EXTINGUISHING THE USE.

Implementing Virtual Reality in Substance Use Disorder Treatments for Patients with a Mild Intellectual Disability or Borderline Intellectual Functioning

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Abstract

This project involves implementing a virtual reality (VR) system into typical Substance Use Disorder (SUD) treatment sessions for patients with a Mild Intellectual Disability or Borderline Intellectual Functioning (MID-BIF). Individuals diagnosed with MID-BIF form an at-risk group for a SUD, and many are treatment facility patients. Their substance use can be explained by specific characteristics of their intellectual disability including inadequate coping mechanisms, imagery defects, poor memory functioning, and social factors like peer pressure. SUD treatments for these patients are possible using Cognitive Behavioral Therapy (CBT) protocols, adapted to the needs of this group. Virtual reality (VR) is an operative way to immerse patients within the therapy addiction treatment sessions, supporting the patient to focus on the treatment and not on their disability. A VR prototype is designed and created for this project and holds four virtual rooms (situations) patients can navigate. An interactive video of the virtual world is developed for non-face-to-face user testing (due to COVID-19 regulations). The VR prototype is evaluated through online interviews with these dual diagnosis patients and relevant clinical professionals from Tactus, a treatment facility in Enschede, Netherlands. The test is whether these patients can effectively state how risky the situation is to smoke marijuana in terms of color (green, orange, or red), as well as state what self-control techniques they can practice (6D's; alternatives to smoking marijuana) during the video. The results of this project show that the VR prototype can be implemented, adds value to SUD treatment sessions for MID-BIF patients, and is recommended to test with patients face-to-face with VR equipment in future work.

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1. Introduction

In this chapter, the motivation behind the graduation project is introduced, the challenges faced are given, and the guiding research questions are described.

1.1 Introduction

1.1.1 Motivation

Figure 1. SUD complexity (images from pixabay.com).

Substance Use Disorders (SUD) are present among a large population of people, specifically with marijuana, alcohol, and drug usage. In addiction care, SUDs are defined as a chronic illness, with exacerbations and remissions, and important negative biological, social, and psychological consequences. There are many facilities and solutions attempting to lessen these SUDs, such as rehabilitation centers. However, there are fewer solutions for patients experiencing a SUD who have a mild intellectual disability or borderline intellectual functioning (MID-BIF). This cognitive impairment is defined as: mild intellectual disability (intelligence Quotient (IQ) 50–70) and borderline intellectual functioning (IQ 70–85) (American Psychiatric Association, 2013; Didden, VanDerNagel, Delforterie, & Van Duijvenbode, 2020).

According to researchers VanDerNagel (2017) and Didden (2020), the percentage of individuals with a SUD is much higher among persons with an intellectual disability than without. In a Belgian study conducted by Swerts and colleagues (2017), over 100 individuals with MID-BIF living independently either smoked (48%), drank alcohol (46%), or used illicit substances (2%) during the timespan of only one month.

Dutch researchers also conducted a study in the Netherlands on substance use among individuals with MID-BIF in a clinical setting (VanDerNagel, et al., 2017). Their research concluded that 61.6% of the patients smoked tobacco.

The Diagnostic and Statistical Manual of Mental Disorders defines a SUD as a problematic pattern of substance use resulting in significant impairments in daily functioning, including failure to meet work responsibilities. Individuals diagnosed with MID-BIF form an at-risk group for a SUD, and many are treatment facility patients. Their substance use could be explained by specific characteristics of their intellectual disability including inadequate coping mechanisms, poor memory functioning, and social factors like peer pressure (Slayter, 2008). Treatment for SUDs in individuals with MID-BIF is possible using Cognitive Behavioral Therapy (CBT) protocols, adapted to the needs of this group (Didden, et al., 2020). However, even these adapted protocols rely on verbal skills and comprehension. Virtual reality (VR) could be an effective way to add value to such therapy protocols. Since these patients have an intellectual disability, VR environments are an effective way to immerse patients within the therapy addiction treatment sessions, conceivably assisting both the patient and the therapist. The transfer between virtual reality and the real-world should be plausibly seamless.

Although there is extensive research about Cue-Exposure Therapy (CET) for addiction treatment, there is less research conducted about CBT (Landowska, Roberts, Eachus, & Barrett, 2018). CET involves controlled and repeated exposure to addiction cues in order to reduce cravings associated with the addiction. CET can extinguish the association of a response to a stimulus, for example smoking when seeing an ashtray, lighter, or cigarette package. Nevertheless, despite the amount of research done on CET for addiction treatment, substantial studies have found that CET does not improve standard CBT. (García-Rodríguez, et al., 2011). CET can be used for phobia treatments or similar treatments but proves ineffective for treating a SUD. As a hypothesis, CET alone will expose the patient to substance use triggers but does not teach them how to deal with the triggers. Therefore, only CBT should be used for effective SUD treatments, and combined with VR for added value.

In CBT patients are taught strategies to identify, avoid, and cope with triggers (i.e. manage cravings, reduce withdrawal symptoms, and engage in social support), as well as self-efficacy (Das & Prochaska, 2017). Patients with lower cognitive ability and limited adaptive skills need experiences that build self-efficacy (Hyde, Hankins, Deale, & Marteau, 2008). By using CBT in combination with VR, patients can practice these training strategies, instead of only being exposed to the addictive stimuli, as with CET combined with VR (Wiederhold & Wiederhold, 2008).

Integrated Clinical Pathways (ICPs) that apply newer virtual reality technologies, as well as other techniques, are promising for this combination of CBT and VR. VR is controllable and can be personalized or tailored to the specific needs of the patient. Redesigning such a system to be used within a typical therapy

session specifically for patients with the dual diagnosis of MID-BIF and SUD can prove to be extremely useful in the addiction treatment field. That is why this project focuses on implementing CBT in combination with VR, which is a different approach and innovative way of applying VR in a clinical setting.

The company this project is partial developed for and tested with is the Dutch company Tactus. Tactus members strive to innovate SUD treatments, specifically with the HTC Vive Pro Eye for 'room-scale virtual reality' (Tactus in Beeld #9 - Virtual reality bij Tactus, 2017). Tactus is currently developing and testing a situational virtual environment; however, they have yet to implement the system in a full therapy session. This in-use prototype virtual environment focuses on tobacco addiction and contains areas where patients are familiar (e.g. a park, a bar, and a street bus stop). There are specific cues in the environment (i.e. proximal cues) meant to focus the patient's attention so the therapist can assess the patient's actions and reactions (Bordnick, Traylor, Carter, & Graap, 2011). Patients can virtually navigate around within this environment with a controller, engaging experientially and situationally, as they are presented with opportunities that trigger their SUD, and are offered alternative choices of behavior (Klaassen, et al., 2019).

The goal of this project is to provide a guide to clinical professionals (therapists) on how to implement a VR system into their SUD treatment sessions while keeping the design patient-oriented, by explaining how the program can be used and benefits both the patient and therapist. The clinical professionals and patients evaluating the final solution are specific to the company Tactus, using the company's regulated CBT+ protocol. The objectives of this project are, therefore:

- To design and build a VR prototype with virtual situations patients can navigate around;
- To immerse patients into the virtual experience so to support the patient to focus on the treatment and not their intellectual disability;
- To have patients practice self-efficacy and self-control techniques through specific CBT+ training sessions;
- And to evaluate the application with these patients and relevant clinical professionals.

The ideation for the design and creation of the prototype was formed by myself, with contribution of Dr. Randy Klaassen MSc. and Simon Langener MSc. who supervised, as well as a clinical professional Dr. Johanna van der Nagel, who offered a body of knowledge in the clinical setting.

In the upcoming sections, the research questions are given and answered, first through literature examination and then through ideation and realization. In order to introduce a VR system into therapy sessions for these dual diagnosis patients (with MID-BIF and SUD), two perspectives are considered: (1) contextual analysis and (2) factors for realism. Meaning, CBT techniques specific to the company's protocol for SUD treatment are analyzed to decide which techniques can be translated to VR effectively,

and specific virtual environment situations are designed to be more realistic in order to provoke a sense of presence for patients.

Chapter 2 presents the literature review and identifies alternative designs already on the market. Chapter 3 describes the methodology behind the project, i.e. what techniques and tools are used. Chapter 4 introduces the ideation phase where the prototype virtual environment is designed. Chapter 5 discusses the specifications of the prototype design based on the target group, i.e. the user requirements and technology specifications. Chapter 6 describes the realization of the prototype and outlines the testing of the prototype with patients and therapists. Chapter 7 presents the evaluation of the prototype and how well the research questions are answered. Chapter 8 details the discussion and conclusion of the project. Finally, Chapter 9 describes the future work of the project and the succession of the overall project's scope.

1.1.2 Challenges

The possible problems that could occur during the project are categorized into two main challenges. The first challenge is the design and usability of the VR prototype, meaning the amount of realism and patient response. The second challenge involves practical research issues, such as the cultural barriers or current real-world health topics.

A design and usability issue that could occur during the designing phase of the virtual environment is having the virtual environment not be realistic enough to invoke a patient's response. It could prove difficult to transfer experiential situations introduced by way of VR to real world environments. The treatment must allow the target group to orient and assimilate responsively, and there may not be enough prototype testing (in pilot studies) to decide on an ultimate/effective result (effective in this context meaning - health benefits). Considering the scope of medical research is beyond the capacity of this project, the possibilities for further research will instead be retained for future work.

A practical issue that could surface during the project is the language barrier between the researcher/designer and the patients (American vs. Dutch language). Although the researcher lives in the Netherlands with indigenous cultural experience, this might prove problematic during the interviews, which should conclude with answers on how the patients suggest making the virtual environment more realistic. Also, the introspective approach to addiction and cognitive impairment treatment may show differences between the two cultures.

An additional practical issue that limits accessibility to interviewees is the current world health crisis, COVID-19, or the Coronavirus. Many cancellations have already occurred due to health problems, which could extend the project's timeline. To reduce the effect of this problem the timeline must be continuously discussed. The Dutch government passed regulations regarding Coronavirus, which the University of

Twente furthered, stating that no face-to-face meetings should take place until September (could be changed to even later in the year). This will cause a challenge to arise in which the target group cannot use the newly made prototype. To alleviate this issue, videos of this prototype will be made and shown to both therapists and patients for their opinions and feedback on the overall idea. Moreover, if patients cannot be reached, then either student psychologists or patients using online forums will be utilized.

1.1.3 Research Questions

To design a virtual reality environment that addresses the objectives and challenges presented in the previous sections, the main research question that will guide the project is:

Main Research Question: *How can a virtual reality environment be implemented into a typical therapy session for dual diagnosis patients (patients who have a mild intellectual disability or borderline intellectual functioning and a substance use disorder)?*

To answer this research question, the following sub-questions are posed:

Sub-Research Question 1: *How can specific self-control techniques for substance use disorder treatment be implemented in a virtual reality environment to build self-efficacy of patients?*

Sub-Research Question 2: *How can a virtual reality environment be designed to be more realistic to invoke a sense of presence for patients within the virtual world?*

Sub-Research Question 3: *How can a realistic virtual reality environment be evaluated by clinical professionals and patients for successful outcomes?*

2. State of the Art

In this chapter, research gathered from scientific, as well as non-scientific, sources are congregated. First, the findings from a scientific literature review are presented, on the topic of therapeutic methods being used in virtual reality, followed by an analysis of related work, such as studies on invoking sense of presence in virtual reality environments and implementing therapy techniques in virtual reality. The findings from this research provide valuable insight into the design of virtual reality environments for therapy session usage.

2.1 Literature Review

2.1.1 Introduction

The Netherlands strives to support the health of their citizens. Last year, the Dutch government introduced the National Prevention Agreement which states their goal of having an entirely smoke-free environment by 2040, along with tackling problematic alcohol consumption and obesity (National Preventie Akkord, 2019). Tobacco, alcohol, and obesity are problems that cause over 35,000 deaths each year in the Netherlands and cost about 9 billion euros in Dutch healthcare expenditure annually (Das & Prochaska, 2017). Tobacco, alcohol, and drug usage can mature into a heavy addiction, known as a substance use disorder (SUD), if the usage has severe negative consequences on the individual's lifestyle. A large majority of addicts are diagnosed while already having a mental illness or intellectual disability (Lasser, et al., 2000). The frequency of cognitive impairments among SUD patients is estimated to be between 30 to 80% (Bruijnen, et al., 2019). For instance, among 39 patients with a mild intellectual disability or borderline intellectual functioning (MID-BIF) in an inpatient treatment facility, 28% abused alcohol and 36% used drugs (Didden, et al., 2020). Multiple researchers have concluded that individuals with MID-BIF are at a higher risk for developing a SUD when compared to persons without MID-BIF, and that the negative effects of the SUD are more intense for these patients (van Duijvenbode & Vandernagel, 2019).

Many factors may account for this increased risk for a SUD, including deficits in coping, social skills, susceptibility to social pressure, and difficulties in understanding the adverse consequences of substance use (Didden, et al., 2020). Although the attention for a SUD among patients with MID-BIF has grown exponentially over the past few years, this form of dual diagnosis has also been largely ignored by addiction treatment professionals (van Duijvenbode & Vandernagel, 2019). Patients with MID-BIF often experience barriers to SUD treatment access. These patients are therefore less likely to initiate and engage in treatment and are more likely to drop out. Statistics suggest that only a small number of patients with MID-BIF and SUD have received specialized SUD treatment and that involvement in addiction medicine is often limited. Addiction treatment programs that are effective for patients without an intellectual disability need to be adapted to the needs and learning styles of patients with MID-BIF, covering this dual diagnosis (Didden, et al., 2020). The research done on these topics comes from studies conducted in many different countries, but this project focuses on the Netherlands, specifically regarding Dutch drug policies and Dutch MID-BIF patients.

Although effective SUD treatments, based largely upon Cognitive-Behavioral principles, have been developed, success rates of these treatments remain uncertain or unverified, especially with intellectual disability patients. Self-efficacy assists with patient initiation and maintenance of an addiction free lifestyle.

Teaching self-efficacy can support patients with MID-BIF to overcome their addiction and prevent relapse to the undesired behavior (Hyde, Hankins, Deale, & Marteau, 2008). Treatment effectiveness for SUD among these patients may therefore be enhanced if self-efficacy is specifically targeted.

Moreover, the use of virtual reality (VR) in therapeutic settings can immerse patients into the treatment. VR can support the patient's intellectual disability in this way. The patient can feel 'empowered' in the virtual environment, which allows the patient to focus solely on the treatment instead of their disability. By combining CBT techniques to teach self-control techniques and build self-efficacy within a VR environment, the SUD treatment can be adapted to the patient's needs and shows potential for increased effectiveness (effectiveness in this context meaning lower substance use and lower relapse rates).

This literature review is used to contribute to the answer of two of the three sub- research questions: *How can specific self-control techniques for substance use disorder treatment be implemented in a virtual reality environment to build self-efficacy of patients?* and *How can a virtual reality environment be designed to be more realistic to invoke a sense of presence for patients within the virtual world?* These questions are partially answered by the theory presented in this literature review, meaning knowledge and understanding about dual diagnosis patients, proper treatments, and ways to combine VR into treatments are gained.

2.1.2 Dual Diagnosis of Mild Intellectual Disability or Borderline Intellectual Functioning and Substance Use Disorder

The target group being discussed are adult patients who have a mild intellectual disability or borderline intellectual functioning (MID-BIF). According to the American Psychiatric Association, an intellectual disability involves impairments, that occur during the developmental period, of general mental abilities. These impairments impact intellectual functioning in the conceptual, social, and practical domains. 'Intellectual functioning' refers to a wide range of mental abilities, such as reasoning, planning, problem solving, judgement, and abstract thinking. Deficits in this functioning define whether a patient will be diagnosed with MID-BIF. These deficits further refer to a lack of certain skills that are needed for daily functioning, such as conceptual, interpersonal communication, and practical skills. Although the severity of the diagnosis is based on the level of impairments and deficits, the standard IQ score of individuals with MID-BIF is approximately between 50 to 85 (Didden, et al., 2020). The MID-BIF group includes 'mild' and 'borderline' patients, but both types share the characteristics of poor physical and mental health, social

disadvantages, limited social support, overrepresentation in clinical settings, and limited access to services including addiction treatment.

Over the past few years, researchers have found it clear that persons with MID-BIF form an at-risk group for a Substance Use Disorder (SUD), and the severity of the negative effects of substance abuse is much higher (van Duijvenbode & Vandernagel, 2019). Their addiction could be explained by specific characteristics including inadequate coping mechanisms, poor memory functioning, and social factors like peer pressure (Slayter, 2008).

A SUD is a multifaceted problem with indicators that an individual will continue to use the substance despite the significant mental and health issues (Bruijnen, et al., 2019). Substance abuse involves an interplay between biological (physiological effects of the substance), psychological (personality traits), and social (peer pressure, socioeconomic status, etc.) factors (van Duijvenbode & Vandernagel, 2019). All three factors interact with each other and either increase or decrease the risk of developing and maintaining a SUD. Substances involved with a SUD include tobacco, marijuana, alcohol, and other illicit drugs. Individuals with MID-BIF that develop a SUD therefore have a dual diagnosis and require even further specialized treatment.

Consequently, dual diagnosis patients with MID-BIF and a SUD warrant special treatment in the areas of medical, social, and psychological help. However, facilities for intellectual disability care often do not have the necessary skills or attitudes to address the combined diagnosis of intellectual disability and SUD, and addiction treatment centers the opposite (Didden, et al., 2020). Addiction treatment centers do not hold adequate understanding of MID-BIF patients. Statistics show that only a small number of patients with this dual diagnosis have received specialized SUD treatment and that involvement in the treatment is often limited (van Duijvenbode & Vandernagel, 2019). This leads to barrier issues like patient initiation, patient dropouts, or ineffective treatments. There needs to be a closer collaboration between intellectual disability care and addiction treatment to minimize these issues.

Additionally, it is possible that patients on this spectrum rely on ritual and routine over ideation, meaning that new habits must be learned in order to replace substance usage habits (Barrett, 2016). Addiction has been proven to be a partially learned behavior (Wiederhold & Wiederhold, 2008). To overcome the addiction, patients with MID-BIF and SUD must re-learn their actions and reactions.

2.1.3 Cognitive Behavioral Therapy to Build Self-Efficacy

There are three main reasons for this disconnect between knowledge and skill level to treat patients with MID-BIF and SUD (Kiewik, VanDerNagel, Engels, & De Jong, 2017). First, this group often holds the stated barriers to addiction treatments or addiction interventions. Second, MID-BIF patients admitted into

addiction treatments are unable to benefit from mainstream interventions due to their limited vocabulary, poor development of memory function, and difficulties discerning between relevant and irrelevant information. Also, these patients have problems with planning and attention, have impaired abstract reasoning, and have low self-insight. Meaning, patients often retain incorrect or unrelated details during an intervention. Third, group activities are difficult for these patients to participate in since the programs can be too abstract, advanced, or require certain social skills. Specialized addiction treatments or interventions for MID-BIF patients are therefore quite necessary.

Cognitive Behavioral Therapy (CBT) is supported by a variety of health professionals for SUD treatment. CBT targets learning processes and contextual factors that sustain the behavioral problem. Treatment sessions are usually delivered every week for a certain number of weeks. In a typical session, the therapist will go over the physiological, psychological, social, and environmental factors of the patient's addiction. The CBT method teaches the patient strategies to identify, avoid, and cope with triggers (i.e. manage cravings, reduce withdrawal symptoms, and engage in social support) (Das & Prochaska, 2017).

Two techniques have surfaced as potential SUD interventions: cognitive behavioral therapy (CBT) and cue-exposure therapy (CET). CBT aims to treat the patients disfunctions, like cognitive patterns and automatic thought processes. This therapy method can increase the patient's motivation and help with relapse prevention through understanding. CET involves controlled and repeated exposure to addiction cues, using pictures or video, to reduce cravings associated with their addiction. CET can extinguish the association of a response to a stimulus, for example smoking when seeing an ashtray, lighter, or cigarette package (Giovancarli, et al., 2016). Nevertheless, despite the amount of research done on exposure therapy for tobacco cessation, substantial studies have found that CET does not improve standard CBT (García-Rodríguez, et al., 2011). CET can be used for phobia treatment or a similar treatment, but CET proves ineffective for substance use disorders. This is because CET alone will have the patient exposed to triggers but does not teach them how to deal with their triggers. Only can be used CBT for effective SUD treatments. The company Tactus developed their own version of CBT, the CBT+ protocol, which their therapists use during sessions with these dual diagnosis patients, maintaining CBT as the core of the therapy.

MID-BIF patient addiction behavior can be partially explained by the Social Cognitive Theory (SCT). SCT is a learning theory based on the idea that individuals learn by observing others (Bandura, 1977). The behaviors that are learned are central to an individual's personality. When an individual witnesses a behavior, the individual's way of thinking can change (cognition). Three factors influence an individual's development: personal, behavioral, and environmental (Bandura, 2008). For example, if a MID-BIF patient sees one of their friends drinking alcohol, the patient could believe that drinking in excessive amounts is socially accepted and is without negative consequences. The patient's reproduction of an observed behavior is explained by the three factors stated previously. First, personal, is whether the individual has high self-

efficacy, or if they believe they are capable of completing a behavior. Second, behavioral, is the response the individual receives after performing the behavior. Third, environmental, analysis of the setting the individual is in, which could influence the individual to accomplish the behavior. Therefore, all three factors need to be accounted for when designing SUD treatments for these patients.

Through Cognitive-Behavioral techniques, self-efficacy should be gained by the patients. Building self-efficacy can help patients maintain their substance-free lifestyle. Self-efficacy is described as the degree to which an individual believes they can perform a certain behavior, such as refraining from their substance use (Bandura, 1989; Hyde, Hankins, Deale, & Marteau, 2008). CBT SUD treatments can therefore be enhanced if self-efficacy is specifically targeted (Hyde, Hankins, Deale, & Marteau, 2008). CBT for SUD focuses on improving self-control, by stimulus control, stimulus response measurements, and response consequences. Moreover, the patient has a higher chance of learning new behaviors to counter their substance use if self-efficacy is focused on. Individuals with high self-efficacy are more likely to achieve a task or behavior and recover from setbacks. Likewise, self-efficacy can be taught through mastery experience, social modeling, improving physical and emotional states, and verbal persuasion (McAlister, Perry, & Parcel, 2008). Therefore, specialized treatments for MID-BIF patients with a SUD should focus on improving self-efficacy through CBT+ training exercises (practicing self-control techniques) while keeping the SCT in mind.

2.1.4 Combination of Virtual Reality and Behavioral Therapy

Virtual reality (VR) is typically described by researchers, like Riva and Mantovani (2012), as "the collection of technological devices including a computer capable of interactive 3D visualization, a head-mounted display, and data gloves equipped with one or more position trackers." The trackers sense the position and orientation of the use and give feedback to the computer which then updates the images in real-time. In general, they describe a VR system as the "combination of the hardware and software that enables developers to create VR applications." Moreover, in behavioral sciences, they describe VR as "an advanced form of human-computer interface that allows the user to interact with and become immersed in a computer-generated environment in a naturalistic fashion." This feature alters VR into an "empowering environment", a controlled setting where patients can explore the environment and act without feeling threatened. The key feature of VR in a clinical setting is that it offers support to the patient by activating the feeling of "presence", the feeling of being immersed in the virtual world. In general, the feeling of presence is described by Riva and Mantovani (2012) as "the product of an intuitive experience-based metacognitive judgment related to the enaction of our intentions: We are present in an environment - real and/or synthetic - when we are able, inside it, to intuitively transform our intentions in actions."

