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Using virtual reality to support substance use disorder treatment in people with an intellectual disability

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Abstract

Virtual reality offers exciting opportunities to an increasing number of industries as the possibilities of the technology are growing. One of the industries exploring these opportunities is mental healthcare. Virtual reality is currently successfully used as an additional tool in the treatment of certain phobias and disorders. Treatment providers for substance use disorders expect that virtual reality can contribute to their field as well. A subset of the substance use disorder clients are diagnosed with an intellectual disability. This entails that these clients experience difficulty with verbal communication and the concept of abstraction as they have limited cognitive capacities. Virtual reality can therefore prove to become an extension to the treatment of these clients as it provides practical learning opportunities that do not rely on verbal communication. It also can enable these clients to repeat exercises with the push of a button, potentially even without needing treatment providers. This could save organizational resources.

This research explores how virtual reality can support the current treatment of substance use disorder for clients with an intellectual disability. This thesis first reports on the theory behind substance use disorders and various methods of treatment. The specific treatment protocols for the target group are subsequently analyzed to form the theoretical background knowledge for this project. This knowledge is used in the process of formulating requirements for the virtual reality product as stakeholders are identified and involved in the project. The result of this process is the determination of the main goal of the virtual reality product: for the clients to practice in virtual risk situations by applying learned self-control techniques. After the requirements are formulated, two prototypes are designed and developed in an iterative process. The results of the evaluation of the first prototype regarding user experience and usability forms the foundation for the second prototype. After the design and development of the second prototype, this prototype is again evaluated by end-users.

It is found that this target group can be easily overwhelmed and distracted and therefore requires a virtual reality product that can gradually increase in complexity. This increase in complexity is implemented in both the realism of the virtual environments as well as the interaction with this environment in the second prototype. As this research is the first explorative step in a larger project to develop a complete virtual reality product, the findings and suggestions that relate to next phases of this project are discussed. It is found that the experienced realism of virtual substances and environments is dependent on a personal factor and this sprouts the idea for developing a content management system. Another suggestion is to use speech system for virtual characters and have the content be determined by actions of the user. Other suggestions include extending the virtual environments to emotional triggers of substance use such as an argument with a partner and to investigate the real world effects of successfully using a virtual talisman in a virtual risk situation.

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Contents

Introduction

Virtual reality is a computer technology that simulates the user's presence in another environment than where the user physically is. This is achieved by simulating the user's sensations, primarily by displaying images but can also include sounds or haptic feedback. Virtual reality (often abbreviated to VR) is a technology on the rise. As of 2015 it is a billion dollar industry and is predicted to reach a value of $33.9 billion by 2022 [1]. The rapid growth of VR hardware and software vendors can be explained by the fact that various industries have started to explore and invest in the opportunities that VR has in store for them. One of these industries is mental healthcare.

Tactus is a Dutch mental healthcare organization, specialized in treating various forms of addiction. A large proportion of their clients come in to seek help for their addiction to substances such as alcohol, cannabis or cocaine. This form of addiction is therefore also called a 'substance use disorder' (often abbreviated to SUD). Treatment protocols are used by Tactus to help these clients in overcoming their SUD. However, a portion of these clients also have a mild intellectual disability. This is defined by the *American Association on Intellectual and Developmental Disorders* (AAIDD) as "a disability characterized by significant limitations in both intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills. This disability originates before the age of 18" [2]. In addition to this, the disability is characterized by an IQ score between 50/55 and 70/75 [3]. Treatment providers in the Netherlands such as Tactus also recognize clients with borderline intellectual functioning (IQ score between 70 and 85) and include both clients with a mild as well as a borderline intellectual disability in a separate group. This is done as Tactus realized that these clients need adapted treatment protocols to better match their characteristics. These treatment protocols have been developed and are currently used by Tactus. In Dutch this group is referred to as *licht verstandelijke beperkten* (often abbreviated to LVB) and will therefore be referred to as people with an intellectual disability (consequently abbreviated to ID).

1.1 Motivation

Tactus is interested in exploring the opportunities that virtual reality can offer to support the adapted treatment protocols of clients that both have a substance use disorder as well as an intellectual disability. Virtual reality is regarded by Tactus as a tool that has a potential to be effective in supporting the treatment of the target group. This is because the target group displays certain characteristics that fit the properties of virtual reality. People with an intellectual disability can find it hard to express themselves verbally and to conceptualize but would rather learn by doing. Virtual reality would therefore be beneficial as clients could practice certain skills in realistic scenarios they can relate to, instead of having to do this in "thought exercises" or roleplaying. In addition to this, VR provides the opportunity to repeat training exercises in a safe environment, without increased therapist involvement, saving both time and resources.

Tactus has therefore approached the Human Media Interaction department of the University of Twente to cooperate in developing a virtual reality product for this target group. This is a large project and this master thesis serves as the first steps in this innovating project. The goal of this thesis is to explore the opportunities by analyzing the current situation, specifying the requirements and designing and developing prototypes. These prototypes are afterwards evaluated by end-users regarding usability and user experience.

1.2 Preliminary research

Prior to this research, another research has been conducted to explore the technological context of the study [4]. It describes the developments of the VR technology in recent years, as well as the results of applying VR in various forms of therapy by reviewing literature. This section shortly describes the findings of this preliminary research.

Firstly, there are various output devices that can be used to display virtual reality. A distinction can be made between devices based on the additional device they need to function. While some only need a smartphone to provide the visual images, others need to be attached to a computer or laptop. The preliminary research investigated the purchasing costs of several of these devices and their additional devices so this can be used later when discussing what device to use at Tactus. There are also multiple types of environments that can be displayed on these devices. An environment can be completely virtual where all objects and the entire scene that the user can experience are digital representations of how the user knows the real physical world, designed in a computer program. Another option is filming the real physical world with a 360° camera and showing this on an immersive device, and thus all objects and the entire scene are images as the user knows them from the physical world. A mix between these two is also possible as both virtual and real world images are displayed in one screen; this is known as mixed reality. This includes augmented reality and augmented virtuality. The first being an otherwise real world environment that is supported by virtual world objects and the second being an otherwise virtual world environment that is supported by real world objects. One goal of this study is to find out what environment is best suited to use at Tactus for this project.

In the preliminary research articles are reviewed that study the effectiveness of applying VR in various therapies. Four types of articles have been analyzed:

1. VR therapy in general.
2. VR therapy to treat substance use disorders.
3. VR learning for people with an intellectual disability.
4. VR therapy to treat substance use disorder for people with an intellectual disability.

The results show that VR can be used in supporting the treatment of various disorders, mainly by exposing subjects to triggers. These virtual reality exposure therapies (VRETs) have proven to be effective in treating phobias, post-traumatic stress disorder (PTSD) and other disorders. The degree of graphic realism is (somewhat) irrelevant in these VRETs; the most important part is that it should evoke the same initial reaction as it would in the real world. Another important

aspect is that it is highly preferable if therapists can set variables in the VRET. Using this, the therapist can adjust the level of exposure to his professional judgment of the patient's readiness and gradually increase exposure levels.

Studies where VR is used in the domain of substance use disorder show that the technology is able to elicit reactions to substance cues as it showed higher craving results for smoking, alcohol and crack cocaine cues when compared to various types of control groups. These researches were also conducted with different types of assessments, both subjective and objective, ensuring the validity and reliability of the results. However, cue exposure is only one component of addiction treatment. Many others, such as social skills training and coping strategies have not been tested with VR. Therefore, it is wise to look into the theoretical knowledge available about how substance addictions work and how these addictions are treated in general as this can benefit this particular research. Also, the current treatment protocols from Tactus are to be analyzed in detail to see what theoretical treatment knowledge is present in their protocols.

Various articles can be found regarding VR products to improve learning, physical fitness and leisure activities for people with ID. The articles mainly discuss results and not the design process. Some lessons learned are covered by one article, which include that three design dimensions create the feeling of immersion: personal, social and environmental presence. Also, the facilitator should not intervene too fast or too much as the participant might lose interest in operating the VR product. Articles discussing the design requirements of human media interaction of general technology for people with ID are found. The most important takeaways for this study are that these articles highlight the importance of consistent and simple design, as well as small steps and repetition.

Articles of the fourth type, which is the appliance of VR for this specific combination of SUD and ID, cannot be found.

The study to be conducted therefore differs from the articles found in three ways. First off, this study is the first to design and develop a VR product for people with both ID and SUD. Studies regarding the results of applying VR for either; SUD or ID, have been found, but the combination appears to be non-existent as of now. Secondly, current VR addiction treatment is mainly focused on cue exposure therapy. There are however other aspects to addiction treatment, that are not covered by VR research as of yet. This research therefore also looks into the theoretical knowledge regarding substance use disorders and how it is treated by Tactus, to see if other aspects can be supported or improved by VR. Lastly, not many articles discuss the design process and specific requirements for VR products developed for people with an intellectual disability. However, general technology design requirements have been found. This study describes the process of gathering requirements for the product as well as the design and implementation process.

1.3   Research Questions

The main research question to be answered is:
How can virtual reality support the substance use disorder treatment of individuals with an intellectual disability?

To answer this research question, several sub questions have to be answered. In these questions, "this group" refers to individuals with both an intellectual disability and a substance use disorder.

1. What is a substance use disorder and how is this normally treated?
2. What are the current treatment protocols for this group at Tactus?
3. What are the requirements for a virtual reality product for this group?
4. Which virtual reality environment and device are to be used for the prototype?
5. How to design a prototype that satisfies both the functional and technical requirements?
6. How to develop a prototype that satisfies both the functional and technical requirements?
7. How is the prototype evaluated by Tactus' treatment providers and patients?

1.4   Methodology

As the nature of this study is explorative, various methods are combined to answer the research sub questions. The first research sub question aims to gain insight in the characteristics of substance use disorders and this is done by reviewing literature. For the second sub question, internal documents that describe the protocols from Tactus are analyzed in preparation of gathering requirements. To gather these requirements, stakeholders have to be identified that can be interviewed to investigate what they expect from a virtual reality product. In these interviews it also becomes clear how stakeholders feel about the various environments and devices that are available for the prototype. The design, development and evaluation of the prototype are iterative processes as two versions are created. The second prototype uses the results from the evaluation of the first prototype as input for adaptations. The evaluation is based on both individual interviews with participants as well as observing their behavior when using the prototype.

1.5   Thesis structure

This first chapter described the motivation and context of the research as well as its implications on the methodology. Chapter 2 gives an in-depth analysis of the theory behind substance use disorder in general and how this is applied in treatment protocols for people with an intellectual disability at Tactus. Chapter 3 describes the approach and results of gathering requirements for the VR product. In chapter 4 the process of designing, developing and evaluating the prototype is described. Chapter 5 reflects on the study by giving a discussion of the results, limitations and suggestions for future research. Lastly, chapter 6 concludes the research by answering the research questions.

Analysis

In this chapter the current situation is analyzed regarding substance use disorder theory, treatment approaches and the treatment protocols that Tactus applies for this specific target group.

2.1 Substance use disorder theory

2.1.1 Types of substances

Substances that change the functioning of the central nervous system and are used to achieve this goal are called drugs. Drugs can be classified into three categories according to the effect they have on the mind [5]:

Depressants   Substances of this category have a calming effect and reduce fear for the user. In smaller amounts the user can experience an energetic feeling; this is because feelings of tiredness are also repressed. Examples of depressants are alcohol, opium, morphine, heroin and benzodiazepines. Physical effects include lower heart rate, relaxation of muscles and worse functioning of the sensory organs.

Stimulants   Substances of this category have an energetic, alert and stimulating effect. The user feels more confident and feels more concentrated. Examples of stimulants are nicotine, caffeine, cocaine, amphetamines and MDMA. Physical effects include higher heart rate, rapid breathing and decrease in appetite.

Hallucinogens   Substances of this category change the perception of the user. The user experiences the world differently as colors are more intense and users can see or hear things that do not actually exist. Perception of time and space is also altered. Examples of hallucinogens are LSD, mushrooms containing psilocybin and certain species of cacti. Physical effects include a slightly increased heart rate and dilated pupils.

Some substances can be categorized as a combination of categories and for most drugs the (strength of) effects are dependent on the dosage and individual genetic factors.

2.1.2 Stages of use

While there are many types of substances and perhaps even more reasons why people use them, five types of users can be classified for every substance. For some people these are also the stages of use as the frequency and amount of substance use keep increasing [5].

Experimental use   a person is curious about a substance or perhaps pressured by peers to try it. The frequency is limited to a few times and there is no pattern in the use.

Recreational use   a person knows the effects and wants to experience this effect. There is no pattern in use, use is irregular and no negative consequences are experienced.

Occasional use   a person has a regular pattern in using. The user is still in control however, a desire for the drug can easily be overcome.

Excessive use   a person uses frequently and regularly and the use affects daily life. Despite negative consequences, the user continues using the substance. The desire for the drug keeps increasing.

Addicted use   a person is dependent on the substance. The desire is in full control and the substance has overtaken the life of the user. Sometimes the user tries to quit, but this fails in most cases.

Not everyone who uses a substance goes through all stages; most people, especially with legal substances such as alcohol or caffeine, keep their use in control. Another note should be made that the border between the stages can be vague, as stages flow into on another. It is intended as a model; the point is that when going through these stages, it gets gradually harder for the user to escape the substance use as the user is entangled into a downward spiral. Therefore, this model is often depicted as the addiction spiral as can be seen in Figure 2.1.
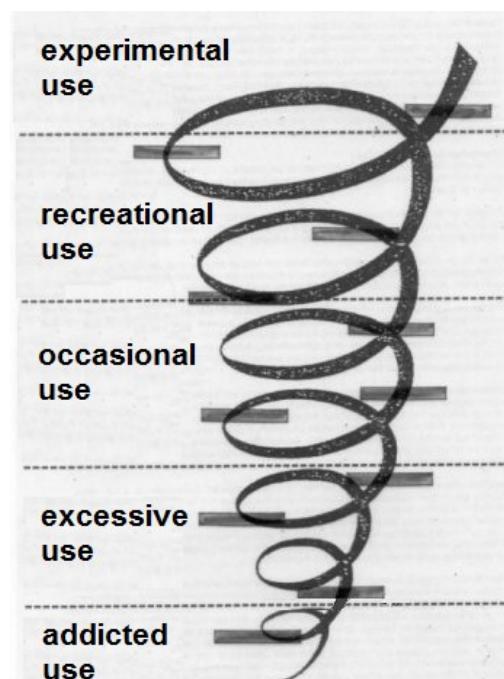

Figure 2.1: Addiction spiral [6]

2.1.3 Criteria for Substance Use Disorder

As it is sometimes hard to categorize substance use of a person into one of the stages or state in general when a person has a problem with a substance, the

American Psychiatry Association (APA) has defined criteria for substance use disorder in their most recent edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM), DSM-V. These criteria are grouped into four categories [7]:

Impaired control
1. The person uses for longer periods of time or in larger amounts than intended.
2. The person wants to stop or reduce substance use, but is unsuccessful.
3. The person spends considerable time obtaining, using and recovering from the substance.
4. The person experiences strong urges to use the substance (craving) that are difficult to ignore.

Social impairment
5. The person fails to fulfil obligations at work, school or home because of the substance use.
6. The person continues using the substance despite interpersonal problems caused by the substance.
7. The person stops or reduces important social, occupational and/or recreational activities because of the substance use.

Risky use
8. The person repeatedly uses the substance in physically dangerous situations (e.g. while driving).
9. The person continues using the substance despite being aware of the physical or psychological problem(s) the substance causes.

Tolerance and withdrawal
10. Tolerance occurs when the person needs to increase the amount of the substance to experience the same effect. This is due to bodily processes that get used to the substance.

11. Withdrawal occurs when the person suddenly quits using the substance altogether after a long period of (heavy) use. The body responds and the person experiences unpleasant symptoms, varying per substance. Upon experiencing these symptoms, the person often uses the substance to relieve them.

SUDs appear in different forms; DSM describes three types of severity depending on the number of criteria that are being met by the person.

- Mild   2-3 criteria present
- Moderate   4-5 criteria present
- Severe   6 or more criteria present

2.1.4 Vicious cycles

Perhaps the most notable phenomenon of a SUD is that a person cannot seem to stop using the substance, despite the negative consequences. This is caused by multiple factors and is represented in the vicious cycles of van Dijk, a famous diagram in the Dutch addiction treatment world [8]. The model illustrates that four vicious cycles maintain the use of the substance, which is a vicious cycle on its own, as illustrated in Figure 2.2.
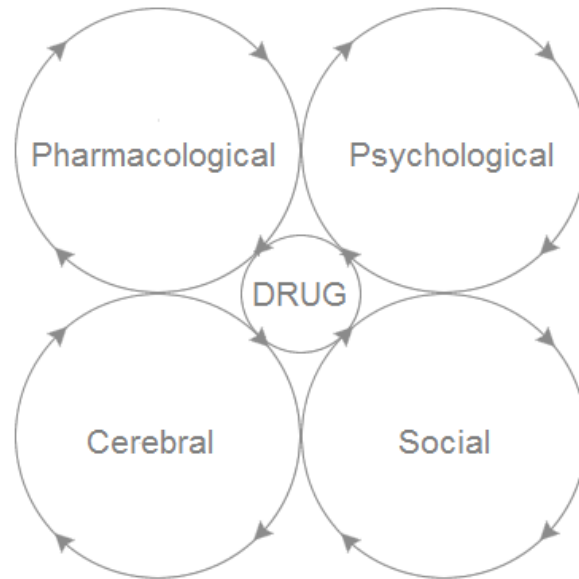
Figure 2.2: Vicious cycles that maintain the addiction [8]

Pharmacological cycle   This cycle refers to bodily processes that react to the substance and the relating symptoms such as tolerance and withdrawal symptoms. As the substance is being used more frequently, the body takes counteractive measures such as a change in heart rate and body temperature. After a while the body can effectively compensate the damaging effects of the usual taken amount of the substance. Tolerance for the substance is created and an increasing amount is needed to experience the same effect as before. When the substance is not used for a while, the bodily processes get disrupted again, and unpleasant withdrawal symptoms occur. Using the substance again relieves the person from the withdrawal symptoms at short notice, but aggravate the withdrawal symptoms in the long term. This becomes a vicious cycle as the withdrawal symptoms become worse as they continue to be relieved by more substance use. Another aspect of this cycle is that physical damaging consequences of the substance use, for instance headaches, sleep deprivation and sexual performance problems are often remediated by the person with more substance use. Again this cures the problem in the short term, but exacerbates it in the long run.

Psychological cycle   The person has associated substance use with (temporal) positive feelings. Negative consequences such as withdrawal symptoms, financial or relational problems, feelings of guilt or low self-esteem occur afterwards. The remedy for this person to deal with these negative feelings is often to use the substance again. This amplifies the negative consequences which cause the person to use the substance again and thus a vicious cycle is created.

Social cycle   The substance use causes problems in the social relations of the person. Just as the body, the people around the person adapt to the substance use. This can take multiple forms such as arguments, people taking emotional distance or intensive checking upon the person. The relation between the person and his social circle worsens. Other social problems caused by substance use include rejection, isolation and criminal

behavior. Again the remedy for the addicted person is to use the substance, which worsens the problems in the long term.

Cerebral cycle Brain damage is a consequence of many substances. This can cause impairment in cognitive and social-emotional functions and skills. Self-control, perseverance, planning, sense of reality can for instance get seriously damaged as a result of long-term substance use. This makes the person less able to resist impulses to use the substance again. This results in more damage; hence it is again a vicious cycle.

2.2 Treatment theory

2.2.1 Types of approaches

Just as there are many factors that cause and maintain a SUD, there are many different perspectives as to how to deal with SUDs. Which of these models are used for treatment often depends on politics and differs per country. Some of these are preventive while others are curative [5].

The moral model This model presumes that a SUD is caused by weak willpower of certain individuals. The addict is described as sinful and the approach is focused on prosecuting substance (ab)users.

The pharmacological model This model presumes that the substance itself is at fault as the substance causes withdrawal symptoms which makes people addicted. The approach is focused on preventive measures to make sure that people cannot get their hands on substances, famous examples from the United States of America are the 'Prohibition era' and the 'war-on-drugs'.

The psychiatric model This model presumes that the SUD is a symptom of an underlying disorder. Examples of these disorders could be PTSD as a result of traumas or a troubled youth. The approach is to treat this underlying cause so that the addict feels no more need to use the substance.

The social model This model presumes that the SUD is caused by a damaged relation in the social circle of the person. Examples are divorces or pressure from work. The approach focuses on involving the social environment in the treatment.

The medical model This model sees the SUD as a purely medical disorder. Because of the physical changes in the brain as a result from long-term substance use, the person cannot use the substance in moderation. The treatment approach is to learn how to stay abstinent. An example of this is the approach used by Alcoholics Anonymous (AA).

The behavioral therapeutic model This model sees the SUD as learned behavior. The positive effects associated with the substance use keep the person addicted. The treatment approach presumes that learned behavior can also be reversed by learning other associations. Many protocols in (Dutch) treatment facilities are based on this model.

The brain disease model   This model views the SUD as a brain disorder caused by the effects of the substance on the reward system. Also the ability to deal with strong desires has been damaged. The approach focuses on medicine treatment that has an effect on the functioning of the brain.

The acceptance model   This model assumes that a person with a SUD can never fully recover and the approach focuses on minimalizing the risks of use. An example of this is providing clean heroin and needles for addicts.

The biopsychosocial model   This model presumes that the SUD can have multiple causes:

- genetic susceptibility for substances
- disorders in the personal development
- social/societal circumstances

    These factors can all be of influence in the development of a SUD. Therefore, the treatment consists of multiple interventions: medication, psychotherapy and improving the social environment.

While it is good to have an overview of the different models that exist on how to deal with SUDs, only some of these models are useful regarding the opportunities of VR support for treatment of people with an already existing SUD. For example, approaches that deal with legal actions to discourage or prevent use such as described in the first two models are not of interest here. To see where VR could be of support in treatment, it is important to describe the Tactus treatment protocols (for ID individuals in particular) in detail. This also uncovers what theoretical knowledge regarding SUDs and treatment approaches can be found back in practice. However, before this is conducted in section 2.3, one particular model that could be categorized into the behavior therapeutic model is discussed.

2.2.2 Transtheoretical model

The transtheoretical model (TTM) of behavior change identifies the stages that a person goes through when changing a behavior [9] and therefore forms the basis of many SUD treatment practices. For that reason it is essential to describe this model and its implications.

