it difficult to get the glasses on.

*Would content from the past be valuable?*

Yes, that would be really nice. For example, using old images, or content of a bike ride through a village.

*Are there any problems that you have run into?*

That the glasses are too heavy. Their heads often hang down a bit, and as a result, the star is always in popping up. This is very distracting for the elderly. And I had some problems with the viewing function.

*What do you think of the HUME applications?*

I would like that too. That would be more pleasant to use than, for example, the HRV band.

*Do you have any recommendations for improvement?*

Those straps of the glasses can be frightening, and that you have something on your head. This can be tight. Maybe an adapted model for the elderly would be a solution.

*With your own implementation plan, what are you looking at?*

My goal is actually that my colleagues know how to use the glasses. When do you identify the problem, behavior, etc. Identifying stress behavior is still a bit difficult. Furthermore I want to include everyone in this, including people without a healthcare background. And when is something objective? I also got this back from my supervisor. Well, no. That's very difficult.

*Would it be nice to get an extra explanation presentation from VRelax?*

I think so. At the moment it was only implementation on one or two groups here and in De Vecht. I really enjoy working with it and explaining every time, but if no one does the same, I think it's a shame.

- II. Organization: **Zorggroep Groningen**  
Profession: Activity coordinator

*Do you use it only for somatic patients or also for people with dementia?*

Only for somatic patients, because I work in a department where only somatic elderly live. There are also people who also have dementia, but they basically come in with somatic complaints, so that is the basis. We are also in the process of rolling it out in the PG department, where the people with dementia live. But that still has to happen, because that's where we want to use it. Colleagues tried it in rehabilitation, in wound care is it used a lot. There they put on the glasses and they could see from the way the client moved and his reflexes that his body language was calmer. He was less likely to pull his leg away or he was less cramped during the time he was wearing the glasses. He said it doesn't work, but they could see that it was having an effect. It was nice to be able to use it in such a way.

*Do you use it together with other colleagues?*

Actually, it's just me. But I think that many more people will benefit from it, and that is why we have also started a working group to make it more widely known, to implement it even more tightly. This includes the behavioural sciences. And there is someone from the scientific research committee involved, as well as the psychologists and a doctor. I use it as an activity and as a distraction, but it would also be nice if you could see a change in behavior and mood. I can see that, but the psychologist can judge even better. So that we can work together nicely between the psychology and the distraction.

*Is it used at fixed moments or moments when clients show restless behavior?*

Yes, I can do the 1 on 1 guidance of the clients here. Every morning I just read how the residents have been doing in the past 24 hours. Well, that's partly where I get new information and get to know where I have to go. As an example, there was a lady who never dared to look outside again. Just looking outside was too much because she thought of her house where she once lived. With the knowledge that she would never live there again. Well, that's pretty intense. We do had a consultation with the psychologist to try it. "Oh, this is beautiful. There are doggies. I also had a dog at home." She started talking about home. And gradually, she gets into those stories and a bit into processing mode. And nowadays she likes to go for walks outside and she gets excited just when I show her the glasses. "Oh that's very nice." Then you turn off the television and then she starts laughing and says: "Well, bring on those dogs." Then you turn someone on completely, and that is an activity with a mental result. And also someone who had a lot of pain, he rang his alarm six times an hour. And if you did a VRelax session, just once an hour or once every hour. Well, that gives such a reduction in the burden for the care staff and they can spend more time with other clients. I think that's a real result. I've also tried it for dementia. Then I am the familiar one with the safe environment, which is very important. They can be a bit confused and then it works better if I'm already known.

*How often do you use it, on average per client?*

That varies. I also offer other activities and I vary it a bit so it is not only VRelax, but that it is also a game, a walk, or a conversation. It is also very often that people see the glasses and ask if they can use it. When the conversation turns to it again, the atmosphere in the group also goes up again, so I use it for that reason too.

*Do you also measure stress with HRV?*

No, I mainly look at body language. Do the shoulders go down? Will there be a smile? Is there also a story verbally? I see that the breathing goes to the abdomen and that people talk more calmly. They breathe more calmly. I pay attention to things like that. And that must remain as accessible as possible.

*Do you think that it can be used independently or are you actually always needed in setting up?*

The latter. Of course, it's a new technology for them.

*Do you use the GRIP app?*

Not yet. But we've found an iPad that we can use. Then, you can better assess how someone reacts to a certain world. I really want that.

*Do you use headphones?*

No, I use the sound on the glasses a lot. I also have a jar with lavender scent. If you want to mimic nature or use a fan to mimic the wind. And if they stroke the cat, I keep a blanket underneath. Many elderly find the glasses a bit oppressive on their head.

*Do the elderly like the static content or the interactive content?*

The interactive ones. The elephants and the horses. Animals, in particular, work well. The husky movies work well. Releasing seals is another dynamic one. They want to have something to see. Otherwise, they'll quickly turn it off, because they get a little bored.

*Are there any problems you run into when using VRelax?*

Updating with the network here. But other than that, hardly anything.

*What is the easiest way for you to give feedback to VRelax?*

By e-mail. I now have regular contact with Jarib, which is a good communication.