Using VR in clinical psychology is becoming more common over the years but is still in its testing-phase. The praised advantages of virtual environments in clinical applications are the high level of control for the therapist and the enriching experience for the patient. During a VR experience, the patient can learn to cope with problematic reactions to stimulus and situations. Virtual Reality Exposure Therapy (VRET) is currently being used for psychological disorder treatments, such as phobias and post-traumatic stress disorders (Landowska, et al., 2018). VRET can provide virtual environments that show certain situations where patients could be triggered. VRET offers many advantages for cue-exposure with controlled environments, dynamic interactions, and three-dimensional situations. VRET has been proposed as a new medium for CET due to VR being more controllable and cost-effective compared to reproducing real-world situations. The rationale of VRET is posed as "in VR the patient is intentionally confronted with the feared stimuli while allowing the anxiety to attenuate; avoiding the problematic situation reinforces the phobia and each successive exposure to it reduces the anxiety through the processes of habituation and extinction" (Riva & Mantovani, 2012). VR allows therapists to guide patients in real-time, supporting the patient to modify emotional responses and addiction-related cognitions. However, CBT+ combined with VRET could be evaluated further in addiction treatments (Giovancarli, et al., 2016), but the intention must be focused on CBT and not CET. This combination is well supported by the Learning Theory and SCT. For example, Bordnick and colleagues (2011) state that "state-dependent learning suggests that information learned in one state of mind and body is more accessible for retrieval when a person is in the same state of mind and body." Therefore, VR is much more powerful and has more potential than only a tool for exposure and desensitization.

A pilot study by researcher Girard and colleagues (2009) revealed that crushing virtual cigarettes reduced tobacco addiction by a significant amount (over 50%). Several smokers (90) were randomly assigned to two different treatment conditions that differed only by the action performed in the virtual environment. The conditions were crushing virtual cigarettes or grasping virtual balls. Each participant received psychosocial support from nurses during each of 12 clinical visits. The eMagin HMD virtual reality system was used to modify a virtual reality game. The study concluded that crushing virtual cigarettes during 4 weekly sessions led to statistically significant reductions in nicotine addiction, abstinence rate, and drop-out rate. The Fagerstrom Test was used to analyze the results. Hypotheses were raised about self-efficacy, motivation, and learning of the patients. The results also held up during a follow-up trial. The sense of presence in the virtual environment seemed to be 'associated with the beneficial effect of the program,' and cybersickness was not a major issue.

The Virtual Reality Medical Center (VRMC), a world leader in virtual reality technology, pioneered the use of VRET in combination with physiological monitoring to treat panic and anxiety disorders in order to treat posttraumatic stress disorder (PTSD) (Wiederhold & Wiederhold, 2008). The combination was

meant to create distraction from pain and to aid in cognitive and physical rehabilitation. Their research has shown that "the combination of VR with traditional therapies results in more successful outcomes being achieved in a highly efficient manner to treat a wide range of issues."

2.1.5 Conclusion

This literature review strives to contribute to the answer of the two sub- research questions: *How can specific self-control techniques for substance use disorder treatment be implemented in a virtual reality environment to build self-efficacy of patients?* and *How can a virtual reality environment be designed to be more realistic to invoke a sense of presence for patients within the virtual world?* There is a need for specialized treatments for patients with the dual diagnosis of MID-BIF and SUD. These patients often experience barriers to treatment access due to addiction and care facilities not associating with one another, causing lack of patient initiation and engagement, as well as high dropout and relapse rates. The use of VR in treatment sessions shows potential for increasing treatment effectiveness since VR is controllable, reliable, and can 'empower' both the patients and the therapist.

Additionally, focusing on teaching self-efficacy through self-control training sessions can enhance the treatment and prevent relapse. The treatments should use Cognitive-Behavioral techniques (CBT+) to teach self-efficacy, while keeping the SCT in mind. The treatments can be done in a virtual environment, which can support patents with their intellectual disability, helping patients focus solely on the treatment instead of their disability and letting patients maintain the feeling of control.

Some limitations to this study are the cultural differences in the journals reviewed, as well as the fact that some studies discussed are recent publications and have not had time to be thoroughly validated. Furthermore, the fact that CET is highly praised for addiction treatments, but CBT has not been largely deliberated causes a difficulty when finding a variety of literature. Finally, to understand if this combination of CBT with VR can have effective results, empirical testing is necessary for this project, in order to provide first-hand evidence for its validity and applicability.

2.2 Relevant Work

2.2.1 Introduction

In this section, relevant work in the field of virtual reality (VR) and Substance Use Disorder (SUD) combinations is explored and summarized. The purpose of this state-of-the-art review is to gain an understanding of the current condition of the market, as well as to learn from the strengths and weaknesses, of different clinical interventions. The accumulated knowledge can then be applied to the development of this project in the next phases.

There are six companies, *InMotion VR, ZeroPhobia App, CleVR, NBH, Trafalgar, C2Care,* that meet the criteria for related work. The criteria for choosing the companies are based on the use of VR and either Cognitive Behavioral Therapy (CBT) or Cue-Exposure Therapy (CET). Although this project focuses on CBT, many relevant companies using VR have only CET aspects. The criteria are therefore:

1. Virtual reality being implemented in a clinical setting
2. The treatment either focuses on Cognitive Behavioral Therapy or Cue-Exposure Therapy

In the following subsections, each company treatment is evaluated on their *treatment type, technology device, strengths, weaknesses,* and quality of *User Experience (UX).* UX is defined as an individual's emotional response and attitudes towards an interaction with a system's User Interface (UI), which may be subjective (Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009). There are two criteria that the choice of the companies was based on. To start, only the first criteria is used for a broader look at treatment companies on the market. Therefore, the first company *InMotion VR* is evaluated although they focus on physical therapy rehabilitation in VR. Next, the second criteria is added to narrow down the search, which lead to evaluation of the other five companies. Moreover, these six companies are looked at as to set a threshold for the ideation stage of this project. Furthermore, the analysis discussion is based on my own opinions and findings.

2.2.2 InMotion VR

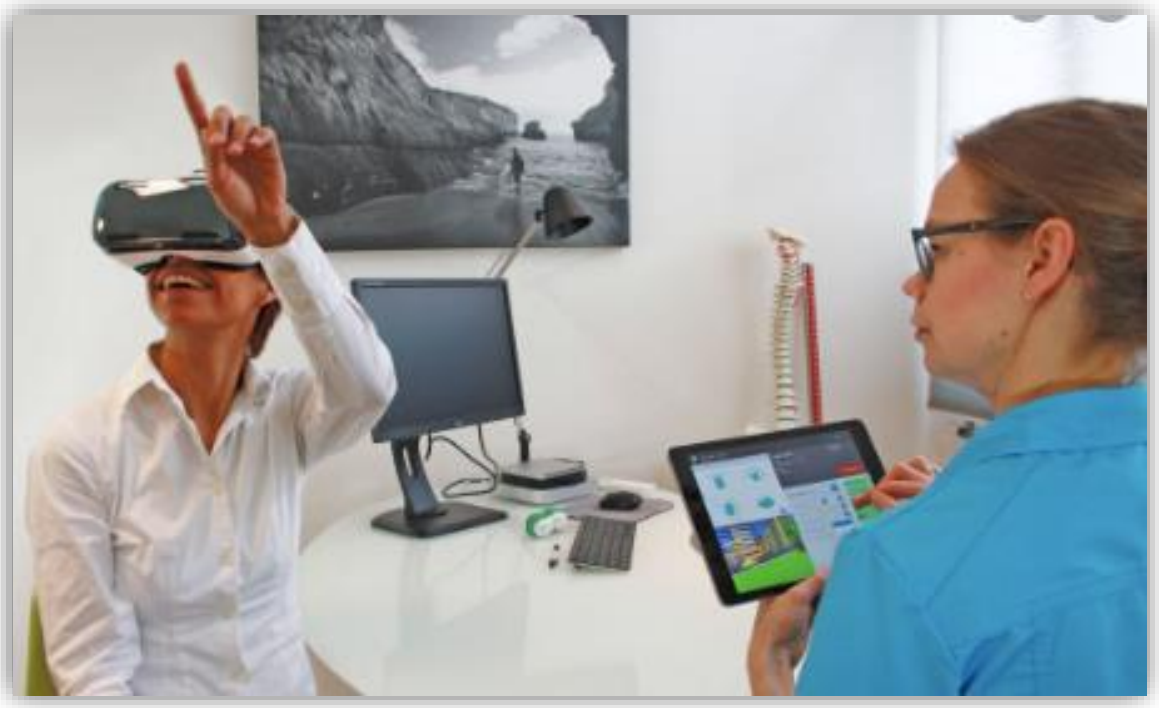


Figure 2. Screenshot of InMotion VR (image from inmotionvr.com).

Dutch company.

Treatment Type NextGen solutions with physical therapy and rehabilitation.

Technology Device Corpus VR Pro and Corpus VR Personal.

Strengths Using a unique integration of AR/VR, sensors, and gaming in custom treatment methods. Qualified team of software developers and physical therapists. Treatment is about games to rehabilitate injuries.

Weaknesses The technology is meant to focus on physical therapy, which is not a weakness but a limitation in this study.

2.2.3 Zerophobia App

Figure 3. Screenshot of Zerophobia App (image from zerophobia.app).

Dutch company. Developed by the University of Twente and the Vrije Universiteit of Amsterdam (UvA).

Treatment Type	Evidence-based solution for the fear of heights (phobias).
Technology Device	Smartphone application in combination with VR make-shift headset.
Strengths	Developed by leading scientists, based on extensive research, and uses a smartphone. Based on CBT, but mainly utilizes CET techniques in VR.
Weaknesses	Only focuses on phobia treatment with CET techniques.

2.2.4 CleVR

Figure 4. Screenshot of CleVR (image from clevr.net).

Dutch company. Collaboration between TU Delft (Interactive Intelligence Group) and the UvA (Clinical Psychology).

Treatment Type Treatments for various mental disorders including: Psychotic disorder (psychosis, anxiety and paranoid as residual complaints), social anxiety disorder, panic disorder (with and without agoraphobia), generalized anxiety disorder, depressive disorder with anxious mood, autism, anxiety complaints in the context of a personality disorder, etc.

Technology Device Custom designed hardware and software.

Strengths Focuses on CBT in VR. The Dutch Healthcare Authority (NZa) has approved this innovative care performance application for their use of VR combined with CBT.

Figures 5 & 6. Screenshots of CleVR virtual environment (images from clevr.net).

Weaknesses Focuses on mental disabilities, which is a weakness in analysis for this project.

2.2.5 Nizik Behavioral Health - NBH

Figure 7. Screenshot of NBH (image by Billetto Editorial).

American company.

Treatment Type	Drug rehabilitation and addiction treatments. Personalized therapies and relapse prevention. Offers adolescent treatment and detox programs.
Technology Device	Does not state explicitly.
Strengths	CET mixed with CBT in VR. Treatments for many types of substance use.
Weaknesses	Does not state details about how their treatments work. In hospital and outpatient treatments are available in multiple locations.

2.2.6 Trafalgar

Figure 8. Screenshot of Trafalgar (image by Laurens Derks).

Canadian company.

Treatment Type CET for addiction treatments, like sobriety maintenance, relapse prevention skills, and ability to cope with cravings.

Technology Device Does not state explicitly.

Strengths CET combined with VR for mental health disorders and substance abuse studies. Accredited therapists utilize VR equipment during sessions to enable clients to practice relapse prevention, distress tolerance, and coping skills to manage cravings and anxiety. In the therapy, the client is exposed to triggering scenarios designed specifically for the individual (i.e. being at a social gathering with alcohol or being at a restaurant). The VR equipment allows the therapists to release scents, such as liquor and smoke, to create a highly realistic relapse

situation, but in the safety of the therapy session. This equipment also permits the therapist to design social interactions that can assist in exposure to social anxiety.

Weaknesses Only focuses on CET.

2.2.7 C2Care

Figure 9. Screenshot of C2Care (image by Micahel Tragno Psychologue).

French company. Works directly with psychoanalysts.

Treatment Type Two types of addiction treatment application available: Substance use disorders (alcohol, cigarettes, cannabis, and cocaine), and behavioral addictions (gambling, shopping addiction).

Technology Device Does not state explicitly.

Strengths Virtual environments reproduce situations where the patient will be exposed to the underlying cause of the craving (the feeling that he or she wants to consume),

and “forces” the patient to confront them. By exposure to the object, or the underlying craving, the therapist can work not only on the cognitive processes (thoughts and dysfunctional beliefs), but also on the behavioral problems, in order to find adequate methods to manage the addiction treatment.

Figures 10 & 11. Screenshots of C2Care virtual environments (images from c2.care).

Weaknesses Uses CET techniques.

2.2.8 Discussion of Relevant Work

Overall, the companies found were each from a different country. They all had similar features, like Cue-Exposure Therapy being used in VR for either addiction treatment or phobia treatment. There was minimal specification on the patient's mental health, except with the company CleVR. The companies did not explicitly state if their patients include intellectual disability patients, which is a partial overall weakness when compared to this project. However, since the analysis of other companies is meant also to focus on the technology, the analysis is adequate for the Designer.

Conclusively, there is an abundance of companies that focus on addiction treatment interventions, and many with the combination of VR. However, at this point, there minimal that focus on the combination of cognitive behavioral therapy with VR. Supported by the findings from the scientific literature review, this means that the development of such a treatment could offer the patients with the dual diagnosis MID-BIF and SUD the specialized treatment that is needed.

Furthermore, there are several features of the reviewed treatments that could serve as inspiration for the addiction treatment being implemented into therapy sessions. The companies that stood out the most and will be further investigated during the ideation phase include: CleVR, Trafalgar, and C2Care. C2Care is interesting in terms of sense of presence in their virtual environments.

3. Methodology

In this chapter, the methods and techniques are described that are used during this graduation project. The actual implementation is described in the upcoming chapters. A structured approached is followed, according to *The Design Methods of Creative Technology*, as described by Mader and Eggink (2014). The design process involves co-design from the target group (MID-BIF patients) and stakeholders (clinical professionals).

3.1 The Creative Technology Design Process

The Design Methods of Creative Technology was developed as a guide for all student projects in the B.Sc. Creative Technology program at the University of Twente. The method is adapted from several related design principles, such as Industrial Design and Interaction Design. The method is an interactive method comprised of four phases: *Ideation, Specification, Realization, and Evaluation* (Mader & Eggink, 2014).

In the *Ideation Phase*, concepts and ideas are generated and collected. These concepts and ideas are the result of a multitude of activities, such as brainstorming, related work, and interviewing stakeholders. After expanding the design space, the ideation phase results in a more elaborated project ideas through *divergence* and then *convergence*.

In the *Specification Phase*, the final resulting idea from the ideation phase is evaluated. The knowledge gained from the User Requirements and Technology Specifications is used to shape the specifications of the final project design.

In the *Realization Phase*, the decided upon design is analyzed in terms of how it can be realized. Once the analysis is concluded, and a planning is made, the idea is realized using prototypes and iterative feedback loops from users. Several prototypes may be created, based on the specifications and new requirements from user-testing.

In the *Evaluation Phase*, the usability tests are carried out and evaluated in order to determine if the original requirements were met. A reflection on the progress, the idea's position compared to the related work, and suggestions for future improvements can then be made.

Moreover, in some phases a *divergence and convergence* approach is applied. At the beginning of a new phase, the design space is widened (divergence) and is later reduced to one final solution (convergence). An overview illustrating the design process can be found in Appendix B, Figure B1.

3.2 Design Techniques (Co-Design)

Given the unique characteristics of MID-BIF patients, implementing co-design proves to be a powerful tool to adapt this project to their specific needs and requirements. These dual diagnosis patients often experience barriers to addiction solutions due to a disconnect between disability care and addiction treatment (van Duijvenbode & Vandernagel, 2019; Didden, et al., 2020; Kiewik, VanDerNagel, Engels, & De Jong, 2017); therefore, considering their needs is extremely important. Co-design is a form of participatory design (Sanders, Brandt, & Binder, 2010), in which users and stakeholders are actively involved in the design process. The objective is to receive information from users regarding their experiences and knowledge to develop and design a product (Liem & Sanders, 2011), and to receive guidance and advice from stakeholders about the product. Moreover, this co-design involves stakeholders like therapists and clinical professionals. The reason for this involvement is to enhance the fit between the intended users (patients) and the solution (VR prototype to be used by therapists in SUD treatment sessions with MID-BIF patients). Researchers suggest that the perspective of co-design is a combination of participatory and empathic design (Steen, Kuijt-Evers, & Klok, 2007).

In this section, the different design techniques used to include both the users (patients) and the stakeholders (clinical professionals) in the design process are briefly described.

3.2.1 Interviews

There are two sets of interviews that occur in this project. The first set is done in the Ideation Phase to support the concept creation of the prototype. The second set is done after the prototype is realized during the Evaluation Phase. Both sets are explained in detail in the related phase.

3.2.1.1 Ideation Interviews

Initial semi-structured interviews with stakeholders (therapists and clinical professionals) are used to obtain important insight regarding the needs of the patients and the context of the therapy sessions. In the early stage of the project, Dr. Johanna van der Nagel was casually interviewed. She offered a body of knowledge to understand patient needs and the CBT+ protocol in place at the company Tactus. One further interview with Dr. van der Nagel resulted in a list of possible implementations of VR within typical therapy sessions for out- and in-patients. Out-patients include MID-BIF patients living independently while attending addiction treatment sessions. In-patients include MID-BIF patients temporarily living at an addiction treatment facility while also attending treatment sessions.

3.2.1.2 Evaluation Interviews

After the ideation and realization of the project is completed, user tests are normally conducted. However, due to COVID-19 restrictions and regulations (there can be no face-to-face contact or sharing of a device), user tests became an issue. To overcome this issue, semi-structured online interviews are done instead. Semi-structured interviews with patients and clinical professionals are carried out by sending the participant an explanatory video of the VR prototype and discussing the participant's opinions through the use of questionnaires. The experimental procedure is discussed in detail in the next section.

3.2.2 Questionnaires

Questionnaires regarding topics from the research questions, self-efficacy and realism, are asked to patients and clinical professionals during the evaluation interviews. Questionnaires are a useful way of collecting qualitative data that can be used for a Thematic Analysis. See Appendix F for the questionnaires.

3.3 Method Overview

The Creative Technology Design Method, mixed with the co-design method, shape the Specification and Realization phases. This is illustrated in Figure 11.

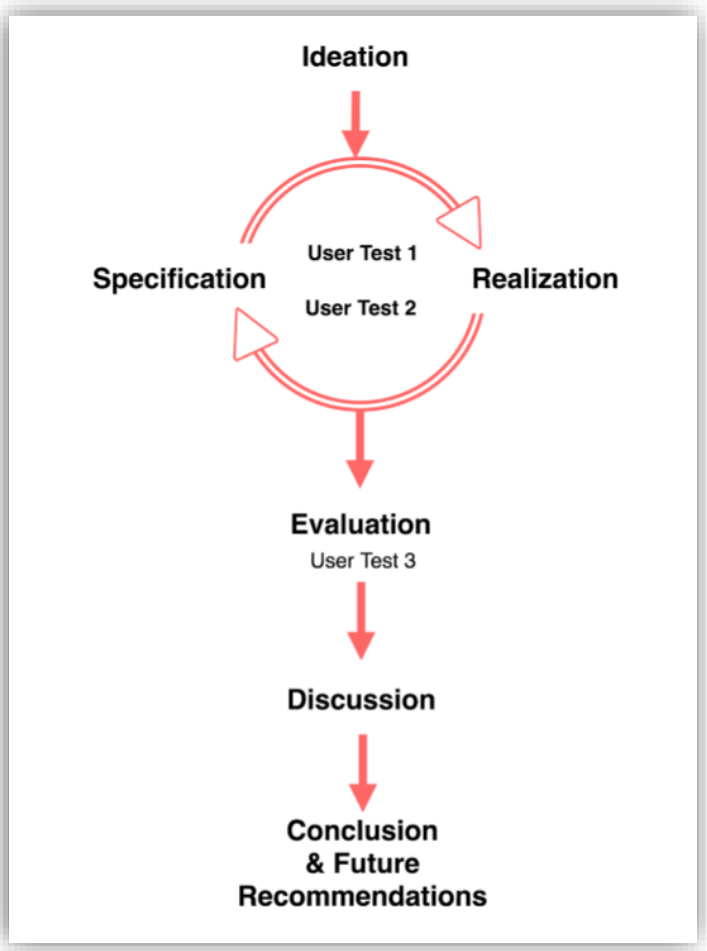


Figure 12. Illustration of The Creative Technology Design Method and co-design for the overall design process of this project (Astrom, 2019).

4. Ideation

In this chapter, the knowledge gained from the literature review, related work, design process, and initial interviews is used to ideate several concepts that could become the final solution for this project. First, the project idea is elaborated on through divergence with a context analysis, target group analysis, and concept brainstorm; then, there is convergence, where a final idea is decided on.

4.1 Divergence

Figure 13. Screenshot of family dynamics in addiction treatment (image from pixabay.com).

4.1.1 Context Analysis – Tactus Treatment Protocols for MID-BIF Patients

Tactus offers two types of SUD treatment protocols for patients with the dual diagnosis of MID-BIF and SUD. This section describes the two protocols, *Minder Drank of Drugs* (MDOD) and *Cognitive Behavioral Therapy Plus* (CBT+ or CGT+ in Dutch). Both protocols are similar in content, with the main differences being that MDOD has group sessions and the number of sessions is higher when compared to CBT+. The protocol that is focused on in this project is CBT+, however, knowledge about both protocols can prove helpful when ideating possible solutions. Outlines of both protocols are summarized from the study by van Aggelen (2017).

4.1.1.1 MDOD

The first protocol entitled *Minder Drank of Drugs* (MDOD) developed by VanDerNagel & van Aggelen (2017) consists of weekly individual meetings with the patient and their 'vertrouwenspersoon', or personal helper, and weekly group meetings with several patients. The *vertrouwenspersoon* is a person the patient trusts and helps the patient relate the theory to the patient's own personal experiences; for example, the

patient's friend, family member, or assigned professional. The protocol runs for 12 weeks, and both types of meetings have a fixed structure, discussed below. Each week's activities are based on a different theme which supports the patient through their addiction rehabilitation. The individual meetings are aimed at introducing the exercises and addiction theory, with the patient's contact person present (vertrouwenspersoon), as well as helping the patient learn the theory of the personal addiction. These are accompanied by group meetings to practice the trained exercises and learned theory (VanDerNagel, 2016; van Aggelen, 2017). The complexity of family dynamics must be understood by the patient and how it may play a role in generational substance use.

The individual meetings begin with introducing the theme of the week, a recap of the last sessions, and going over the previous week's homework. The patient then discusses what they have learned and their personal feelings. Afterwards, new theory is discussed, an outlook is given for the group session, and new homework is given. The total time of individual meetings is maximum 45 minutes.

Moreover, the group meetings are aimed at helping the patient practice the learned theory from the individual group meetings. The group meetings begin with each patient informally discussing their personal issues and achievements. Afterwards, the meeting starts officially and exercises regarding their SUD are practiced, corresponding to the theme of the week. The group meetings give an opportunity for patients to share their personal experiences and receive social support. The total time of group meetings is maximum 90 minutes, including a 15-minute break.

The objectives of the MDOD protocol are for patients to learn theory about their substance use, learn coping mechanisms, and learn relapse prevention skills all through exercises and homework.

The weekly themes are listed below (van Aggelen, 2017):

- Week 1: Introduction
- Week 2: Substance information
- Week 3: Pros and cons
- Week 4: Goals and tips
- Week 5: Habits
- Week 6: Cravings
- Week 7: Saying no
- Week 8: Goals and excuses
- Week 9: Different thinking and different acting
- Week 10: My plan
- Week 11: Preventing relapse
- Week 12: Parting and proceeding

4.1.1.2 CBT+

The second protocol entitled *Cognitive Behavioral Therapy Plus* (CBT+) also developed by VanDerNagel & van Aggelen (2017) is a combination of cognitive behavioral therapy techniques, adapted to treat individuals with ID for their SUD issues. The protocol runs for 9 weeks, and there are two types of sessions each week: one individually with the patient (meeting A) and the other with the patient and the patient's *vertrouwenspersoon* (meeting B). Having two meetings each week provides repetition and allows the patient to stay focused and attentive. The separation of meetings also ensures the patient has both autonomy and social support. The meetings have a fixed structure, described below, and each week has a theme, as with MDOD (VanDerNagel & Kiewik, 2016; van Aggelen, 2017).

Moreover, the meetings begin with an informal discussion about how the patient is feeling, followed by a short recap of the last meeting. The homework from last week is then discussed, the new theme of the week is introduced, new theory is discussed, and exercises are practiced. Finally, new homework is given, and the meeting is summarized. Both types of meetings have a similar structure, with the exception that meeting B is with the patient's *vertrouwenspersoon* and the exercises can then implement role play to deeper the understanding of the patient regarding their addiction.