Before the stages are explained in detail, it is important to envision the model as a circular process rather than a linear one with a tangible beginning and ending point. Changing often involves taking two steps forward while taking one step back and at every stage, people can go back one stage or have a complete relapse. This model assumes that people, in general, do however learn from their relapses eventually. As the time that individuals spend in stages may vary per individual, the characteristics of the stages are assumed to be invariant. This is depicted in Figure 2.3 where the model is illustrated as a circle.
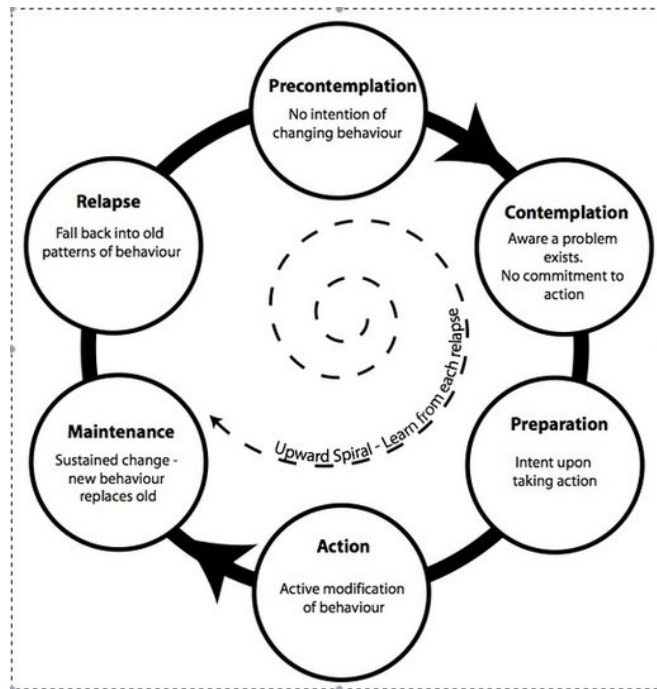
Figure 2.3: Circles of change

Precontemplation   At this stage the person has no intention to change behavior any time soon. Most people are unaware of what is problematic about their behavior. The person sees more pros than cons in their behavior. This can last for long period of times and for that reason it is sometimes described more as a situation than a stage, because a stage implies a dynamic process. Treatment in this situation is focused on encouraging the person to gain insight into their behavior as well as to become more conscious about the negative effects of their behavior and realizing that there is in fact a problem at hand.

Contemplation   At this stage the person becomes aware that there is a problem with the behavior but has not yet made a decision to change it. People are often in a state of doubt as their perceived pros and cons about changing the behavior are roughly equal. Treatment in this stage is focused on reducing the perceived cons of changing behavior and thus getting the person to have an open mindset about change.

Preparation   At this stage, the person makes the decision to do something about their problematic behavior. A plan is made and often a date is set in the near future for the action. Preparations are made to fully commit to the change by taking small steps that help them in achieving their goal. Treatment in this stage is focused on helping the person with their plan. Also, depending on the type of behavior, the person's social circle gets informed that the person is making steps to change as to make sure he/she receives support.

Action   At this stage the person changes their behavior to overcome the problems. This requires commitment of time and energy. This stage compromises the first six months since the change has been made. Treatment at this stage is focused on learning new behavior when the person is faced with situations that previously resulted in the undesired

behavior as well as providing advice when the person struggles with feelings of doubts or guilt.

Maintenance At this stage, the person has changed their behavior more than 6 months ago. The person experiences the advantages of having changed the behavior for a longer time period. Treatment at this stage focuses on support as well prevention of relapse by being aware of tempting situations. The person becomes gradually autonomous in remaining free of the old habit.

Relapse At this stage, the person has fallen back into the old behavior, for whatever reason. While relapse can happen at any stage, it is depicted in the circle as a separate stage. It is important to realize that a relapse does not mean that all is lost. Insights gained from the previous stages are still present and after some reflection lessons can be learned in what went wrong, and this knowledge can be applied in the next cycle. Some people go through all stages again after a relapse where others continue (almost) immediately at the action stage.

As most people have several relapses before having changed their behavior indefinitely, the process to successful behavior change can be depicted as an upward spiral as in Figure 2.4. For some people, reaching the end of the spiral never happens in their lifetime and others never relapse and successfully maintain their changed behavior after a first attempt. This model is mostly meant to provide a general outline of behavior change. The main point is that the treatment provider should recognize what stage clients are in, in order to provide adequate support and treatment.
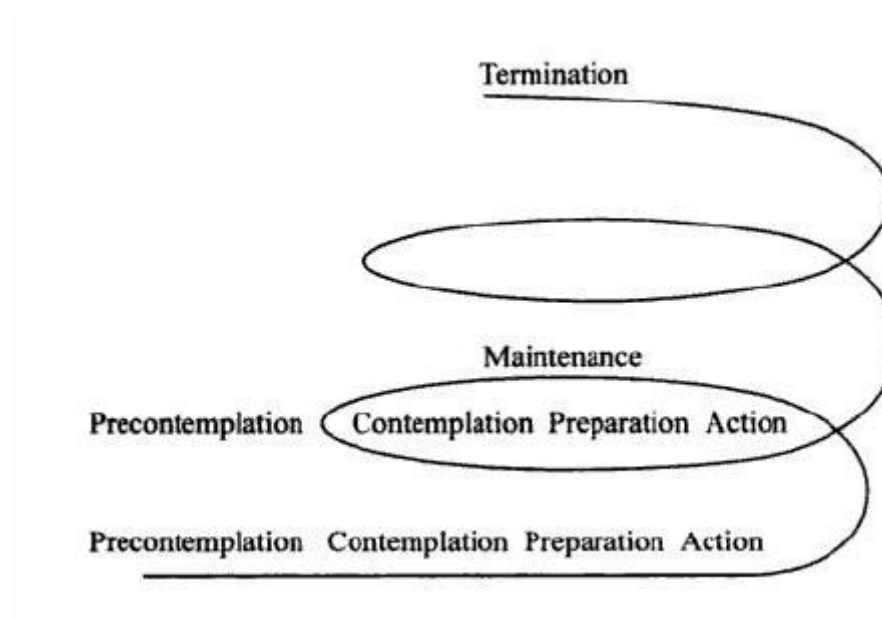

Figure 2.4: Successful behavior change spiral [9]

2.3 Tactus treatment protocols for clients with an intellectual disability

Tactus offers two treatment protocols specifically for clients with ID. This section describes the two protocols, *Minder Drank of Drugs* (MDOD) and *Cognitieve Gedragstherapeutische behandeling Plus* (CGT+) in more detail. They both contain a lot of the same elements in their content, the main differences are that MDOD also has group sessions and the number of total sessions is higher.

2.3.1 MDOD

This subsection is based on the MDOD manual and the corresponding explanation module [10]. Every week has an individual and a group meeting. Both the individual and group sessions have a fixed structure. The individual sessions are aimed at introducing and explaining the theme of the week, while a person that the client trusts is present. This trusted person can help to explain new subjects by relating them to personal examples of the client. The individual sessions start with a recap of the last group session and the client can tell what has been learned. After this, a new theme is introduced using psychoeducation and personal analysis. Lastly, an outlook is given for the group session and homework is given. The individual meetings last approximately 45 minutes in total. The group sessions are aimed at practicing the learned theory from the individual sessions and having social support from other clients. Group sessions start informally to give everybody the chance to catch up briefly. After this, the meetings start officially and exercises are done with the group corresponding to the theme of that week. The group sessions provide an opportunity for the clients to exchange stories and experiences as well as having social support from peers. The group meetings last 90 minutes in total, including a 15 minute break. For both these meetings, the standard structure components are not incorporated in the detailed explanation about the themes in the following paragraphs.

The most important goals of the program are that clients can break the behavior of problematic substance use by quitting or greatly reducing the use as well as knowing how to deal with relapses. The program's content is based on existing principles of addiction treatment, such as balancing pros and cons, relapse prevention, psychoeducation and dealing with peer pressure. Characteristics of the target group have been taken into account and the program has been adapted to this: limited vocabulary, repetition and game elements are used. Additionally, the program keeps in mind that the target group is impulsive and impressionable as well as that they can have a hard time generalizing and seeing connections between certain matters (for example cause – effect relations). A description of each theme's content, for both the individual as the group session, is given below.

Week 1: Introduction
This week introduces the treatment providers, the program and the group. Rules are set in the individual meeting regarding the meetings for the coming weeks; being on time, being sober, making homework. These rules are explained alongside pictograms. The treatment provider explains what the program entails and how group meetings proceed. The group meeting involves an introduction to each other (in game form) as well as a board or card game about substances. There is a lot of room for interaction and the goal is that clients get to know each other and start to

feel comfortable in the group.

Week 2: Substance information
This week is about seeing what clients know about various substances and providing additional information to take away any misconceptions that they may have. The individual meeting starts by showing pictures of various substances and the substances that the client knows, are discussed regarding characteristics and effects of the substance. Next, a conversation about the problematic substance(s) of the client is started alongside a brochure of this substance which features images and short texts. The group meeting starts by showing informational videos regarding substances made for schoolchildren that highlight what happens when you use particular substances. These movies show an objective view of substances and highlight both the positive and negative sides. The group can discuss what they recognize from these videos. After the break, each client is asked to briefly tell about the substance that they (have) use(d) and how long they are using it, after which a discussion can be started and stories can be exchanged.

Week 3: Pros and cons
This week is about gaining insight into why the clients use the substance (pros) and what negative effects they experience (cons). The goal is to make a balance of the pros and cons by laying them next to each other with colors (green for pros, red for cons) and with this visualization show them that there are always two sides of substance use. The individual meeting starts with a discussion about what the client likes and dislikes about using. After a while, a top 3 of both pros and cons can be made together with the client. The individual meeting also introduces the registry form where clients can keep track of how much they have used per day (for the coming weeks). This is for the client to gain insight into the occasions that they use, perhaps a pattern can be found. It can also be motivating for clients to see when their use declines. The group meeting starts by discussing everybody's registry form and how the week went. From this week onwards, discussing the registry form is also a fixed part of the meetings. The group is split in pairs and each pair receives cards with pros and cons and is asked to discuss what they recognize. Eventually, the whole group makes a balance of the pros and cons cards. Dependent on the outcome of the pairs, the total balance has more pros or cons. This can be discussed and put in perspective by the treatment provider. After the break, the pros and cons of stopping substance use are discussed by the group. Often, this involves the opposites of the negative effects of using the substance. It is important to formulate this more positively and concretely instead of just using words as "no more". For example: a negative effect of substance use could be "financial problems". The pro of stopping the substance use should then be "having more money to buy nice things" instead of "no more financial problems". Reviewing the pros and cons of substances relates to the transtheoretical method discussed in section 2.2.2 as it can give new insights that clients did not have before.

Week 4: Goals and Tips
The individual meeting starts by identifying situations; what situations make it (extra) difficult for the client not to use the substance. Also, situations with a low risk are identified. These situations are grouped into three categories with respect to how risky they are and giving a corresponding color; no/low risk (green), be careful (orange), high risk (red). After this, it is discussed how the client could deal with these situations. These are called self-control techniques and as mnemonic

called the 6D's (or 6A's in Dutch) and are discussed in Table 2.1. These six techniques can be grouped into three types.

- Stimulus control is about avoiding risky situations and people and for this group focused on taking a physical distance.
- Stimulus response is about learning alternative behavior in risky situations.
- Response consequences are traditionally about rewards and punishments. However, as punishments can result in dishonesty of the client when registering substance use, it is better to use a reminder of the cons that were identified in the week before.

Technique	Situation	Type	Example(s)
Distance	Risky (red & orange)	Stimulus control	Going for a short walk
Distraction	Risky (red & orange)	Stimulus response	Talking about or doing something else
Declare	Risky (red & orange)	Stimulus response	Expressing what you (do not) want and calling for help
Different thinking and different acting	Risky (red & orange)	Stimulus response	Thinking about the consequences of use, ordering a non-alcoholic drink at a football game or birthday
Doing great (Thumbs up!)	Before and after (green)	Response consequences	Rewarding desired behavior
Deals	Before and after (green)	Response consequences	Making rules (deals) about limits of use and consequences of undesired behavior

Table 2.1: The self-control techniques: 6D's [10]

In the individual meeting they are shortly introduced and kept simple with examples. They are repeated a few times during the program from now on as to help the client remember the mnemonic of the 6D's. The last item in the individual meeting is to formulate goals regarding stopping or declining the substance use. The treatment provider can ascertain that they are SMART goals (Specific, Measureable, Acceptable, Realistic and Timely) that can be achieved in the coming weeks. Rewards for obtaining goals are also discussed.

The group meeting involves an exchange and discussion of the goals and the risky situations that clients identified individually. This way, the clients could gain some perspective into what others have formulated and perhaps see some overlap. After the break, tips and tricks to quitting or reducing substance use are discussed with help of the 6D's. The group can give personal examples and categorize tips into techniques that might work well and techniques that might not work so well in practice for them. Of course, this depends on personal situations and these are discussed so that the clients in the group see what overlaps and differences they have with other clients. The risk situations that are identified relate to the circles of van Dijk discussed in section 2.1.4 as this discusses what situation causes clients

to use substances. Learning about self-control techniques is in line with the behavioral therapeutic models discussed in section 2.2.1 as new behavior has to be learned in order to deal with risk situations.

Week 5: Habits
This goal of this week is to identify habits and to discuss how they could be broken. The individual meeting starts with a conversation about habits in general (e.g. brushing your teeth before going to bed) to introduce the concept. Next, habits regarding substance use are discussed; what days of the week, certain places, with whom and perhaps there are some rituals that the client performs before or during the substance use. Afterwards, a discussion on recent habits gets started and the tips and tricks from last week's group meeting are repeated to see if some could already be applied. The group meeting involves exchanging stories and experiences about habits in general and substance use habits. After the break, the group can exchange stories about how they have changed habits in the past. This is so they can identify strategies that worked and strategies that did not work. Lastly, they are asked to do an exercise regarding habits; drawing lines between activities and how this is helpful in breaking a habit. These are given below, in the exercise these are mixed around. If necessary, the treatment provider can help them by giving examples.

Registering use – Knowing what the habit is
Setting goals – Knowing what you want to change
Doing something different – Changing habits
Rewards –Doing something positive when you reach a goal
Trusted person – Getting help from others
Pros in stopping/reducing use – Knowing what you want to accomplish

Week 6: Cravings
The goal of this week is to educate the clients about the association that they have between certain activities, friends, sights, smells or other things and substance use and that this learned behavior can change. The individual meeting starts with discussing cravings in general, for example regarding food to introduce the concept. Next, Pavlov's conditioning experiment is explained in lay terms. The goal is that the client understands that a dog gets hungry and starts drooling when he hears a bell because that is what he learned: after the bell comes food. If the dog hears the bell enough times without the food, the association disappears again. The treatment provider explains that for humans this works the same. Finally, the associations that the individual has with substance use are discussed, what would be their "bells" to use the substance. The treatment provider summarizes what cravings are and that just as with the dog; they disappear if the client lets them pass. The group meeting involves a discussion about personal cravings and what everyone can relate to. Next up, some tasty food and drinks are shown on a table and the clients are asked to indicate how much they crave it. Immediately afterwards, the table is covered up with a blanket and a game starts that is irrelevant to the food and drinks. After the game, the clients are asked whether they thought about the food and drinks during the game and to indicate their cravings now. This is to illustrate that distraction (one of the 6D's) can be helpful when experiencing cravings. Showing the food and drinks and distracting is repeated after the break, but this time with various relaxation, breathing and physical exercises. At the end, all the clients are complimented for resisting the cravings so well and are given one food or drink item that was on the table. The

clients are asked if they would like to consume it now or perhaps can resist their craving a while longer and eat it at home.

Week 7: Saying no
The goal of this week is to practice the various ways that a client can refuse substances in tempting situations as there is often social pressure from peers to use a substance. The individual meeting starts by discussing the earlier mentioned risk situations and that it is helpful to practice refusing. This is done in a role-playing exercise. After this, various ways of refusing (e.g. ignoring, just saying "no thanks", explaining the reason of refusal) are discussed and the client is asked to evaluate them. The group meeting continues with practicing to refuse a substance with various role-plays. Also a video explaining the techniques is being shown and discussed. Lastly, the clients make a plan for what they want to say no to when they are at home. They describe the situation and how they plan to refuse. Keeping track of their progress is the homework assignment for this week.

Week 8: Goals and excuses
At the beginning of the individual meeting the goal that was set a few weeks ago is evaluated. If the client is on track to reach the goal it is evaluated how this has been achieved in the last few weeks and how to keep going. If the client has trouble to reach the goal, it is discussed what has gone wrong and how this can be improved. Also, a new goal can be set that seems more realistic. It is important that this is brought positively, as some progress has been reached or at least new skills are being learned. Also, the program is not over yet and there is still room for improvement as the client learns more in the last weeks. Next, excuses (rationalizing reasons to use the substance again) are being discussed with examples to see what the client recognizes. The last item of the individual meeting is to discuss that when these thoughts occur, the client can also think about something else. These different thoughts can help to change the perspective and are a form of different thinking (one of the 6D's). In the group meeting the clients can discuss their excuses and different thoughts and exchange stories and experiences about what helped and what did not help in the past. Also, a role-playing exercise provides room to practice different thinking. After the break, a game is played to visualize the progress made so far by making a starting and finishing line in the room and letting the clients position themselves between it. A discussion is started to see what has got them so far and how they can continue to go towards the finishing line. This can involve the 6D's as well as the registry form, identifying risk situations, saying no and learning about substances and their negative effects (or the positive effects of changing use behavior).

Week 9: Different thinking and different acting
The goals of this week are to practice with the self-control technique different thinking and different acting and to introduce the concept of slip-ups. Slip-ups are not the same as relapses as they are shorter (several days or just occurring one time) and the client asks for helps and is ready to quit again after the slip-up. The individual meeting starts by discussing various forms of thinking and acting differently. The client can write down what different thoughts or actions could be that work for him/her. Next, the concept of slip-ups is explained and the difference with relapse. This is to ensure that the client understands that a slip-up is sometimes part of the changing progress and certainly does not mean that all the effort was for nothing. This is similar to Prochaska and Di Clemente's behavioral change spiral where relapses can be educational for next time. The

difference here is that the client is told that shorter relapses (slip-ups) are easier to deal with than longer relapses. The group meeting features the fabrication of a memory card, a card that clients can keep in their wallet or purse as a reminder as to what can help them through a craving. Before the break, the clients can write down some helpful thoughts or actions on the memory card. Next, the clients practice what to do after a slip-up with role-playing exercises. After the break, the clients are asked what they still remember about the 6D's and this is written on a board. The rest of the meeting is for the clients to complete their memory card with concrete examples of (some of) the 6D's that work for them. The memory card can also be completed at home.

Week 10: My plan
This week features the plan of the clients which summarizes what to do in what situations. All concepts of the last weeks are addressed. The goals of the plan are to prevent slip-ups when everything is going okay, to prevent a relapse after a slip-up and to recover from a relapse. The situations that the client can be in are indicated with colors; green (everything is going great), orange (slip-up), red (relapse), blue (change). The goal for the client is to stay in the green zone of the plan. If due whatever reason this fails, the plan is there to help them. The 6D's can be applied to every type of situation and are helpful when making the plan. The individual meeting introduces the concept of the plan and a start is made by filling in a scheme featuring the colors. This is given as homework and the group meeting starts with short presentations of the plans of the clients. After the break the progress is discussed by presenting how the group has performed the last weeks (their registry forms). The treatment provider focuses on the periods where the substance use declined. A discussion is started what benefits the clients have experienced with their change to reduce or stop the use. These benefits are written down and categorized into the categories of social contacts, body, and head.

Week 11: Preventing relapse
This meeting focuses on the social environment of the client and preventing relapse. The individual meeting starts by discussing people in the social environment and how they are evaluated by the client, especially whether they are a good or bad influence when they want to stop or reduce substance use. After this, the plan and memory cards of previous weeks are supplemented with this knowledge about the social circle. Who can help during risky situations, cravings or slip-ups and who can best be avoided? The group meeting starts with an exercise regarding the different situations; the clients are asked to position themselves on an orange square on the floor (representing the orange situation of a slip-up). The treatment providers now ask the clients to move to the green (everything is going good) or red (relapse) situations by alternating between the 6D's and excuses that have been identified earlier. After the break, the compliment game is played. The game entails that while a client leaves the room, the rest of the group write down how that particular client has progressed and what good actions he has performed.

Week 12: Parting and proceeding
This is the last week and therefore focuses on concluding the program and ensuring that the client knows how to proceed. The individual meeting starts with going over the social circle again and identifying the three best people that the client can reach out to. This is written down. Also the rules (deals of the 6D's) and rewards (doing great of the 6D's) are repeated. The plan of the participant is

reiterated and when necessary completed. The group meeting involves a recap of the program, in particular the 6D's and the plan and how each client has progressed. The clients are rewarded with a certificate. In both the individual meeting and group meeting it is stated that the treatment providers are always available in case this is needed.

2.3.2 CGT+

This subsection is based on the manual of CGT+ [11]. The CGT+ protocol is a variation of the regular cognitive behavioral therapeutic (abbreviated to CGT in Dutch) protocol, adapted to help people with ID. It lasts nine weeks and each week has two sessions; one individually with the client (meeting A) and one where a trusted person of the client is also present (meeting B). The normal CGT protocol has only one longer meeting once a week. Separating this into two meetings of 30-45 minutes each ensures that the client stays focused during both meetings and allows for repetition. The separation also ensures that there is a balance where the client has both a sense of autonomy (meeting A) as well as support (meeting B). The meetings have a fixed structure as they start with how it is going right now, followed by a short recap of last time, discussing homework, discussing the content of this week, preparing homework exercises for the next meeting and summarizing this meeting.

As with the MDOD protocol, each week has a theme. These themes are discussed briefly as much of the components overlap with the MDOD protocol; the registry form, self-control techniques (6D's), SMART goals, making a plan (in the format of various situations indicated with the colors green, orange, red and blue) and psychoeducation on substances, cravings, refusing and relapses are all integrated in CGT+. A difference can be found in the pros and cons balance and risk situations analysis of MDOD; this is integrated into one technique of CGT+ called the function analysis. In the most basic form the treatment provider discusses in what situations the client uses the substance and the consequences of the use. There are actually five ascending levels of complexity; a version of the function analysis is chosen dependent on how the treatment provider evaluates the client's cognitive abilities.