*Do you have anything else to say about the product or about VR and healthcare?*

Well, what I might like for the people is a tour through the city of Groningen. I think a lot of people would love that too. And then one from 30 years ago. Or images of the departure of the boat to Ameland. That bring back real memories. The best thing would be to integrate Google Maps into VRelax. And that you then use the viewing function, with the GRIP app, to go back to the street where the resident was born. That you walk through the city and recognize things from the past, such as a shop.

### III. Organization: **Zonnehuisgroep Noord**

Profession: Nurse

*In which elderly people have you used VRelax?*

In several elderly with dementia.

*At what time did you use it?*

When they were restless and when I knew that they could still sit quietly. And I also tried it with a gentleman, and I knew that there was also a video with cows in the Alps. And I once wondered if he can still remember his profession as a farmer, which he can no longer do. And that was the case.

*Did a lot of memories come up and did you also see that he became much calmer?*

He got excited about it. For the other lady, who was also restless, for whom I had used him, I chose another video with autumn leaves falling. It actually calmed her down.

*Have you been using this for a long time?*

Yes, we've been using it for about three years. But in my opinion, it is not used enough and our manager has become critical. The staff is busy with worries, which is a hindering factor. You really have to invest time in it. The psychologist knows about its existence and really uses it as an intervention to try it out on someone. And we recently loaned it to home care.

*Are you the only one who really uses it?*

Together with the psychologist, I am the most informed. And we are looking how are we going to ensure that it is used more often. So, for example, we would like to show it in a training carousel to all employees.

*Do you also notice that you need to support a VRelax session?*

Usually, I have an idea in advance. I know my resident so well that I know which video to turn on.

*Does it make the elderly nauseous or dizzy?*

No, it doesn't.

*To see if it actually works, do you look at body language or mood? Or other things you measure?*

Especially body language. Observing body language, verbal and non-verbal.

*Do the elderly prefer the quiet images or the interactive images?*

It is very personal. Most of the people I've spoken to thought it was pretty boring when it was static content. They would quickly turn it off again and they would prefer a little more interaction.

*Do you use the headphones?*

No.

*Would you recommend it with headphones?*

I think that the sound of the glasses themselves is sufficient. And I do think it's important to be able to keep in touch. Especially if you're just starting.

*Have you run into any problems? Or do you have recommendations?*

That they can't start it themselves. Even employees sometimes don't know exactly. In addition, many employees are afraid of the risk of falling from the clients.

*In what way do you prefer to give feedback?*

I think it works best via email. And if I really run into a problem, I'll pick up the phone.

IV. Organization: **GGZ Drenthe**  
Profession: Nurse

*So you have been researching long-term geriatric psychiatry. Those were people with schizophrenia, mood disorder, anxiety disorder, etc. Why exactly was it tested on these specific elderly people?*

These elderly people have been chosen because they stay within the setting for this. We are a long-term care clinic for patients with psychiatric diagnoses. Psychiatry really needs to be at the forefront here. Based on the literature review that the geriatric psychiatrist did, and based on results from VRelax, we also wanted to see what the effect is within this patient category.

*Was everyone included who wanted to participate?*

Yes, basically everyone who wanted to participate in the study. An informed consent had to be signed. There are also a number of patients who have used the glasses, but have not participated in the study.

*Did you see much difference between the different diagnoses?*

No, we have a target group of patients who are almost all in the third phase of life. So that means they don't have a working life anymore. Their social network is already disappearing. And in terms of diagnoses, it was very difficult. Patients who stay here are generally quite stable from a psychiatric point of view. I can't distinguish whether one diagnosis was easier than the other.

*At what point did you use it?*

That was a bit tricky. We work here with quite a large nursing team. This means that there was also self-interest in using the glasses. And some of my colleagues also forgot about it. It just wasn't in your system to provide those glasses. There were several moments when the glasses were handed to me. There didn't have to be any unrest at the root of it. And we monitor this in a form. It was at all kinds of different times at which we used those glasses, not just in times of restless behavior.

*In what kind of setting was it used?*

In a room with a low-stimulus environment.

*Did you feel that some people found it difficult to deploy? Or that it caused problems?*

Yes, it's much easier in the younger nurses. You have to control the system with your eyes. So you have to know how it works, which sometimes caused frustration. This means that the glasses were not so easy to use.

*Do you agree that you will have to invest time at first, but that it could save time in the end?*

Yes, I absolutely agree. And also for the patient. In our case, they investigated whether glasses are more effective than a pill. And by a pill we mainly mean benzodiazepine. So that's a calming drug. And sometimes it was just more effective to give a pill, because that operation is simply much easier than installing such glasses. Even though the exposure time of a pill is of course much longer than the effect that glasses can produce.

*Was it possible to use it independently by the elderly?*

No, I always get the glasses ready first. There was only one person who could control the glasses independently.