The weekly themes, along with a short explanation of each theme, are listed below (van Aggelen, 2017):

- Week 1: The Start (Preparation)
    - Social introduction, discuss substance use
    - Exercise to draw a lifeline of important moments in the patient's life
- Week 2: Let's get to work (Goals & self-monitoring)
    - Exercise of setting goals for the patient to try not to use the substance
    - Introduce 4 parts of the 6D's: deals, distance, declare, and doing great
- Week 3: When do I use? (Self-control techniques & function analysis)
    - Practicing the learned 4 self-control techniques (6D's) further
- Week 4: I can change (Function analysis & emergency measures)
    - Explain slip-ups and relapses
    - Exercise to make emergency plan in case of relapse
    - Introduce 1 part of the 6D's: distraction
- Week 5: Dealing with cravings (Emergency measures & cravings)
    - Explain cravings
    - Role-playing exercises on how to deal with cravings
- Week 6: Thinking differently & acting differently (Dealing with cravings & changing thoughts)

    - Introduce 1 part of the 6D's: different thinking & different acting
    - Exercises on cravings and helping thoughts
- Week 7: Saying no to use (Changing thoughts & refusing)
    - Introducing various ways to refuse a substance
    - Exercise on how to change dangerous thoughts into helpful thoughts when in risky situations
    - Role-playing exercises on how to refuse a substance
- Week 8: Dealing with slip-ups (Refusing and relapse prevention)
    - Extending emergency plan
    - Exercise that repeats all skills and techniques of saying no and self-control (6D's)
    - Extending plan of what to do (blue) in different phases (green, orange, red)
- Week 9: I have achieved something! (Evaluation)
    - Completing the plan
    - Receive certificate
    - Assess readiness to finish treatment

4.1.2 Target Group Analysis

In order to gain an understanding of the wants and needs of these dual diagnosis patients, information was gathered through semi-structured interviews with psychiatrist Dr. Johanna Van Der Nagel in the early stages of the design process. These semi-structured interviews came in the form of casual conversations, discussing the research questions and possible solutions. What was found out in these interviews was:

1. These patients are greatly influenced by their peers.
2. These patients are strong yet vulnerable, open, and naively honest (can be profoundly dishonest).
3. These patients have generalization issues (if they learn in something in one context, they have difficulty applying it to another context).
4. The number of stimuli in the virtual environment needs to be under control, so to not overload the patients.
5. There should be no punishments involved in the treatment since these patients already have enough negative experiences in their lives.
6. These patients need their *vertrouwenspersoon* present with them because patients cannot come up with many personal examples on their own, in general.
7. These patients could have a fear of rejection or experience peer pressure.

8. There are many important exercises in the protocols that should be considered to recreate in VR, such as:
    a. Self-control techniques (6D's)
    b. Assessing risk situations
    c. Safe situations
    d. Relapse prevention
9. Due to the Coronavirus, Tactus is having trouble assessing the readiness of in-patients to be able to go home since these patients cannot leave the facility.

4.1.3 Concept Brainstorm

Due to the broad nature of the research questions, the initial ideation phase was divergent, exploring a wide range of possible solutions. The main objective is to implement VR into typical therapy sessions for patients with the dual diagnosis of MID-BIF and SUD. Therefore, the concept brainstorm starts with a general brainstorm of ideas, and then discusses multiple ways of tackling one decided upon idea. The conclusion of the brainstorm made it clear that the CBT+ protocol, specifically CBT+ exercises, is to be focused on.

4.1.3.1 Word Association Activity and Moodboard

To open the mind for brainstorming on the topic of VR and these specific addiction treatment sessions, a word association activity (see Figure C1, Appendix C), along with a moodboard (see Figure C2, Appendix C), was carried out. Following the project objectives *to design and build a VR prototype with virtual situations patients can navigate around, to immerse patients into the virtual experience so to support the patient to focus on the treatment and not their intellectual disability, to have patients practice self-efficacy and self-control techniques through specific CBT+ training sessions, and to evaluate the application with these patients and relevant clinical professionals,* lightly, the following four themes were found: *addiction*, *immersion*, *virtual*, and *patient*. These themes serve as inspiration for the brainstorm, with the purpose of generating a solution that could answer the research questions.

4.1.3.2 General Brainstorm of Ideas

Based on the underlying themes found in the word association activity, a general brainstorm of potential solutions was carried out. A total of 10 concepts were generated, varying in levels of complexity (see Figure C3, Appendix C). Due to the complexity of some concepts, and the desires of the patients and stakeholders discussed in the target group analysis, the concept of recreating CBT+ protocol exercises in VR deemed the most desirable for the solution.

There are multiple CBT+ exercises. Therefore, the exercises were listed out and a total of 6 exercises are further discussed. Due to therapy sessions usually lasting a maximum of 45 minutes, only 1 type of exercise was decided to be implemented as the solution in the later stages of this project. To decide which exercise to recreate, each exercise is assessed based on four criteria created by the designer (levels being low, medium, or high):

1. Level of feasibility in virtual reality
2. Level of complexity for an addiction treatment session (added value)
3. Level of risk for the patient (negative effects)
4. Level of usefulness for the therapist or clinical professional (difficulty)

The *level of feasibility in VR* refers to how possible would it be to implement the exercise in VR with the technology at hand. The *level of complexity for an addiction treatment session* refers to if implementing the exercise in VR would add value to the treatment session or if the same effect could occur without the use of VR. The *level of risk for the patient* refers to the negative effects that occur to the patient due to the use of VR, such as cybersickness, trauma, or overexposure to visual cues. The *level of usefulness for the therapist or clinical professional* refers to the difficulty level that could occur to the therapist or clinical professional using the VR technology to conduct the exercise, especially during the time limit of the session.

Self-Control Techniques (6D's)

Self-control techniques, called the 6D's, are introduced to the patient throughout the first 7 weeks of the CBT+ program. The different techniques are practiced each week, and during the week 8 all 6D's are practiced. The 6D's are self-control techniques that call for identification of the specific situations that could make it difficult for the patient regarding their substance use by the therapist and client. These situations are grouped into three categories with respect to their level of risk and given a corresponding color: no/low risk (green), be careful (orange), and high risk (red). The patient is taught the self-control techniques in the form of a list called the 6D's (6A's in Dutch). The six techniques can be grouped into three types: stimulus control (avoiding the risky situations and people by practicing distancing), stimulus response (practicing alternative behaviors in risky situations), and response consequences (focusing mainly on rewards but explain negative consequences that could occur).

The 6D's can be seen in the table below:

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 1. Self-control techniques exercise, 6D's (VanDerNagel & Kiewik, 2016; van Aggelen, 2017).

Lifeline Drawing Exercise

During the week 1 of the CBT+ program, the patient is introduced to substance use and an open discussion is held regarding the patient's addiction. An exercise is conducted where the patient must draw a lifeline on paper or a whiteboard with important moments of the patient's life singled out as anchor points (i.e. transfer from primary to secondary school, transfer from school to work, death of a loved one, etc.). Then the patient must draw the periods of their substance use, showing points at which they were out of control or in control of their use.

Role-Playing Exercises

Role-play exercises can be conducted during any of the 9 weeks of the CBT+ protocol. The focus could be on either role-play exercises on how to deal with cravings or how to refuse a substance. During the week 5 cravings are introduced, and during week 7 refusing a substance is introduced. These role-playing exercises could be done with the patient's *vertrouwenspersoon* or without depending on what the therapist deems helpful for the patient.

Dangerous Thoughts Exercise

During week 7, the concept of changing dangerous thoughts (when the patient might consider using a substance again) into helping thoughts (helpful thoughts for the patient to refuse the substance) in introduced. A role-play exercise is conducted where the patient is offered a substance, the patient analyzes their thoughts, and the patient practicing refusing the substance. The different situations during the role-play are categorized by color, discussed as part of the 6D's. Exercising on how to change dangerous thoughts into helping thoughts in risky situations is part of the CBT+ protocol.

Emergency Plan Exercise

During week 4 of the CBT+ protocol, the patient comprises a first draft of an emergency plan that the patient can follow in case of a slip-up or relapse. The plan involves the 6D's, emergency contacts, and different techniques that can support the patient during substance use slip-ups or relapse of substance use. During week 8, the emergency plan is extended with the color-coding of different situations; what to do (blue) and the types of situations (green, orange, and red).

Cravings Exercise

The concept of cravings is introduced to the patient during week 5 of the CBT+ protocol, along with coping mechanisms, tactics, and the theory behind cravings. Role-play exercises are conducted on how the patient can deal with their substance cravings. One specific exercise is the *sweets exercise*, which is when the therapist places sweets in front of the patient and says the patient is not allowed to have any. A deeper connection and understand of cravings are then created in the patient's mind.

4.1.3.3 Criteria Assessment

Each of these 6 exercises are assessed, based on the four criteria, below.

Exercise 1: Self-Control Techniques (6D's)

1. High level of feasibility in a virtual environment
2. High level of complexity for an addiction treatment session
3. Medium level of risk for the patient
4. Medium level of usefulness for the therapist or clinical professional

Exercise 2: Lifeline Drawing Exercise

1. High level of feasibility in a virtual environment
2. Low level of complexity for an addiction treatment session
3. Low level of risk for the patient

4. Low level of usefulness for the therapist or clinical professional

Exercise 3: Role-Playing Exercises

1. Low level of feasibility in a virtual environment
2. High level of complexity for an addiction treatment session
3. High level of risk for the patient
4. High level of usefulness for the therapist or clinical professional

Exercise 4: Dangerous Thoughts Exercise

1. Low level of feasibility in a virtual environment
2. High level of complexity for an addiction treatment session
3. High level of risk for the patient
4. Medium level of usefulness for the therapist or clinical professional

Exercise 5: Emergency Plan Exercise

1. Medium level of feasibility in a virtual environment
2. Medium level of complexity for an addiction treatment session
3. Low level of risk for the patient
4. Medium level of usefulness for the therapist or clinical professional

Exercise 6: Cravings Exercise

1. High level of feasibility in a virtual environment
2. High level of complexity for an addiction treatment session
3. Medium level of risk for the patient
4. High level of usefulness for the therapist or clinical professional

4.2 Convergence

4.2.1 Chosen Exercise: Self-Control Techniques (6D's)

After the criteria assessment of the 6 CBT+ protocol exercises, it is clear that implementing the self-control techniques (6D's) exercise in VR would add the most value to a therapy session for these dual diagnosis patients. The other exercises also present added value but would come with the risk of adding difficulty for the patient or the therapist. For instance, role-play is difficult since the patient has limited trust, and adding a simulated character in VR that the patient knows calls for more advanced technology. The cravings exercise could be interesting and presented in a way that the illicit substances change into something unattractive or undesirable, but this might cause trauma to the patient if not implemented correctly. Additionally, the emergency plan exercise could be extended in VR by the patient attending a group activity

similar to an American AA meeting with virtual conversational agents. However, this may lead to the patient becoming scared or anxious considering these patients do not benefit from standard addiction interventions. Therefore, implementing the self-control techniques (6D's) in VR seems the most promising for this project.

Possible implementations of self-control techniques, in the form of the 6D's, in VR are listed below:

- A virtual environment in which the patient can move around freely to different situations that are based on the color-coding (green, orange, and red) from the CBT+ protocol
- The patient has a wrist band in the virtual environment (similar looking to a smart watch) that the patient can choose the color it shows depending on how the patient perceives the color-code of the situation the patient moves into
- Color theory is used to display the substance (tobacco, marijuana, alcohol) as grey and colorless, while the situations that are less risky or one of the 6D's are displayed as colorful and more appealing, so that the patient is more enticed to the latter situations that could support their addiction rehabilitation
- Gamification occurs for the patient as colored cubes present around the virtual environment in accordance to the color-coding of situations and the patient can choose to pick up the cube or ignore it (representing whether the patient confronts their addiction or not)

By combining these implementations, a solution can be created in the form of a virtual environment where a certain number of different situations (approximately 4) are available in the 3D world for the patient to navigate around. The patient navigates with the VR controller around the 3D world and sees colored cubes next to objects that could trigger their addiction. The patient can then choose to pick up the cube and discuss with the therapist which of the 6D's they could use to deal with their trigger; picking up the cube and attempting to cope with their addiction would reward the patient (either gold stars or some form of reward in the 3D world). In addition, when the patient enters one of the 4 situations, the patient's virtual wrist band will alert and the patient will choose what color the situation is (green, orange, or red) after the patient analyzes the situation, providing a notification for the patient to self-assess the situation.

Moreover, the substances in the virtual environment that are related to the patient's addiction are colorless, dull, and unappealing in looks. While the outside or a surrounding environment that the patient could choose to explore instead of focusing on their addiction (meaning to exercise one of the 6D's) look colorful, full of life, and appealing in comparison. This follows the Color Theory and the Psychology of Color with individuals who have an intellectual disability. Individuals on the autism spectrum have increased sensory responses, stronger visual processing abilities, and differentiated cognition pathways,

meaning these individuals are more sensitive to colors (Bolger, 2019). The color theory is the notion that colors surrounding an individual can have an effect on the individual's health, whether mental or physical (Babin, 2013; Goethe, 1810). The psychology of color is based on the notion that colors an individual is exposed to can have an effect on the individual's emotions or mental health (Elliot, 2015). By using both these theories, the patient can be supported to learn that less-risky situations, with regard to their substance use, are more appealing and the patient can control the environment.

4.2.2 Description of Virtual Environment

The design of the prototype has 4 virtual rooms the patient can choose from, a living room, supermarket, gym, and coffeeshop. The designer decided on these choices after multiple meetings with psychiatrist Dr. Johanna Van Der Nagel; possible triggers and situations were discussed. The following table includes the description of the virtual rooms, which involve the implementations of the 6D's.

Situation	**Predicted Riskiness Color**	**Predicted Triggers**	**Predicted Self-Control Techniques**	**Design Elements**
Situation 1: Living Room Scene	Orange (in-between)	• Type of music • Relaxation • Dim lighting	• Distance: go for a walk • Distraction: read a book • Deals: write down goals	• Wristband • Phone • Joint & ashtray • Coffee cup • Notebook & pen • Books • Door
Situation 2: Supermarket Scene	Green (very unlikely to smoke)	• Overexposure to colors / hypersensitivity • Bright lights • Radio music playing • People talking	• Distance: leave store • Distraction: listen to music with headphones • Declare: call someone	• Wristband • Phone • Headphones • Door

Situation 3: Gym Scene	Green (very unlikely to smoke)	• Rock music playing • Machine noises • People talking	• Distance: leave gym • Distraction: listen to music with headphones • Declare: call someone	• Wristband • Phone • Headphones • Weights • Door
Situation 4: Coffeeshop Scene	Red (very likely to smoke)	• Smoke everywhere • Jamaican music playing • People talking	• Distance: leave coffeeshop • Distraction: play game • Declare: tell others no or call someone • Different thinking: order food	• Wristband • Phone • Joint & ashtray • Coffee cup • Chess set • Cards • Bottles • Pool table • Door

Table 2. Description of the 4 virtual situations.

5. Specification

In this chapter, a Quality Function Deployment (QDF) approach is used to connect User Requirements to Technology Specifications (QFD (Quality Function Deployment) - Elite Consulting, 2019). A user scenario is provided to demonstrate how the prototype can be used in SUD treatment sessions for MID-BIF patients.

5.1 Specification

The Quality Function Deployment (QDF) approach is used to develop a relationship matrix between the User Requirements and Technology Specifications. First, QDF is used as a means of eliciting user requirements and turning them into technology system requirements in an engineering language. After, the matrix is created, which indicates the strength of the correlation between the user requirements and technology specifications. Both the user requirements and technology specifications form the functions of the prototype solution, which are implemented during the realization phase.

Before the Technology Specifications are decided upon, the designer must understand the depth of a typical dual diagnosis patient; a user persona and scenario are provided. Afterwards, specifications for the prototype are definite, and flowcharts for the prototype use are given.

5.1.1 User Persona and Scenario

To demonstrate how the prototype can be used by patients and therapists in a typical treatment session, a user persona and scenario are provided. The first aspect, the user persona, can be seen in the figure below.

5.1.1.1 User Persona

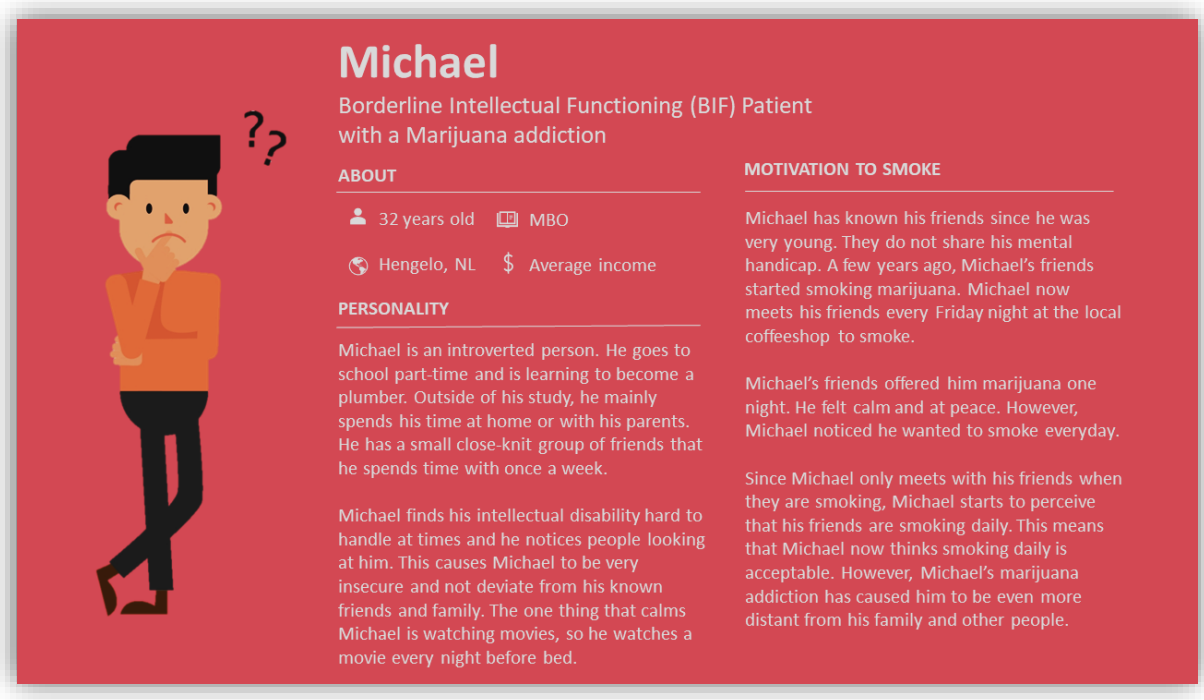


Figure 14. User persona of dual diagnosis patient.

5.1.1.2 User Scenario

For the second aspect, the user scenario, to be effective, the reader must perceive the story user's perspective, the user being Michael.

To begin, Michael is known to hang out with his group of friends every Friday night at the local coffeeshop. Michael's marijuana addiction is sustained by multiple reasons: peer pressure, insecurity, relaxation, and his introvert personality. Although marijuana is widely accepted in the Netherlands, Michael's addiction has become a problem. Michael's parents have stopped wanting to be around him, Michael's spending has gotten out of hand, and Michael feels even more insecure when sober than before, which causes him to not want to leave the house. The parents of Michael have contacted an addiction treatment facility for help and guidance. Michael is eager to start the program since he wants to please his family and learn to overcome his addiction.

The addiction treatment facility is specific to intellectual disability patients, meaning the facility knows how to treat both the patient's addiction and disability; a rarity to find. The facility is trying out a new program that involves virtual reality (VR) integrated in the therapy sessions. Michael and his family are intrigued by this program since Michael is an avid gamer and has a passion for movies.

The treatment is typically a 9-week program (as described in the CBT+ protocol section). By week 6 Michael has learned six self-control techniques, which are alternative activities and guidance for his addiction cravings. An extra week is added to the program (the new week 7) where the VR technology is introduced with a total of four VR sessions; however, the VR application could be implemented during any week of the program according to the judgement of the therapist.

Each of the four VR sessions involves a specific situation where Michael is immersed in the virtual environment. During the first VR session, Michael is asked to put on the VR headset and hold the controller. The virtual environment Michael sees through the headset is of a coffeeshop setting. Michael looks around and notices the virtual wristband on his arm. The therapist tells Michael to pick a color on the wristband depending on how risky the situation feels to Michael. Michael picks the color red because by standing in a coffeeshop, Michael feels the urge to smoke. Time goes by as Michael walks around the virtual coffeeshop, still feeling triggered to smoke. Michael asks the therapist "How can I deal with my cravings? I really want to smoke!". The therapist tells Michael to use one of the self-control techniques he learned. Michael debates whether he should walk out the door to practice distancing or use his phone to call for support to practice declaration. Meanwhile, the card game on one of the tables in the coffeeshop starts to glow. Michael does not want to leave the coffeeshop since he wants to practice how to deal his addiction so he can spend time with his friends in real life. Michael decides to play the card game to practice distraction.

There are three more VR sessions that Michael completes, and by week 10 Michael has finished his addiction treatment. By practicing real world situations, Michael feels ready to use the self-control techniques he learned in real life. The treatment has allowed Michael to feel empowered and in control of his situation, as well as encouraged and confident with his disability. Moreover, Michael still must work daily to overcome his addiction as it cannot be cured but instead dealt with.

Figure 15. New user persona of marijuana addiction patient after treatment.

5.1.2 User Requirements

Prior to developing the VR prototype solution for patient interaction, it is critical to consider what core elements the user (patients) requires, as well as what elements the stakeholders (clinical professionals) require. From the ideation phase, core user requirements are derived, that together form the essence of the intended user experience of the prototype. The user experience is designed to be patient-oriented. The prototype should (1) immerse the patient in the virtual environment, (2) assist the patient in self-assessing the type of situation in terms of risk of their SUD (risk level by color: green, orange, or red), (3) support the patient with learning the self-control techniques (6D's), (4) provide a reward for the patient during their rehabilitation process, and (5) sustain the patient's feelings of control and empowerment (self-efficacy). These five requirements implemented in the prototype will add value to the therapy session. A summary of the core requirements of the prototype concept can be seen below.

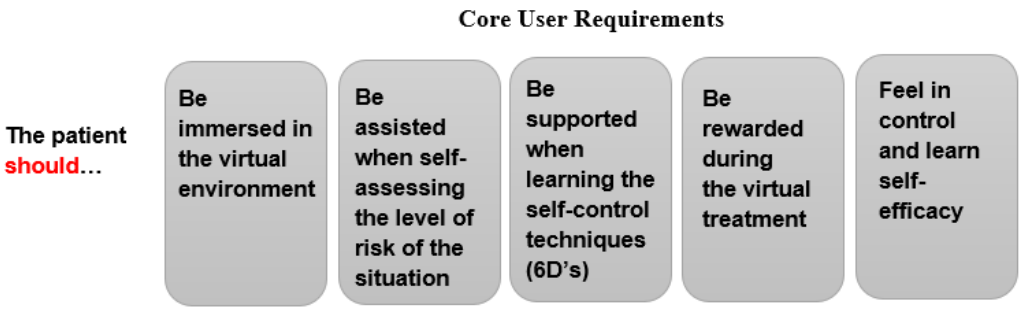


Figure 16. Summary of the core user requirements of the VR prototype solution.

5.1.3 Technology Specifications

Based on the requirements of the user experience, the technology specifications are defined. These specifications for the technology of the prototype include (1) use of VR technology and equipment, (2) allow the user to move around the virtual environment freely and orientate, (3) provide the 4 virtual situations (as described in the ideation phase) that differ in terms of risk level, (4) have a virtual wrist band that the user can change the color, associated with the level of risk of the situation, (5) present alternative options to substance use in the virtual situations, (6) provide gamification with a point system for the user, and (7) implement the CBT+ protocol exercise for use in a SUD treatment session. These seven specifications combined with the user requirements form the specifications of the prototype. The prototype can then be compared to competitors, and further aspects for added value can be deliberated.