- Version 1: Situation - Use - Consequences
- Version 2: Situation - What did I notice? - Use - Consequences
- Version 3: Situation - What did I notice about my body? What did I notice about my feelings? - Use - Consequences
- Version 4: Situation - What did I think? - What did I notice about my body? What did I notice about my feelings? - Use - Consequences
- Version 5: Situation - What did I think? - What did I notice about my body? What did I notice about my feelings? - Use - Consequences for both short and long term

Week 1: Start (Preparation)
1A: Social introduction, talking about use, discussing substances, explanation of the program and rules, explanation of registry form and this is homework (also for next meetings).
1B: Short and lower level of function analysis, exercise to draw a lifeline with important moments in the client's life.

Week 2: Let's get to work (Goals and self-control)
2A: Setting one experimental goal where the client tries to not use the substance in a situation. Introducing a part of the 6D's with exercises and examples: deals and distances.
2B: Setting goals for changing the substance use the coming weeks. Introducing a part of the 6D's with exercises and examples: declaring and doing great.

Week 3: When do I use? (Self-control techniques and function analysis)
3A: Practicing with the learned self-control techniques. More detailed function analysis in both length and complexity.
3B: Practicing with the learned self-control techniques. More detailed function analysis in both length and complexity. Possibly readjusting goals.

Week 4: I can change (Function analysis and emergency measures)
4A: Introducing a part of the 6D's with exercises and examples: distraction. Explaining slip-ups and relapses. Making an emergency plan in case of a relapse; this often involves the 6D's.
4B: Introducing the concept of a plan to change. Exercises with this plan and relapses. Making first draft of plan.

Week 5: Dealing with cravings (Emergency measures and cravings)
5A: Introducing the concept of cravings and how to deal with cravings using what has been learned so far of the 6D's.
5B: Role-playing exercises on how to deal with cravings.

Week 6: Thinking differently (Dealing with cravings and changing thoughts)
6A: Other exercises on how to deal with cravings. Introducing a part of the 6D's with exercises and examples: different thinking & different doing.
6B: Explanation about various helping thoughts and dangerous thoughts. Exercise on how to have more helping thoughts.

Week 7: Saying no (Changing thoughts and refusing)
7A: Exercise on how to change dangerous thoughts in helping thoughts in risky situations. Introducing various ways of refusing a substance.
7B: Practicing how to refuse a substance with various role-playing exercises.

Week 8: Dealing with slip-ups (Refusing and relapse prevention)
8A: Practicing refusal with other exercises. Extending the emergency plan on what to do in case of slip-ups or relapses.
8B: Exercise that repeats all skills and techniques of saying no and self-control (6D's). Extending the plan of what to do (blue) in the different phases (green, orange, red).

Week 9: I am ready (Evaluation)
9A: Evaluating the program, the change progress and the newly learned skills and techniques. Completing the plan.
9B: Last meeting to finish the program. Both the client and the trusted person can look back on how the last weeks have been and look forward to how the newly learned skills can be applied. Possible follow-up treatments are discussed. The participant receives a certificate.

Requirements

Before software can be designed and developed, it is crucial to document what the software is expected to do. It is important to discuss the desires and expectations of stakeholders before the development starts as it helps to ascertain that there is a mutual agreement between all stakeholders and thus prevents costly rework at a later stage. From a practical point of view, the goal is not to have the perfect software requirements but to have a shared understanding of requirements so that design and development can be started. The process of discovering, analyzing, documenting, classifying and specifying the requirements for the to be developed software is called requirements engineering (RE). "*Requirements are a specification of what should be implemented. They are descriptions of how the system should behave, or of a system property or attribute. They may be a constraint on the development process of the system* [12]". This definition of requirements describes the various types of information that are captured by it.

3.1 Types of requirements

This definition recounts for the fact that requirements can contain both the view of the end-user regarding the behavior as well as the internal properties that make the system suitable. In fact there are three levels of requirements that can be distinguished: business, user and system requirements. System requirements can be split up in functional and nonfunctional system requirements [13].

Business requirements   These requirements include the benefits that the organization implementing the system wants to achieve. It describes the goals and added value of the system in regard to the organization, Tactus in this case.

User requirements   These requirements involve what the end-users should be able to achieve with the system. What activities the end-user is able to conduct using the system. This can for example be represented with user stories and use case diagrams.

Functional system requirements   These requirements specify what must be implemented so that the user requirements can be fulfilled. The plan for implementing the functional requirements can be specified in the system design.

Non-functional system requirements   These are all the requirements that do not fall into the category of functional system requirements. Often they are also termed supplemental or quality requirements as they specify operation attributes of the system rather than behavior. Examples of non-functional requirements are requirements regarding the accessibility, availability, compatibility, security and response time. The plan for implementing the non-functional requirements is specified in the system architecture.

To prioritize requirements, the MoSCoW prioritization can be used. With this technique the requirements are categorized into four categories [14]. The idea behind the MoSCoW prioritization is that in agile development projects there is often no time to satisfy all requirements. Even though all requirements can be

important, the most important features have to be implemented first to deliver the largest benefits of the system to the stakeholders. MoSCoW is an acronym for the four categories.

Must have   These are features that are absolutely vital to have in the product. Satisfying these requirements is the minimum scope of every development project before launching the product.

Should have   These are still important features to include in the product but they are often not as time-critical as the must have features.

Could have   These are features that are nice to have, but not necessary for the software to function. When the time and resources are available, these can be implemented in the current development phase.

Won't have (but would like)   These are the features that are the least critical or perhaps not appropriate at this moment. These requirements could always be satisfied in a later development phase.

3.2 Process

The process of requirements engineering can be divided into various activities that each have their own methodologies and techniques [15]. Often these activities are incrementally repeated as more requirements are specified.

Eliciting requirements   Often termed the first step of the requirements engineering process, eliciting requirements is about gathering initial information from stakeholders in order to be able to formulate requirements. This information gathering can be done using techniques that are focused on individuals such as questionnaires, surveys and interviews, but also with more informal group elicitation techniques such as focus groups and workshops. Other techniques include analyzing existing documentation (usually from the organization), prototyping when there is a lot of uncertainty about the requirements and model-driven techniques to visualize missing information.

Modelling and analyzing requirements   After information has been gathered in the elicitation step, the requirements can be modelled and analyzed. This involves visualizing relations between requirements and classifying requirements into one of the earlier mentioned levels. The modelling techniques include enterprise, data and domain modelling.

Communicating requirements   After the requirements have been discovered and specified, the succeeding step is to communicate the requirements back to the stakeholders to ensure that the stakeholders and the developers all comprehend the requirements so far. The way that the requirements are documented is crucial as this needs to be understandable for all the stakeholders. The documentation technique is also important for later stages to trace back the requirements and be able to check if all requirements are met in the final software product.

Agreeing requirements   After all stakeholders understand the requirements, it is time to reach an agreement of the final requirements as requirements can sometimes conflict each other. This is done by prioritizing requirements in

negotiations. It is preferable of course that unrealistic expectations and desires of stakeholders are already attenuated in earlier activities.

Evolving requirements   As the software design and development evolves, the requirements can change and new requirements can be added on top of the initial requirements as the requirements engineering process starts to make stakeholders think about what they want. This activity is to ensure that requirements are managed and if new requirements conflict with already existing ones, trade-offs are made regarding costs and benefits.

3.3 Approach

Before requirements can be gathered to suit the needs and desires of various stakeholders, these stakeholders have to be identified. It is thus the first step in the information gathering process. The method to identify the stakeholders is a stakeholder analysis.

After the stakeholders are known, this research combines multiple techniques to determine the requirements for a VR product that helps people with ID in their SUD treatment. An article describing requirements elicitation techniques classifies these techniques into four categories; traditional, cognitive, collaborative and contextual [16].

Traditional techniques are used to determine the limits of the current system and for this research three of them can be used in combination; introspection, reading existing documents and meetings. Introspection implies that we firstly try to understand the shortcomings of the system. This is mostly used as a starting point for other elicitation techniques. Although we have some general ideas about this, the assistance of involved stakeholders is crucial. With the current situation described, the existing documents on the used treatment protocols at Tactus are summarized. Using meetings with stakeholders that are involved in these treatment protocols (treatment providers and clients) areas can be identified where VR can improve the current protocols.

Because knowledge of this specific domain is needed, the most appropriate technique category is the collaborative one. Requirements can be selected and prioritized for the product together using a group technique with stakeholders. Focus groups are interactive discussions that are led by a moderator where participants share their opinion and preferences. In these groups, the technique of brainstorming can also be used.

After having the initial focus group session with stakeholders, cognitive techniques can be used. For this research, task analysis is suited to describe what the end-user is able to do with the product. Contextual techniques are used to identify requirements in the environment where the end-user eventually uses the product. For this research, this is where clients would eventually use the product such as in a therapy session. An applicable technique for this research is participant observation where the reaction of the participant on the first version of the prototype can be evaluated.

3.3.1 Stakeholder analysis

Before the actual requirements engineering process can begin, the stakeholders have to be identified and analyzed first. Stakeholders are all individuals or organizations that are impacted in some way by the new product or who influence the requirements of this product [17], in this case the virtual reality product to be designed and developed. In this exploratory phase of the research, many details of the final implementation are still unknown, such as what party would develop the final product and who would maintain this. This exploratory phase therefore focuses on the baseline stakeholders as defined by the approach of Sharp, these are individuals or groups that are going to use the system in one way or another or have an extensive stake in the project as they are decision makers of some sort [18]. All satellite stakeholders, as they are defined in this approach can be defined in a later phase of this project when more details are known. This includes suppliers of the final system, insurance companies, legislative organizations concerned about the effects and safety of the final system. For these baseline stakeholders the general characteristics, main role, impact by the system and responsibilities of this stakeholder is described, in accordance with the approach of Maguire & Bevan [19] in section 3.4.1.

3.3.2 Interview

The business requirements describe the goals and added value of the system in regard to the organization, Tactus in this case. These are gathered in an interview with two Tactus employees who both work at the E-health department, which means that they are investigating and developing new technologies for Tactus. Examples of such technologies are mobile applications and online treatment for clients. Because of their experience at Tactus as a company and more specifically their involvement with new digital technologies they can represent Tactus as an organization (S3 in Table 3.1) to explain the business goals and wishes for this project. Both participants are given the information brochure for this interview (Appendix A) and sign the informed consent form (Appendix B) before the interview begins. The interview is guided by the list of questions that can be found in Appendix C. The results of this interview are textually described in section 3.4.2 and concluded in the (business) requirements of the final requirement list in Table 3.2.

3.3.3 Focus group

The activities and techniques described in the previous sections can be combined in a pilot study where initial prototypes can be evaluated. Tactus has a facility in Rekken (Gelderland, The Netherlands) where clients reside during their treatment. This is practical for this research as their presence is continuous and there is thus no reliance on setting appointments as would be the case in facilities where clients only come in when they are scheduled for treatment. Besides the clients there are also treatment providers in Rekken that are asked to participate in a focus group to determine the user requirements and also some of the functional and non-functional requirements, before the pilot starts.

It is important to understand the role of the moderator in focus groups. The moderator leads the discussion by introducing the participants when they do not know each other, asking questions, keep the conversation on track and make sure

that everybody has a chance to talk. The moderator should have a non-judgmental reaction to the discussion and encourage comments of any type, both positive and negative [20]. The moderator can propose and explain ideas or designs to the focus group, but cannot interfere with the discussion that follows afterwards where the participants give their opinion. During the discussion, the moderator only takes notes and optionally keeps order of the discussion if it turns into an argument or when participants start discussing irrelevant issues.

Before the focus group starts, a short explanation of this research and the goals are given. The process and goal of a focus group is explained to the participants. It is stated that the participants are all here because they have valuable experience in the treatment field with the target group and this is useful for this research. It is accentuated that there are no wrong answers as their professional opinions contribute to gathering user requirements.

Finally, information brochures alongside informed consent forms are distributed (see Appendix D and Appendix B). With the participants that sign the informed consent form, the actual focus group is started.

Appendix E lists the topics and questions classified into multiple categories that are discussed by the focus group of treatment providers of Tactus to determine the requirements that they envision. The results of this focus group are textually described in section 3.4.3 and concluded in the requirements of the final requirement list in Table 3.2.

3.4 Results

3.4.1 Stakeholder analysis

Tactus clients with an intellectual disability   This group is currently being treated for their substance use disorder. In addition to this they have an intellectual disability which causes their need for a specialized form of treatment. These are the main end-users of the product and are henceforth referred to as EU1. They are impacted by the final system as it could be incorporated in their treatment. The design and usability of the prototype has to be evaluated by this group. A risk is that they could feel threatened by this new technology as they could fear that they find the use confusing or are afraid to make mistakes. This risk can be addressed with proper design according to usability principles in combination with guidance from the treatment providers before, during and after the session. Another risk that concerns this stakeholder is they could only be enthusiastic about using virtual reality as they see at some sort of game and not a serious tool for their treatment. This risk can be addressed by properly informing EU1 about the product before they use it.

Tactus treatment providers   This group currently provides treatment for the people with substance use disorders. Because of their experience with the target group, they are the source of the user requirements. Other responsibilities that they have are to explain the system and its goals to EU1 before the sessions and to monitor their response and provide verbal support for EU1 during and after the sessions with the product. Therefore,

they are a different type of end-users of the system and are henceforth referred to as EU2. They also have the responsibility to ensure that the clients are not exposed to virtual environments that they cannot handle. Therefore, they need to preview the product before use and apply their professional judgment to ensure this. They are impacted by the system as they would have to incorporate these new responsibilities in their current ways of working. A risk is that they could feel threatened by this new technology as they could fear it would replace them or that they could not operate it in sessions with clients. This risk can be addressed by ensuring they are still the treatment providers and the product would be a new tool to help them with their job in combination with proper design according to usability principles. Another risk is that they can feel they do not have time to (learn to) use this new tool; this risk can be addressed by scheduling.

Tactus as an organization   The organization is a mental health facility specialized in treating substance use disorders. They have an interest in development of new technologies as they could support and/or improve current treatment. They are impacted by this system as this could change their treatment plans and the development and maintenance of an initial system could require an investment. For this phase of the research, they are the source of the business requirements and this is thus their responsibility.

The stakeholders and their stakes in the project are summarized in Table 3.1.

#	Name	Stake
S1	Tactus clients with an intellectual disability (EU1)	They are the main end-users as the product is to be integrated in the treatment they receive.
S2	Tactus treatment providers (EU2)	They are the second type of end-users as they are to use the product as a tool when treating clients. They have the responsibilities of ensuring that the clients are guided before, during and after use of the product.
S3	Tactus as an organization	This is the organization that wants to investigate the possibilities of this technology in their treatment plans.

Table 3.1: Stakeholders of the project

3.4.2 Interview

The interview with two Tactus employees who are working at the E-health department took place on the 3rd of April 2017. Both state that they are key players at Tactus regarding the development of new E-health technologies and can therefore represent the organization in this interview. They do not have direct influence on the board of directors but have sufficient knowledge regarding the current strategy and vision of the organization to represent S3.
Generally speaking, most money is earned by treatment when insurance

companies cover the costs of their clients. For younger clients, the municipality covers the costs. They also receive other subsidies from municipalities to prevent substance use and to develop new technologies. The costs of development of new technologies, such as VR, would have to come from subsidies and when applied on a larger scale in the future would be covered by insurances in the price of treatment after it is proven in effect studies that it has benefits over regular treatment. This research would be the first to develop a VR product for Tactus; it is however a wish from Tactus for some time as it is already used at the GGZ (Dutch mental healthcare providers) for treatment of phobias.

The goal of applying VR in the treatment of individuals with ID would be to make the clients more resilient and to practice self-efficacy. The end goal, as with all treatment, is to help the client reach their own goal to reduce or completely stop their substance use. It would also help to communicate with the target group, to better illustrate examples and to better explain what is expected of them in certain exercises. Another goal would be to support the client after their treatment with VR, as they could practice certain exercises again when they desire without going to Tactus. This is however not a fixed business requirement in the sense that this would be an ideal future situation, but practically has constraints as Tactus is not planning to provide VR equipment for all their clients individually.

The power of VR, especially for this target group, is that it allows the clients to practice certain skills in a more realistic environment, but this environment is still safe. The protocols currently feature practice by role playing games, but it can be hard for clients to completely identify themselves with the situation as they are physically still in a treatment room. The clients would not have to rely on just theoretical instructions and examples regarding learned theory but can immediately apply these in realistic exercises. They are also able to repeat exercises or activities that they are struggling with as the VR program can simply be reset and played again with the push of a button. The participants state that VR would not have the goal to only stimulate cravings, such as virtual cue exposure, but to practice certain activities when cravings arise. Another option would be to visualize goals of the clients in a virtual environment. Regardless of what environments are shown or what exercises are practiced, key points are that it would be done in a more realistic environment than with role playing games, but still in a safe virtual world, and these are thus two of the most important business requirements.

A requirement for equipment to apply VR on a larger scale in the future is that it would be an affordable and portable system, meaning that the system consists of a powerful laptop with a wireless VR device and controllers which can be easily set up at various locations. One of the participants mentions that the development speed of VR devices keeps increasing and therefore believes that in the near future, such a system could fit the budget of a larger scale operation. No actual number is put on the budget, but this has to be within limits. Furthermore, it would depend on the results of the first prototype evaluation whether environments have to be customizable to better fit the client. If this would be the case, Tactus would envision a content management system (CMS) that allows for quick individual adjustments in virtual environments so that they better appeal to clients. Another option for this customizability is to use cameras that could scan a room and map this to a virtual environment.

Regarding devices that exist at this point the main points that are discussed are that devices as the *Samsung Gear VR* are too basic regarding resolution and interaction. High quality devices such as the *HTC Vive* provide better options for this but are rather expensive to implement and provide on a larger scale and do not comply with the portable wishes of Tactus. The development of VR devices is exponentially growing and therefore it is still too early to determine the hardware device at this stage of the research. The point of this stage would be too determine what type of VR environments and activities could help clients and to develop a prototype of one of these environments to be evaluated by the target group regarding design and usability.

Regarding the options of environments, virtual environments would suit the requirements of interaction best as filmed environments are just a 360° layer mapped on a virtual reality device and therefore do not allow for much interaction. Besides this, virtual environments can be implemented as either realistic or abstract. Abstract environments only focus on a certain exercise without the environment itself being very realistic. This also allows for the opportunity to gradually increase the level of realism in various exercises. The focus group and the prototype evaluation should determine what level of realism in a virtual environment would suit this target group best. One of the participants states that when an environment is very realistic, a user could find it missing certain personal elements which would take the realism away in their experience. Whether this statement is true, should be determined in prototype evaluations. Also other factors, such as the amount of virtual characters or certain sounds could determine how immersive the virtual environment is for EU1. This should all be evaluated with prototypes.

3.4.3 Focus group

The focus group consisted of 5 treatment providers of the Tactus facility in Rekken and took place on the 18th of April 2017. The participants all have a different role in the facility, ranging from psychomotor therapist to senior mental health nurse, but they have in common that they all have experience communicating with and treating the target group. The participants remain anonymous but are referred to as P1-P5 to clarify to whom each opinion belongs. When all participants agree on an issue, they are referred to as "the participants".

Regarding the current protocols the general theme is that clients find it hard to generalize their learned theory into practice when they encounter real situations that are outside the facility. Practicing learned theory occurs in therapy sessions to prepare the client for when they encounter a real risk situation outside the facility, but to apply what has been learned in situations that differ from the practiced situation and where stress and other factors come into play is challenging for the clients. This applies to all exercises of the current treatment protocol and the participants of the focus group therefore state that this would be a main goal of what the user should achieve in the virtual environment: being able to practice learned theory in realistic situations. The treatment provider would then be present when a client does this in a virtual environment to coach them on the spot. P1 mentions that the 6D's are mostly used as a mnemonic for the clients to remember what options they have when they encounter a craving or a risk situation. They do however have a hard time to apply this to a specific situation

they encounter in the real world. For instance they remember that they can use "different thinking and different acting" but find it hard to apply this to the real life context of being on a birthday party where people drink alcohol. Because there are many environments and factors that could trigger a craving, a possibility that is envisioned for the product is that clients could practice applying the 6D options in various virtual environments when they are still coached by their treatment providers. Another specific exercise that is mentioned by P2 is saying no. Clients find it hard to understand why they should also say no to substitute substances (for instance weed) as they express that they are not addicted to that substance but only to their main substance (for instance cocaine). This is also a form of generalizing as they view different substances as having completely different characteristics and find it hard to see that these substances all share the addictive potential and the use of a substitute could be the first step to their relapse. Also, the participants share a story of how clients also find it hard to declare (one of the 6D's) that they need help. They feel that once they are out of treatment they have to face the problem all alone again. A difficult concept that is not on the reference list (see Table E.1) but often reoccurs in conversations is that thoughts can be helping and non-helping for the addiction. Particularly that you can actively control your thoughts and are that they are not just something you passively have is often hard to grasp for the clients. This could be visualized in a virtual environment by virtual characters that look stereotypically good and bad (e.g. angel and devil) and represent these thoughts. P2 finally expresses that the protocols are used as general guidelines but because of the characteristics of the target group, the treatment providers need to be flexible in the use of it. Depending per client and situation the real treatment deviates from the protocol guidelines as the experience of the treatment provider allows them to estimate what form of treatment would suit them best at the clients' current stage.

After the demo which entailed a minimalistic tutorial environment to explain some controls and a bar environment to demonstrate how real environments could look, the participants indicate that to achieve the goal of practicing learned theory in a virtual environment, this environment would have to be realistic. For this target group the protocols normally state to keep visualizations as abstract as possible, therefore they use simple icons. The participants however think that environments would have to be realistic to practice risk situations. There are various environments that could be made to represent risk situations such as bars, living rooms, train stations and supermarkets. It would be good to keep a minimalistic environment where the clients would learn the controls; this could be made into a tutorial game that is enjoyable for the clients. Whether factors such as personalizing the environments, peer pressure from virtual characters, sounds of specific environments, and use of colors would have to be integrated in the environments to be perceived as more realistic has to be evaluated with initial prototypes. P3 mentions that they would like to integrate more positive psychology and personal development into the treatment, instead of just focusing on the addiction itself. The other participants however still envision the main objective of the virtual reality product to practice learned theory and not to do have a visualization of the end goal that clients want to reach. A consensus is reached when an environment would reward good choices with pleasant visuals, for instance when of the 6D's is applied in a risk situation. This way the positive psychology factor would be incorporated in the environment but the main objective is still to practice learned theory in realistic situations. Another possible element to be incorporated is mentioned by P1 and that is to show the negative

effects of substance use with virtual reality. The client would see other virtual characters using a substance and act inappropriately afterwards. This way the client could see this from a third person view and thus be confronted with what behavior could follow from substance use.