*You measured stress with a stress scale. Did you experiment with other measurements?*

Yes, also a questionnaire. The question of how relaxed or how calm do you feel before using VRelax on the scale of 0 to 10. And how relaxed or calm do you feel after using VRelax on the scale of 0 to 10. And for that, we indicated the reason for the use. That was the list we had to fill out every time we used it. And then we also filled in a list that was filled in periodically. And it described, among other things, how many times during the past month you have been upset by something unexpected that happened. How many times during the past month have you felt unable to control the important things in your life. How many times have you felt nervous and tense during the past month? How many times during the past month have you felt confident about your ability to address your personal problems. How many times during the past month have you had the feeling that things were going well? How many times during the past month have you felt like you weren't up to all the things you had to do. How many times in the past month have you been able to control irritations in your life. How many times during the past month have you felt like you were in control of things. How many times during the past month have you been angry about things that happened out of your control? And how many times during the past month have you had the effect

of causing the difficulties to pile up so high that they could not overcome? This questionnaire has been completed monthly by the psychologist who wants to monitor the effect of the VRelax on patients.

*Was this questionnaire drawn up by yourself?*

Yes, it was prepared by the geriatric psychiatrist herself.

*Was there a difference in what kind of content the older people liked?*

Mainly the images which were less dynamic, so the soothing images such as the beach, the cows and the horses. And we had a lady that we guided in a euthanasia process, who has benefited a lot from the husky sleigh ride. She thought that was a nice distraction.

*Did you use the headphones when using it?*

No, because with those headphones it is difficult to get in touch with them and communicate with them.

*Are there any general problems that you have run into?*

Yes, the battery life is quite short. In addition, we have about 80 patients in care within this building, of which we only had three pairs of glasses. So the glasses were centered in a room, which meant that the nurse first had to walk to a separate room to pick up those glasses and then give them to the patient. And that has really been experienced as an obstacle. Actually, it will just be nice that the glasses are available in every department. What I liked about the glasses was that you immediately entered the VRelax app when starting up.

*Does everyone understand how to work with the glasses?*

Everyone knows the idea, but about controlling, it's quite tricky.

*Do you actually use other relaxation methods?*

Yes, benzodiazepine mainly. And also walks outside.

*Was the use of medication decreased?*

That is hard to state. We had expected that VRelax would be easier to integrate. I think when the glasses are used effectively, that certainly the use of the benzodiazepine can be reduced. Especially if we work within the signaling plans, which indicate in what phase they are. When someone goes in the transition from the green to the yellow phase, that you can really prevent escalation. And as a result, you also have to dispense fewer medications. Those drugs really do have a lot of adverse effects.

*What is the easiest way for you to give feedback to VRelax?*

I had a contact person that was immediately approachable. So I didn't have any problems with that. I have been in contact by e-mail or by phone.

- V. Organization: **Zorggroep Meander**  
Professions: Nurse and psychologist

*Are you the only one using VRelax?*

Me and my colleague here. I know exactly how to approach it, and this is with both demented and somatic elderly.

*Do you use it with many elderly?*

It's about three or four.



*What kind of positive effects do you get? Was it directly after the first session?*

I had a lady who absolutely didn't want to wear it, she was terribly looking at it. And I tried to stimulate that lady anyway. I first asked what this woman likes to look at. Then she said, "I love the beach". She thought it was scary, but I said, we're just going to try. And she was completely happy after the first time. She was so relaxed. This lady is very nervous and panicky and it would be very nice if she could get rid of her medication by putting on those glasses.

*Is this about a woman on the somatics or the PG?*

On somatics. And then I have a gentleman on the PG. He lies in bed all day. And then I put the glasses on him and I put the images of horses on him. Well, you got tears in your eyes. It was amazing to see. He kept pretending to be petting the horse with his hand.

*Do you see a difference in the effect of VRelax between somatics and PG?*

No, I don't see any difference.

*Do you need a difference in approach?*

Yes, you need a different approach. In somatics, they are aware that something is going to happen. On PG, that is not the case, and more attention is needed.

*Are you working with a traffic light system?*

Yes, we would like to do something with that too. So does the psychologist.

*Do you mainly use it when people have agitated or restless behavior?*

Yes, we do want to respond to people who are agitated or nervous, for example.

*Do you also notice that it might save time in the long run?*

I think so. It will take a while in the beginning to really calm someone down. I think it also works well if several people know about it, so that it can be used more widely and effectively.

*How are you going to measure whether it has an effect?*

We have evaluation forms. It has to be short and be easy to do for healthcare workers. And what we really want is to fill it in before and after the VRelax session. Then we can see that the mood is improving. And in addition to the form, perhaps also pay a little attention to body language and include observations of the employees.

*And in terms of content, is there a particular preference for still, moving, or images with animals?*

Yes, there is a difference. Sometimes people were sickened by certain images. For example, I want a farm and Mozart on it. We always have a life story, a client story. And then I always take a look at this to know what the person like.

*Do you use the GRIP app?*

No.

*Do you think it works for both the somatics and PG departments?*

It fits very well with both. In terms of moments, we also want to use the traffic light system. Here, the use of smileys makes the traffic light easier.

*Would you use it if someone is at orange or if someone is just in front of it?*

No, preferably a little sooner, because that's where things go wrong. You should definitely use it before or with orange. When it is red, it is already too late. Then, you can no longer put the glasses on.