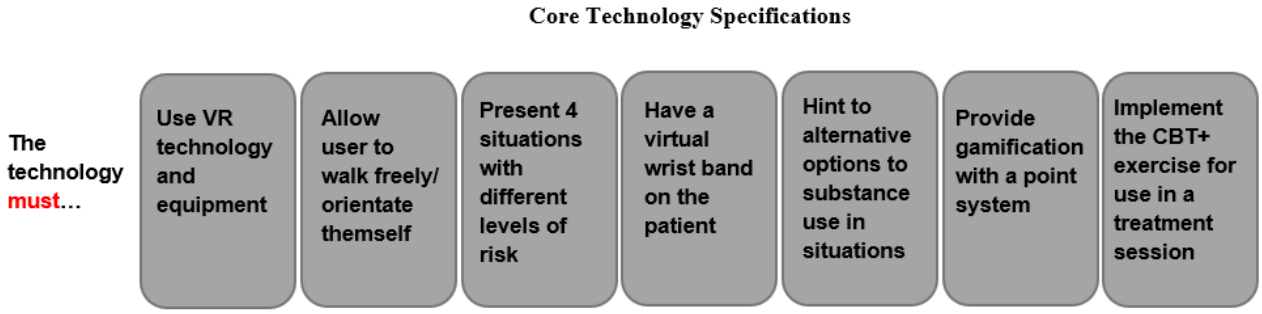


Figure 17. Summary of the core technology specifications of the VR prototype solution.

5.1.4 House of Quality Matrix

Using the House of Quality matrix from the QDF approach (QFD (Quality Function Deployment) - Elite Consulting, 2019), a matrix is created. The rows represent the core user requirements and the columns

represent the core technology specifications. By using this matrix, the developer can be certain the prototype implements the technology specifications needed to satisfy the user requirements. If the specific technology specification satisfies one of the user requirements, an 'X' is placed in the matrix.

Beneath the matrix is an additional Benchmark matrix. Two companies described from the Relevant Work section, C2Care and CleVR, are analyzed to see if the similar work implements any of the technology specifications. Both companies implement 4/7 specifications in their technology.

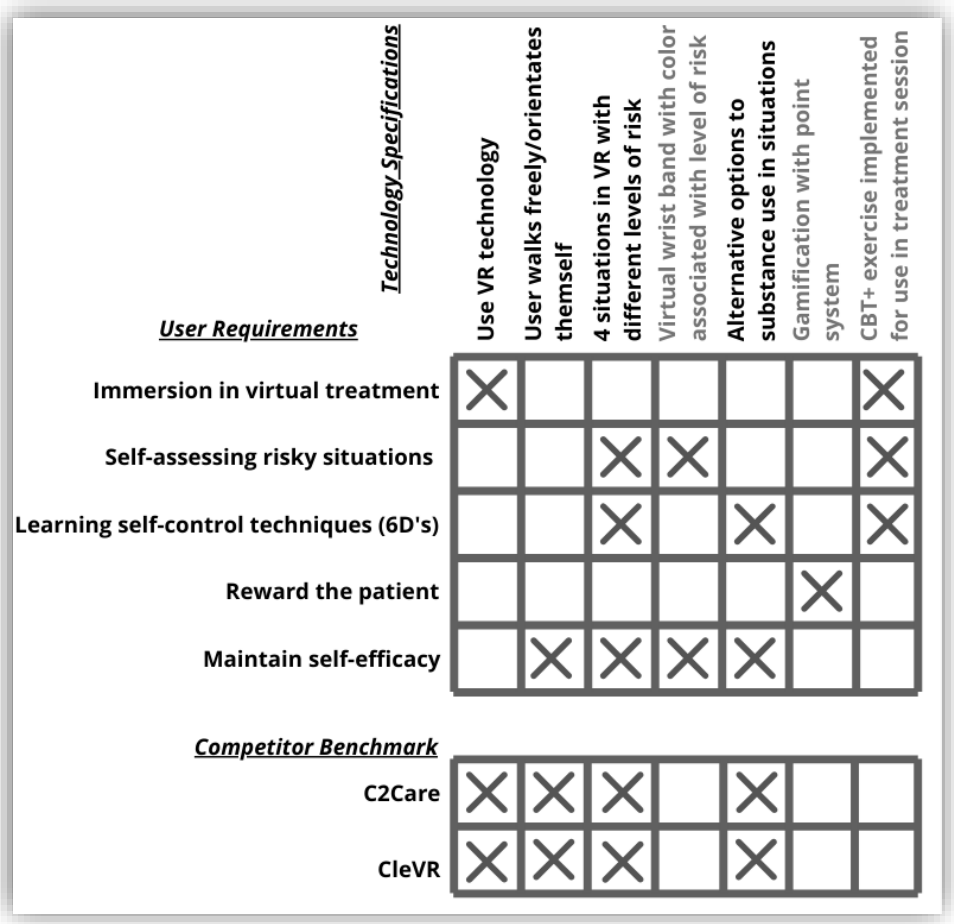


Figure 18. The House of Quality matrix comparing user requirements and technology specifications.

The other three specifications that the related companies do not implement can be seen as 'delighters' in marketing terms. These delighters are aspects of a technology that go beyond what competitors have benchmarked, possible reasons for this prototype to succeed if put on the market. The delighters for the prototype, therefore, include: (1) the virtual wrist band that the user can change the color which is associated with the level of risk of the situation, (2) gamification with a point system for the user, and (3) implementing a CBT+ protocol exercise for use in a SUD treatment session.

Self-efficacy is also part of it, feeling empowered. Reward builds self-efficacy and patients feel empowered and encouraged. These delighters are used to go above the competition so that the product is useful; to go above simply satisfying user expectations and what is already benchmarked in order to delight users.

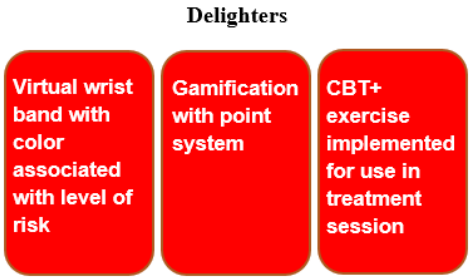


Figure 19. Summary of the delighters of the VR prototype solution.

5.1.5 Flowcharts

To understand how each of the specifications can be implemented with the VR prototype, flowcharts are created. The initial orientation for the user (patient) with the prototype is described, as well as each of the four situations in the virtual environment.

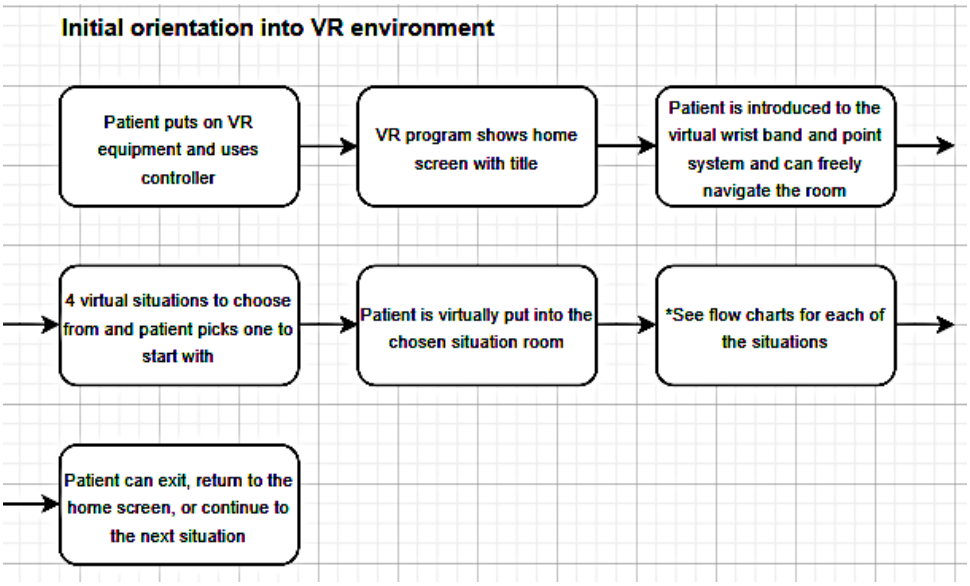


Figure 20. Flowchart of initial orientation,

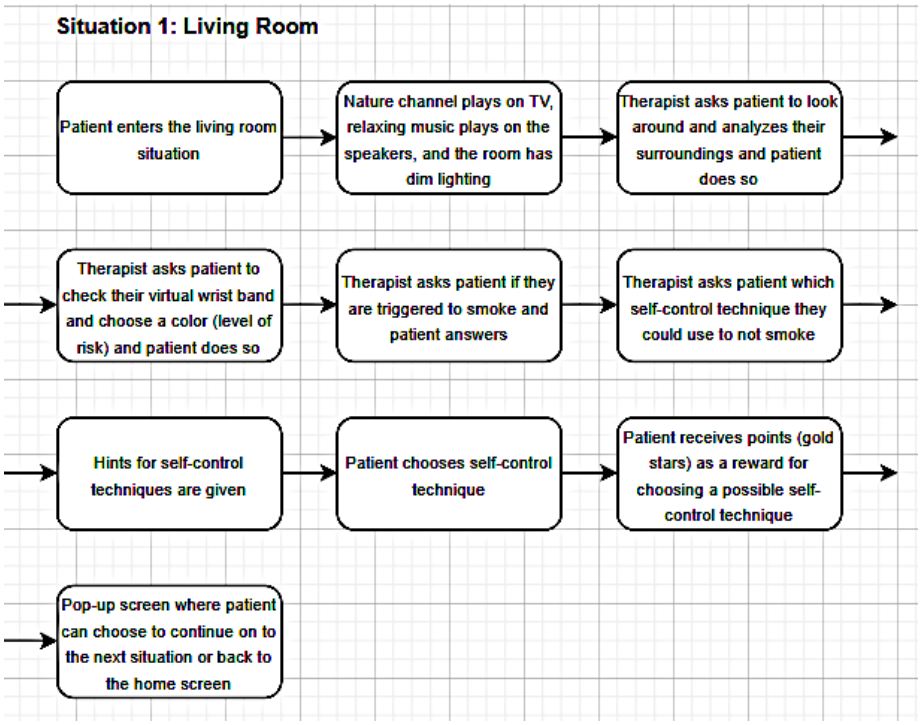


Figure 21. Flowchart of living room.

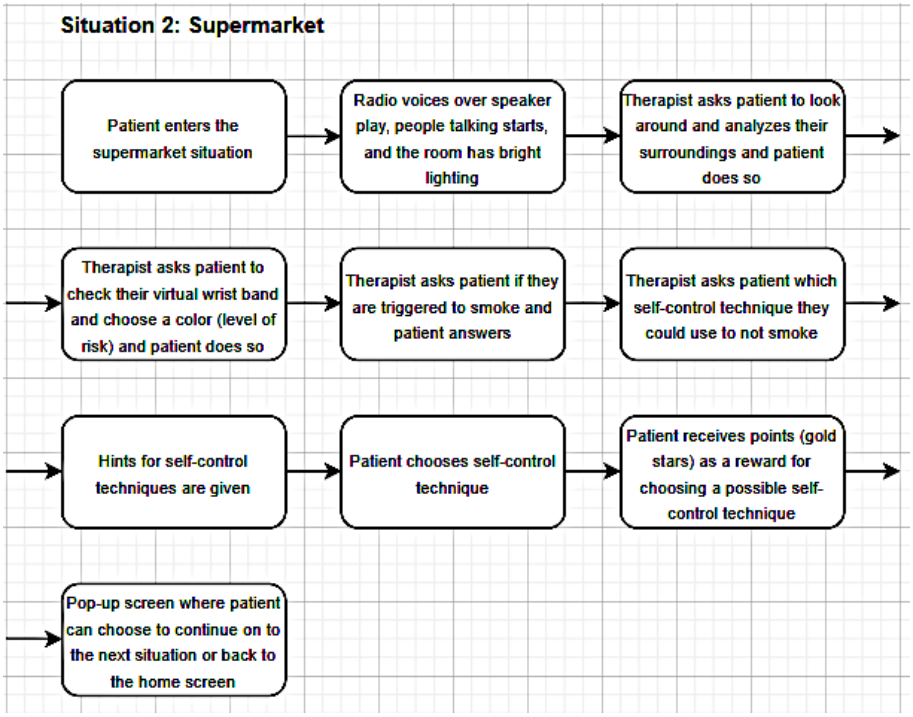


Figure 22. Flowchart of supermarket.

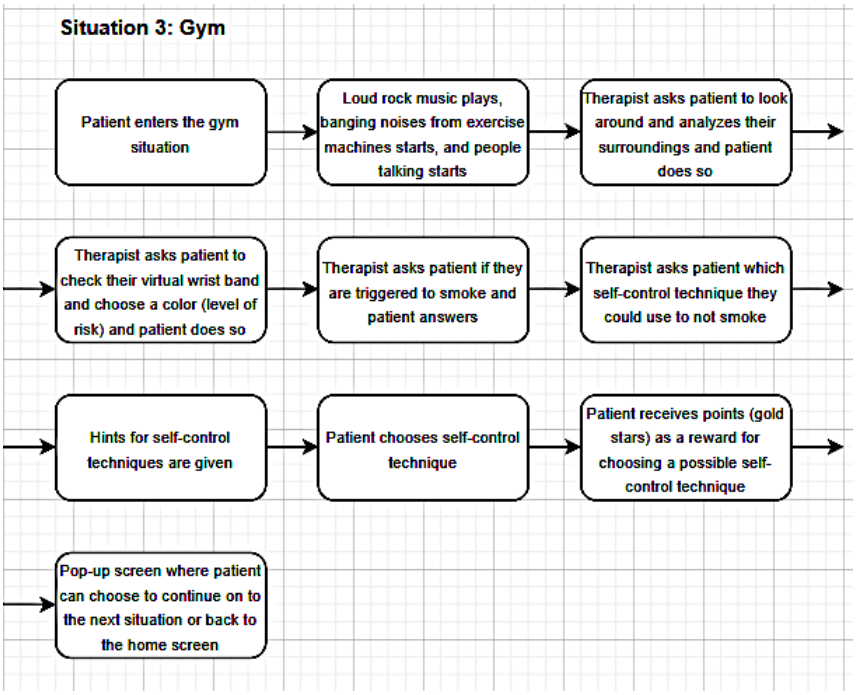


Figure 23. Flowchart of gym.

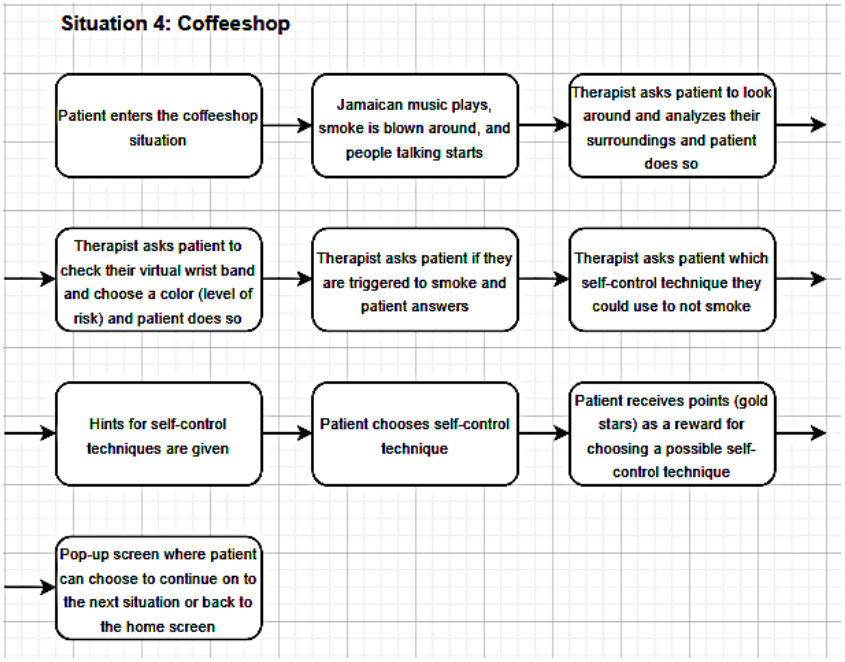


Figure 24. Flowchart of coffeeshop.

6. Realization

In this chapter, based on the specifications of the prototype defined during the Specification Phase, versions of the VR prototype are realized. Typically, user tests would be conducted around the initial version. However, due to the current world health crisis COVID-19, this cannot be done. Instead, the designer creates an interactive video of the VR prototype to gain information from patients and clinical professionals during the evaluation interviews.

6.1 Prototyping

Prototyping is the next step in the project, as part of the Realization Phase. The creation of the final prototype revolves around multiple iterations and a feedback loop which is based on the final design concept decided upon in the Ideation Phase, and the User Requirements and Technology Specifications from the Specification Phase. From these phases, the prototype is realized by creating four virtual rooms (situations) that patients can navigate around with virtual reality (VR) equipment.

The in-use prototype at the company Tactus is made with the Unity, a cross-platform game engine developed by Unity Technologies. However, since this project partly focuses on realism and creating a virtual environment that is realistic enough to evoke a sense of presence with patients, Cinema 4D is chosen as the main 3D design program to build the environment. Since COVID-19 prevents testing face-to-face and sharing of devices (VR equipment), videos of the virtual environment are rendered and shown to patients and clinical professional during the Evaluation Phase interviews. However, if in the future this project remains relevant, the virtual environment created in Cinema 4D can easily be transferred to Unity, as Unity has the virtual reality (VR) function. The technology used for the prototype therefore includes:

- Unity game engine
- Cinema 4D animation program
- Adobe Captivate video editing program

6.1.1 Cinema 4D Software

Cinema 4D is a 3D software suite developed by the German company Maxon. The interface and functionalities of the program are straight forward and clear to follow (see Figure 23). Objects placed on the 3D landscape have shadows and a base material predesigned. The functions used for this project include the following:

- **Import Drag & Drop** → Used to import the digital elements downloaded from the online databases.
- **Move, Scale, Rotate** → Used to place an object in a designated location.
- **Create** → Used to create a new object (of any shape) or create a new material.
- **Materials** → Materials are colors or textures that can be placed on objects or sections of objects.
- **Lighting** → Used to create certain types of lights to brighten the area.
- **Environment** → Used to create a 'sky', which envelopes the 3D landscape so shadows are realistic.

- **Camera** → Creates a camera, which the designer can then switch between the normal view and the view of the camera.
- **Frame Scale** → The gridline contains of a number of frames, which can be changed and adjusted. When rendering, each frame is rendered and turned into a video, similar to cartoons are drawn on each piece of paper and flipped through for a video.
- **Record** → Used to record the view of the camera or the movement of an object. The designer can select a certain frame, and record the movement, and the program smooths the movement.
- **Render** → There are multiple render settings, but the default settings are adequate for this project due to the amount of time rendering takes. Each frame is render in high definition and turned into a video (MP4) as specified by the designer. The total render time for four scenes when using a high-speed desktop computer is about 40 hours.

Table 3. Functions in Cinema4D used to create the VR prototype.

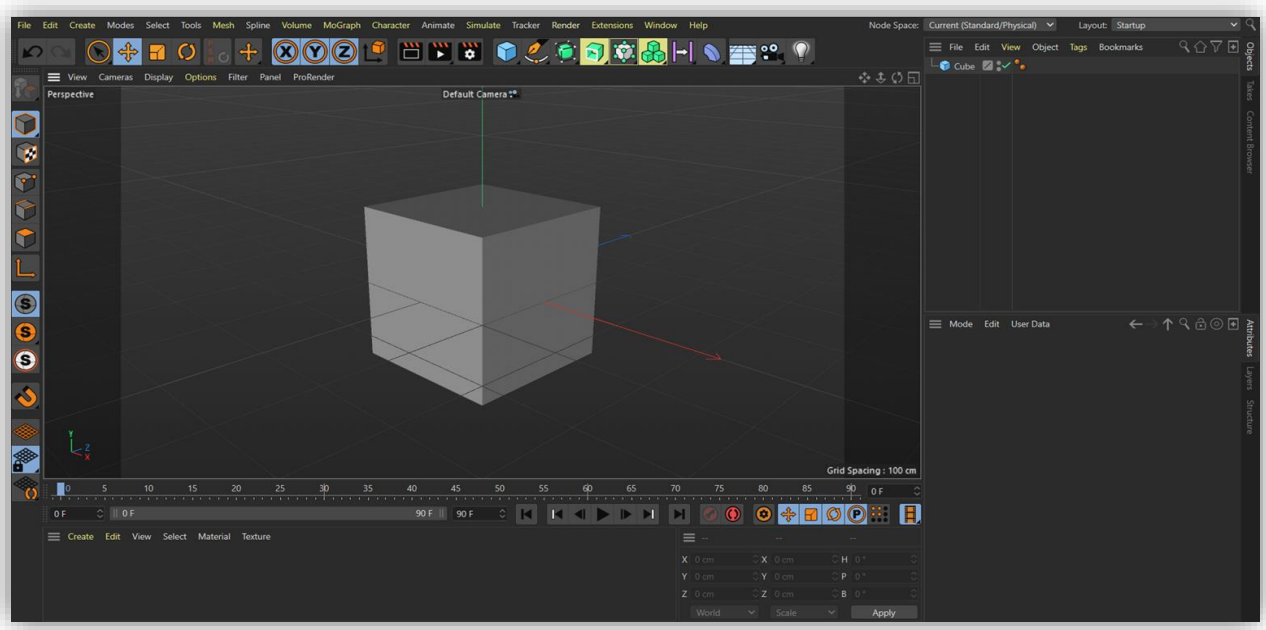


Figure 25. Screenshot of Cinema4D program.

6.1.2 Design Elements

As is seen in the Ideation Phase, the design elements and theme of each room have been decided upon. The elements are repeated in Table 4.

Situation	**Design Element**
Situation 1: Living Room Scene	• Wristband • Phone • Joint & ashtray • Coffee cup • Notebook & pen • Books • Door
Situation 2: Supermarket Scene	• Wristband • Phone • Headphones • Door
Situation 3: Gym Scene	• Wristband • Phone • Headphones • Weights • Door
Situation 4: Coffeeshop Scene	• Wristband • Phone • Joint & ashtray • Coffee cup • Chess set • Cards • Bottles • Pool table • Door

Table 4. Specific design elements for each situation of the virtual environment.

Due to the limited time of the project, not every digital element in the rooms is made from scratch (i.e. sofa, coffee cup, etc.), but instead is taken from free 3D object databases. The databases used include:

- www.free3d.com
- www.turbosquid.com

The creators of the 3D objects used published the objects and state ‘for personal or professional use’. The objects and the corresponding creator can be seen below.

General

- Phone and wristband: free3d.com by Alexander Rasskazchikov
- Headphones: free3d.com by ilsmolev
- Door: free3d.com by printable_models
- Joint and ashtray: free3d.com by MarcosStyLL
- Coffee cup: free3d.com by floriuszzz

Living Room

- Living room books and notebook: turbosquid.com by Hadwa
- Living room scene aspects (couches, TV, playstation): free3d.com by ibrahim

Supermarket

- Supermarket fruit crate: free3d.com by yurkp
- Supermarket register: free3d.com by jonsansk8
- Supermarket shelf images: pixabay.com
- Supermarket shelves: turbosquid.com by Martin Diavolo and DHK_krm

Gym

- Gym treadmill: free3d.com by Shahid Abdullah
- Gym weights: free3d.com by Neth Maison
- Gym training device: turbosquid.com by Kamykazee

Coffeeshop

- Coffeeshop glasses: turbosquid.com by Valiantsin
- Coffeeshop cards: turbosquid.com by importSJC
- Coffeeshop pool table: free3d.com by Peter David McHugh
- Coffeeshop chess set: free3d.com by zappbrannigan
- Coffeeshop marijuana neon sign: free3d.com by Colin Quinn
- Coffeeshop poster images: pixabay.com
- Coffeeshop sofa: free3d.com by severus07

- Coffeeshop chairs and table: free3d.com by emrecskn

6.2 Prototype Version 1

The prototype includes four virtual rooms (situations). The rooms comprise of a living room, a supermarket, a gym, and a coffeeshop. Each room includes different elements specific to the scene and the virtual environment has a virtual wristband the patient must interact with. The initial idea also included a point system that the patient would see on the screen; points would go up when the patient answers a question as a self-control exercise.