When the participants discuss what they would like to have when they would use the virtual reality product as a tool when they treat clients numerous things come up. Firstly, it would suit the learning purpose if the screen of the session is recorded. This way, the treatment provider and client can later analyze what choices were made in the virtual environment. Also, when shown in a group, clients could discuss their recordings with their peers and could receive feedback from them. This could be of value as the participants state that clients often feel more understood by their peers who know how an addiction feels and often have been in the same situations as them. Another functionality they envision is a simple menu in the final product to enable or disable certain objects or interactions in an environment and to adjust the difficulty level to match the capacities of the client.

3.4.4 Conclusion

From the interview can be concluded that the main business goal is that the product should support clients in their treatment. The product should allow EU1 to repeat exercises in an environment that is reviewed as safe by EU2. To realize the full potential of VR the product should allow for interaction. For practical reasons the product should be easy to set up and transport. The costs of developing and maintaining the software as well as the purchase of hardware should fall within a reasonable budget. Because VR is such a developing technology, this should be achievable within a few years.

From the focus group can be concluded that the main user goal for EU1 is to practice self-control techniques (6D's) that have been learned in the treatment in a realistic virtual environment. This environment should represent a risk situation such as a bar, living room, train station or supermarket where substances are available. Thus, virtual substances should be displayed to EU1 and the goal is to recognize and apply the 6D's in these situations. Therefore, there should be objects and/or characters that represent the 6D's which EU1 could interact with. The substances could also be offered and EU1 would have to practice saying no in that case. Positive psychology should be integrated for rewarding good choices but would not be the main focus of the product. Furthermore, for the responsibilities of EU2, the screens of the sessions should be recordable and EU2 must be able to see what EU1 sees during a session. For usability the final product should have a menu for EU2 to select (parts of) environments and change difficulty levels. Because of the characteristics of EU1 the sessions should have a limit of 15 minutes and any textual or audial material should be with simple vocabulary and in Dutch.

The results can be summarized into a requirement table (Table 3.2) where the requirements are sorted on types: business requirements (BR), user requirements (UR), functional requirements (FR) and non-functional requirements (NFR). They are also given a MoSCoW priority. Many possibilities beside the main goal have been discussed in the interview and focus group and these are also included in the requirement lists as could haves or won't haves. These could thus be implemented later. Additionally, the origins of the requirements are indicated in the table.

#	Type	Requirement	MoSCoW	Origin
1	BR	Support clients in accomplishing their goals to reduce or stop substance use.	Must	Interview (S3)
2		The environment is reviewed as safe by the qualified Tactus treatment providers before the clients use it.		
3		Exercises can easily be repeated.		
4		Virtual environment(s) combined with hardware allows for interaction.		
5		The final product is made for a portable system that can easily be set up in any room.	Should	
6		The purchase of hardware to support the final product on a larger scale is within limits of a (to be determined later) budget.		
7		The costs of developing and maintaining the final product is within limits of a (to be determined later) budget.		
8	UR	EU1 learns the controls in a minimalistic fun environment.	Must	Focus group (S2)
9		EU1 practices learned self-control techniques (6D's) in a realistic virtual environment that represents a risk situation such as a bar, living room, train station or supermarket.		
10		EU2 can live watch (in 2D) what EU1 sees while using the virtual reality device.		
11		EU1 practices saying no to a variety of virtual substances that are offered by a virtual character.	Should	
12		EU1 sees from a third person perspective what the negative consequences of substance use could be.	Could	
13		EU1 can interact with two virtual characters that visualize helping and non-helping thoughts.		
14		EU1 views and interacts with an ideal future situation for motivation.	Won't	

15	FR	EU1 sees a variety of virtual substances that can be picked up.	Must	Focus group (S2)
16		EU1 has options to interact with virtual objects and/or characters that represent the self-control techniques (6D's).		
17		Positive psychology is incorporated by rewarding EU1 for making the right choice.	Should	
18		EU1 can interact with virtual characters that are either good (and offer helping thoughts) or bad (and offer non-helping thoughts or substances).	Could	
19	NFR	A session in the final product is no longer than 15 minutes because of the characteristics of EU1.	Must	
20		Any textual or audial material integrated in the final product is in Dutch as this is the first and sometimes only language of EU1 and EU2. This is kept simple with short sentences and basic vocabulary to ensure that EU1 understands it.		
21		The 2D view of the sessions in the final product is recordable so that they can be analyzed later by EU1 and EU2 for learning purposes.	Should	
22		The final product has a menu for EU2 to pick an environment, enable or disable virtual objects and adjust difficulty levels.		

Table 3.2: Requirements of the virtual reality product

Design, Implementation and Evaluation

In this chapter the design, implementation and evaluation of the prototypes is described. This is an iterative process as an initial prototype that satisfies the requirements from the previous chapter is designed and implemented. This initial prototype is evaluated by the client end-users of the system (EU1) and then improved in the design and development of a second prototype, which again is evaluated and improved. User evaluations take place in the Tactus facility in Rekken, Gelderland. These evaluations are aimed at improving the usability and user experience of the product.

By involving the end-user (EU1) in this phase of the development the design and implementation are user-centered. The iterative approach ensures that the best possible prototype is developed in the limited timeframe of the project [21].

4.1 First prototype

4.1.1 Design

The prototype is designed with the heuristics that are used for evaluations of virtual reality applications in mind [22]. Briefly, these heuristics state that movement, interaction and physics in the virtual reality application should be as natural as possible and correspond to the user's expectation of behavior of real world objects.

One of the requirements of the previous chapter is that EU1 learns the controls in a minimalistic fun environment. The tutorial scene from the demo at the focus group (see Figure E.1) is altered to comply with this. The tutorial environment keeps the minimalistic design of basic objects such as cubes and spheres and colors to indicate interaction possibilities but extended with bowling pins to make it more enjoyable. In this tutorial environment EU1 can learn the controls that are needed in other environments. As virtual spaces are likely to be larger than the physical space in which EU1 uses the application, a controller must be used to teleport. Another interaction that is necessary to comply with the requirements is grabbing objects so they can be moved. To have some reference of the controller, the system should keep track of the position and rotation and show these for EU1. Using a tutorial scene is a practical way of learning the controls and learning by doing best fits the target group [10].

Besides the tutorial environment, the prototype consists of a bar environment. Again, this is an extension of the demo at the focus group (see Figure E.2). In this bar environment, EU1 is confronted with substances in order to apply the 6D's. Table 4.1 explains the design of the 6D's in the bar environment.

Self-control technique	Design
Distance	EU1 can leave the bar by going out the door and entering an outside area.
Distraction	EU1 can play darts in the bar.
Declare	EU1 can pick up a mobile phone.
Different thinking and different acting	EU1 can choose other drinks such as coffee and soda instead of alcoholic drinks.
Doing great (Thumbs up!)	This is a response consequence (see Table 2.1) but can be implemented by making it a pleasant experience in the virtual application when EU1 makes the right choices.
Deals	This is a response consequence (see Table 2.1) and is not implemented.

Table 4.1: How self-control techniques (6D's) are applicable in prototype 1.

Furthermore, virtual characters that are engaging in various activities are necessary to make the bar environment realistic. One of these virtual characters has to offer a substance to EU1 for the purpose of practicing saying no.

4.1.2 Implementation

The virtual reality environments are implemented in *Unity 5.6.0f3* and are made for the *HTC Vive*. Both the tutorial and bar environment use *SteamVR* asset packages to attach the *HTC Vive* headset to the camera view and to recognize the two controller objects. The *Vive-Teleporter* package[1] is used to implement the teleportation. EU1 can teleport to areas on the floor that are indicated as such with visual assistance. EU1 sees a parabolic pointer when pressing the touchpad with a thumb, the end of the pointer is the new location when EU1 releases the touchpad. To prevent EU1 from teleporting into objects, objects are attached collider components. This feedback of where EU1 can and cannot teleport to is given by the circle at the end of the pointer.

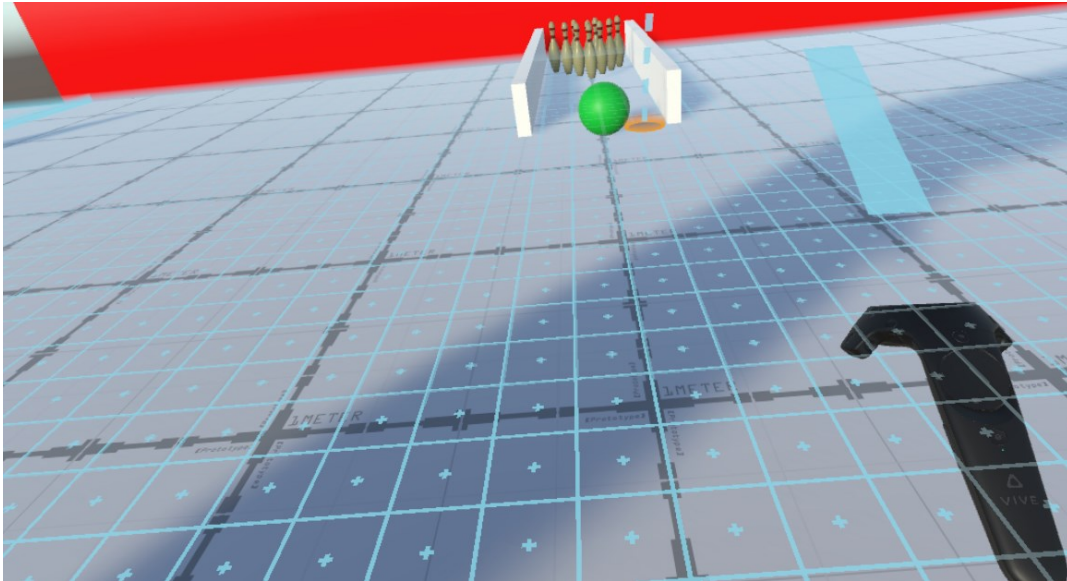[1] Retrieved from https://github.com/Flafla2/Vive-Teleporter/

Figure 4.1: Teleporting with the parabolic pointer in tutorial environment

Another package that is used is the *ViveGrip* package[2]. With this package EU1 can grab objects and move them around using the trigger of the controller. To support the simultaneous use of both packages (teleporting with objects that are grabbed), the scripts have been edited.

In the bar environment there are various alcoholic drinks displayed that could trigger the craving from EU1. When this happens, EU1 can practice to apply the 6D's. Distance is implemented by adding an extra area and relocating the static doors of the original bar environment. Some environmental attributes are added to the outside area such as a tree, some rocks and a bench. There are also virtual characters outside. No virtual substances are displayed outside as EU1 could not take any further distance from the substances that way.

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[2] Retrieved from https://github.com/JScott/ViveGrip/

Figure 4.2: Distance (6D's) - Doors leading to the outside area

EU1 can seek distraction in the bar environment by going to the dartboard and playing darts. This is implemented by adding a collider to the dartboard and the wall behind it that reacts to the collider of the dart arrows and consequently freezes the position of the dart arrows, so they appear to be stuck in the dartboard. EU1 can then get them out of the board with the controller. When the grab script is called, the position of the arrows is unfrozen and corresponds to the position of the controller again.
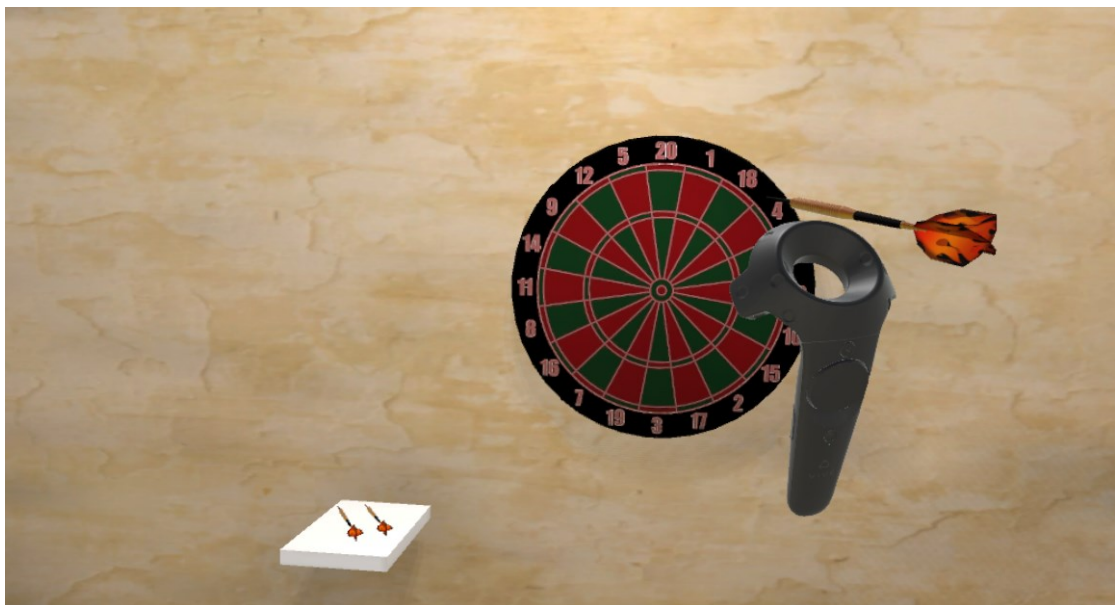

Figure 4.3: Distraction (6D's) – Playing darts

EU1 also has the option to apply the declare self-control technique. On the corner of the bar a smartphone is laying that can be picked up. The screen of the phone is static (i.e. EU1 cannot interact with a menu on the phone to call someone), but the idea is to practice reaching for a phone when situated in a risky situation.

Figure 4.4: Declare (6D's) – Grabbing a phone

The barman confronts EU1 with a choice when EU1 is close enough. The barman points at both a can of soda and a glass of beer. This is implemented in an animation that is triggered when EU1 is close enough. This is when EU1 can apply the self-control technique called different thinking and different acting. EU1 can go for a soda instead of the alcoholic drink and thus act differently than to give in to his craving. The barman stops pointing at the drinks when the distance between EU1 and the barman exceeds a certain threshold.

Figure 4.5: Different thinking and different acting (6D's) – Choosing a soda instead of a beer

Lastly, EU1 can interact with one character that is standing in the bar and talking to another character. This character holds a bottle of beer which he offers when EU1 comes close enough. This implementation relies on parenting the character's hand

to the beer bottle such that the bottle is positioned in the hand. Again, animations are triggered depending on the distance between EU1 and the character. This character is implemented for EU1 to practice saying no. Also, there may be a part of EU1 that does not get cravings from just seeing a bar and needs to have this social interaction of a character offering an alcoholic drink for the situation to become a risk situation.

Figure 4.6: Character offering a beer

In total there are 14 characters in the bar environment. The characters have been created using the *UMA (Unity Multipurpose Avatar) framework*. Their appearances are character recipes that are built using the *UMA DCS scene*. These characters have various animations triggered to them as some are standing or walking and some are seated. All characters appear to have a conversation as they have different audio sources (which are actually muted) attached to them which correspond with a lip syncing script, using the *Oculus OVR Lip Sync* package. There is one sound playing on loop which is a bar background sound which includes people talking and laughing[3].

The four standing characters form two groups which respond to EU1 being close to them as they have variables set for a social distance, at which they look at EU1 and a personal distance, at which they take steps back as EU1 is coming too close to them. There is one group outside (visible in Figure 4.2) and one group inside (visible in Figure 4.6).

The sitting characters have various animations for gestures and postures implemented to evaluate what feels most natural to the participants. Two men sitting on bar stools as well as the female and male in the booth switch between their baseline pose and 30 gesture animations with a script that randomly picks one of the gesture animations.

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[3] MP3 file ripped from https://www.youtube.com/watch?v=4bD-hao3zlY

Figure 4.7: Two males sitting on bar stools

Figure 4.7 shows the two males on the bar stools. The right male is in the base position with his arms resting on his upper legs. The left male performs one of the 30 gesture animations.

Figure 4.8: Male and female in booth

Figure 4.8 shows the male and female in the booth. The male performs his baseline posture with his arms crossed. This baseline posture has been chosen as other postures would make the arms and hands of the characters go through the table when the animations are played after the baseline positions. The female performs one of the 30 gestures.

Figure 4.9: Two males and two females sitting in a booth

The four people sitting in a booth (Figure 4.9) only have a baseline posture with their hands resting on their upper legs and additional lip syncing.

The environments are played in *Unity* for the usability evaluation. By doing this, both the requirements of easily repeating exercises (Table 3.2 #3) as well as live 2D watching (Table 3.2 #10) are satisfied.

4.1.3 Evaluation

Procedure

The evaluation took place on the 6th of June 2017 at the Tactus facility in Rekken, Gelderland. Five Tactus clients with an intellectual disability participated after they had been invited the week before during group session by their treatment providers. The treatment providers informed the group about the evaluations with the information provided on the information brochure (Appendix F). Those that indicated to be interested to participate were given the information brochure and the informed consent form (Appendix G) with adjusted, simplified vocabulary. The inclusion criteria for participants of the evaluation therefore are that they are currently being treated at Tactus for their substance use disorder and they are in the group of clients that has been diagnosed with an intellectual disability.

The evaluation mainly focuses on evaluating the experience of EU1 with virtual reality in general, using the controls, the look and feel of the bar environment and applying the 6D's in the bar environment. The evaluation consists of three sessions. After an explanation of the research and the controls, the first session takes place in the tutorial environment to practice the controls and aims to explore if this tutorial environment is enough or if more is needed. It also focuses to explore what EU1 thinks of the use of the controllers. In the second session the participants are free to explore the bar environment and give their feedback on what they see. In the third session the participant is asked to apply the 6D's in the bar environment and give their feedback. Each session is planned to be approximately 5 minutes and in the beginning an explanation is given of the experiment and the participants are asked to think out loud during all sessions. There are thus task-based instructions as well as free form evaluation about the environment and controls. A detailed description of the procedure that is prepared for the evaluation can be found in Appendix H. With each session at least one treatment provider from Tactus was present in the room. This treatment provider also helped with asking the questions if participants did not understand what was asked of them. Besides the treatment provider(s) there were also two experimenters in the room and the participants are aware of their presence. The first experimenter explained the controls as well as the experiment and asked questions during the sessions while the second experimenter only took notes. The sessions were audio recorded.

Results
The following paragraphs describe each evaluation per participant. The participants remain anonymous and are therefore indicated with a code instead of their names (P1-P5). In the last paragraph a general discussion of the evaluation is described.

P1 learned to use the controls in the tutorial environment but would also attempt to use his feet from time to time. The participant asked if he could also use just one controller as he would prefer this. However, when P1 was in the tutorial environment with one controller, he attempted to grab something with his bare hand. He was very positive to be in the virtual environment and was looking forward to how the bar environment would look. P1 found the controls easy to use but indicated that he would sometimes still get confused with teleporting and grabbing and accidentally pressing the wrong one. The bar environment was intriguing to P1 but he indicated that he would not go to bars often. P1 did therefore not describe it as a risk situation but did indicate that the bar environment looked realistic. The treatment provider however indicated that he would smack his lips as he looked to the beers and he could say this because he could be ashamed to admit that he had a craving. An improvement he mentioned is that the bar could feature brands such as Grolsch or another Dutch brand to be more realistic. P1 found the characters fun to see but did not understand how to interact with them as he seemed more intrigued by the objects such as the phone and the various drinks on the tables and the bar. Regarding the 6D's the participant recognized the phone for declaring and the outside area for distance. These are the ones he most applies in real life situations too. He found it hard to apply other self-control techniques as he indicated that he did not have real cravings. P1 appeared to lose focus after this and the evaluation session was therefore stopped.

P2 firstly put on the headset when it was too tight with a lot of force. A general lesson for the procedure is to give the headset when it is set very loosely and have the researcher strap it on to a good fit. When the tutorial environment was started, the participant found it very overwhelming and immediately took off the headset. P2 explained that it was a nauseous experience because of being in a standing position. P2's legs felt very shaky and therefore he took off the headset. The treatment provider that was present in the room later explained that this is also caused by the participant's alcohol addiction and that P2 in general has trouble with standing or walking for longer times. For the next participants it was chosen to take a precaution to prevent this from happening again. The next participants all start the first session in a seated position.

P3 came into the room and was very careless about the explanation of the controllers and the fitting of the headset, saying that it did not matter to him. In the tutorial environment he very easily picked up the controls saying that he has a lot of experience with videogames and this was a lot alike. He immediately stood up as he gained confidence in his skills in the virtual environment and indicated that the controls were simple and he was ready for the next environment. When the bar environment was started, P3 was able to apply the controls he just learned very quickly. He asked if he could start a fight with the virtual characters and go behind the bar to steal money from the cash register. This tough behavior was later explained by the treatment provider as his way to deal with nerves, just as with the carelessness in the beginning. P3 also indicated in the first minute that the bar was not real. When asked about his opinion of the characters he indicated that there could be more people for it to be more realistic. Also the background noise did not match the lip sync of the characters when P3 came closer. When he was asked about if he experienced this as a risk situation, P3 indicated that he did get cravings from the beers displayed. After this he found the dartboard and found this easy to use. The more time P3 spent in the virtual environment, the more his "though shell" disappeared and at the end he would indicate that he was very tired. When the treatment provider asked to indicate his level of cravings at the moment, he indicated that it was at 9 out of 10 and he was sweating a lot. Regarding the 6D's he found it easy to recognize playing darts as distraction, the outside area as the distance. In the end he explained that he did not expect that it would have such an impact on how he feels, but said he could imagine that it can be very educational. The exposure in the bar environment was very realistic. He also indicated that he would normally drink a lot when he was playing videogames, so this level of craving can also be explained by his association with games and alcohol. After the participant left, the treatment provider explained that he was new in the facility and therefore still experiences very high levels of cravings.

For the fourth participant the tutorial level went alright. P4 indicated that it took some time to get used to the controllers and just as with P1 the controls were sometimes confused. P4 seemed to be rather quickly done with the virtual environments and did not want to continue with the bar environment.

P5 also learned the controls rather easily in the tutorial environment. He seemed to be surprised with each teleportation as the surroundings would change. Also when asked if he could move to another area of the environment he would first attempt to do it by walking instead of using the teleport functionality of the controller. In the bar environment P5 seemed to be more engaged in the details of each object and character than the general surroundings. He indicated that it did

not give cravings as a coffeeshop (in Dutch the term coffeeshop refers to an establishment where people can buy and use cannabis) is a stronger personal risk situation. As feedback for the bar environment he said that there could be more virtual characters, as well as a slot machine and a cigarette vending machine to make it more realistic.