6.2.1 Virtual Wristband

The initial virtual wristband design can be seen in Figure 26. The patient can choose a color to represent how risky the situation is in terms of wanting to smoke marijuana. The patient's heartrate is also displayed for the color to be meaningful.

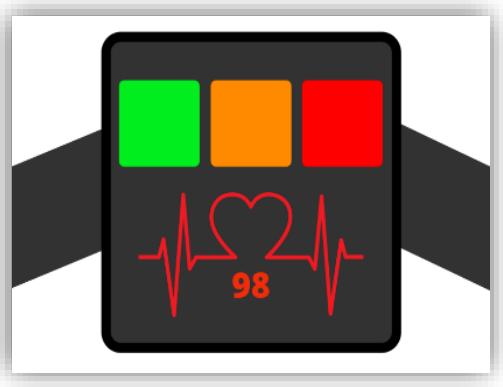


Figure 26. Initial virtual wristband design.

6.2.2 Living Room

The initial design of the living room includes calming colors and all the necessary elements, as seen in Figures 27 & 28.

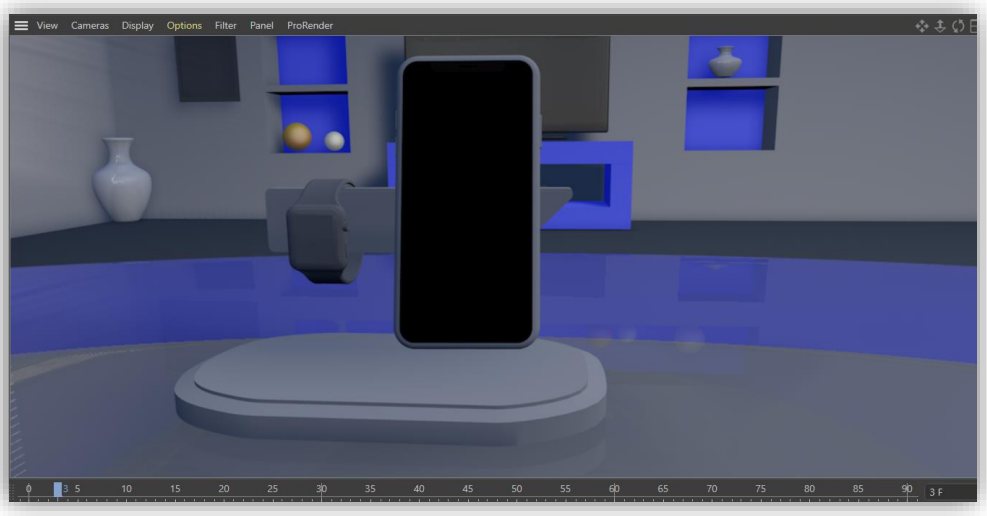


Figure 27. Initial living room design.

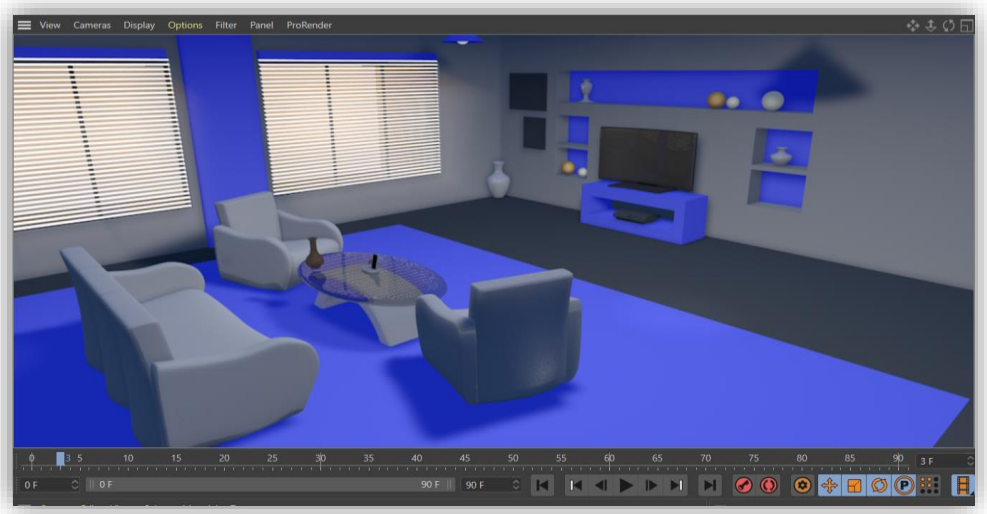


Figure 28. Initial living room design.

6.2.3 Supermarket

The initial design of the supermarket is basic and not yet completed, as seen in Figure 29.

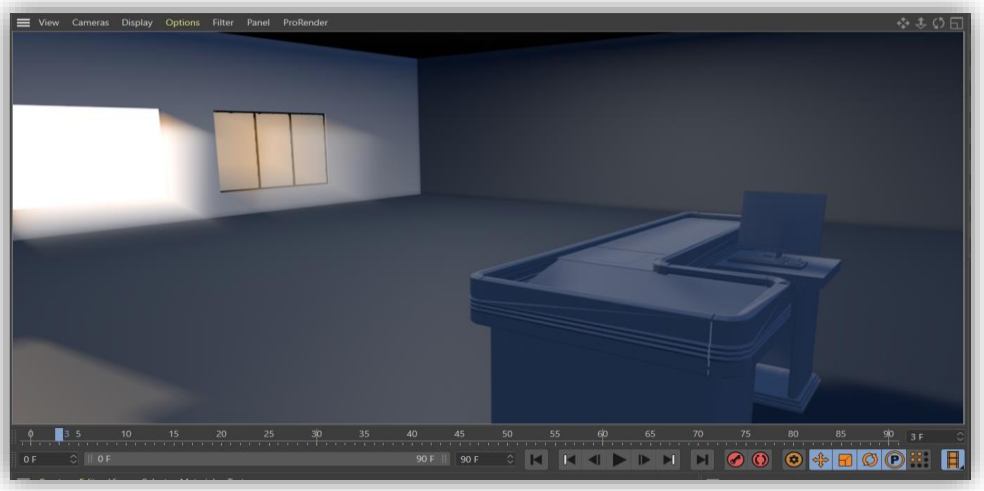


Figure 29. Initial supermarket design.

6.2.4 Gym

The initial design of the gym includes some necessary elements but is not complete, as seen in Figure 30.

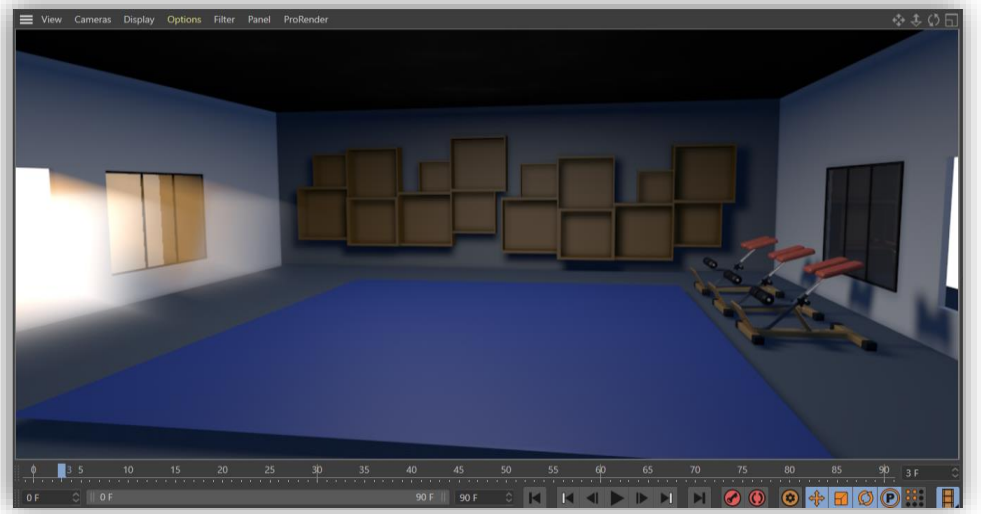


Figure 30. Initial gym design.

6.2.5 Coffeeshop

The initial design of the coffeeshops includes some necessary elements, such as the pool table and tables, but is not complete, as seen in Figures 31, 32, & 33.

Figure 31. Initial coffeeshop design.

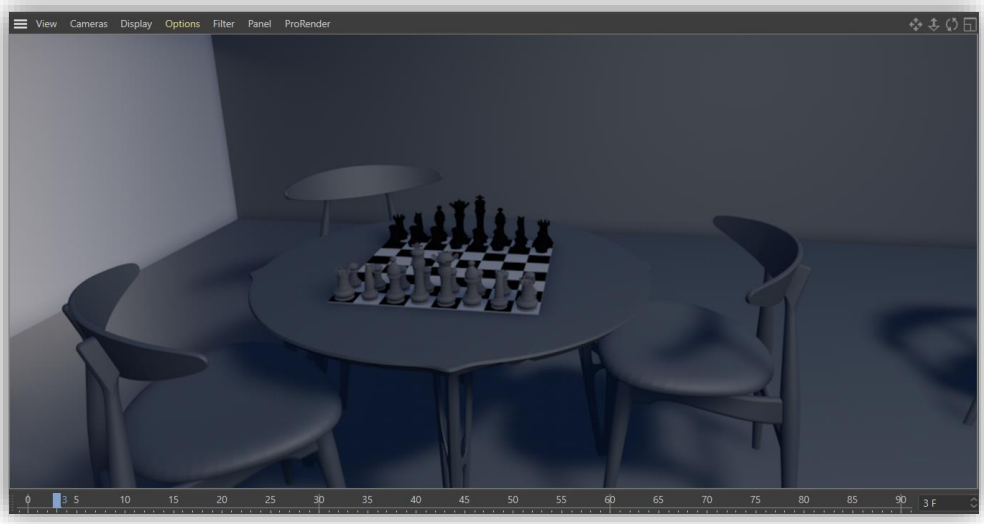


Figure 32. Initial coffeeshop design.

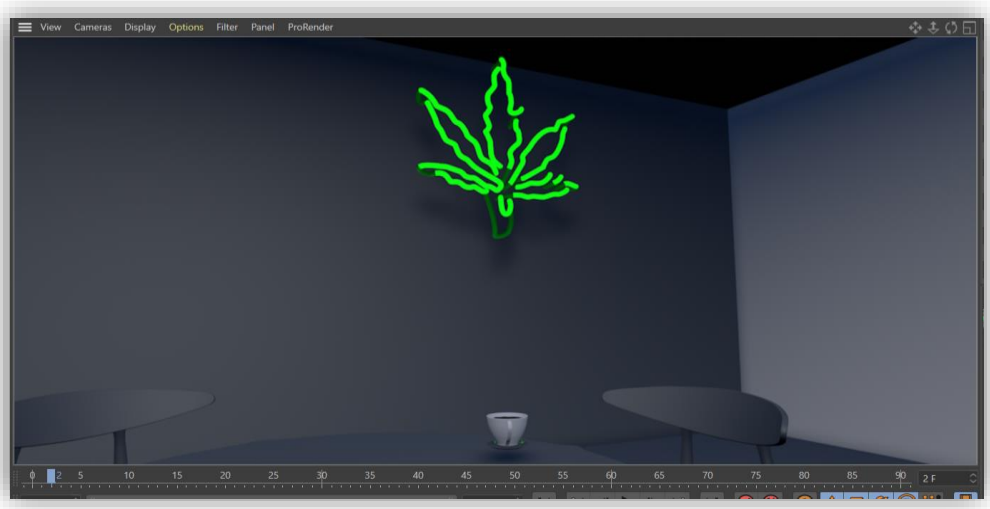


Figure 33. Initial coffeeshop design.

6.3 Prototype Version 2

The final prototype includes the four virtual rooms (situations). The rooms comprise of a living room, a supermarket, a gym, and a coffeeshop. Each room includes different elements specific to the scene and the virtual environment has a virtual wristband the patient must interact with.

6.3.1 Virtual Wristband

The final virtual wristband design can be seen in Figure 34. The patient can choose a color to represent how risky the situation is in terms of wanting to smoke marijuana. The heartrate display is no longer added. Instead the design is kept simple and understandable, without distractions.

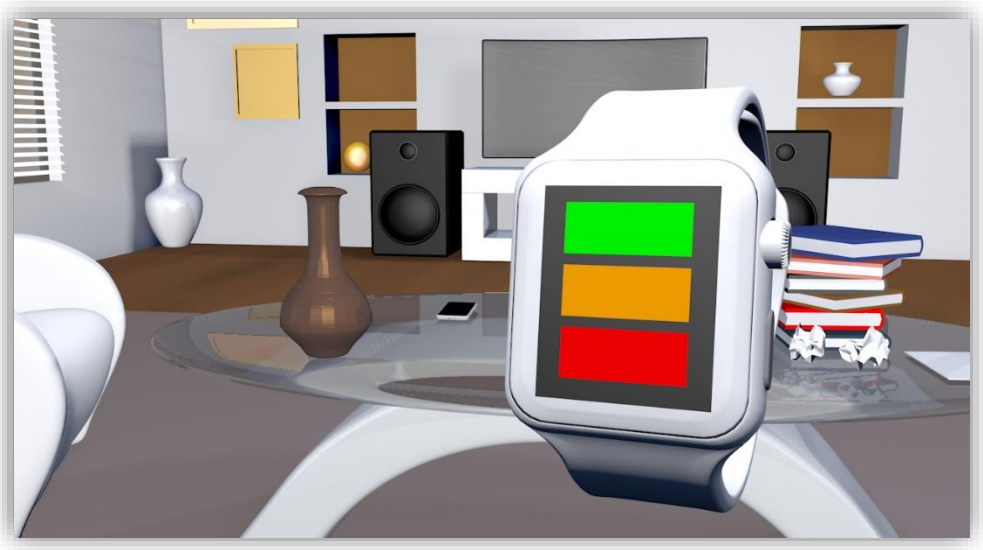


Figure 34. Final virtual wristband design.

6.3.2 Living Room

The final living room design can be seen in Figures 35, 36, & 37. The necessary design elements are present, and the colors are neutral based on the Designer's choices.

Figure 35. Final living room design.

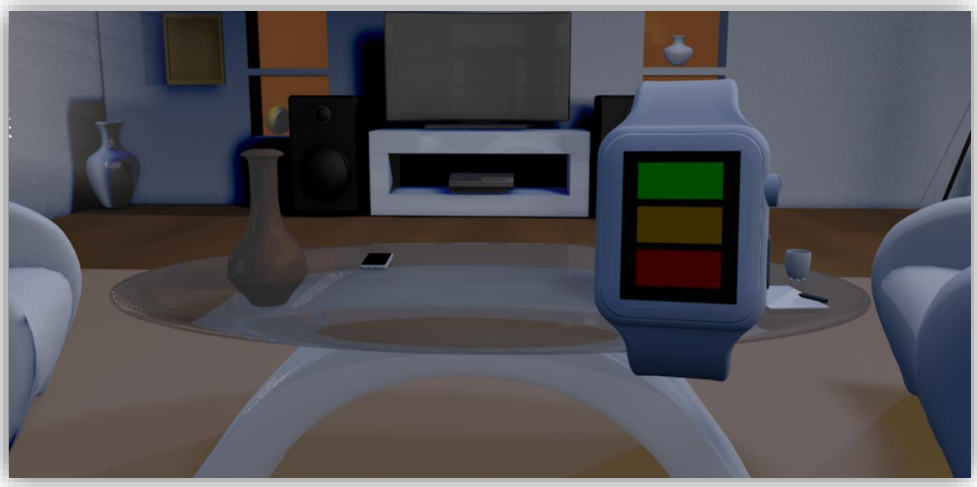


Figure 36. Final living room design.

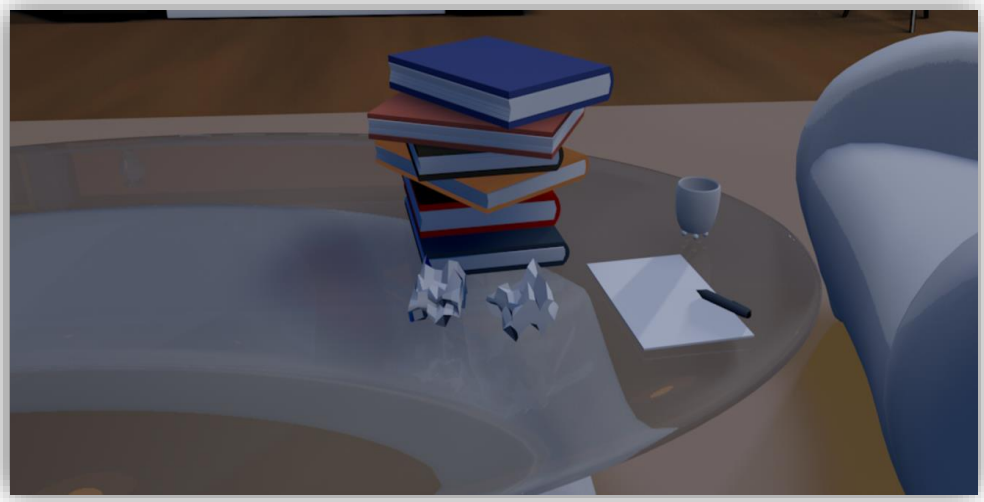


Figure 37. Final living room design.

6.3.3 Supermarket

The final supermarket design can be seen in Figure 38, 39, & 40. The necessary design elements are present, and the mass amount of color exposure is based on the Designer's choices.

Figure 38. Final supermarket design.

Figure 39. Final supermarket design.

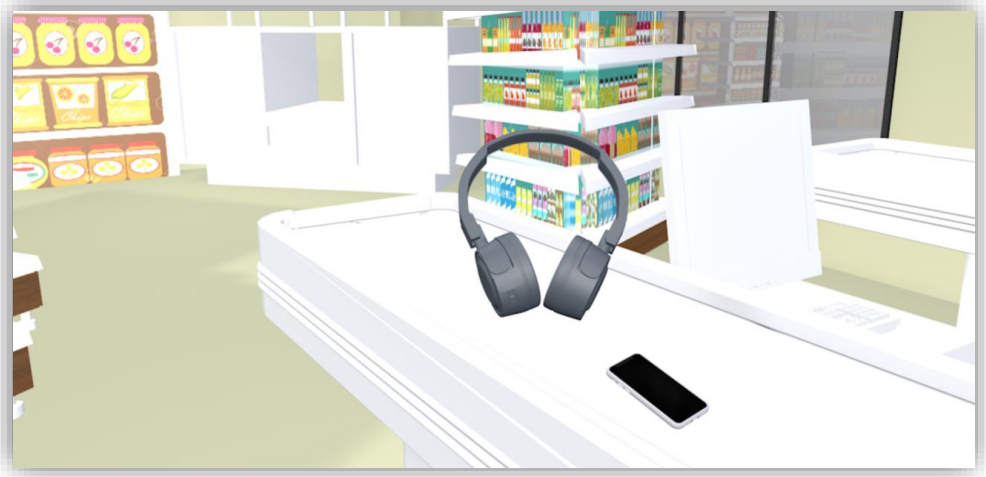


Figure 40. Final supermarket design.

6.3.4 Gym

The final gym design can be seen in Figures 41, 42, & 43. The necessary design elements are present, and the colors are neutral based on the Designer's choices.

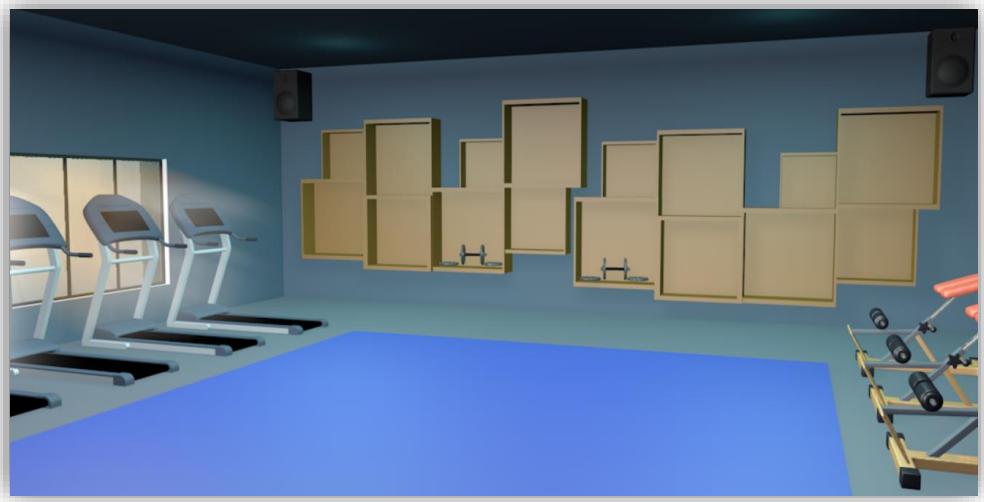


Figure 41. Final gym design.

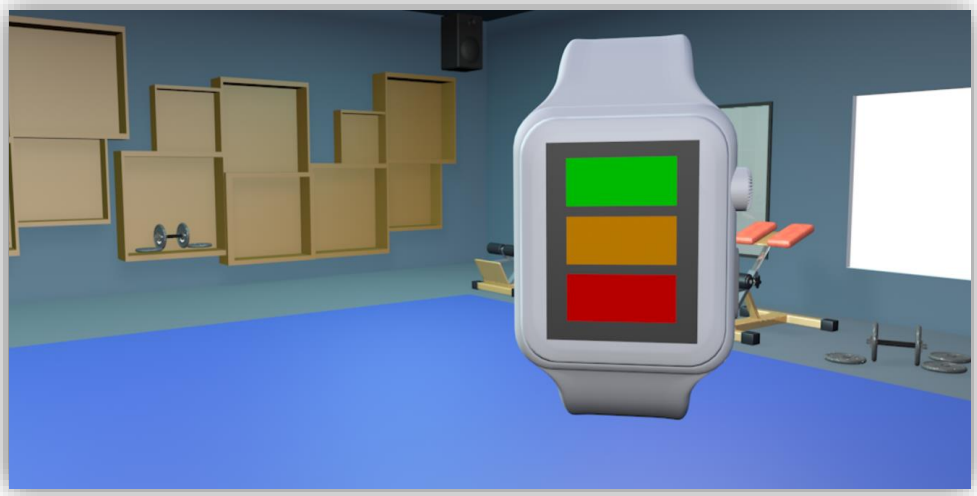


Figure 42. Final gym design.

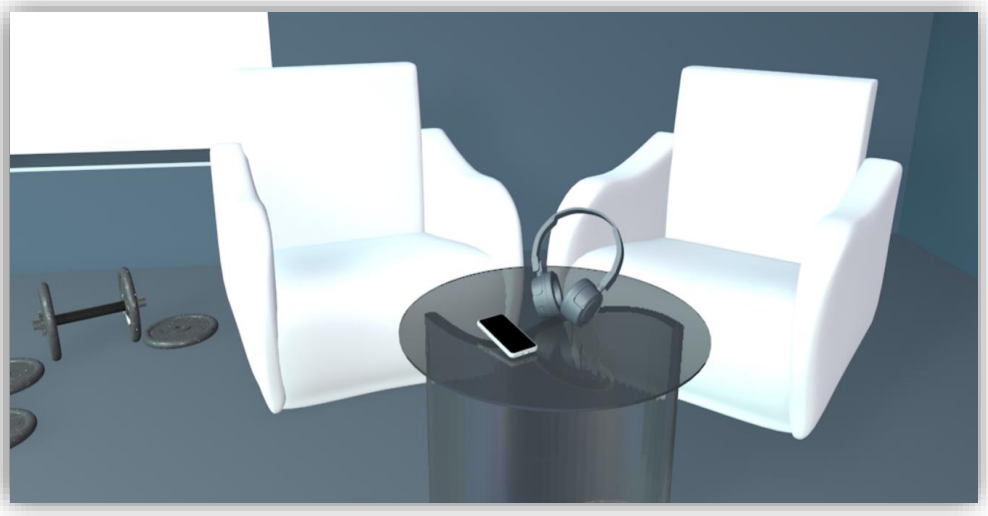


Figure 43. Final gym design.