In the time between the session of P4 and the session of P5 a resident of the Tactus facility entered the room. He would originally also be a participant of the evaluation but was not feeling he would be ready for exposure. He was curious and wants to participate the next time if he feels he is ready at that time. He did however indicate that a coffeeshop environment would help him more with learning to apply theory into practice than a bar environment as this is more a risk situation personally.

Several general themes could be found when looking at the evaluation of all the participants. Firstly, most participants were nervous as they had never experienced virtual reality before. The evaluation session was overwhelming as this was not the only factor that was new for them. The experimenters in the room were new people, they had to learn the controls and the bar environment appeared a bit complex in the beginning, especially when they were additionally asked about the 6D's. Some participants did not make it until the second or third session (see Appendix H for description of sessions) as they indicated that they were done. A lesson learned for the real implementation is that it would be better for the participants to get to know the virtual environments, controls and exercises in smaller steps. For instance, to practice with virtual reality for 10 minutes every other day. The bar environment as it was implemented for the first prototype with full freedom to navigate and interact with objects and having the possibility of applying several self-control techniques could be one of the last sessions. This way, very high cravings as experienced by P3 could also be prevented as the virtual therapy is used according to how far the clients are with their regular protocol. This could also benefit the concentration and the nerves of clients in the future as in smaller sessions with more introductions to the virtual environments as exercises and opportunities gradually increase. This could additionally reduce some of the multitasking of the treatment provider as they now also had to focus on how participants walk around in the virtual environment; participants had to be warned when they would near the border of the physical space in the room. An implementation for the future could be that (at least in the beginning) the treatment provider moves the participant in the virtual environment with the push of a button, so the participants do not have to worry about using the teleport functionality. This could also prevent them from confusing the controls as they could solely focus on grabbing in the first few sessions. Some valuable lessons were also learned procedure wise when testing virtual reality with this target group again. Each session is best to be started in a seated position for the participants as this could prevent incidents of being overwhelmed and nauseous as what happened with P2. The general consensus is that the controls are learnable, but it takes some time to get used to them. This is also a reason why simplifying the first experience with the virtual environments and gradually increasing the possibilities for interaction would be better. The general consensus of the realism of the bar environment was positive as everybody recognized this as a bar. Whether it would be a risk situation was very personal as some participants did not have problems with alcohol but rather with other substances. Therefore it was suggested to also use other environments featuring other substances, such as cannabis or cocaine in

the next prototype. Lastly, some things should be taken into consideration that could have influenced the results of the evaluation. It has to be noted that the participants were eager to give answers that they expected the experimenter wants to hear (experimenter effect). This is partly a characteristic of the target group [10]. Because the evaluation took place in the Tactus facility in Rekken, participants that already participated in the evaluation could speak to other participants that still had to undergo the sessions in the recreational rooms of the facility. This could have influenced the outcome of the evaluation as not every participant entered the evaluation sessions with the same knowledge. To prevent this in the evaluation of the next prototype, participants are asked to only talk to other participants about the evaluation when they have both completed all sessions.

4.2 Second prototype

A second prototype can be designed, implemented and evaluated using the results of the evaluation of the first prototype. This second prototype is used to evaluate several aspects regarding usability and user experience. It is also used to evaluate whether a learning curve is present in the use of virtual reality applications with EU1 when some of the participants of the evaluation of the first prototype also evaluate the second prototype.

4.2.1 Design

The evaluation pointed out that a prototype where EU1 is completely free to move around (by teleporting) and grabbing various objects in a complete bar environment can be distracting and too complex, at least to start with. Therefore, changes have to be made in several aspects of the prototype.

Firstly, regarding the complexity of the controllers, the controls are limited by removing the teleporting function. EU1 is also seated in the second prototype. To still implement the changing of position for EU1, buttons are implemented on the screen where EU2 is watching which can be used to move EU1 around the bar with fixed positions. This way, it prevents EU1 to get into inconvenient positions when allowed to move freely and EU2 does not have to focus their attention on repositioning EU1 when this happens. These buttons are a form of graphical user interface (GUI) for EU2.

A second aspect that can be implemented with these buttons is to gradually increase the environment's realism. As the evaluations of the first prototype have shown, a bar that is filled with characters and objects such as drinks and a phone is experienced as realistic but also as distracting for the first virtual reality sessions by EU1. Therefore the second prototype focuses on building up environments with key components. This can be accomplished in various steps, visible in Table 4.2. The evaluation serves to see how EU1 experiences this and at which level it is experienced as a risk situation.

Level	Components added
1	At first, EU1 sits at an empty table in an empty environment.
2	EU2 can add a substance to the table using a button.
3	EU2 can then add a character that sits across the table and offers the substance using another button.
4	EU2 can then add the base layer of the environment, for the structure of a bar or coffeeshop.
5	EU2 can finally render the details of the environment such as characters, substance related objects, decoration of the environment and background noise.

Table 4.2: Levels of realism in environments

The steps of increasing the realism can be used for multiple environments where only the substances and the latter steps would have to be changed to fulfil environment specific purposes. For this prototype, in addition to the already developed bar environment from prototype 1, a coffeeshop environment is also be created as some participants of the evaluation indicated that this would apply more to them as they had a problem with cannabis instead of alcohol. During the evaluations, it can thus be chosen what environment and substance are used in the build-up, depending on the participant and what substance they have problems with.

The interaction with the controller is thus simplified as teleporting freely with the trigger is replaced by teleporting to fixed points in the bar with GUI buttons used by EU2 for this prototype. For a future implementation of an entire virtual reality product, levels could be implemented in which EU1 gradually learns about key components of the product including the controls. Each level could be practiced in different environments, starting in the tutorial environment and later adding substances and complete environments using the levels of realism described earlier. An example of the content of these levels is given in Table 4.3. This prototype thus focuses on implementing the third level with the GUI teleportation whereas the first prototype could be classified as level 5 as EU1 had full freedom of teleporting and grabbing with the controllers.

Level	Position	Controller	Teleportation	Objective for EU1
1	Seated	No	No	Get used to the headset and environments.
2	Seated	No	By GUI	Get used to being teleported to fixed positions.
3	Seated	Yes (only grabbing)	By GUI	Learn how to grab objects.
4	Standing	Yes (only teleporting)	By controller	Learn how to use teleporting.
5	Standing	Yes (both grabbing and teleporting)	By controller	Learn how to use both controls (grabbing and teleporting) simultaneously.

Table 4.3: Example of technological complexity levels for future implementation

In this thesis not all levels are implemented since there is a limited amount of time for developing and evaluating prototypes. In addition to this, the evaluations can only last a maximum of 30 minutes because of the characteristics of EU1. This differs from the realism levels in this prototype featured in Table 4.2 as environments can be built up in one session and thus this aspect can be evaluated fully for user experience. The point is that the idea of building up the technological complexity levels for EU1 to understand the controls of the application can be taken into consideration when making a final product and realizing a program for actual implementation at Tactus.

Another functionality that is implemented in the second prototype is for EU1 to have the "superpower" to make substances disappear at the push of a button. EU1 could use this when their levels of cravings are too high. EU2 could take notes of the moments that EU1 uses this option and talk about it after the virtual sessions. In this prototype evaluation, the user experience of this functionality is evaluated. This functionality is not in the original requirements but was conceptualized after the evaluation sessions as it could improve the user experience of EU1 as they do not have to keep indicating their levels of cravings verbally but could easily show when it becomes too much by using this "superpower". If this functionality is experienced positively by both EU1 and EU2 this functionality could also be used to extend the goal of the virtual application in the future. This suggestion for future research is also described in more detail in section 5.3.2.

For overview purposes and terminology we can thus separate three aspects which can vary in the virtual application. These are summarized in Table 4.4.

Aspect	Description
Levels of realism	Building up the complexity of the environment by adding more key components as described in Table 4.2. Done by EU2 with GUI buttons. Building up these levels is important as starting with the highest level can be distracting for EU1.
Levels of technological complexity	The amount of freedom that EU1 has regarding the controls. Building up these levels is important as starting with the highest level can be confusing for EU1.
Environments	The surroundings that are visible for EU1 as EU2 adds more components. In this prototype there are two environments: the bar and coffeeshop. More environments are needed in the final product as different persons have different risk situations in which they need to practice.

Table 4.4: Aspects of the virtual application

4.2.2 Implementation

The first prototype is altered for the implementation of the second prototype. Several changes have been implemented. Firstly, almost all objects have been given tags for the levels of realism (Table 4.2). When running the prototype, all objects with tags have their renderer disabled which makes them invisible. The only objects with an exception for this are the floor, the walls, the ceiling, a table, two chairs and the fences and grass outside. EU1 starts as if he is sitting in one of these chairs as depicted in Figure 4.10. Only EU2 sees the GUI buttons on the monitor as EU1 is wearing the virtual reality headset. The GUI buttons are in Dutch to comply with the requirement that states that text should be in Dutch (Table 3.2 #20).
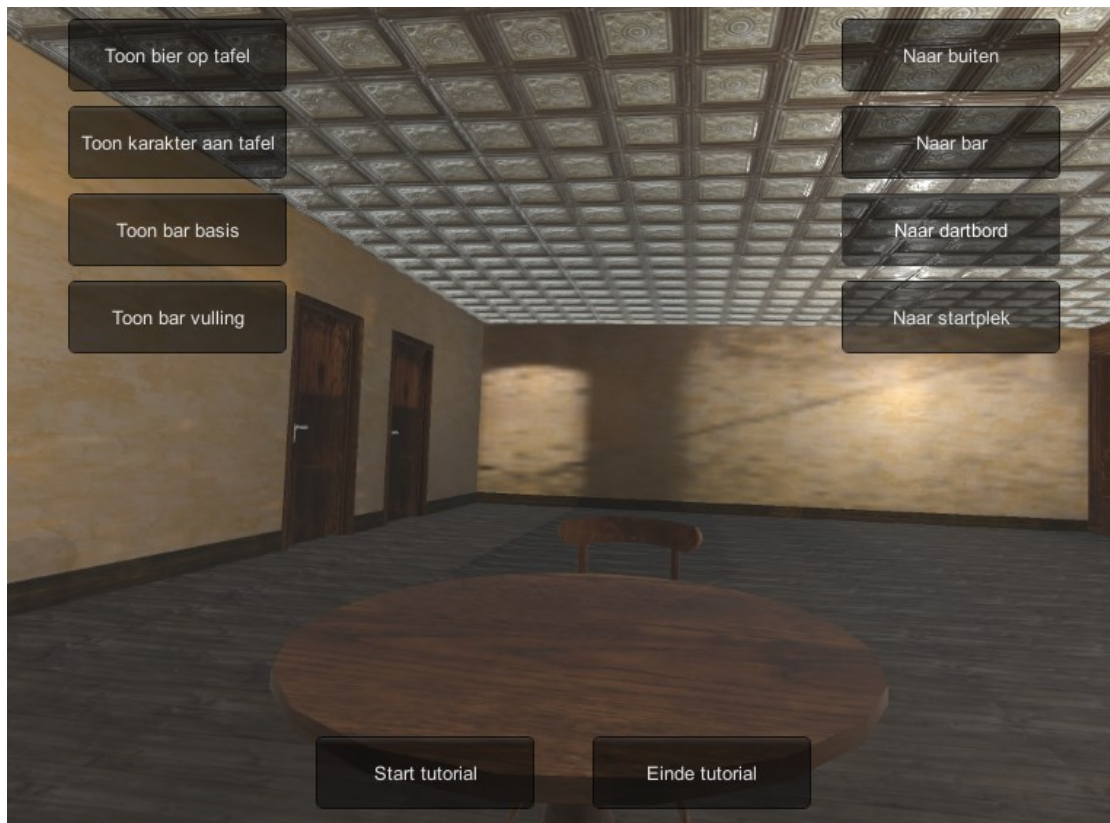
Figure 4.10: The starting structure with only the room, a table and chairs

A fader has been implemented for the screen each time a GUI button is used. This fader is an adaption of the *SteamVR_Fade* script and is used to increase the user experience of EU1 as the environment changes when the environment gets more complex or the position of EU1 is changed by the GUI buttons. After the screen fades to black, the change occurs and afterwards the black fade disappears.

As observations during the evaluation indicated that some participants did not conceptualize the controls from the tutorial level into the bar environment, we implemented a small tutorial in the bar environment instead of doing this in a completely different environment. This tutorial is implemented by GUI buttons on the bottom of the screen. The left button starts the tutorial and makes two objects visible for EU1, a can of soda and a phone as depicted in Figure 4.11. They can practice grabbing with these objects. The right button ends the tutorial and makes the objects invisible again.
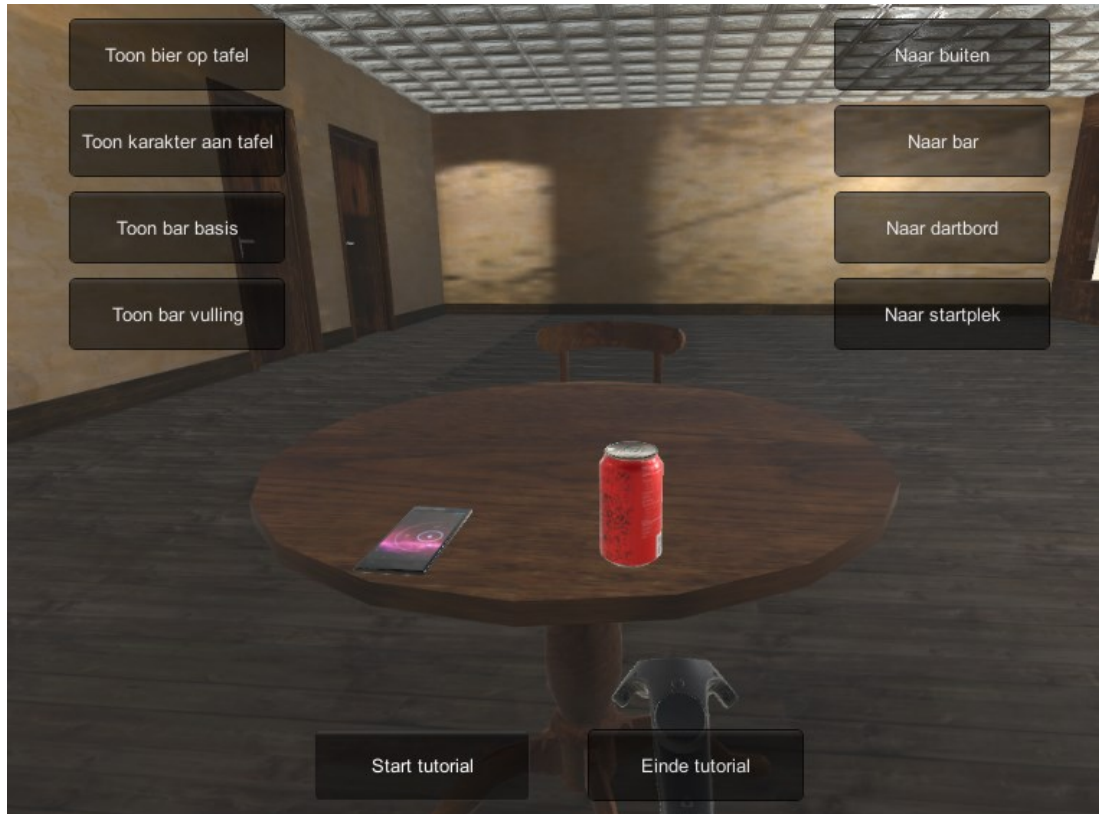
Figure 4.11: Tutorial objects appear to practice grabbing when GUI button "Start tutorial" is used

The GUI buttons on the left are used to build up the environment. This is done by enabling the renderer of objects with certain tags. With the first button a beer becomes visible on the table. With the second button a character becomes visible. When both the beer and the character are visible, EU1 sees the environment as depicted in Figure 4.12. The view of EU1 is without the GUI buttons as mentioned before.

Figure 4.12: The view after the beer and opposing character have been rendered

The third GUI button makes the bar basics visible. This includes the basic structure of the bar such as the inner walls, stools and booths as well as the rest of the outside environment. This is depicted in Figure 4.13. The final GUI button on the left side fills the bar with characters and smaller objects such as drinks, glasses and the dartboard. This is depicted in Figure 4.14. The background sound also starts to play when this button is pressed.

The order of these buttons correlates to the order of showing the various items that build up the realism of the environment. The display of these buttons can easily be interchanged to other text or icons if necessary to be better understandable for EU2. The main goal of the buttons in the prototype is to evaluate how EU1 reacts to building up the environment.
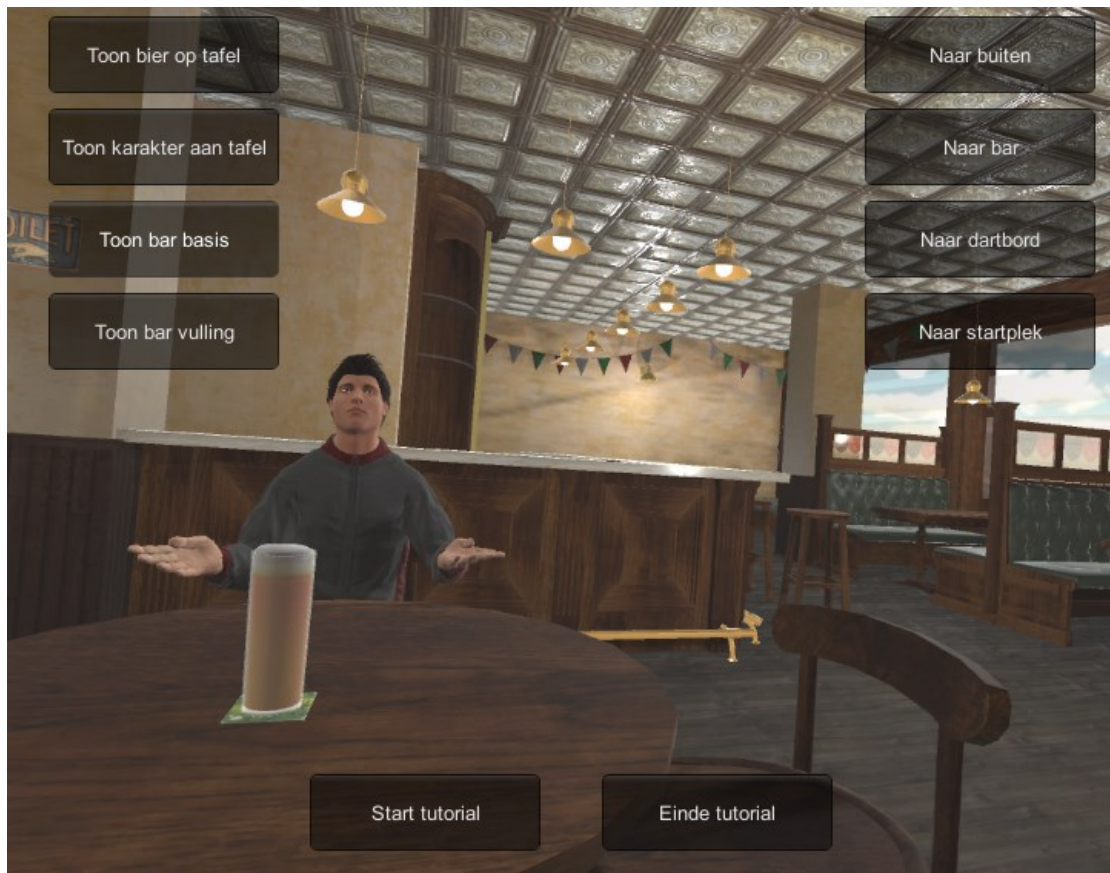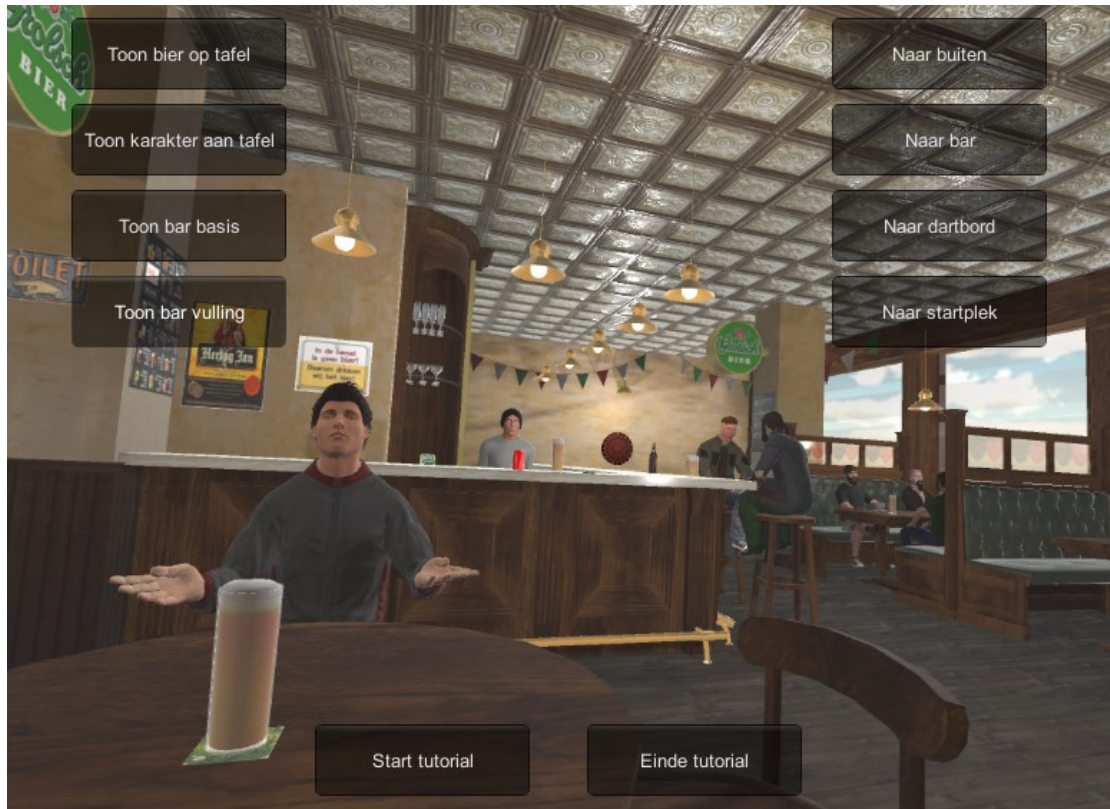
Figure 4.13: The basic structure of the bar

Figure 4.14: The final level of realism as the bar is filled with characters and decoration objects

EU2 can change the position of EU1 by using the GUI buttons on the right. Fixed positions have been chosen to teleport to. From top to right the GUI buttons state the available positions to teleport to: outside, bar, dartboard and back to the starting position. In every position EU1 can remain seated and face the same direction. Therefore, the characters that sit on the bar stools in the first prototype have been placed to another position to make room for EU1's teleportation position. Figure 4.15 shows the bar position. Here, EU1 can apply different thinking and different acting as well as declaring with the phone as discussed in section 4.1.2. The teleported position has been heightened on the y-axis for the bar position so that it appears for EU1 to sit on a bar stool. Otherwise, EU1 would look at the side of the bar when being teleported to this position.

Figure 4.15: The new position after being teleported to the bar

The "superpower" functionality has been implemented by assigning tags to all objects that represent substances. In this bar environment this includes (empty) glasses, bottles and some of the decoration of the bar such as signs on the wall and beer coasters. This has been added to this prototype to make the bar more realistic. Specific Dutch signs and brands have been used to improve the experience of EU1. By pressing the touchpad down, EU1 disables the visibility of all these objects. This also lowers the volume of the background noise to 5%. This has been implemented as the background noise of a bar can also contribute to cravings. Figure 4.16 depicts what the bar position looks like after using the superpower. Note that not only the glasses and bottles of beer on the bar have disappeared but also the decoration that is related to alcohol. EU1 can enable the visibility of the substances again by releasing his finger from the touchpad.

Therefore, EU1 does not have to verbally communicate about his cravings but can simply turn off the visibility of substance related objects when it becomes too much and turn them on again when the cravings have decreased. The superpower stays enabled even when being teleported to another position.
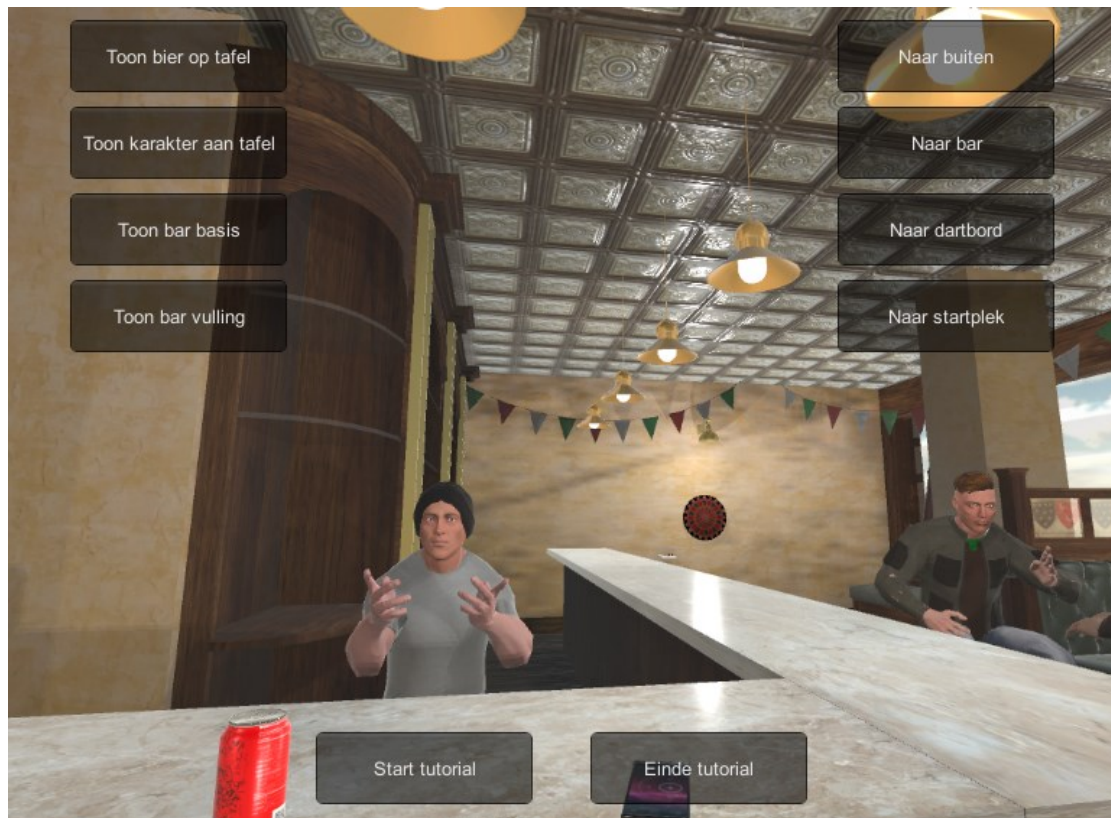

Figure 4.16: The superpower has been used and all objects that relate to substances are invisible

A second environment has also been developed for this prototype. This environment features a coffeeshop as some participants of the evaluation indicated the need for this. The coffeeshop environment features the same functionalities as the bar environment as described above. This includes the tutorial, building up the environment and teleportation by GUI and the ability to grab objects and apply the superpower by applying the controller. Therefore for all new objects in this environment, the correct tags are assigned.

Many assets and materials from the bar environment are used to design the basic structure of the coffeeshop environment such as the floor, chairs and tables. The filling of the environment however requires cannabis related objects. To see what objects are generally present in coffeeshops, images that have been found using *Google Images* have been analyzed. The substance related objects include menus, bags of weed, prerolled cannabis cigarettes (often called joints), lighters, ashtrays, specific types of water pipe intended for cannabis (called bongs), cannabis plants. Other objects that are often present in coffeeshops are intended for entertainment (such as slot machines or board games) or decoration (such as posters).

3D models found on *Sketchup*[4] have been used for most of these objects. Other items such as menus and posters simply use an image found on Google Images as a material. Furthermore, the *Unity particle system* has been used to simulate smoke coming from lighted joints. The outside area of this environment features a street instead of the garden used in the bar environment as coffeeshops usually do not have gardens. Figures 4.17 – 4.20 illustrate the different positions where EU1 can be teleported to. In these figures the environment has been build up completely. Figure 4.21 shows the use of the superpower.

Figure 4.17: The starting position in the coffeeshop

[4] 3D modelling application with community made models found at https://3dwarehouse.sketchup.com/

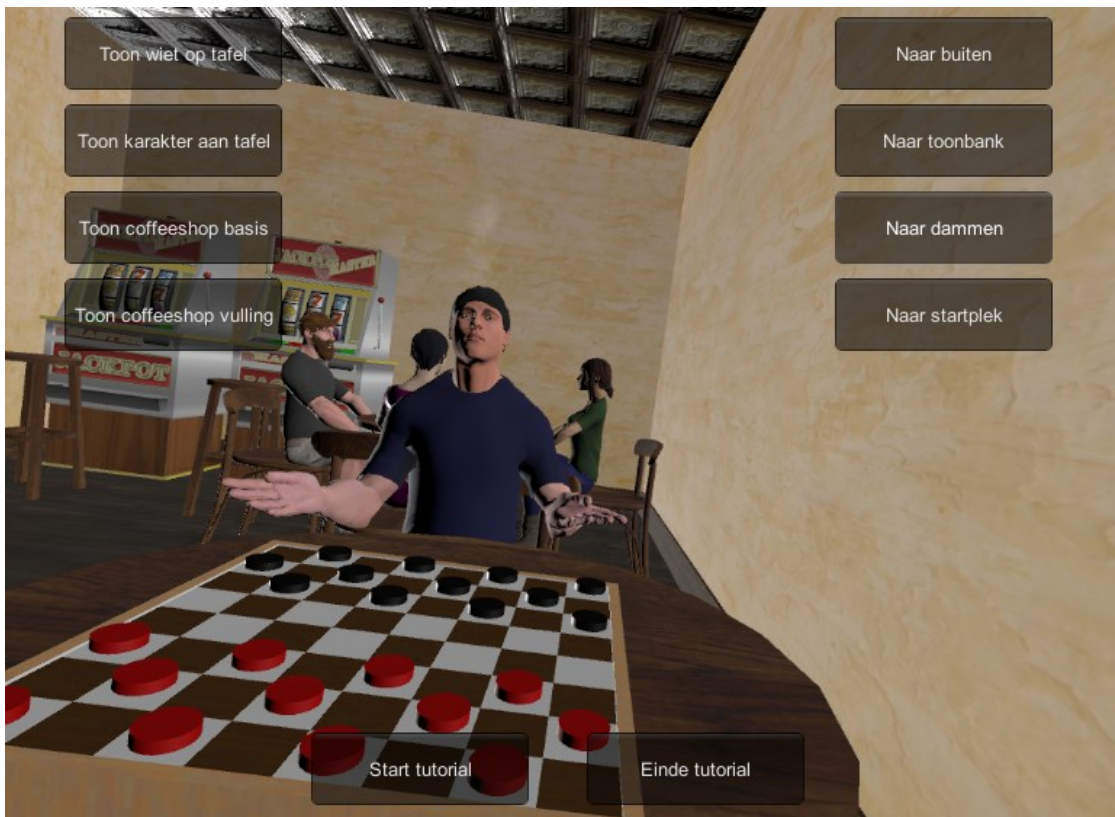Figure 4.18: The new position after being teleported outside

Figure 4.19: The new position after being teleported to "checkers". Here distraction can be applied by playing a board game
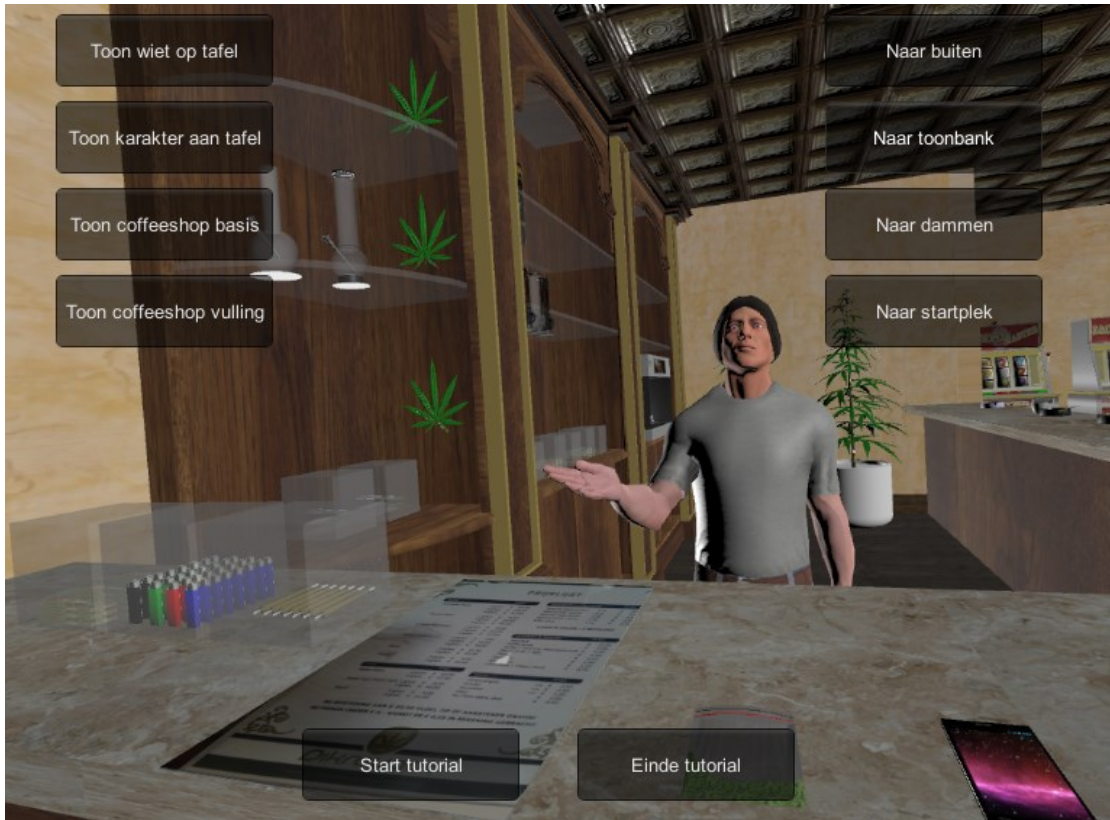
Figure 4.20: The new position after being teleported to the counter of the coffeeshop

Figure 4.21: All objects that relate to substances disappear after using the superpower

4.2.3 Evaluation

Procedure

The second evaluation of the prototype took place on the 28ᵗʰ of June 2017, again at the Tactus facility in Rekken, Gelderland. The procedure of inviting clients of the facility to participate in the evaluation is the same as for the first prototype. For this evaluation four clients of the facility agreed to participate.

The evaluation aims to examine how EU1 experiences the three aspects mentioned in Table 4.4. Before the session of each participant, it is asked whether a bar or a coffeeshop poses more of a risk to them to determine which environment should be used for the evaluation. In the evaluation only one controller is needed and therefore used to reduce the complexity of having two controllers. Firstly, the grabbing interaction is evaluated with the tutorial objects. If this is clear, the build-up of the environment is evaluated. When the substance on the table is visible, the superpower can be tested by EU1. This substance is either cannabis or beer depending on the environment is used. Whenever the use of the superpower is clear it is asked to use the superpower only if the cravings become too high. After this, the rest of the environment is built up and it is evaluated how EU1 experiences this as well as the realism of this environment. Lastly, EU1 is teleported to various positions of the environment and asked to evaluate this. Asking participants to actively recognize the 6D's is not incorporated in this evaluation as it turned out that this was too much during the evaluation of the first prototype. It is now simply stated what the use of each position is before the participant is teleported to this position and whether they find this a realistic representation the 6D's in this environment. At the end of the session in the virtual environment, a final interview is conducted. This means that the evaluation session is shorter compared to the previous evaluation as the controls are learned in the same environment. Also the teleporting control, which proved to be difficult in the previous prototype, does not have to be learned by the participants. It is expected that this causes participants to complete the session as some participants of the evaluation of the first prototype lost focus. Two participants that have participated in the evaluation of the first prototype also participate in this evaluation. For these participants, it is investigated if a learning curve can be observed and how they experience the changes in this prototype compared to the first prototype. A detailed description of the questions that are prepared for the evaluation can be found in Appendix I. A factor that has been changed compared to the procedure of the previous evaluation is that there are less people present in the room. During the evaluation sessions there is only one treatment provider present and only one experimenter and the participants are aware of their presence.

A script has been implemented to log certain events and the times they occurred in a file for each session. This includes all GUI interactions as well as the superpower. This log file is used to better analyze the session of each participant in combination with the audio recording.

Results
The following paragraphs describe each evaluation per participant. The participants remain anonymous and are therefore indicated with a code instead of their names (P1-P4). In the last paragraph a general conclusion of the evaluation is described.

The first participant of this evaluation (P1) was also the first participant of the previous evaluation (P1 mentioned in section 4.3.1) and had therefore already some experience in virtual reality. He indicated that he did not have problems with either bars of coffeeshops as he would mostly use substances at home. He therefore evaluated the bar environment to compare it to last time. The interaction with the controller to grab objects was no problem as he remembered this from last time. He also found the superpower interaction easy to use. According to P1, the gesture of the opposing character at the table indicated "bring it on" and was not related to the beer on the table. He also felt that the character has weird eyes. When rendering the rest of the bar P1 indicated that he recognized this from last time and found it a realistic bar, especially since it now features some Dutch brands on the menu and on the walls. After being teleported to the various positions P1 indicated that it takes some getting used to but it was not an unpleasant experience. He recognized the phone again as declaring and indicated that the outside area is good for distance. After the session P1 indicated that building up the environment was not necessary for him as he is not easily distracted in a bar as it is not a risk situation for him. The superpower was used 9 times after the instruction had been given to only use it for cravings, which would contradict this statement. However, when looking at the time that the substances are hidden, 1.96 seconds on average, it could be argued that the participant was not using the function as intended but rather at random. The fact that he also used the superpower twice when being outside, where no substances are featured, supports this hypothesis. Compared to the first prototype he indicates that he found it quite similar in use. The VR session lasted a total of 8 minutes.

P2 has never experienced virtual reality before. He indicated that he was receiving treatment for his cocaine addiction but also regularly visited bars and this would therefore be more of a risk situation than a coffeeshop. Grabbing objects and using the superpower went easy after he found the buttons while holding the controller. The realism of the opposing character was a positive surprise for the participant. To P2 the gesture indicated that he would like to order something. When the bar is filled with people and other details P2 indicates that it seems like a nice bar where people have fun and it looks realistic. The participant says he is positively surprised by the technology when he is being teleported and does not find this shocking or unpleasant. He immediately recognizes his new position and looks back at the starting table to confirm this. The participant has not yet learned about the 6D's as he is in the beginning of his treatment program. Therefore the 6D's have not been further discussed with P2. After being teleported outside, he indicated that it is a nice and calm area. After the session P1 indicated that he found it a lot of fun to experience virtual reality and easy to interact with the environment. He said that the building up of the environment felt odd in the beginning as new objects or characters magically appear. However, he also indicated that it was good to gradually increase the content of the environment because it probably would be too distracting to have everything at once. He was positive about the teleporting and said that this felt natural. To this he added that it is a prerequisite that somebody announces the teleportation, otherwise P2 expects this could be odd or even shocking. He indicated that he did not need the superpower as he does not have a lot of problems with alcohol but could see how this could be convenient for people who do have an alcohol addiction. This statement is supported by the log file as he did not use the superpower at all after receiving the instruction to use the superpower when experiencing cravings. The VR session lasted a total of 6 minutes.

P3 has also never experienced virtual reality before and is thus a new participant in this study similar to P2. He indicates that one of his problems is alcohol and thus the bar environment would be best to evaluate. He was positive to see a virtual environment for the first time. The grabbing control was easily learned during the tutorial and was evaluated as pleasantly. When the beer on the table was rendered P3 indicated that it looked not very real to him as he usually drinks from bottles. The glass could be improved by adding a brand or sign that is familiar to him. The control to use the superpower was easily learned. P3 indicated that the opposing character at the table reminded him of *The Sims*[5] but that he looked realistic enough. The gesture was interpreted as if the character asked the participant what he would want to order. When the basics of the bar were shown P3 indicates that he got some cravings but not enough to use the superpower. After the details of the bar were shown, P3 indicated that it was a realistic bar and his cravings increased a bit. The teleporting was experienced as a bit odd as P3 found the movement too fast. He suggested to changing this by adding an animation of "walking" to the new position so it would be clear that you change position and where this position is. He also just started the program and did not know about the 6D's and could therefore not comment on this. The outside area was evaluated as calm. The building up was evaluated as pleasant. His statements about cravings are supported by the log file as he did not use the superpower once after practicing. The VR session lasted 8 minutes. At the end he made some suggestions for other environments which feature drugs: living rooms with a few characters on a couch who consume drugs or a festival where you are standing in a group of characters who consume drugs and invite you to partake in this.

The last participant (P4) of this evaluation is the same person as P3 in section 4.1.3. He indicates that he would regularly visit bars and coffeeshops so he does not mind to try out both environments to give feedback. Similar to last time the controls were very easy for this participant. The gesture of the opposing character was interpreted as "come and get it" by P4. The new decoration of the bar environment was evaluated as realistic as details such as coasters and menus seemed familiar to the ones P4 saw in real bars. He also said that the sound reminded him of people drinking. The way that teleporting works is not annoying to him but he is disappointed that he cannot move around freely anymore. The participant used the superpower 5 times in the bar. However, with a sample mean time of 0.44 seconds, it can again be argued that this is rather at random than to actually hide substances because of cravings. This is also supported by the fact that the participant used the superpower twice outside. The VR session in the bar lasted 5 minutes for this participant.

As the controls, building up and teleporting functions are similar in the coffeeshop environment, the participant mainly focused on evaluating the realism. The participant had several points of improvement to improve this.

- The rolling papers used for the joints are brown and he always used white ones (from Rizla[6]), and if this was used, this would increase his craving he expects.

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[5] The Sims is a life simulation videogame series.

[6] Rizla is a brand of rolling papers.

- The bags of cannabis would be more realistic if they clearly showed the cannabis buds instead of just a green grass texture.
- Normally there is music playing in a coffeeshop so this could be added to the background sound.
- While the cannabis plants behind the counter are nice decorations it is not realistic.
- The coffeeshops he attended usually have security personnel at the entrance, so this is a character that can be added.
- What could also be visible from the outside is a sign which indicates that it is a coffeeshop.

He did mention that especially the details of the menu gave him cravings. At the end he indicated that his cravings were very high, just as last time. When looking at the log file for this environment it is therefore surprising to see that he did only use the superpower once at the coffeeshop for a total of 0.6 seconds. The VR session of the coffeeshop lasted 7 minutes.

Participant	Total time in VR (in minutes)	Use of superpower (number of times)	Mean duration of superpower use (in seconds)	Standard deviation of duration of superpower use (in seconds)
P1	8	9	1.96	2.37
P2	6	0	-	-
P3	8	0	-	-
P4 – Bar session	5	5	0.44	0.21
P4 – Coffeeshop session	7	1	0.6	-

Table 4.5: Summary of the results of the log files

Some general themes can be found when looking at the evaluation of all participants together. All participants completed the evaluation sessions in contrast to the evaluation of the first prototype as only 3 out of 5 participants completed that. This can be attributed to the measures that have been taken to decrease the overwhelming of participants. Only one experimenter and one treatment provider were present in the room this time, the controls were learned in the same environment, the freedom of teleporting was restricted as the participant could remain seated at all times and the environment was gradually rendered. The new features of the superpower, gradually building the environment and teleporting were generally evaluated as positively. However, for the

participants that have already experienced full freedom with teleporting with the first prototype it can observed that they are either annoyed to have their freedom of movement restricted such as P4 or not be too impressed by the whole experience as P1. A general lesson learned for the final product is that when people reach a higher level (mentioned in Table 4.3), they should stay on this level, unless it is evaluated as too hard. For the new participants, it could be observed that gradually building the environment and being teleported is perceived as pleasant after getting used to it. The teleporting motion could be animated as suggested by P3. Furthermore, there are some improvements for the realism of both environments mentioned by the participants such as the details of the substances and decorations. It is remarkable to see that the new participants did not use the superpower anymore when receiving the instruction to use it when the cravings become too high after practicing. There is a possible explanation of why the participants that also participated in the evaluation of the first prototype did use the superpower and mostly for short periods of time (see Table 4.5) after receiving the same instruction. They could have remembered using the touchpad of the controller (which was used for teleporting) and could be confused because of this. Therefore, if the superpower functionality would be implemented in the final product, alongside with free teleportation and grabbing controls, this could best be implemented at a separate button of the controller. This is possible as the *HTC Vive* controllers have a grip button that has not been implemented in the prototypes (see Figure E.4).