6.3.5 Coffeeshop

The final coffeeshop design can be seen in Figure 44, 45, & 46. The necessary design elements are present, and the posters, colors, and marijuana paraphernalia are based on the Designer's choices.

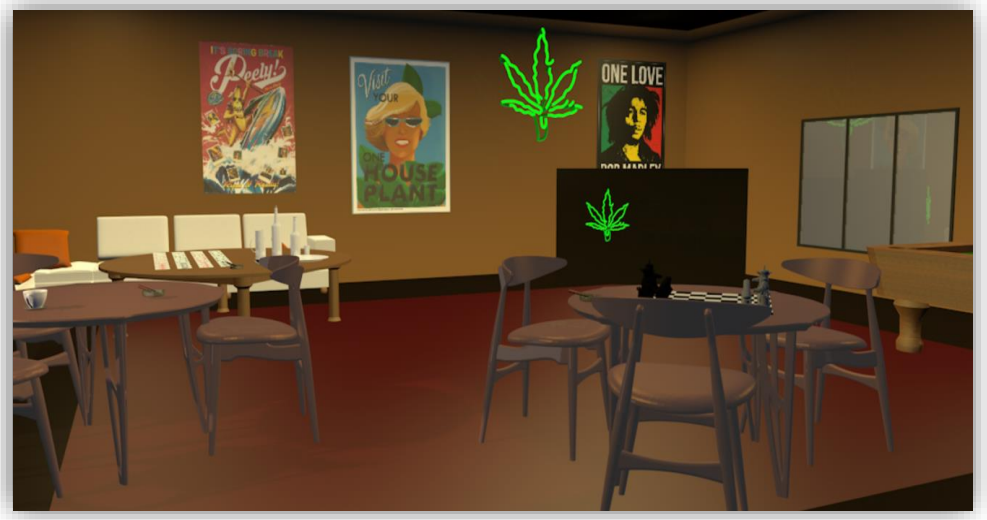


Figure 44. Final coffeeshop design.

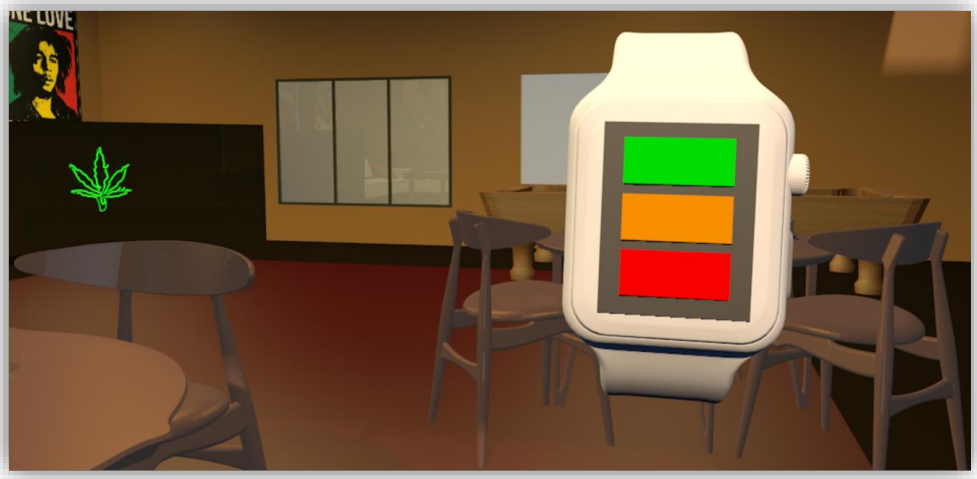


Figure 45. Final coffeeshop design.

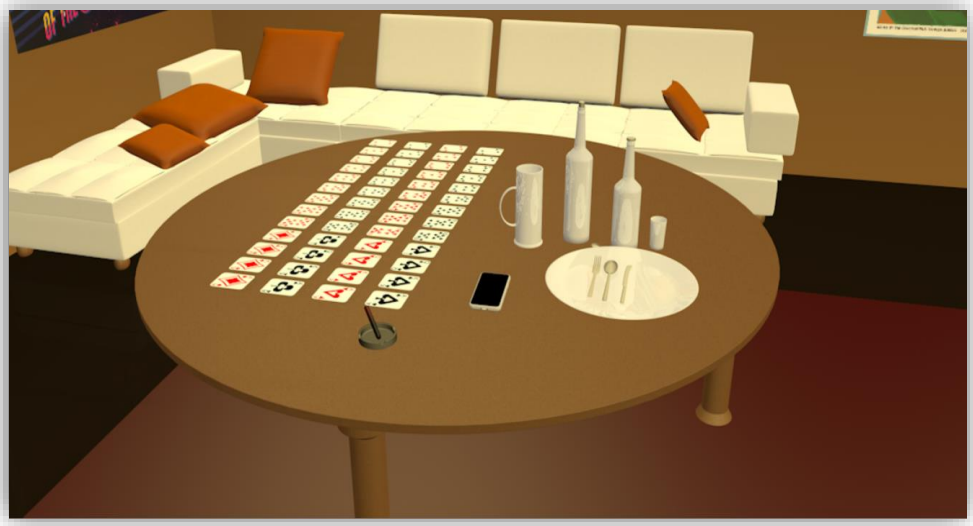


Figure 46. Final coffeeshop design.

6.4 Interactive Video

An interactive video is created due to the restrictions and regulations (no sharing of VR equipment allowed). The first part of the video is the initial orientation of the participant into the virtual environment, or video environment. The video is in Dutch due to the language differences between the patients and the designer. The first scenes of the video can be seen in Figures 47 - 55, and translated to English in Table 5

Figures 47 & 48. Scenes from interactive video.

Figures 49 & 50. Scenes from interactive video.

Figures 51 & 52. Scenes from interactive video.

Figures 53 & 54. Scenes from interactive video.

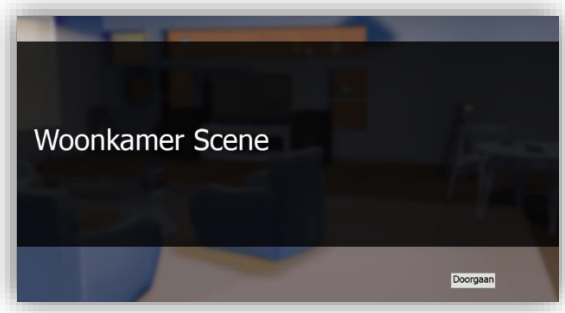
Figure 55. Scene from interactive video.

Figure	**Dutch**	**English**
	Extinguishing the Use: Virtual Reality voor Cannabis Verslaving	Extinguishing the Use: Virtual Reality for Cannabis Addiction
	Heb je een marihuanaverslaving?	Do you have a marijuana addiction?
	Ben je in behandeling?	Are you being treated?
	Stel je eens voor... Nu gebruik je Virtual Reality in je behandeling!	Just imagine ... Now you use Virtual Reality in your treatment!
	Je gebruikt een VR bril en afstandsbediening om door de virtuele wereld te bewegen	You use VR glasses and remote control to move through the virtual world

	Je gebruikt een virtuele polsband om te laten zien hoeveel trek je hebt in Cannabis...	You use a virtual wristband to show how much cannabis you crave ...
	...en zoek uit welke technieken voor zelfcontrole je kan gebruiken om niet te roken	... and find out what self-control techniques you can use to avoid smoking
	Kies uit een van deze vier situaties	Choose from one of these four situations
	Let op: zeg je antwoorden hardop!	Note: say your answers out loud!

Table 5. Scene translation from Dutch to English.

The second part of the video involves showing the participant the 4 different virtual rooms (situations), which include a living room, supermarket, gym, and coffeeshop. In each video, three pop-up screens appear with the title of the scene and two questions for the participant; the same questions appear in each room. The pop-up screens can be seen in Figures 56, 57, & 58, and translated to English in Table 6.



Figures 56 & 57. Scenes from interactive video.

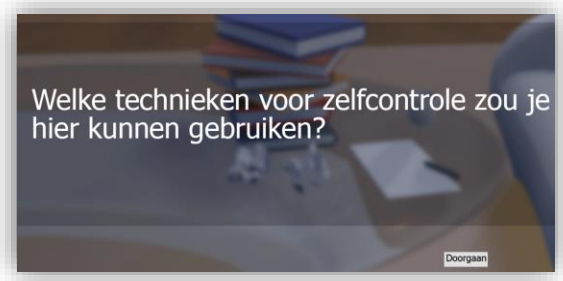


Figure 58. Scene from interactive video.

Figure	Dutch	English
	Woonkamer Scene	Living Room Scene
	Hoeveel trek heb je in cannabis? Green: ik wil niet roken Oranje: ik twijfel of ik wil roken Rood: ik wil echt roken	How much cannabis craving do you have? Green: I don't want to smoke Orange: I doubt whether I want to smoke Red: I really want to smoke
	Welke technieken voor zelfcontrole zou je hier kunnen gebruiken?	What self-monitoring techniques could you use here?

Table 6. Scene translation from Dutch to English.

6.5 Rendering & Complications

Cinema4D rendering (downloading of scenes in high quality with movements, etc.) requires a high-power graphics card, CPU, RAM, and hard drive. The Designer's computer is not powerful enough for this rendering. Therefore, a computer at the University of Twente is used to render the 4 virtual situations. Due to COVID-19 regulations, scheduling rendering at the university proved difficult. Meaning, the prototype realization timeline was slightly delayed. The Designer accessed the university's computer remotely on the Designer's home computer. The total render time for the interactive video was approximately 40 hours.

7. Evaluation

In this chapter, upon completing the first and second versions of the prototype, the prototype is evaluated with an interactive video during online interviews, to see how well the prototype is able to meet the requirements from the user, system and developers. This section describes how the evaluative user tests (interviews) are carried out, as well as the raw results of the evaluation.

7.1 Evaluation Research Design

After the Realization Phase of this project, the prototype needs to be evaluated, so interviews are done as part of an 'experimental procedure'. Since user tests (face-to-face interviews with sharing of the VR equipment) are no longer possible due to COVID-19 regulations and restrictions, structured evaluation interviews are done online. A total of 5 patients and 2 clinical professionals are recruited for the interviews, conducted over Skype. The focus of the VR prototype is on marijuana addiction, so these 5 patients therefore have a dual diagnosis of MID-BIF and a SUD, specifically a marijuana addiction. The 2 clinical professionals differ in terms of VR technology knowledge and CBT+ protocol knowledge; one has VR experience and limited CBT+ protocol experience, and vice versa. This separation is done in order to gain feedback on the prototype by participants with a variety of knowledge.

During the interviews, an interactive video of the VR prototype is sent to the participant. The participant answers pop-up questions during the video and gives their opinions of the prototype. Afterwards, questions are asked to the participant from two types of questionnaires. The interviews are also audio recorded for transcribing purposes. The interviews are meant to sustain grounded answers regarding the research questions and evaluate if the project objectives and requirements from the user, system and developers have been achieved. The two types of questionnaires therefore focus on the design of the prototype, meaning how well the prototype facilitates the teaching of self-efficacy to patients by patients practicing self-control techniques and is realistic to real world experiences. Other questions focus on how understandable and easy the prototype is to use by patients and clinical professionals, meaning if the participant perceives the prototype to add value to a therapy session.

Therefore, the actual Evaluation Research Design answers the sub- research question: *How can a realistic virtual reality environment be evaluated by clinical professionals and patients for successful outcomes?* And the evaluation interview question answers partially answer the other two sub- research questions: *How can specific self-control techniques for substance use disorder treatment be implemented in a virtual reality environment to build self-efficacy of patients?* And *How can a virtual reality environment be designed to invoke immersion and a sense of presence of patients within the virtual world?*

7.1.1 Participants

There is a total of 5 MID-BIF in-patients from the Tactus treatment facility and 2 clinical professionals working with Tactus recruited for the evaluation interviews. The patients are within the target group of the project, being that they have a dual diagnosis of a MID-BIF and a SUD, specifically marijuana with the exception of one patient (due to time constraints for finding patients), and each are between the ages of 18

– 50, since children are not being recruited for this project. The patients are contacted through Tactus employees.

The clinical professionals differ in terms of CBT+ and VR technology knowledge for a broad evaluation. Both professionals work with Tactus as well as the University of Twente. The professionals are contacted directly by the designer.

7.1.2 Safety

To preserve each participant's safety and privacy, an Information Brochure (see Figure D1, Appendix D) and Consent Form (see Figure E1, Appendix E) are sent via email to the Tactus contact for the patients and to each of the clinical professionals prior to the interview. The participants also must give consent for the audio recording of the interview beforehand. The data (audio recordings) is stored on the University of Twente database, and personally identifiable information (PII), such as name and age, is kept anonymous. Any personal information about the patients is under the control of Tactus.

7.1.3 Interactive Video

Since the actual VR prototype cannot be tested, an interactive video is sent to patients and clinical professionals to view during the online interviews (shown in the Realization Phase). Although it may seem like the video is a fallback and might not achieve what this project is set out to, the limitation of not being able to implement the VR prototype in a real-life session with patients and therapists becomes less important than the results. The use of a video is effective in discovering the usefulness of the presentation to the patient of the VR environment and scenarios to develop self-efficacy. The positive response from the patient is an essential indicator and offers a first step toward in familiarity before the actual VR environment is introduced. Experiences in the actual VR environment will hold similar expectations and remove fear of the unfamiliar through dependable and experiential activities. In essence, showing the video before contact testing becomes part of the process of orientation to a future VR application and a predictor of change in addictive behavior, which will result in an experience in partial mastery. As long as the patient perceives the practicing of self-control techniques will enhance his or her decision-making skills, the video presentation becomes a new source of information for research. Moreover, the video assists patients to know what to do during the interviews by having the sections of the video split up and instructions in big block text.

7.1.4 Procedures

The time limit of the interviews has a maximum 60 mins. Since participant attention must be engaged and constant, the video is split up into 5 different sections (the introduction and the 4 virtual rooms), and the full interview is split up into 6 parts, while signing a consent form beforehand. The 6 parts of the interview are explained below, and the 5 sections of the video are shown in detail in the Realization Phase. First, a scenario is given to the participant to allow the participant to understand the persona they should be evaluating the video with (patients instead have their SUD refreshed by being asked questions like "Do you attend therapy sessions?" and "Do you have a marijuana addiction?"). Then the 4 rooms are shown separately, with pop-up questions along the way. Finally, the interview concludes with questions being asked from the questionnaires. In order to not elongate the interview or overwhelm the patients and therapists, the video is split up into sections and the full questionnaires are asked during the final section.

7.1.4.1 Patient Interview Procedure

Patients need a helper to initiate the Skype interview on a computer, as well as setting up the computer. Due to the language barrier between the interviewer (designer) and the patients – the patients speaking Dutch and the designer speaking English with a limited Dutch vocabulary – communication may prove difficult. The helper, Simge Emir, works at Tactus and is recruited prior to the interviews. Additionally, the interviewer speaks a few Dutch sentences, the text of the interactive video is in Dutch for the patient version, and the audio is recorded for further translation purposes.

In order to make sure the patient understands the information given and needed during the interview, after each part of the interview the interviewer asks the patient if they understand and can continue. This evaluation interview serves as a test mode: showing the patient the video, and then showing the VR environment later, which can prove to be less intrusive and may conclude with more positive results in future work. The procedure for the patient interviews can be seen below.

Part 0: Preparation

- Designer sends Brochure and Consent Forms to Tactus contact member via email, each patient signs for consent, and the forms are sent back to the Designer.

Part 1: Initiation

- Both parties open the Skype application for the online interview - helper assists patient with computer and Skype.
- Designer introduces herself to the patient and explains what will happen during the interview.

- Designer asks for permission of audio recording.
- Designer begins audio recording.
- Designer tells patient to open the interactive video (link received in Skype chat) and begin watching.
- Patient watches Section 1 of the video: Introduction & User Case Scenario.

Part 2: Situation 1

- Patient watches Section 2 of the video: Situation 1.
- Patient answers pop-up question about how risky the situation is to smoke marijuana (red, orange, green).
- Patient answers pop-up question about what self-control techniques they could use instead of smoking.
- Designer asks patient if they have any other comments about the virtual environment.

Part 3: Situation 2

- Patient watches Section 3 of the video: Situation 2.
- Patient answers pop-up question about how risky the situation is to smoke marijuana (red, orange, green).
- Patient answers pop-up question about what self-control techniques they could use instead of smoking.
- Designer asks patient if they have any other comments about the virtual environment.

Part 4: Situation 3

- Patient watches Section 4 of the video: Situation 3.
- Patient answers pop-up question about how risky the situation is to smoke marijuana (red, orange, green).
- Patient answers pop-up question about what self-control techniques they could use instead of smoking.
- Designer asks patient if they have any other comments about the virtual environment.

Part 5: Situation 4

- Patient watches Section 5 of the video: Situation 4.

- Patient answers pop-up question about how risky the situation is to smoke marijuana (red, orange, green).
- Patient answers pop-up question about what self-control techniques they could use instead of smoking.
- Designer asks patient if they have any other comments about the virtual environment.

Part 6: Conclusion

- Patient stops the video.
- Designer asks patient questions from the Patient Self-Efficacy Questionnaire (Questionnaire Form A1).
- Designer asks patient questions from the Patient Realism Questionnaire (Questionnaire Form A2).
- Designer asks patient if they have any other comments about the virtual environment.
- Designer thanks the patient and concludes the interview; both parties exit the Skype interview.
- Designer stops the audio recording.

7.1.4.3 Clinical Professional Interview Procedure

The clinical professional interviews are similar to the patient interviews, excluding that the clinical professionals do not need a helper or translator. Clinical professionals are meant to put themselves in the place of these dual diagnosis patients through the use of a persona and scenario given in Part 1 of the procedure. The procedure in 7 parts for the clinical professional interviews can be seen below.

Part 0: Preparation

- Designer sends Brochure and Consent Forms to Clinical Professional via email, the professional signs for consent, and the form is sent back to the Designer.

Part 1: Initiation

- Both parties open the Skype application for the online interview.
- Designer introduces herself to the clinical professional and explains what will happen during the meeting.
- Designer asks for permission of audio recording.
- Designer begins audio recording.

- Designer tells clinical professional to open the interactive video (link received in Skype chat) and begin watching.
- Clinical professional watches Section 1 of the video: Introduction & User Case Scenario.

Part 2: Situation 1

- Clinical professional watches Section 2 of the video: Situation 1.
- Clinical professional answers pop-up question about how risky the situation is to smoke marijuana (red, orange, green).
- Clinical professional answers pop-up question about what self-control techniques they could use instead of smoking.
- Designer asks clinical professional if they have any other comments about the virtual environment.

Part 3: Situation 2

- Clinical professional watches Section 3 of the video: Situation 2.
- Clinical professional answers pop-up question about how risky the situation is to smoke marijuana (red, orange, green).
- Clinical professional answers pop-up question about what self-control techniques they could use instead of smoking.
- Designer asks clinical professional if they have any other comments about the virtual environment.

Part 4: Situation 3

- Clinical professional watches Section 4 of the video: Situation 3.
- Clinical professional answers pop-up question about how risky the situation is to smoke marijuana (red, orange, green).
- Clinical professional answers pop-up question about what self-control techniques they could use instead of smoking.
- Designer asks clinical professional if they have any other comments about the virtual environment.

Part 5: Situation 4

- Clinical professional watches Section 5 of the video: Situation 4.

- Clinical professional answers pop-up question about how risky the situation is to smoke marijuana (red, orange, green).
- Clinical professional answers pop-up question about what self-control techniques they could use instead of smoking.
- Designer asks clinical professional if they have any other comments about the virtual environment.

Part 6: Conclusion

- Video ends.
- Designer asks clinical professional questions from the Clinical Professional Self-Efficacy Questionnaire (Questionnaire form B1).
- Designer asks clinical professional questions from the Clinical Professional Realism Questionnaire (Questionnaire form B2).
- Designer asks clinical professional if they have any other comments about the virtual environment.
- Designer thanks the clinical professional and concludes the interview; both parties exit the Skype interview.
- Designer stops the audio recording.

7.1.5 Pop-Up Questions & Questionnaires

In the interactive video and after the video certain questions are asked by the interviewer (designer) to participant. The pop-up questions during the video are strategically placed so the participant can choose a color to represent how risky the situation is to smoke marijuana (colors explained during the ideation phase as part of the CBT+ protocol), as well as what self-control techniques the participant can practice instead of smoking. The clinical professionals are shown a user case scenario so that when watching the video, the professionals can put themselves in the persona of a dual diagnosis patient, while the patients are simply reminded of their SUD.

7.1.5.1 Pop-Up Questions

The pop-up questions are the same for each of the 4 situations, and they are:

- What color is the situation in terms of the risk to smoke marijuana?
- What self-control techniques can be used to avoid this risk?

7.1.5.2 Self-Efficacy Questionnaires

Questionnaires are asked verbally by the Designer to participants after the video has ended. The first type of questionnaire is meant to partially answer the sub-research question: *How can specific self-control techniques for substance use disorder treatment be implemented in a virtual reality environment to build self-efficacy of patients?* The self-efficacy questionnaire is adapted from the questionnaire written by researcher Gaumer Erickson and colleagues (2018). The original questionnaire is designed to measure a student's perceived level of proficiency in two essential components of self-efficacy:

1. Believe that ability can grow with effort.
2. Believe in your ability to meet specific goals and/or expectations

The questionnaire asked to patients versus to clinical professionals differs slightly with wording since clinical professionals should answers the questions as clinical professionals and no longer from a patient persona. The questionnaires can be seen in Figure F1, Appendix F (patient version) and Figure F2, Appendix F (clinical professional version).

7.1.5.3 Realism Questionnaires

The second type of questionnaire is meant to partially answer the sub-research question: *How can a virtual reality environment be designed to be more realistic to invoke a sense of presence for patients within the virtual world?* Since face-to-face interviews are no longer possible, the initial goal of creating an immersive VR environment cannot be greatly evaluated. To relieve this challenge, the questionnaire type that focuses on immersion is changed to one that focuses on realism. Meaning, how well the VR environment mimics real-life in design and render through the video view. Instead of asking the initial questionnaire type for immersion, a new questionnaire type about realism is asked during the interviews.

The self-efficacy questionnaire is adapted from three questionnaires, the first written by Witmer and Singer (1998), the second written by igroup (2016), and the third written by Wilson and Colleagues (2018). The original questionnaires are designed to assess the sense of presence and realism in virtual simulators. The questionnaire asked to patients versus to clinical professionals also differs slightly with wording since clinical professionals should answers the questions as clinical professionals and no longer from a patient persona. The questionnaires can be seen in Figure F3, Appendix F (patient version) and Figure F4, Appendix F (clinical professional version).

7.1.6 Data Analysis

As explained in the Information Brochure (see Figure D1, Appendix D) the interviews are audio recorded with permission. The data (audio recordings) is stored on the University of Twente database, and personally

identifiable information (PII), such as name and age, is kept anonymous. Any personal information about the patients is under the control of Tactus. The research results include participant answers to the pop-up questions and questionnaires.

7.2 Research Results

The raw data results from the online interviews with patients and clinical professionals are presented here. The results include notes from the interviewer (designer), comments from the participant, participant answers for the pop-up questions in each of the 4 virtual situations, and participant answers for the two questionnaires.

7.2.1 Patient Interview Results

The patient interview results are displayed in this section.

7.2.1.1 Patient 1 Interview

The first patient has a SUD of marijuana. The notes and comments from the patient can be seen below.

- Marijuana addict
- Answered yes to having a marijuana addiction
- Video is going to fast
- Knows what virtual reality is
- Sad that there are no virtual glasses

"In the coffeeshop, the joint looks like a cigar."

The results can be seen below from the two pop-up questions asked during each room in the video.

Situation: Living Room	What color is the situation in terms of the risk to smoke marijuana? • Red What self-control techniques can be used to avoid this risk? • Leave the room

Situation: Supermarket	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Listen to music
Situation: Gym	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Leave the gym
Situation: Coffeeshop	What color is the situation in terms of the risk to smoke marijuana? • Green, because the joint does not look real What self-control techniques can be used to avoid this risk? • Go for a walk

Table 7. Patient 1 interview pop-up question results.

7.2.1.2 Patient 2 Interview

The second patient has a SUD of marijuana. The notes and comments from the patient can be seen below.