Discussion

This chapter discusses the findings of the study and compares this to the knowledge presented in earlier chapters to see what new insights can be gained. Furthermore, it discusses the limitations of the study that need to be taken into consideration when interpreting the results. Lastly, it discusses suggestions for future research as this study is the first step in a bigger cooperation project between Tactus and the University of Twente.

5.1   Interpretation of results

As the reviewed literature in the preliminary research [4] suggests, the design of any VR learning product should keep the characteristics of the target group in mind. This means that the design should be kept simple at first and take small steps in increasing the complexity. The effect of this could be observed when comparing the results of the evaluation of the second prototype to those of the first prototype. As the first prototype was too complex as a first experience with virtual reality, some of the participants seemed to lose interest or focus. However, when the complexity is reduced by taking measures as gradually building the virtual environment and limiting the complexity of the controls by removing the free teleportation, it can be observed that all participants finish the evaluation sessions. This confirmation forms the foundation of the idea that when Tactus wants to implement virtual reality in their protocols, this should be a program on its own where clients first learn to use the technology step by step before practicing risk situations. This is further discussed in section 5.3.1.

Another confirmation of knowledge gathered by reviewed literature in the preliminary research is the fact that substance cue exposure in virtual reality can be effective. Most participants of the evaluations indicated that they would get cravings, although it must be noted that the level of cravings differed between participants and some participants made suggestions to make the substances more realistic.

The evaluation sessions with clients (EU1) also found that when virtual reality environments are designed with the heuristics of Sutcliffe & Gault in mind [22], the larger part of EU1 experiences the virtual bar and coffeeshop environment as realistic. It has to be noted that there are still some improvements to be made for the environments as suggested by some participants. These suggestions can differ per person and this can be explained. The heuristics only state that for someone to experience the virtual environment as real, components and their interaction and physics in the virtual world have to behave as this person expects them to. This expectation is based on their experience in the real environments that are represented in the virtual environment. While this can be generalized for natural forces as gravity or friction, the realistic representation of objects in the virtual world differ because the experiences in the real environments differ per person. This means that what is experienced as a realistic virtual substance or structure of

an environment by one client can be experienced as non-realistic for another client, because they have different experiences in the real world. This sprouts the idea of developing a framework for treatment providers (EU2) to change or create environments by using default components. This is further discussed in section 5.3.2.

5.2 Limitations

It has to be noted that the small sample size for both participants in the requirements gathering process as well as the evaluation processes could contribute to findings and the decisions that were based on these findings. Unfortunately this small sample size is caused by the limited time available for the research and the amount of clients at the Tactus facility in Rekken. This is however a qualitative and explorative research that takes each participant as a particular case to see what knowledge can be gathered from their participation. While a larger sample size of participants could have revealed more findings on both the requirements as evaluation of the prototype, it should be taken into account that this is not study that tries to test a hypothesis but rather explores what should be taken into consideration for the development of this innovative product.

Another factor that may affect the findings is a characteristic of EU1 that has been discussed briefly in the evaluation results of the first prototype. This characteristic causes EU1 to eagerly give an answer that they feel is expected of them, rather than to think about the question and to honestly answer with their opinion [10]. In hindsight, treatment providers of Tactus could have been asked how they deal with this characteristic when talking to EU1. While there was at least one treatment provider in the room of the experiment during all evaluation sessions, they were not instructed to help with this specifically.

5.3 Suggestions for future research

There are various suggestions for the next phases of this project. These suggestions can be categorized into different types which are discussed in according subsections. The first subsection discusses what in general could be the next step to continue this project. The second subsection discusses possible additions to the virtual reality product.

5.3.1 General continuation of project

One of the main findings of this study is that EU1 needs to learn to use this new technology in small steps. Therefore, a next phase of this project could be to design and develop a program in which the detailed elaboration of these small steps is implemented. In this program, EU1 could for instance do small VR exercises each week to learn the controls and get used to the virtual environment before getting objectives relating to applying the 6D's in risk situations. An example of gradually building up this technological complexity is given in Table

4.3. This ensures that when they learn about the 6D's in theory in the protocols, they are ready to apply it in VR as they have already learned how to use the controls. When virtual environments and additional instructions are developed for this program, this could be piloted to evaluate the user experience of the complete program. When the breakdown of technological complexity in smaller steps and the objectives relating to the 6D's are evaluated positively by the pilot group, the next step would be to test it for effectiveness. This can be done by comparing the results regarding slip-ups and relapses of a group that has followed the VR program to a control group that only follows the regular program (i.e. the MDOD protocol). As the goal of the program is to overcome substance use disorders this can be regarded as medical research[7]. To be allowed to perform medical research, it is necessary to have permission from a certified medical ethical validation committee (METC[8] in Dutch).

5.3.2 Possible additions

There are some ideas that have been discussed informally with Tactus treatment providers (EU2) regarding additions for the virtual reality product. These aspects can be investigated when this project is continued to see if these additions are worth implementing. This investigation can be performed in the same way; firstly gathering requirements by organizing focus groups with stakeholders and evaluating prototypes that have been designed and developed in line with these requirements. This is necessary as these ideas would add new goals to the product.

As mentioned in the evaluation of the second prototype it is perhaps best that the superpower control is implemented as an extra technological level in the future product (see Table 4.3) where a third control is added for the superpower. It could be interesting to investigate whether this control above the already available controls is understandable for EU1 when they have reached a later level. The controller could be represented as something that EU1 can later use as an actual talisman (lucky charm) such as a Tactus coin, key or sunglasses. The goal of the application would be expanded as EU1 would not only learn how to apply the 6D's in realistic scenarios but also by transforming a talisman from the virtual world to the real world. A study shows that carrying a lucky charm can make people more optimistic and confident in life [23], so it would be interesting to research if this is effective for the target group regarding abstaining from substances as well. Before this can researched, it has to be investigated if this group has the ability to realize the abstraction of the virtual talisman to the physical talisman and its superpower it had in the virtual environments.

Another aspect that can be investigated is creating and changing environments easily for Tactus treatment providers. When it turns out that for particular clients a small change in the environment is necessary to make it realistic, it would be convenient for EU2 to have the possibility to do this using a framework instead of having to contact developers that an extra environment has to be created for a specific client. This framework could even be in VR as EU2 could drag and drop

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[7] https://www.ccmo.nl/nl/uw-onderzoek-wmo-plichtig-of-niet

[8] https://www.metctwente.nl/

objects into the environment and save them when they are finished with editing. This idea can even be extended by not only having EU2 make changes to existing environments to fit wishes of particular clients but could also create completely new environments. For this there would have to be a catalogue that contains certain default objects such as walls, floors, tables, chairs but also decorating materials and a variation of representations of substances. This is in line with the content management system (CMS) that has been discussed in the results of the interview in section 3.4.2.

An addition for the virtual characters concerns their speech. A participant in the evaluation of the first prototype mentioned that he noticed that the sounds do not change if you come closer to a certain character. This is because they only have a lip synced movement to muted sounds and there is one background sound for the environment. It could be investigated whether adding real Dutch monologues to certain characters (that start to play when approaching the character) enhances the experienced realism of the environments. The content of these monologues would have to be discussed with Tactus treatment providers or even clients as they have most experience with what phrases or expressions are often found in these environments. It could even be developed as an interactive dialogue system which reacts to the choices that EU1 makes in the virtual environment.

A last informal addition, which was suggested by a treatment provider after the evaluation session of the second prototype, concerns the environments. The risk situations that are represented in virtual environments should not only contain environments where substances are present. Another type of risk situations are emotional triggers that often lead to substance use for EU1. A heavy emotional trigger could be the death of a relative or being fired from a job in a time of financial insecurity. They can however represent smaller triggers such as an argument with a partner. The point is that these situations could be represented in virtual reality to learn how to deal with these situations. This relates to the theory of the treatment protocols of having certain habits and how to deal with these (by using the 6D's). It can be found in the literature regarding substance use disorders that for EU1 it is common to see the substance as a remedy for any problem encountered in life, while in fact they often make the problem worse afterwards and maintain a vicious cycle of substance use [8]. When applied to this situation, it can be argued that EU1 normally deals with these emotions by using substances instead of processing them naturally and therefore needs to practice this in virtual reality. Virtual reality can simulate these situations and help EU1 to learn how to cope with negative emotions without relapsing to substance use.

Conclusion

This project explores the opportunities and possibilities of a virtual reality product for treatment of individuals with both a substance use disorder and an intellectual disability at Tactus. This study analyzes literature to get a better understanding of what defines substance use disorders and how this is treated. Literature shows that substance use disorders are complex as they have psychological, physical, social and cerebral factors that maintain the disorder. Because of this, there are various methods used to treat the disorder, often dependent on the political and social understanding of the disorder. The transtheoretical model, which is analyzed in greater detail, shows that for every change, generic stages and their characteristics can be identified. Two Tactus treatment protocols for this target group are analyzed in detail to get an understanding of the current situation. These treatment protocols give insight into people with an intellectual disability and their learning methods that rely on small steps and repetition. General recurring concepts, that aim to give the clients better insight into why they use substances and how they can prevent to do this in the future, can be found in both protocols. These concepts include habits, risk situations, cravings, saying no, self-control techniques (6D's), slip-ups, and relapses.

After laying the theoretical foundation for this research, the practical following steps could be taken. Firstly, the stakeholders in this project have been identified and their domain specific knowledge has been incorporated in the requirements for the virtual reality product. This determined that the user goal of the product is to practice the self-control techniques (6D's) in realistic virtual environments that represent risk situations. With two prototypes, several aspects of usability and user experience have been evaluated. It has been evaluated what makes environments realistic for this target group as well as what types of interaction with the environments work best for this target group. The findings show that gradually building the environment as well as starting with a low level of technological complexity regarding the controllers seems more efficient to keep the focus and motivation of participants. The properties of virtual reality allow this target group to express themselves by physical actions rather than verbally. These properties have been utilized by letting the target group learn the controls in the virtual environments and express their levels of cravings with the superpower.

This project is the first to involve a virtual reality product for people with both a substance use disorder and an intellectual disability as current literature only shows virtual reality applications for each aspect separately but not the combination. The literature that was found concerning virtual reality products for people with an intellectual disability did not document the design and development process. This study documented the design, development and evaluation of two prototypes and this is therefore relevant as this is a gap in current literature. A last aspect of relevance is that this project aims to extend the virtual reality substance use disorder treatment goals. Other virtual reality literature relating to substance use disorders focuses solely on cue exposure. While this is also incorporated in the prototypes, the main focus of the virtual

reality product to be developed is to practice applying learned theory regarding self-control techniques in realistic virtual representations of risk situations. Before this can be practiced, the controls and environments should gradually increase in complexity in a way that the target group is comfortable using this technology. This explorative research demonstrated how virtual reality can be used as a tool to support the substance use disorder treatment of people with an intellectual disability.

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Dutch information brochure for interview participants

Beste lezer,

Met deze brochure willen we u inlichten over het onderzoek waar u aan meewerkt. Het onderzoek getiteld "Using virtual reality to treat substance use disorders of people with an intellectual disability" heeft als doel om te verkennen wat de mogelijkheden zijn van virtual reality voor de verslavingsbehandeling van cliënten met een licht verstandelijke beperking (LVB). Een onderdeel hiervan is het verzamelen van de business requirements, zodat duidelijk is wat de partij Tactus wilt bereiken met dit onderzoek. Het interview neemt plaats op 03-04-2017 in het Zilverling gebouw op de Universiteit Twente te Enschede. Het interview vindt 1 op 1 plaats met de onderzoeker (ondergetekende) en u kunt verschillende virtual reality apparaten uitproberen. Er zijn enkele zaken waar u zich bewust van moet zijn voor u deelneemt:

- Ten eerste zijn er geen foute antwoorden in het interview, wij zijn juist benieuwd naar uw mening. Wat u van de organisatie Tactus weet, is juist erg nuttig voor dit onderzoek.
- Ten tweede wordt het interview opgenomen (alleen audio) zodat de onderzoeker (ondergetekende) deze later kan terugluisteren voor de analyse van de resultaten. De enige partijen die toegang kunnen krijgen tot deze resultaten zijn de bij het onderzoek betrokkenen individuen van Tactus en de Universiteit Twente puur ter beoordeling van het onderzoek. Deze data wordt niet zonder uw expliciete toestemming verder aan derden verspreid. De gepubliceerde resultaten van het onderzoek zijn niet terug te leiden tot individuen.
- Ten derde is er een risico verbonden aan virtual reality. Het kan namelijk zijn dat u een lichte misselijkheid ervaart in een virtuele omgeving, vergelijkbaar met wagenziekte. Mocht u snel misselijk worden in voertuigen dan kan het zijn dat u dit ook wordt met virtual reality. U bent te allen tijde vrij om de virtual reality bril af te zetten.
- Ten vierde bent u te allen tijden vrij om uw gehele deelname aan het onderzoek te beëindigen, zonder dat u hiervoor een reden hoeft op te geven of consequenties van ervaart. Wanneer u hiervoor kiest, wordt de verzamelde data die van u afkomstig is ook verwijderd en niet meegenomen in het onderzoek. U heeft daarnaast het recht om tot 24 uur na deelname, het verzoek in te dienen bij ondergetekende dat uw data niet wordt gebruikt in het onderzoek.
- Ten vijfde kunt u indien u naderhand klachten heeft over het onderzoek contact opnemen met de secretaris van de Ethische Commissie van de faculteit EWI van de Universiteit Twente, drs. Jorien van Loon, P.O. Box 217, 7500AE Enschede (NL); e-mailadres: j.vanloon@utwente.nl

Ondertekend,
Onderzoeker: Joost van Aggelen, telefoonnummer: +316 39 33 85 41, e-mail adres: j.m.vanaggelen@student.utwente.nl

Dutch informed consent form

Toestemmingsverklaring formulier (informed consent)

Titel onderzoek: Using virtual reality to treat substance use disorders of people with an intellectual disability

Verantwoordelijke onderzoeker: Joost van Aggelen

In te vullen door de deelnemer

Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode, doel en de risico's en belasting van het onderzoek door middel van de "informatiebrochure Virtual Reality onderzoek". Ik weet dat de gegevens en resultaten van het onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden. Mijn vragen zijn naar tevredenheid beantwoord.

Ik begrijp dat audio opnames of bewerking daarvan uitsluitend voor analyse en/of wetenschappelijke presentaties zullen worden gebruikt.

Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen. Wanneer ik hiervoor kies, wordt de verzamelde data ook verwijderd en niet verder gebruikt.

In het geval dat ik naderhand klachten heb over dit onderzoek, weet ik dat ik mij kan richten tot de secretaris van de Ethische Commissie van de faculteit EWI van de Universiteit Twente, drs. Jorien van Loon, P.O. Box 217, 7500AE Enschede (NL); e-mailadres: j.vanloon@utwente.nl

Naam deelnemer: ……………………………………………………………………

Datum: …………… Handtekening deelnemer: …………………………………………

In te vullen door de uitvoerende onderzoeker

Ik heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden. Ik zal de opnames van dit onderzoek niet verspreiden naar derden en de resultaten van het onderzoek zullen niet terug te leiden zijn tot individuele deelnemers. De deelnemer zal van een eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden en de desbetreffende data zal worden verwijderd en niet verder worden gebruikt in het onderzoek.

Naam onderzoeker: …………………………………………………………………………

Datum: …………… Handtekening onderzoeker: …………………………………………

Interview questions

1. Could you describe your function at Tactus? How would you justify your representation as the organization Tactus for this project with regards to adjudications about vision, strategy and goals of Tactus?

2. What is the general vision and strategy of Tactus? What is the general business model?

3. What types of projects are currently running at the E-health department? Are there already projects for the development of VR?

4. What does Tactus want to achieve by using VR for this target group?

5. What advantages does Tactus suspect that VR will have over other techniques or approaches?

6. What advantages does Tactus suspect that VR will have over other techniques or approaches?

   For this exploratory phase the HTC Vive with a virtual environment has been chosen because of the many opportunities for interaction, movement and customizability options in the environments. The next questions however are about the future, when Tactus would apply a VR solution on a larger scale.

7. When VR is applied to a larger scale, how would Tactus envision this? When would clients use VR and what budget would there be to purchase and maintain a VR solution?

8. Regarding the various options for VR devices, what device(s) would suit the needs but would fall into budget of Tactus for a future larger scale implementation?
   A mobile device such as the Samsung Gear VR is portable, but has a lower resolution and has fewer options for interactions. The costs are considerably lower however than more high-end devices such as the HTC Vive and the Oculus Rift. These devices provide a better resolution, more interaction possibilities with the controllers but need to be connected to a powerful laptop or desktop computer. Therefore these devices are less practical considering portability and are more expensive, both the device itself as the computer that they need.

9. Regarding the various options for types of environments, what (combination of) environments would suit the needs but would fall into budget of Tactus for

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a future larger scale implementation? A 360⁰ camera could film an environment in the real world and could thus quickly be made; there are however no opportunities for interaction with this filmed layer. A virtual environment has to be designed and would thus be more costly to develop but there are more possibilities regarding interaction with the environment. Also for game like environments, the environments would not have to comply to normal rules of physics as this can be customized for each environment for example.

10. Do you have anything else to add regarding business requirements for this project?

Dutch information brochure for focus group participants

Beste lezer,

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- Ten eerste zijn er geen foute antwoorden in de focus group, wij zijn juist benieuwd naar uw professionele mening, ook als deze in strijd is met die van andere deelnemers. De discussie die hieruit ontstaat is juist erg nuttig voor dit onderzoek.
- Ten tweede wordt de focus group opgenomen (alleen audio) zodat de onderzoeker (ondergetekende) deze later kan terugluisteren voor de analyse van de resultaten. De enige partijen die toegang kunnen krijgen tot deze resultaten zijn de bij het onderzoek betrokkenen individuen van Tactus en de Universiteit Twente puur ter beoordeling van het onderzoek. Deze data wordt niet zonder uw expliciete toestemming verder aan derden verspreid. De gepubliceerde resultaten van het onderzoek zijn niet terug te leiden tot individuen.
- Ten derde is er een risico verbonden aan virtual reality. Het kan namelijk zijn dat u een lichte misselijkheid ervaart in een virtuele omgeving, vergelijkbaar met wagenziekte. Mocht u snel misselijk worden in voertuigen dan kan het zijn dat u dit ook wordt met virtual reality. U bent te allen tijde vrij om de virtual reality bril af te zetten.
- Ten vierde bent u te allen tijde vrij om uw gehele deelname aan het onderzoek te beëindigen, zonder dat u hiervoor een reden hoeft op te geven of consequenties van ervaart. Wanneer u hiervoor kiest, wordt de verzamelde data die van u afkomstig is ook verwijderd en niet meegenomen in het onderzoek. U heeft daarnaast het recht om tot 24 uur na deelname, het verzoek in te dienen bij ondergetekende dat uw data niet wordt gebruikt in het onderzoek.

- Ten vijfde kunt u indien u naderhand klachten heeft over het onderzoek contact opnemen met de secretaris van de Ethische Commissie van de faculteit EWI van de Universiteit Twente, drs. Jorien van Loon, P.O. Box 217, 7500AE Enschede (NL); e-mailadres: j.vanloon@utwente.nl

Ondertekend,
Onderzoeker: Joost van Aggelen, telefoonnummer: +316 39 33 85 41, e-mail adres: j.m.vanaggelen@student.utwente.nl

Focus group topics and questions

Improvement of current situation

- It is stated that this category is meant for a discussion of what could be improved in the current treatment protocols for the clients. The perspective of the treatment providers will be discussed in a later category. Also other options on how to apply virtual reality for this target group will be discussed later.
- The MDOD and CGT+ protocols introduce concepts to the clients such as cravings and habits. An overview of all these concepts is given to the participants as reference material, see Table E.1. "In your experience as treatment provider, what concepts are clients having a hard time with to understand? For what concepts do you notice that the client needs extra explaining or repetition?"
- The MDOD and CGT+ protocols contain exercises for the clients such as balancing pros and cons and applying the 6D's. An overview of all these exercises is given to the participants as reference material, see Table E.2. "In your experience as treatment provider, what activities or exercises are clients having a hard time with to perform? For what activities do you notice that the client needs extra instructions or repetition?"
- "In your experience as treatment provider are there any other aspects of MDOD or CGT+, besides concepts and exercises mentioned before, that clients are having hard time with?"

Concept (in English)	Concept (in Dutch)
Characteristics and effects of substances	Eigenschappen en effecten van middelen
Registry	Registratie
Pros and cons	Voor- en nadelen
Risk situations	Risico situaties
Goals	Doelen
Explaining self-control techniques (6D's) - Distance - Distraction - Declare - Different thinking and different acting - Doing great (Thumbs up!) - Deals	Zelf-controle technique uitleggen (6A's) - Afstand - Afleiding - Aangeven - Anders denken en anders doen - Applaus - Afspraken

Habits	Gewoontes
Conditioning/associations	Conditionering/associaties
Cravings	Trek
Excuses	Smoesjes
Slip-up	Uitglijder
Relapse	Terugval

Table E.1: Concepts in the protocols

Exercise (in English)	Exercise (in Dutch)
Balancing pros and cons	Voor- en nadelen balans
Applying self-control techniques (6D's) to practice how to deal with risk situations, cravings, slip-ups and relapses. • Distance • Distraction • Declare • Different thinking and different acting • Doing great (Thumbs up!) • Deals	Zelf-controle technique toepassen (6A's) om te oefenen hoe je moet omgaan met risico situaties, trek, uitglijders en terugval. • Afstand • Afleiding • Aangeven • Anders denken en anders doen • Applaus • Afspraken
Saying no to substances	Nee zeggen tegen middelen
Making a plan	Een plan maken
Function analysis (CGT+)	Functie analyse (CGT+)

Table E.2: Exercises in the protocols

Design requirements for target group

- It is explained that two VR demo environments have been developed. An environment with a minimalistic design and an environment with a more realistic design, in this case a bar environment (see Figure E.1 and Figure E.2). It is asked if anyone would like to volunteer to play the demo using the HTC Vive. If no volunteers arise, the moderator will demonstrate the environments. Either way, the participants that do not actively use the VR equipment can watch what the active player sees on a screen (see Figure E.3). The objective of the minimalistic environment is to get used to the controller, the player can teleport using the trackpad and can grab the green objects using the trigger (see Figure E.4).

The objective of the bar environment is to move around in the bar and trying to grab some objects such as glasses or bottles. This environment shows possibilities of a more realistic representation of the physical world. "Now that you have experienced both a minimalistic and a realistic environment, what do you think would suit the target group?" If no discussion is started, examples can be given such as "Perhaps both would suit different types of exercises" or "that they are dependent on what the client could be exposed to regarding tempting situations."

- "Regarding the design of a VR environment, what aspects should I take into account considering the target group?" If no discussion is started, examples can be given such as "length of exercises/sessions", "consistency of color use with the protocols" or "levels of exposure to virtual resemblances of alcohol/drugs".

- "There are more possibilities on how to apply virtual reality for this target group than supporting current protocols. What other possibilities would you imagine? And what would better fit this target group: improving the current protocol by using virtual reality or doing something else?" If no discussion is started, examples can be given such as "using a virtual environment to visualize what they would like to achieve after completing the rehab program, as it is often hard for this target group to think in a long term perspective. Virtual reality could help them to experience what it would be like to achieve their goals".
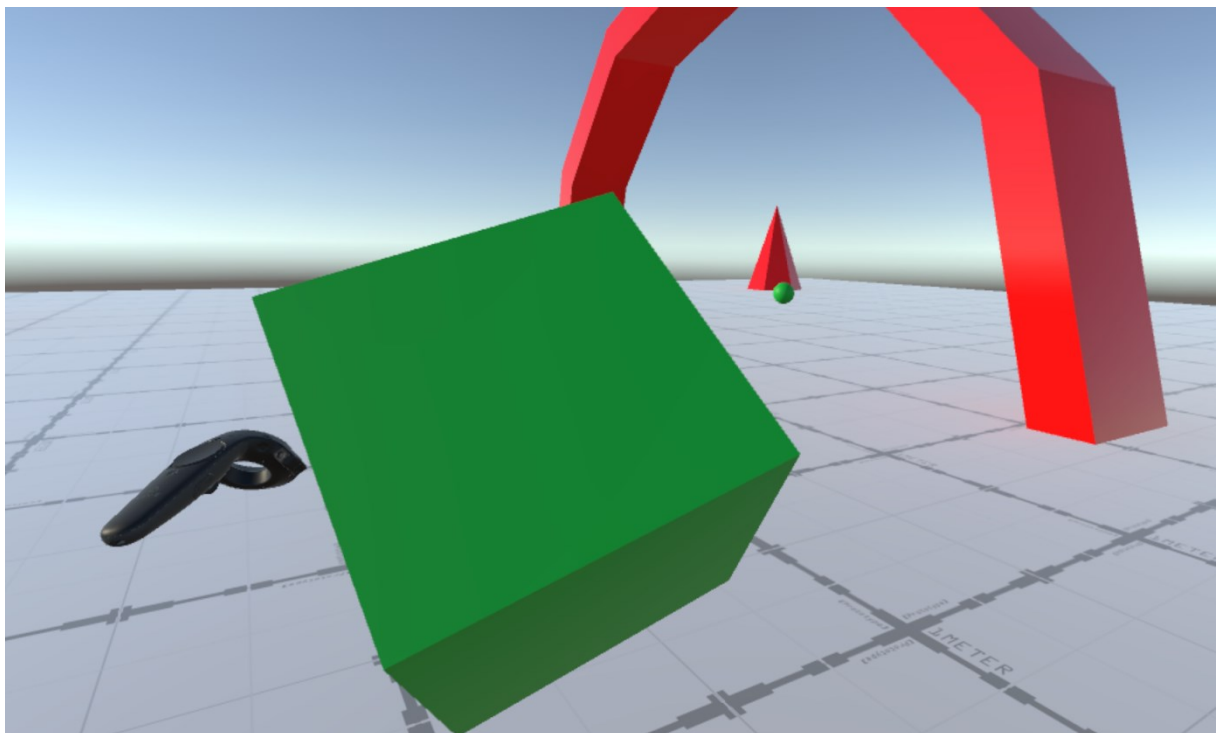

Figure E.1: Minimalistic demo environment – grabbing an object with the Vive controller in the tutorial level.

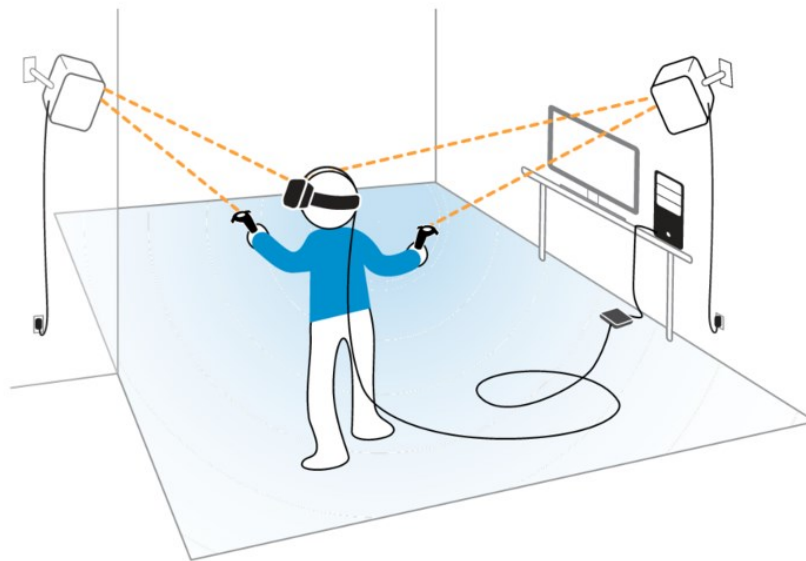Figure E.2: Realistic demo environment – standing in the bar level.
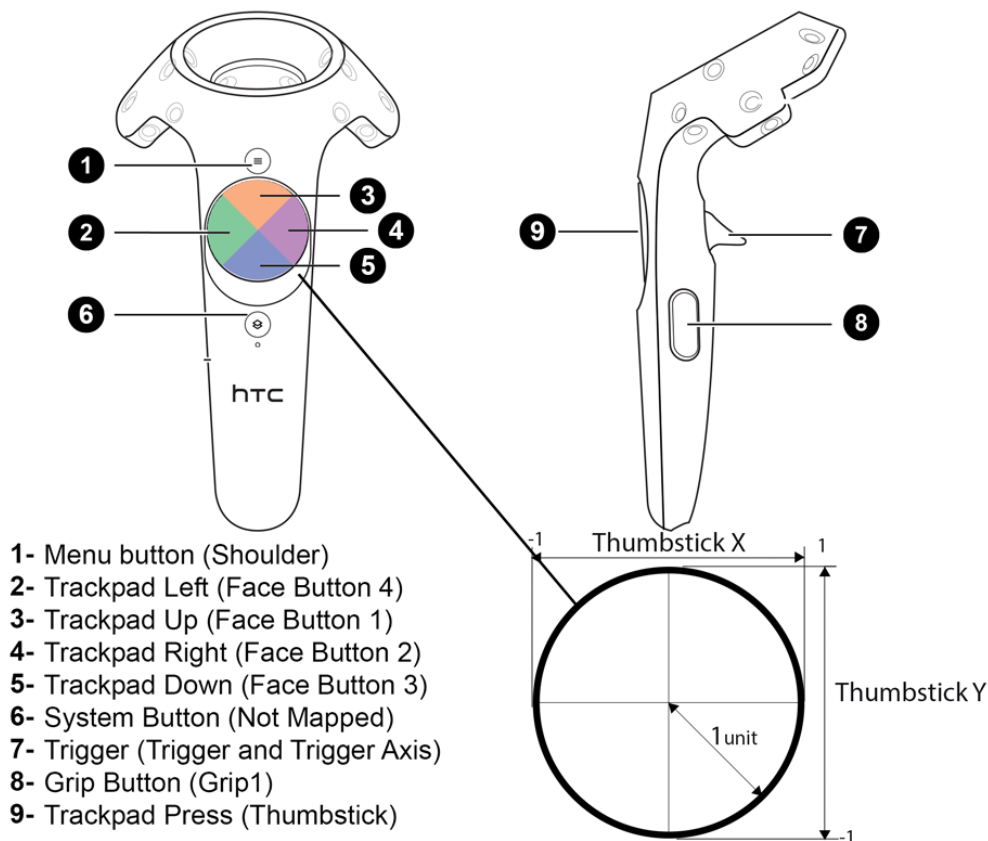

Figure E.3: HTC Vive setup diagram

1- Menu button (Shoulder)
2- Trackpad Left (Face Button 4)
3- Trackpad Up (Face Button 1)
4- Trackpad Right (Face Button 2)
5- Trackpad Down (Face Button 3)
6- System Button (Not Mapped)
7- Trigger (Trigger and Trigger Axis)
8- Grip Button (Grip1)
9- Trackpad Press (Thumbstick)

Figure E.4: Vive Controller lay-out

Other preferences as end-user "treatment provider"

- It is stated that this category is meant for a discussion of what the treatment providers would like to have in a VR product. It is also stated that the VR product would be a tool for the treatment providers to incorporate in their way of working and will never replace them.
- "When a final product would be incorporated in the treatment protocols of Tactus, treatment providers would have to explain the controls and the objective of the VR exercises. It is also crucial that the treatment provider monitors the progress of the VR exercise. What are things that you would find important or would like to have then?" If no discussion is started, examples can be given such as "being able to see what the client is seeing with the VR device" and "being able to adjust settings to change the level of difficulty to fit the client's capabilities".

Conclusion

- Asking if the participants have any other comments that could be helpful for the requirements that have not been discussed already.
- Asking if the participants have any other questions.
- Thanking the participants for their involvement and ending the focus group. The audio recording is also stopped.

Dutch information brochure for prototype evaluation participants

Informatiebrochure Virtual Reality onderzoek (<u>evaluatie ontwerp</u>)

Beste lezer,

Je bent uitgenodigd om mee te doen aan het Virtual Reality onderzoek van de UT. In deze brief staat meer informatie. Als je mee wilt doen met het onderzoek, is het belangrijk dat je je handtekening zet. Dan heb ik zwart op wit dat je mee wilt doen en weet wat we gaan doen.

Voor het onderzoek bouw ik een Virtual reality product wat kan helpen bij de behandeling van verslaving bij mensen die moeilijk lerend zijn. Een Virtual reality product is een soort 'game'. Ik wil graag van jou weten wat jij van de game vindt. Je bent uitgenodigd om hem uit te proberen op dinsdag 06-06-2017 in de Tactus kliniek in Rekken. Daarna ga ik je vragen wat je er van vond.

Er zijn een paar dingen die je moet weten voordat je meedoet.

- Ik wil weten wat je van de game vindt. Je mag helemaal eerlijk zijn. Er zijn geen foute antwoorden.
- Ik maak een geluidsopname van het gesprek. Dan kan ik later naluisteren wat je precies hebt gezegd. Deze geluidsopname is alleen voor mij, mijn docenten en behandelaren van Tactus die mij helpen.
- Jouw naam komt niet in het onderzoeksverslag.
- Het kan zijn dat je een beetje misselijk wordt als je de game speelt. Dan kan je de bril afzetten. Je mag de bril sowieso altijd afzetten wanneer je wilt.
- Als je later toch wil stoppen met het onderzoek, kan dat. Dan wordt jouw bijdrage aan het onderzoek verwijderd. Dit kan tot een dag (24 uur) nadat je de game hebt getest.
- Als je een klacht wilt indienen over het onderzoek, kun je contact opnemen met de secretaris van de Ethische Commissie van de faculteit EWI van de Universiteit Twente, drs. Jorien van Loon, P.O. Box 217, 7500AE Enschede (NL); e-mailadres: j.vanloon@utwente.nl

Ondertekend,
Onderzoeker: Joost van Aggelen, telefoonnummer: +316 39 33 85 41, e-mail adres: j.m.vanaggelen@student.utwente.nl

Adjusted Dutch informed consent form for EU1

Titel onderzoek: Using virtual reality to treat substance use disorders of people with an intellectual disability

Verantwoordelijke onderzoeker: Joost van Aggelen

In te vullen door de deelnemer

Ik snap wat we gaan doen, dankzij de "informatiebrochure Virtual Reality onderzoek". Ik weet dat de resultaten van het onderzoek alleen anoniem en vertrouwelijk worden verwerkt.

Ik snap dat de geluidsopnames alleen worden gebruikt voor het onderzoek en de beoordeling van het onderzoek.

Ik wil vrijwillig meedoen aan dit onderzoek. Ik mag altijd stoppen als ik wil zonder te zeggen waarom. Als ik dat doe dan wordt mijn bijdrage verwijderd.

Als ik later klachten heb over dit onderzoek, weet ik dat ik dat kan melden bij de secretaris van de Ethische Commissie van de faculteit EWI van de Universiteit Twente, drs. Jorien van Loon, P.O. Box 217, 7500AE Enschede (NL); e-mailadres: j.vanloon@utwente.nl

Naam deelnemer: ……………………………………………………………………

Datum: …………… Handtekening deelnemer: ………………………………………

In te vullen door de uitvoerende onderzoeker

Ik heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden. Ik zal de opnames van dit onderzoek niet verspreiden naar derden en de resultaten van het onderzoek zullen niet terug te leiden zijn tot individuele deelnemers. De deelnemer zal van een eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden en de desbetreffende data zal worden verwijderd en niet verder worden gebruikt in het onderzoek.

Naam onderzoeker: …………………………………………………………………………

Datum: …………… Handtekening onderzoeker: ……………………………………

Prototype 1 evaluation procedure

- Before the sessions
  - Welcoming, going over information brochure (Appendix F) and informed consent form (Appendix G) that they have received. "Do you have any questions before we begin about the information that was handed to you?"
  - Start audio recording.
  - Explanation of the research: "We made something and we would like to hear your opinion on it. This way we can improve it. There are no wrong answers; we would just like to know what you think."
  - Explanation of the controller (by demonstrating)
    - "If you press the big button with your thumb, you see an arch. When you release the button, you will be at the end of the arch. This is how you teleport. "
    - "You can grab objects with your index finger on the back. When you release the button, you drop the objects. This is how you can grab and interact with objects."
    - "You will see the controllers on your screen when you have the headset on."
  - Let the participant put on the headset and adjust if needed.

- First session (tutorial environment)
  - "Now you can practice in the first improvement. You can move around and grab some things with the controller. At any time you can take off the headset and stop. For instance when you don't like it anymore or want more explanation."
  - The minimalistic tutorial environment is started.
  - The participant is free to look and move around. "What are your first thoughts?"
  - "Try to go to the green cubes."
  - "Try to grab a cube."
  - The participant is free to play around with the cubes. "What do you think of this?"
  - "Try to go to the green ball."
  - "Try to grab the ball as if you would be bowling."
  - The participant is free to move around some more in the environment. After this, the participant is asked to remove the headset and the tutorial environment is stopped.
  - "What did you think of the tutorial?" "Do you find the controllers easy to use?"

- Second session (free in bar environment)

- o "You just learned how to move around and grab objects with the controllers. You did this really well. The controls are the same in the next environment. Thumb on the big button to teleport and index finger on the back button to grab objects. In the next environment you are in a bar. You can freely move around and think aloud about what you see, think and feel. At any time you can take off the headset and stop. For instance when you don't like it anymore or want more explanation."
  - o The bar environment is started.
  - o The participant can freely look and move around. "What are you seeing and what do you think?" "Does this feel like a real bar to you or do you miss anything to make it more realistic?" "What do you think of the characters and how they look and behave?" "Would you describe this as a risk situation and if yes, why?" If the participant is not sure on what he/she should do interactions could be suggested. For instance, going to see what is outside or going up to virtual characters. This part is mainly to get a first evaluation of the bar environment.
  - o The bar environment is stopped.

- Third session (exercises in bar environment)
  - o "You just explored the virtual bar. In this last session you will be in this bar again. Now you will get a number of exercises that are related to the 6D's. Do you remember those? They are also written on that flap over and we can go over them if you like."
  - o The bar environment is restarted.
  - o "Walk up to the bar and see what happens then" (Virtual characters offers the choice between a glass of beer and a can of soda with an animation when the player gets close (see Figure 4.5)). "How does this make you feel?"
  - o "Which of the 6D's could you apply here?" (Distance can be applied by going outside. Distraction can be applied by playing darts. Declaring can be applied by picking up the phone. Different thinking and different acting can be applied by choosing the soda. Deals and Doing great are not explicitly present in the environment as objects, but the participant is right if he/she mentions that previous made deals about use can be applied or that he/she can reward him- or herself with something positive such as playing darts or enjoying outside.
  - o For each of the 6D's that the participant mentions: "Try to apply them".
  - o "What do you think of how it is going?" (For each one of the 6D's more questions can be asked, for instance if playing darts feels natural and as how they would expect it).

- The bar environment is stopped after the participant has tried out the 6D's.

- Closing evaluation interview
  - "What did you think of being in virtual reality?"
  - "Was it easy to use the controller for moving and grabbing?"
  - "Did you think the first environment with the cubes and bowling was clear enough to learn the controls?"
  - "What did you think of the virtual bar?"
  - "What did you think of the virtual characters in the bar?"
  - "What would you change in or add to the virtual bar so it would be more realistic for you?"
  - "What did you think of the 6D's in the bar? Did you find them easy to recognize or was that hard?"
  - "What did you think of applying the 6D's? Did it work as you would expect?"
  - "Would you expect to have other examples of the 6D's in the bar? Such as another form of distraction?"
  - "Do you have any other comments or questions about the virtual environments?"
  - "Thank you very much for participating. You did a great job and this helps us with our research".
  - Stop audio recording.

Prototype 2 evaluation procedure

- Before the session
  - Welcoming, going over information brochure (Appendix F) and informed consent form (Appendix G) that they have received. "Do you have any questions before we begin about the information that was handed to you?"
  - Start audio recording.
  - Explanation of the research: "We made something and we would like to hear your opinion on it. This way we can improve it. There are no wrong answers; we would just like to know what you think."
  - "Firstly, I have a question for you, what would you consider more of a risk situation: a coffeeshop with cannabis or a bar with alcohol?"
  - Explanation of the controller (by demonstrating)
    - "I will now demonstrate the use of the controller. Do not worry if you do not immediately understand it. You can practice in the virtual environment."
    - "You can grab objects with your index finger on the back. When you release the button, you drop the objects. This is how you can grab and interact with objects."
    - "You can use a superpower to make substances disappear. You do this with your thumb on the big button. If you press it, they disappear and if you release it, they re-appear."
    - "You will see the controller on your screen when you have the headset on."
  - "During the evaluation, you sit on this chair. I will give you a headset so you can see the virtual environment. You can take off the headset at any time if you want but please remain seated as long as you have the headset on."
  - Let the participant put on the headset and adjust if needed.

- Evaluation session
  - "You will start by seeing an empty room with a table and a chair."
  - The environment is started.
  - "You can look around. How is this going?"
  - *Tutorial of grab controls*
    - "Do you see the controller if you look at your hand? Some objects will be placed on the table so you can practice grabbing with the controller."
    - Press GUI button "Start tutorial".

- "A can of soda and a phone have appeared. Can you grab them? How do you think this is going?"
- Press GUI button "End tutorial".

o *Practicing superpower*
- "Now I will place substances on the table so you can try out your superpower."
- Press GUI button "Show substance".
- "A substance has appeared. Can you make it disappear? How do you think this is going?"
- "From now on, please only use the superpower when you think your cravings become too high. When you are ready again, you can release the button so the substances come back."

o *Building up rest of environment*
- "Now you know that you can grab objects and make substances disappear with the controller, we can extend the environment. Someone will sit across from you at the table."
- Press GUI button "Show table character"
- "What do you think of him? Does he look realistic to you? What does his gesture say to you?"
- "I will now further extend the environment by adding the basic structure of the environment."
- Press GUI button "Show environment basics".
- "What do you think of what you see? Can you describe what has been added?"
- "I will now complete the environment by adding details of the environment"
- Press GUI button "Show environment fill".
- "What do you think of what you see? Can you describe what has been added? Is this environment realistic for you?"

o *Teleporting to other positions*
- "Now that the environment is built completely, we can go to other places in this environment. At every place you can use the controller like you practiced, you can grab objects and make substances disappear. You can remain seated while I make you go to another place. We call this teleporting. I will now teleport you to another position."
- Press GUI button "To bar/counter".
- "How was the teleporting? What do you see at this position? What do you think of this?"
- "When you see substances and experience cravings you can do several things. Tactus calls them the 6D's, do you know

them? You could use the phone here to declare. Would you say this is a realistic representation of declare in this environment?"

- ▪ ***Only in bar environment:*** "You can also apply different thinking/different acting when you see substances. This can be done by getting a can of soda instead of a beer. Would you say this is a realistic representation of different thinking/different acting in this environment?"
- ▪ "I will now teleport you to another position."
- ▪ Press GUI button "To dartboard/checkers".
- ▪ "How was the teleporting? What do you see at this position? What do you think of this?"
- ▪ "When you see substances and experience cravings, you can look for a distraction. Would you say this is a realistic representation of distraction in this environment?"
- ▪ "I will now teleport you to another position"
- ▪ Press GUI button "To outside".
- ▪ "How was the teleporting? What do you see at this position? What do you think of this?"
- ▪ "When you see substances and experience cravings, you can seek distance from them. Would you say this is a realistic representation of distance in this environment"?
- ▪ "I will now teleport you back to the start position."
- ▪ Press GUI button "To start position"
- ▪ "How was the teleporting? Do you recognize this as the starting position?"
- ▪ "That was it for being in the virtual environment. You can take off the headset and then we can go over some questions about what you think of the product."
- ▪ Stop virtual environment.

- Closing evaluation interview
  - o "What did you think of being in virtual reality?"
  - o "What did you think of the build-up of the environment?"
  - o "What did you think of the environment when it was fully visible?"
  - o "What would you change in or add to the environment so it would be more realistic for you?"
  - o "What did you think of the virtual characters in the environment?"
  - o "How did it go with the controller?"
  - o "Could you grab objects when you wanted to? Could this be improved?"
  - o "What did you think of your superpower? Did you use it a lot? Could this be improved?"
  - o "What did you think of the teleporting? Could this be improved?"

- **In case the participant was also a participant at the first evaluation:** "What differences did you notice compared to the first time you participated?" "Which prototype do you feel was more pleasant to use?" "Do you feel that now you participated a second time, it was easier?"
- "Do you have any other comments or questions about the virtual environment?"
- "Thank you very much for participating. You did a great job and this helps us with our research. You are done now. I have one final request and that is that you do not talk about the experiment with other participants when they still need to go. This way it is fair for everyone and everybody starts the same."
- Stop audio recording