- Marijuana addict
- Answered no to having a marijuana addiction

"The places in the video look like places I've seen in real life."

"Virtual reality would help yes in the sessions."

The results can be seen below from the two pop-up questions asked during each room in the video.

Situation: Living Room	What color is the situation in terms of the risk to smoke marijuana? • Orange, because there is a joint What self-control techniques can be used to avoid this risk? • Watch TV • Distractions
Situation: Supermarket	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Leave the supermarket
Situation: Gym	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Work out • Leave the gym
Situation: Coffeeshop	What color is the situation in terms of the risk to smoke marijuana? • Red, because of the joint What self-control techniques can be used to avoid this risk? • Still would want to smoke even if did not see the joint • Distractions • Call mother

Table 8. Patient 2 interview pop-up question results.

7.2.1.3 Patient 3 Interview

The third patient has a SUD of marijuana. The notes and comments from the patient can be seen below.

- Marijuana addict
- Answered yes to having a marijuana addiction
- getting tired at the end
- the rooms look a little different from reality
- VR would help in the sessions
- was confused there were no glasses

"If I had an alcohol addiction and was in the supermarket then I would want alcohol, but I do not want to smoke in the supermarket. Supermarkets are for going grocery shopping."

The results can be seen below from the two pop-up questions asked during each room in the video.

Situation: Living Room	What color is the situation in terms of the risk to smoke marijuana? • Orange, because there is a joint What self-control techniques can be used to avoid this risk? • Call someone • Leave the room
Situation: Supermarket	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Go shopping • Call someone • Leave the supermarket
Situation: Gym	What color is the situation in terms of the risk to smoke marijuana? • Green

	What self-control techniques can be used to avoid this risk? • Leave the gym
Situation: Coffeeshop	What color is the situation in terms of the risk to smoke marijuana? • Red What self-control techniques can be used to avoid this risk? • Call someone • Leave the coffeeshop

Table 9. Patient 3 interview pop-up question results.

7.2.1.4 Patient 4 Interview

The fourth patient has a SUD of illicit substances. The notes and comments from the patient can be seen below.

- Illicit substances addict
- Answered no to having a marijuana addiction
- getting tired at the end
- the rooms look a little different from reality
- VR would help in the sessions
- was confused there were no glasses

"If I heard cannabis or hippie music in the living room I would want to smoke."

"When someone is in a supermarket, they should avoid the alcohol section if they are an alcoholic. But I don't have an alcohol addiction. But it is normal to drink so you shouldn't avoid it. Alcohol is normal and everywhere, but cannabis isn't."

"Why would I go to a coffeeshop if I had a cannabis addiction?"

"When you have a cannabis addict, [practicing self-control] can help if the person really wants to fix it."

“The coffeeshop should be taken out, it is strange for me, because you make questions about what to do in a coffeeshop when you have a cannabis addict. You must not come in a coffeeshop then. It's the same if you have an amphetamine addict and you go drink a cup of coffee in a lab.”

“Maybe when you make a video of outside in a park, it can also help.”

“You should decide for yourself if you can go to these places and if you can handle it or not.”

The results can be seen below from the two pop-up questions asked during each room in the video.

Situation: Living Room	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Use paper and pen • Watch a movie • Call someone • Listen to music, but not hippie music
Situation: Supermarket	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Noticed there should be alcohol • Did not say
Situation: Gym	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Did not say
Situation: Coffeeshop	What color is the situation in terms of the risk to smoke marijuana? • Red

	What self-control techniques can be used to avoid this risk? • Drink coffee • Use the bathroom • Play a game

Table 10. Patient 4 interview pop-up question results.

7.2.1.5 Patient 5 Interview

The fifth patient has a SUD of marijuana. The notes and comments from the patient can be seen below.

- Marijuana addiction
- Had a hard time understanding the video would be in VR

"It did not look realistic."

"Virtual reality could help."

The results can be seen below from the two pop-up questions asked during each room in the video.

Situation: Living Room	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Did not say
Situation: Supermarket	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Did not say
Situation: Gym	What color is the situation in terms of the risk to smoke marijuana? • Green

	What self-control techniques can be used to avoid this risk? • Did not say
Situation: Coffeeshop	What color is the situation in terms of the risk to smoke marijuana? • Red What self-control techniques can be used to avoid this risk? • Did not say

Table 11. Patient 5 interview pop-up question results.

7.2.1.6 Patient Interview Procedure Errors

During the first interview, it is noticed the patients are having difficulty understanding that VR is to be implemented later and not currently. The patients also seem tired by the end of the video. Therefore, the interviewer (designer) made the decision to select two questions from the questionnaires to ask as an alternative to their entirety. Normally, this change would not be allowed. However, the change is accepted by the helper during the interviews and discussed with the designer's supervisors after the interviews. The resulting data is still found to be significant even without the other question answers.

7.2.1.7 Helper Notes

Simge Emir is the helper during each of the 5 patient interviews. She also commented on the project's succession. Her comments include:

"The questions are difficult for the patients, like self-control, they need something more specific. And because there is no actual virtual reality environment, it is a little hard and that is unfortunate. This is why the patients do not answer very widely. But even with this, the project is really a great thing."

"It is hard for patients [to have an interview] after a whole day of treatment."

"If people think 'I do not have a cannabis addiction so it's not my problem', they don't realize if they have another substance abuse, they can replace it instead of cannabis. But they are not at that point yet. so maybe it would be better to use substance in general [instead of marijuana only]."

"Maybe a park instead of a gym would be better."

"It took a little while to understand what was going on in the video."

"[Virtual reality] would be a great experience for the people here, for you, for us."

7.2.2 Clinical Professional Interview Results

The clinical professional interview results are displayed in this section.

7.2.2.1 Clinical professional interview 1 – more CBT+ knowledge

The first clinical professional has adequate CBT+ protocol knowledge and less VR technology knowledge. The notes and comments from the clinical professional can be seen below.

- Patients will not think of objects or things outside of their view
- Pop-up question background too dark; cannot see what is behind it
- If there were a lot of people, then feel overwhelmed and want to smoke
- Because of the image in view, maybe wouldn't think of using sports equipment because that is out of view

"I have no experience with virtual reality, so I would like to have someone telling me how it works, and then I think I will understand it easily. But the first time I will need some help."

"In the treatment room we talk about [self-control] but we do not see it, but here it is so visual. You see a door multiple times, and it is not bad at all to see it multiple times because when a patient is at home and he sees the door maybe he will think 'oh right that's a distance I can take', but when we only talk about it, there's no association with that door."

"There are no other people [in the virtual environment]. In real life there are other people, and I think seeing other people smoke is a great risk. In the supermarket when it's really crowded, people will become afraid and run away and want to smoke."

"Communicating with people in the [virtual] environment is not necessary. In the coffeeshop, at another table, there can be people talking to each other. Maybe it is not even necessaire to see eyes. They can look at the back of the person or sunglasses. Maybe at the gym people can be walking on the treadmill and you only see the back of people. I cannot imagine that to be traumatizing [for the patients]."

"When you have virtual reality glasses it would look real. But based on the video, you can still imagine it as a 3D world due to the rotation [of the camera]."

"In the coffeeshop, the neon green leaf caught my eye. I did not have the feeling to get distracted by things. My focus was on where the camera pointed."

The results can be seen below from the two pop-up questions asked during each room in the video.

Situation 1: Living Room	What color is the situation in terms of the risk to smoke marijuana? • Red What self-control techniques can be used to avoid this risk? • Distraction • Read a book • Write down feelings or story • Get a cup of coffee and sit down • Visit friend • Walk outside
Situation 2: Supermarket	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Listen to music or podcast • Play game on phone • Call a friend or someone to pick them up • Leave the supermarket • Visit a friend • Go for a walk
Situation 3: Gym	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Listen to music • Play a game on phone

	• Call a friend • Use sports activities in the gym like walking or lifting • Leave the gym • Visit a friend • Go for a walk • Go home
Situation 4: Coffeeshop	What color is the situation in terms of the risk to smoke marijuana? • Red What self-control techniques can be used to avoid this risk? • Eat or drink something • Call a friend • Play a game on phone • Play cards

Table 12. Clinical professional 1 interview pop-up question results.

The first clinical professional's answers to the two questionnaires can be seen in Figures G1 & G2, Appendix, G.

7.2.2.2 Clinical professional interview 2 – more technology knowledge

The second clinical professional has adequate VR technology knowledge and CBT+ protocol knowledge. The notes and comments from the clinical professional can be seen below.

- Patients will not think of objects or things outside of their view

"I think my knowledge of technology is good enough because I did a research of my own, but I think most therapists would not be familiar enough with virtual reality. So, I think some instruction would be nice."

"It was very clear what the situations are supposed to represent."

"With virtual reality, it is more practice [of self-control techniques] for the patients."

"The virtual reality environment looks very great. Other virtual reality environments are not that realistic. It felt like I was there. You could really see the details."

"If you are a marijuana smoker, the gym is not a place you would normally visit."

The results can be seen below from the two pop-up questions asked during each room in the video.

Situation: Living Room	What color is the situation in terms of the risk to smoke marijuana? • Orange What self-control techniques can be used to avoid this risk? • Watch TV • Go outside for a walk • Go to store and buy some groceries
Situation: Supermarket	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Listen to music • Go out of the situation • Go outside
Situation: Gym	What color is the situation in terms of the risk to smoke marijuana? • Green What self-control techniques can be used to avoid this risk? • Call a friend • Call a councilor • Listen to music • Sports activities • Go out of the situation

Situation: Coffeeshop	What color is the situation in terms of the risk to smoke marijuana? • Red What self-control techniques can be used to avoid this risk? • Call a friend • Play cards • Distract myself • Play pool • Go out of the situation

Table 13. Clinical professional 2 interview pop-up question results.

The second clinical professional's answers to the two questionnaires can be seen in Figures G3 & G4, Appendix, G.

8. Discussion

In this chapter, once the Evaluation Phase is completed, the results are discussed by answering the research questions and assessing the project objectives, as well as preparing a Thematic Analysis (Braun & Clarke, 2006). A Thematic Analysis is a way of predicting topic categories from the qualitative data presented in the research results.

8.1 Project Evaluation

Once the evaluation interviews are completed and the results are delivered, the overall project is evaluated and discussed. The project must comply with the initial objectives, answer the research questions, and fulfill the user requirements and technology specifications set in the previous phases. Further discussion involves the Thematic Analysis of the prototype evaluation results, meaning the results from the patients and clinical professionals and analyzed for topic of conversation and brought to further development in the future work.

8.1.1 Objectives

The project objectives are:

- To design and build a VR prototype with virtual situations patients can navigate around;
- To immerse patients into the virtual experience so to support the patient to focus on the treatment and not their intellectual disability;
- To have patients practice self-efficacy and self-control techniques through specific CBT+ training sessions;
- And to evaluate the application with these patients and relevant clinical professionals.

Each objective has been completed to some extent. Although the prototype could not be tested with the actual VR equipment, the idea was expressed to patients and clinical professionals. The scope of the project was confined to using the 6D's with the VR environment. A sequence of steps was followed that oriented the patient with the equipment and screen of viewing in the headset for the patient to visualize themselves navigating through the rooms. However, the patients did have trouble understanding that the videos of the virtual environment are meant to be in VR. For example, the helper of the patients stated:

"The questions are difficult for the patients, like self-control, they need something more specific. And because there is no actual virtual reality environment, it is a little hard and that is unfortunate. This is why the patients do not answer very widely. But even with this, the project is really a great thing."

Beyond that, the VR prototype was designed and built, the patients were focused on the interactive video and not on their disability, the patients practiced self-control techniques by stating how they would handle the situation and alternative activities to smoking, and the prototype was evaluated by patients and clinical professionals during the online interviews. Therefore, the project objectives were followed and completed in a creative and successful way.

8.1.2 Research Questions

The main research question led to three sub questions that the project was based around. Each sub- research is discussed and answered based on the results of the research and project in general.

Sub-research question 1: *How can specific self-control techniques for substance use disorder treatment be implemented in a virtual reality environment to build self-efficacy of patients?*

During the Ideation Phase, the SUD treatment protocols for MID-BIF patients were investigated. The CBT+ protocol from Tactus involves the learning and practicing of certain self-control techniques (6D's). VR offers a medium for patients to practice these self-control techniques. Positive patient response toward the videos of the virtual environment in the online interview is an essential indicator of self-efficacy exaction to be used in the actual VR Environment.

Considering that these patients need treatment services to extinguish reliance on a substance, specifically marijuana, and to develop better coping skills to overcome addiction, therapeutic use of the VR prototype is an effective tool. The VR prototype is a product for MID-BIF patients with a SUD to attain self-efficacy in practice along with CBT for a real-world application. It allows for a method to take control over their addictive behavior due to the VR environment's ability for receptiveness and familiarity. A patient can repeat and practice as many times as he or she perceives is necessary to accomplish the self-set goal. Familiarity in overcoming unfamiliar threats is key to self-efficacy in the real world and living a more productive life, free of addiction.

Sub-research question 2: *How can a virtual reality environment be designed to be more realistic to invoke a sense of presence for patients within the virtual world?*

The realism factor is quite significant in this project. These dual diagnosis patients experience difficulty with abstract thinking and imagery. Meaning, the use of a virtual environment is already supporting their disability. Designing a virtual environment that is realistic to patient real-world experiences is important for facilitating the practicing of self-control techniques. Clinical professionals particularly stated that:

"The virtual reality environment looks very great. Other virtual reality environments are not that realistic. It felt like I was there. You could really see the details."

"In the treatment room we talk about [self-control] but we do not see it, but here it is so visual. You see a door multiple times, and it is not bad at all to see it multiple times because when a patient is at home and

he sees the door maybe he will think ‘oh right that's a distance I can take’, but when we only talk about it, there's no association with that door.”

Sub-research question 3: *How can a realistic virtual reality environment be evaluated by clinical professionals and patients for successful outcomes?*

The limitation of not implementing the VR prototype in real-time session with a patient and therapist becomes less important than the results. The use of the interactive video is effective in discovering the usefulness of the presentation to the patient of the VR environment. The positive response from the patient is an essential indicator and offers the first step toward familiarity before the actual VR environment is introduced. By evaluating the prototype with the interactive video during online interview, the patients were still able to imagine themselves using the system after some explanation. Patients and clinical professionals stated:

“The places in the video look like places I’ve seen in real life.”

“[Virtual reality] would be a great experience for the people here, for you, for us.”

Therefore, the use of the interactive video during the online interview with patients and clinical professionals proved to be an effective evaluation method.

8.1.3 Requirements, Specifications, and Delighters

During the Specification Phase, User Requirements were turned into Technology Specifications for the prototype. These specifications were then compared to two companies with similar VR addiction treatment technology designs in order to come up with three ‘delighters’, or aspects of this project’s design that would stand out against others. The delighters implemented into the prototype include:

- Virtual wrist band with color associated with level of risk
- Gamification with point system
- CBT+ exercise implemented for use in treatment session

Although there was no gamification implemented in the interactive video tested with patients, the actual VR system has gamification explained in the Ideation Phase.

8.1.4 Creative Solution

Due to the restrictions and regulations the project was forced to follow, the sharing of devices (VR equipment) was not allowed. To handle this issue, an interactive video was created to show patients and clinical professionals the virtual world. As explained earlier, the video is not a fallback and might not achieve what this project is set out to, the limitation of not being able to implement the VR prototype in a real-life session with patients and therapists becomes less important than the results. The use of a video is effective in discovering the usefulness of the presentation to the patient of the VR environment and scenarios to develop self-efficacy. The positive response from the patient is an essential indicator and offers a first step toward in familiarity before the actual VR environment is introduced. Experiences in the actual VR environment will hold similar expectations and remove fear of the unfamiliar through dependable and experiential activities. In essence, showing the video before contact testing becomes part of the process of orientation to a future VR application and a predictor of change in addictive behavior, which will result in an experience in partial mastery. As long as the patient perceives the practicing of self-control techniques will enhance his or her decision-making skills, the video presentation becomes a new source of information for research. Moreover, the video assists patients to know what to do during the interviews by having the sections of the video split up and instructions in big block text.

Additionally, once the patient realizes that the VR environment is custom designed for him or her to explore and make decisions, intellectual functioning increases to meet the demands of the environment. In other words, through the use of self-efficacy, a patient will determine if they understand the purpose of the VR environment and therapist's role in the environment. Efficacy begins to take on intellectual capacities to bring about intend results. The simple desire to understand the environment, its content and context is an intellectual task. The patient is presented with a scenario that requires efficacy.

8.2 Research Discussion

A Thematic Analysis was conducted to come up with topics for discussion based on the results of the patient and clinical professional evaluation interviews. A Thematic Analysis (Braun & Clarke, 2006) is a way of predicting topic categories from the qualitative data presented in the research results. The themes found include social bias, influence of treatment, cross reactivity, re-diagnosis, add value, and overcoming limitations.

8.2.1 Social Bias

The helper, Simge Emir was present during the patient evaluation interviews. This could have caused a bias to how the patients acted or what they said. Maybe they were trying to please the person or show that the treatment has been effective.

8.2.2 Influence of Treatment

The influence of treatment on patients was present and acknowledgeable during the evaluation interviews. One recommendation from Dr. Joanne Van Der Nagel: “This is an inpatient group, maybe we have to do similar exercise with patients not so far in their treatment. Patients showing competence - why should I go to a coffeeshop - they show self-efficacy - goals and failure. Patients are practicing self-control techniques, so to test these patients at this late of a stage showed that they already have self-efficacy skills.”

8.2.3 Cross Reactivity

Many patients stated “where is the alcohol” in two of the four situations, the supermarket and the coffeeshop, while watching the interactive video. This displayed that cross reactivity is present within the virtual environment. Cross reactivity is difficult to prevent; however, it can be accounted for.

8.2.4 Re-Diagnosis

MID-BIF patients commonly have imagery defects, meaning they have trouble imagining. The patient who does not have the skill to imagine a real situation is unable to build a mental representation of meaning. Objects are associated with qualities, relationships, and actions. Fast mapping of words in context is a process of mastering grammatical that is developed in childhood. A child distinguishes which words are organized together into sentence structure and whether some phrases lack meaning. The same can be said of images in the mind and ideas. MID-BIF patients have difficulties with ideation and an inability to imagine themselves in situations. To overcome poor imaginative construction - a patient can learn a skill by a process of scaffolding. In this way, the foundation and levels can be built to have a strong structure. Just as hearing oneself speak develops into using inner dialogue to sort out solutions to a problem, so does placing meaning on objects in an environment. For example, a visual object identified as a fan acts as a means to make air flow. Imagination requires a sophistication in applying a concept, an idea conceived in thought, and making an association with objects or environment that one is familiar. This is the way an idea develops meaning and context upon which situational can be analyzed and decisions can be made.

In VR, an imaginary space is made using three dimensional objects in an interior room, store/bar, or outside setting. Visually tactile objects have textures and colors that resemble real chairs, tables, and other furniture with appropriate lighting. Despite the lack of temperature, smell, or taste sensing, a VR environment have components of visual and touch realism. Even though these patients have imagery defects, the majority of the time during the evaluation interviews, the patients were able to understand the virtual environment they were seeing.

8.2.5 Overcoming Limitations

One of the real-life challenges is understanding language, the Designer speaks English and the patients speak Dutch. Met with verbal queues, facial expressions, and body language, listening comprehension and reading comprehension requires a good working memory to sort through and organize thoughts. The way one responds or reacts takes skill and attention. The patient should communicate the amount of time they are willing to actively participate. Their attention span is dependent upon comprehension.

8.3 Experiential Learning

In the VR environment, the patient is presented with a set of circumstances that they are able to visualize through objects. Objects move, light up, change shape, and stimulate the patient to make a decision. This is a situational decision that the patient stores in their mind and associates with a way to handle or apply to similar situations, especially in real social settings.

Once the patient realizes that the VR environment is custom designed for them to explore and make decisions, intellectual functioning increases to meet the demands of the environment. In other words, through the use of self-efficacy, a patient will determine if they understand the purpose of the virtual environment. Efficacy begins to take on intellectual capacities to bring about intended results. The simple desire to understand the environment, its content and context is an intellectual task. The patient is presented with a scenario that requires efficacy.

The belief in one's ability to make the effort to acknowledge barriers that can cause setbacks but still persist and not succumb to risky behavior (such as substance abuse) is key to the motivation a patient experiences in the VR therapeutic session. Knowing that affective behaviors (such as mood, conduct) can indirectly impact a patient's success, clear goals and their concept of success are defined by the patient before a session to ensure the VR application is an enjoyable, positive experience each time. Gradually, the patient will realize that they are intelligent, can make intelligent decisions, that their brain neurologically, and intellectually constructs ideas and acquires knowledge that can be put into

practice every time they use the virtual environment. Each session reinforces the decisions made and builds self-efficacy. It will dynamically evolve from repetition and variation when the patient is actively engaged in learning and seeking information. Out of the patient's need to be self-sufficient, independent, and intelligent in the virtual environment, will come the ability to conceptualize new scenarios through imagination.

The patient will learn to identify obstacles to progress and accept that mistakes are not failures. The sense of value will develop as he or she believes in their ability to succeed when circumstances in the virtual environment are challenging.

A thorough orientation using illustrative tasks to determine comprehension should be presented prior to introduction of the virtual environment. The context for the imaginary environment is to be explained using language that the patient clearly understands. Tasks that illustrate listening comprehension, a patient's ability to remain attentive for 20 minutes may be the maximum amount of time for a VR therapy session. Orientation should be instructed twice so that the patient is familiar with the equipment, head and hand controls, and VR environment before a therapy session. It requires a good interpersonal relationship between the prototype designer, patient, and therapist. The message spoken must be understood by the listener in the correct context for the communication to be effective. Use only one language at a time for instructing: verbal instructions or written instructions or kinetic instructions. This means speak the instructions, so the patient hears the words. Allow the patient to read the instructions. Show the patient the equipment and how to use the controls.

Using written instructions, the patient can determine if the words they are reading have meaning and in what way the words will be used in the VR environment. Names or actions (such as go, stop, pause) or instructions must be easily intelligible. If instructions must be memorized before a VR session begins, then the patient can practice memorization techniques.

In the virtual environment, the patient can anticipate the sequence of events with practice and develop verbal and visio-spacial memory. Spacial organization becomes a response versus a reaction to the unknown. The patient starts to evaluate their ability to remember the order of tasks to perform in the situation for a good outcome. The patent should express that it is a pleasant user experience.

9. Conclusion

Concluding all chapters, this chapter summarizes the project and prototype, and delves deeper into the future work. The future work can be done after the current world health crisis, COVID-19, has ended, as well as working with Tactus for further VR implementation in dual diagnosis patient treatment sessions.

9.1 Project Conclusion

The main research question of how to implement a virtual reality environment for dual diagnosis patients with a substance use disorder (SUD) and a mild intellectual disability or borderline intellectual functioning (MID-BIF), to be used in conjunction with a cognitive behavioral therapist engagement, was addressed by determining its effectiveness to empower, build self-efficacy, the feeling of self-control, and invoke a sense of presence in the patient population. Empirical research provided evidence for the validity and applicability of using addiction treatment interventions with virtual reality technologies.

In consideration of the patient's intellectual disability related to MID-BIF, that is the impairment of imagination, the virtual environment's ideation and realization in this project adapted a realistic design to enhance the patient's experience which ensured a successful outcome for patients and therapists. Co-designing was a unique participatory and empathic approach that engaged the patient in the concept creation, supported by user requirements. Patient's interviewed while viewing an interactive video of the VR prototype revealed that patients were able to imagine themself in the 3-D fictious space.

To blend into the design the important project stakeholder's two SUD treatment protocols created by the Dutch Company Tactus, the substance abuse rehabilitation exercises and substance use behavior theory for individual and group activities were incorporated. The structured individual exercises created by Tactus transition over the course of weeks from discussions of substance use in the patient's life, setting goals, self-monitoring, self-control techniques, changing, and dealing with cravings, to roleplay. Roleplay exercises then elicit thinking and acting differently, refusing, preventing, achieving, and completing the plan.

The virtual environment in the project's design met the patient's criteria of trust, safety, and prevention, by immersing the patient in a virtual space that offered a way to try and repeat self-control techniques to teach self-efficacy, The core user requirements which included the need for a self-assessment tool, rewards, and empowerment were refined through core technology specifications for free movement to orient oneself, a virtual wrist band with color coded for situational risk, accessible alternatives, a gamification point system, a timeframe to implement therapy exercises, and flowcharts for using each situation.

Limitations, of course, were imposed by the global pandemic COVID-19 and lack of one-on-one testing of the prototype in real-time; however, overcoming these limitations became part of the overall goal of the project. Creating an interactive video of the VR prototype proved a useful introduction into the VR environment for the patient and clinical professionals. Not only were patients delighted to experience the new technology, they enjoyed participating in the design of a VR environment customized to their requirements. The combined patient and clinical professional interviews demonstrated that the scenarios posed in the videos gave patients a sense of presence therefore empowering them to use their self-control

techniques but was also an effective enhancement to the prototype for the eventual product model that could be used to introduce VR during a particular phase of individual or group therapy. The therapeutic impact of the VR prototype demonstrated successfully that a patient could use the VR videos to practice skills to overcome temptations of substance use. Ultimately, the limitations gave way to more uses for the VR prototype than had been anticipated at the start of the project, proving that co-design was a positive approach to a creative technology solution.

9.2 Future Work

Reflecting on the conclusions, future work could draw upon the way the patient and therapist interact in the virtual environment, whether self-efficacy accelerates at a given stage of intellectual development. The treatment protocol is a 9-week process. At week 1 and progressing to week 9, the VR application should be tested at different points to evaluate if the level of treatment affects the effectiveness of the program in the virtual environment setting. This could give more insight into self-efficacy technologies used to overcome addiction.

References

Reference List

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders.* Fifth edition. Washington DC: American Psychiatric Association.

Astrom, F. (2019). *Designing an e-Health web-platform to promote joyful physical activity amongst university employees* (Bachelor thesis, University of Twente). Available from University of Twente database. (UMI No. N/A)

van Aggelen, J. (2017). *Using virtual reality to support substance use disorder treatment in people with an intellectual disability* (Bachelor thesis, University of Twente). Available from University of Twente database. (UMI No. N/A)

Babin, S. E. (2013). Color Theory: The Effects of Color in Medical Environments. *Honors Theses.* 115.

Bandura, A (1977). Self-efficacy: Toward a Unifying Theory of Behavioral Change. *Psychological Review, 84*(2), 191–215.

Bandura, A. (1989). Human Agency in Social Cognitive Theory. *American Psychologist, 44*(9), 1175–1184.

Bandura, A. (2008). Social cognitive theory of mass communication. *Media Effects: Advances in Theory and Research*, 94-124.

Barrett, S. L. (2016). *Is there a relationship between imagination and repetitive behaviours in autistic adults?* (Master thesis, Wales Autism Research Centre). Available from Semantics Scholar. (UMI No. N/A)

Bolger, N. (2019, December 6). Colours vs. Special Needs Individuals: What You Need to Know. Retrieved from https://www.disabledliving.co.uk/blog/colours-vs-people-with-special-needs/

Bordnick, P. S., Traylor, A. C., Carter, B. L., & Graap, K. M. (2011). A Feasibility Study of Virtual Reality-Based Coping Skills Training for Nicotine Dependence. *Research on Social Work Practice, 22(3),* 293–300.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology, in Qualitative Research in Psychology. *3*(2).

Brouwer, L. (2020). *Go up in smoke! A proof of concept study on tobacco craving in a virtual reality environment* (Bachelor thesis, University of Twente). Available from University of Twente database. (UMI No. N/A)

Bruijnen, C. J. W. H., Dijkstra, B. A. G., Walvoort, S. J. W., Markus, W., VanDerNagel, J. E. L., Kessels, R. P. C., & DE Jong, C. A. J. (2019). Prevalence of cognitive impairment in patients with substance use disorder. *Drug and Alcohol Review, 38*(4), 435-442.

Das, S., & Prochaska, J. J. (2017). Innovative approaches to support smoking cessation for individuals with mental illness and co-occurring substance use disorders. *Expert Review of Respiratory Medicine, 11(10),* 841–850.

Didden, R., Vandernagel, J., Delforterie, M., & Van Duijvenbode, N. (2020). Substance use disorders in people with intellectual disability. Current Opinion in Psychiatry, 33(2), 124-129.

Elliot, A. J. (2015). Color and psychological functioning: a review of theoretical and empirical work. *Frontiers in Psychology, 6.*

García-Rodríguez, O., Ferrer-García, M., Pericot-Valverde, I., Gutiérrez-Maldonado, J., Secades-Villa, R., & Carballo, J. L. (2011). Identifying Specific Cues and Contexts Related to Smoking Craving for the Development of Effective Virtual Environments. *Cyberpsychology, Behavior, and Social Networking, 14(3),* 91–97.

Gaumer Erickson, A. S. & Noonan, P. M. (2018). Self-efficacy formative questionnaire. In The skills that matter: Teaching interpersonal and intrapersonal competencies in any classroom. *Thousand Oaks, CA: Corwin.* 175-176.

Giovancarli, C., Malbos, E., Baumstarck, K., Parola, N., Pélissier, M.-F., Lançon, C., … & Boyer, L. (2016). Virtual reality cue exposure for the relapse prevention of tobacco consumption: a study protocol for a randomized controlled trial. *Trials, 17(1),* 2–9.

Girard, B., Turcotte, V., Bouchard, S., & Girard, B. (2009). Crushing Virtual Cigarettes Reduces Tobacco Addiction and Treatment Discontinuation. *CyberPsychology & Behavior, 12(5),* 477–483.

Goethe, W. (1810). *Theory of Colors.*

Grilli, M. D., & Mcfarland, C. P. (2011). Imagine that: Self-imagination improves prospective memory in memory-impaired individuals with neurological damage. *Neuropsychological Rehabilitation, 21(6),* 847–859.

Hyde, J., Hankins, M., Deale, A., & Marteau, T. M. (2008). Interventions to increase self-efficacy in the context of addiction behaviours: A systematic literature review. *Journal of Health Psychology, 13*(5), 607-623.

igroup (2016). igroup presence questionnaire (IPQ). Project consortium - a multi-disciplinary project consortium. Addresses new interfaces between humans and the real and virtual environment. Defines itself through project work.

Kiewik, M., VanDerNagel, J. E. L., Engels, R. C. M. E., & DeJong, C. A. (2017). The efficacy of an e-learning prevention program for substance use among adolescents with intellectual disabilities: A pilot study. *Research in developmental disabilities, 63*, 160-166.

Kiewik, M., VanDerNagel, J. E. L., Engels, R. C. M. E., & De Jong, C. A. J. (2017). Intellectually

disabled and addicted: a call for evidence based tailor-made interventions. *Addiction, 112*(11), 2067-2068.

Klaassen, R., van Delden, R., VanDerNagel, J., van der Kamp, M., Thio, B., & Heylen, D. (2019). In body experiences: Persuasion by doing. Paper presented at the *CEUR Workshop Proceedings, 2340.*

Landowska, A., Roberts, D., Eachus, P., & Barrett, A. (2018). Within- and Between-Session Prefrontal Cortex Response to Virtual Reality Exposure Therapy for Acrophobia. *Frontiers in Human Neuroscience, 12*, 1–16.

Lasser, K., Boyd, J. W., Woolhandler, S., Himmelstein, D. U., McCormick, D., & Bor, D. H. (2000). Smoking and mental illness: a population-based prevalence study. *Jama, 284(20),* 2606-2610.

Law, E. L. C., Roto, V., Hassenzahl, M., Vermeeren, A. P., & Kort, J. (2009). Understanding, scoping and defining user experience: a survey approach. *In Proceedings of the SIGCHI conference on human factors in computing systems*, 719-728.

Levy, B., Monzani, B. A., Stephansky, M. R., & Weiss, R. D. (2008). Neurocognitive impairment in patients with co-occurring bipolar disorder and alcohol dependence upon discharge from inpatient care. *Psychiatry Research, 161*(1), 28-35.

Mader, A. H., & Eggink, W. (2014). A Design Process for Creative Technology. *Proceedings of the 16th International Conference on Engineering and Product Design*, 568-573.

Maskey, M., Rodgers, J., Grahame, V., Glod, M., Honey, E., Kinnear, J., … & Parr, J. (2019) A Randomised Controlled Feasibility Trial of Immersive Virtual Reality Treatment with Cognitive Behaviour Therapy for Specific Phobias in Young People with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders,* 1912-1927.

McAlister, A., Perry, C., & Parcel, G. (2008). How Individuals, Environments, and Health Behaviors Interact: Social Cognitive Theory. *Health Behavior and Health Education: Theory, Research, and Practice 4*(1), 169–188.

National Preventie Akkord. (2019). *The National Prevention Agreement. A healthier Netherlands.*

Netherlands Smoking Rate 2000-2020. (2020). Retrieved from https://www.macrotrends.net/countries/NLD/netherlands/smoking-rate-statistics

Niechwiadowicz, K. (2017). *Virtual Reality and Game Mechanics in Generalized Social Phobia Treatment* (Master thesis, University of Twente). Available from University of Twente database. (UMI No. N/A)

O'Sullivan, M. (2019). What is CBT? Retrieved from https://www.mentalhealthtoday.co.uk/blog/therapy/what-is-cbtplus-the-therapy-combining-traditional-and-third-wave-approaches

Prochaska, J. J., Das, S., & Young-Wolff, K. C. (2017). Smoking, mental illness, and public health. *Annual Review of Public Health, 38*, 165-185.

QFD (Quality Function Deployment) - Elite Consulting. (2019). Retrieved from https://elite-consulting.com/quality_processes/dfss/qfd/

Riva, G., & Mantovani, F. (2012). Being There: Understanding the Feeling of Presence in a Synthetic Environment and its Potential for Clinical Change. *Virtual Reality in Psychological, Medical and Pedagogical Applications*, 1–29.

Sanders, E. B. N., Brandt, E., & Binder, T. (2010). A framework for organizing the tools and techniques of participatory design. *In Proceedings of the 11th biennial participatory design conference*, 195-198.

Slayter, E. M. (2008). Understanding and overcoming barriers to substance abuse treatment access for people with mental retardation. *Journal of Social Work in Disability & Rehabilitation*, *7*(2), 63-80.

Steen, M., Kuijt-Evers, L., & Klok, J. (2007). Early user involvement in research and design projects–A review of methods and practices. *In 23rd EGOS Colloquium*, *5*(7), 1-21.

Swerts, C., Vandevelde, S., VanDerNagel, J. E. L., Vanderplasschen, W., Claes, C., & DeMayer, J. (2017). Substance Use among Persons with Intellectual Disabilities (ID) Living Independently in the Community in Flanders. *Research in Developmental Disabilities, 63,* 107 – 117.

Tactus in Beeld #9 - Virtual reality bij Tactus. (2017). Retrieved from https://www.tactus.nl/gedeeldMagazine/index/details/id/46/page/301

VanDerNagel, J. E. L. (2016). *Minder drank of drugs handleiding: een behandeling voor patiënten met een lichte verstandelijke beperking en verslavingsproblemen.*

VanDerNagel, J. E. L. & Kiewik, M. (2016). *Handleiding CGT+: Cognitief gedragstherapeutische behandeling van problematisch middelengebruik bij mensen met een lichte verstandelijke beperking.*

VanDerNagel, J. E. L., Kiewik, M., Didden, R., Korzilius, H. P. L. M., van Dijk, M., van der Palen, J., Buitelaar, J. K., & de Jong, C. A. J. (2017). Substance use in individuals with mild to borderline intellectual disability in the Netherlands: An exploration of Risks and Rates. *Advances in Neurodevelopmental Disorders*, 283-293.

van Duijvenbode, N., & Vandernagel, J. E. L. (2019). A Systematic Review of Substance Use (Disorder) in Individuals with Mild to Borderline Intellectual Disability. *European Addiction Research, 25*(6), 263-282.

Wiederhold, B. K., & Wiederhold, M. D. (2008). Virtual reality with fMRI: a breakthrough cognitive treatment tool. *Virtual Reality, 12(4),* 259–267.

Williams, J. B. W. (2013). Diagnostic and Statistical Manual of Mental Disorders. *Encyclopedia of Social Work.*

Wilson, E., Hewett, D. G., Jolly, B.C., Janssens, S., & Beckmann, M. M. (2018). Is that realistic? The development of a realism assessment questionnaire and its application in appraising three simulators for a gynecology procedure. *Advances in Simulation*, 1-7.

Witmer, B. G. & Singer, M. J. (1998). Measuring Presence in Virtual Environments: A Presence Questionnaire. *U.S. Army Research Institute for the Behavioral and Social Sciences. Presence, 7(3),* 225–240.

Zantinge, E. M., Kelfkens, C. S., Brink, C. L. van den, Snijders, B. E. P., & Zantinge, E. M. (2020, March 11). Roken Cijfers & Context | Huidige situatie: volwassenen. Retrieved from https://www.volksgezondheidenzorg.info/onderwerp/roken/cijfers-context/huidige-situatie-volwassenen#!node-roken-naar-leeftijd

Appendices

Appendix A. Literature Review Matrix

Question	Bordnick, et al., 2011	Das & Prochaska, 2017	García-Rodríguez, et al., 2011	Giovancarli, et al., 2016	Girard, et al., 2009	Landowska, et al., 2018	Niechwiadowicz, 2017	Wiederhold & Wiederhold, 2008	Sub-conclusion
How can specific therapeutic techniques for smoking cessation be implemented in a virtual reality environment?	VR-based cue reactivity has been successfully used for the assessment of drug craving. A VR-based treatment approach for smoking cessation was developed and tested.	Behavioral therapy (BT) teaches patients strategies to identify, avoid, and cope with triggers (manage cravings, reduce withdrawal symptoms, and engage in social support.	Cue exposure therapy (CET) does not improve standard cognitive behavioral therapy (CBT), but when combined using VR it can work more effectively.	CET situations are difficult to thoroughly reconstruct using only passive images or video, but when used with immersive VR it can work.	Example study where smokers were immersed in a VR environment and they crushed virtual cigarettes. This showed a significant impact in tobacco addiction.	Virtual reality exposure therapy (VRET) is currently being used for psychological disorder treatments, such as phobias and post-traumatic stress disorders, as well as for smoking cessation.	VR is becoming a popular solution among therapists. In VR, the exposure can be adjusted to the patient's needs, it is more safe, controllable, and cost effective. It has so far been proven to be as effective as the conventional treatment-CBT.	The emerging application of VR in conjunction with functional magnetic resonance imaging (fMRI) is helping to improve upon current VR systems.	VR when combined with CET and CBT becomes VRET. This method is highly effective to immerse a patient in the trauma situation for cue-exposure and behavioral interventions.

Table A1: Literature matrix for research sub-question 1.

Question	Bordnick, et al., 2011	Girard, et al., 2009	Riva & Mantovani, 2012	Sub-conclusion
How can a virtual reality environment be designed to invoke immersion and a sense of presence within the virtual world?	VR, a technological medium that effectively immerses individuals into realistic complex cue environments, appears an ideal tool to help improve the effectiveness of CBT training.	Smokers immersed in a VR environment containing stimuli associated with urges to smoke, such as burning cigarettes, reported a statistically significant increase in cravings and response to smoking cues compared to still images. Immersion in an interactive and 3D virtual environment significantly increased craving compared to still images.	The feeling of presence can be described as the product of an intuitive experience-based metacognitive judgement related to the enaction of our intentions. We are present in an environment to intuitively transform our intentions into actions. Presence is produced by means of the disappearance of the medium from the conscious attention of the subject.	VR can be made immersive when the medium disappears from the conscious attention of the patient. The environment should be made realistic enough with stimuli associated with urges to smoke, such as burning cigarettes.

Table A2: Literature matrix for research sub-question 2.

Question	Barrett, 2016	Das & Prochaska, 2017	Grilli & Mcfarland, 2011	Maskey, et al., 2019	Slayter, 2008	VanDerNagel, et al., 2017	Sub-conclusion
How can an immersive virtual reality environment be evaluated to support patients who have a tobacco addiction and borderline cognitive disability?	Investigated long-held claim that reliance on routines and rituals (restricted and repetitive behaviours) is related to a difficulty with flexibly generating novel ideas (imagination) in those with autism spectrum disorder.	It is not so much that smoking treats psychiatric illness, but rather that smoking reverses nicotine withdrawal and mitigates psychiatric medication side effects. BT targets learning processes and contextual factors that have been sustaining the problem behavior.	The 'self-imagination effect' has potential in cognitive rehabilitation. Since patients with borderline cognitive disabilities cannot imagine on their own, VR applications are effective if they still allow the patient to believe they are in full control.	Brief VRE exposure with CBT is feasible and acceptable to deliver through child clinical services and is effective for some participants.	Addiction for patients with borderline cognitive disabilities could be explained by specific characteristics including inadequate coping mechanisms, poor memory functioning, and social factors like peer pressure.	Dutch researchers conducted a study on substance use among individuals with a mild to borderline cognitive disability. Their research concluded that 61.6% of patients smoke tobacco.	Patients with borderline cognitive disabilities may rely on repetitive behaviors. Their continual addiction could be explained by inadequate coping mechanisms, poor memory functioning, and social factors like peer pressure.

Table A3: Literature matrix for research sub-question 3.

Appendix B. The Creative Technology Design Process

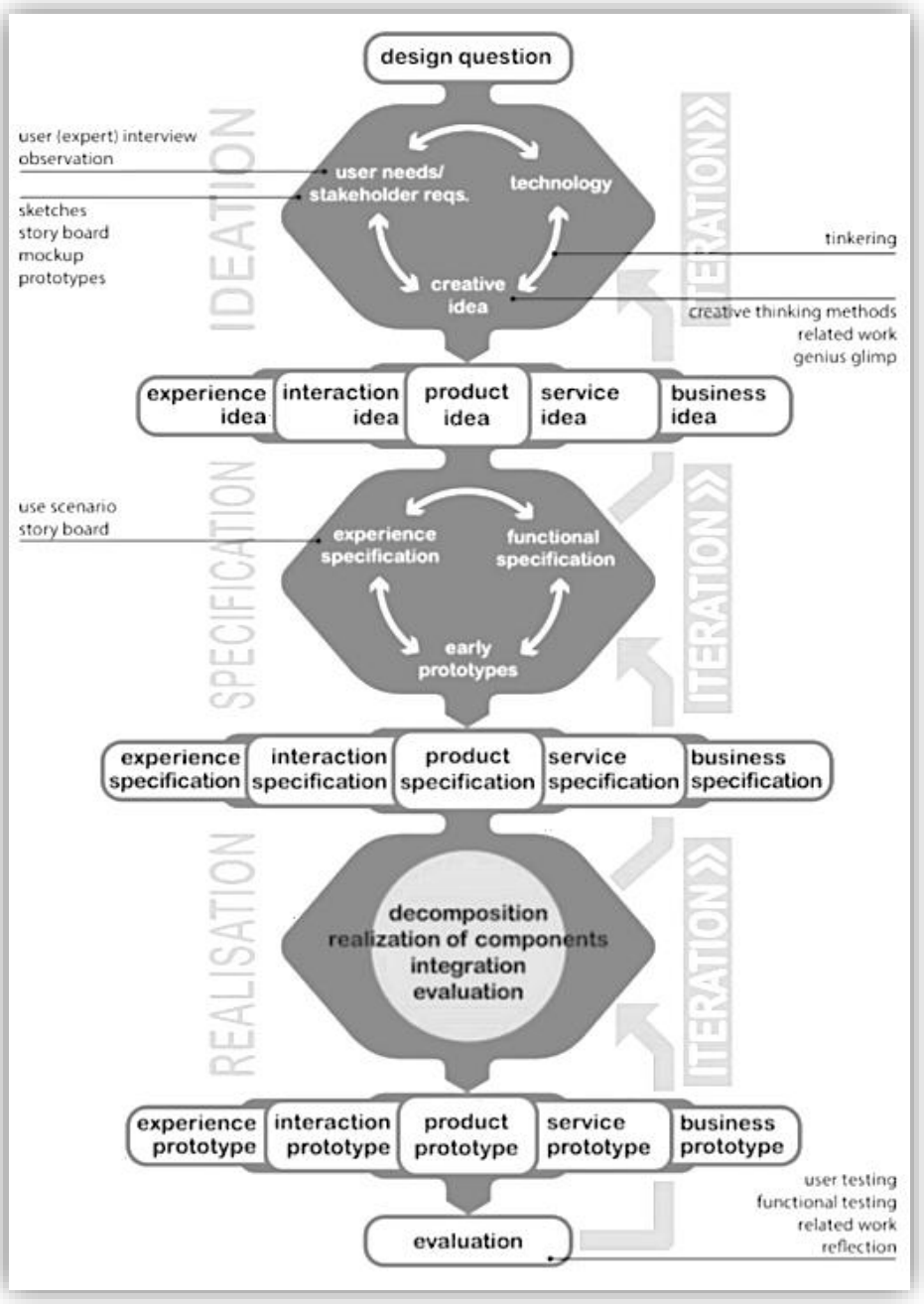


Figure B1. The Creative Technology Design Process (Mader and Eggink, 2014, p. 3).

Appendix C. Concept Ideation

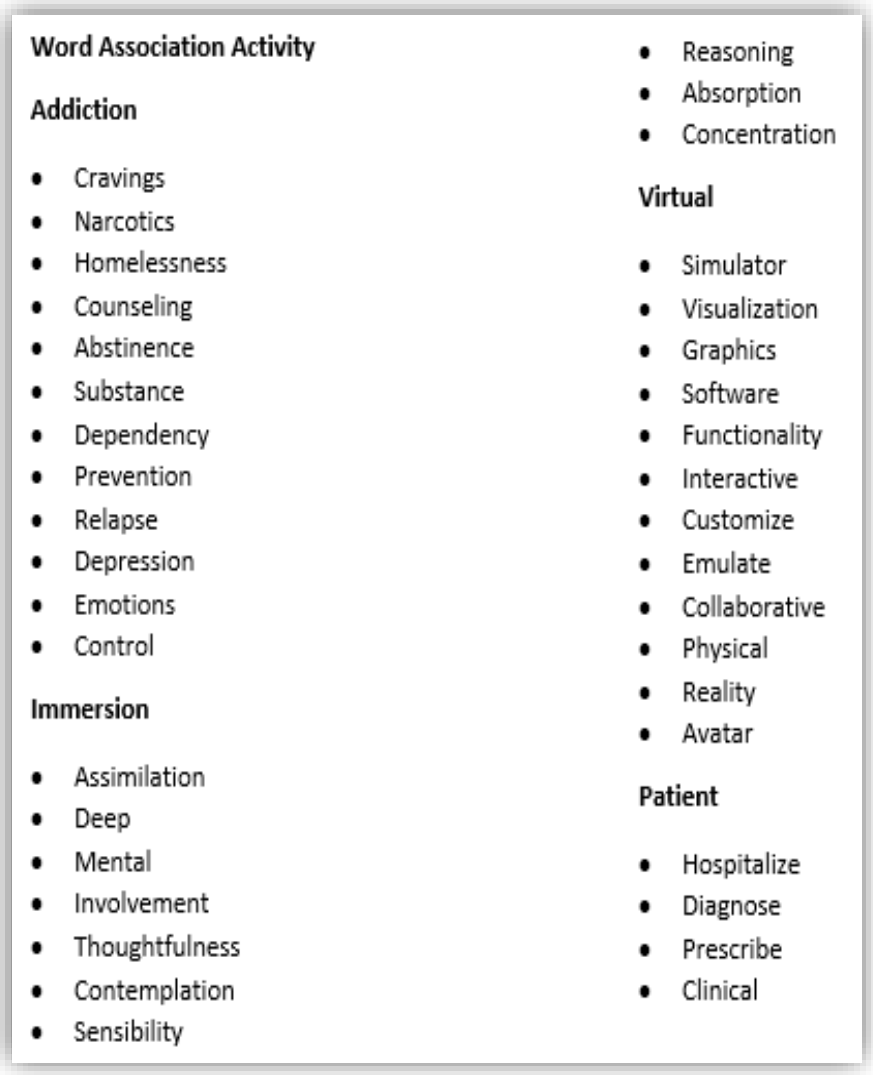


Figure C1. Word Association Activity.

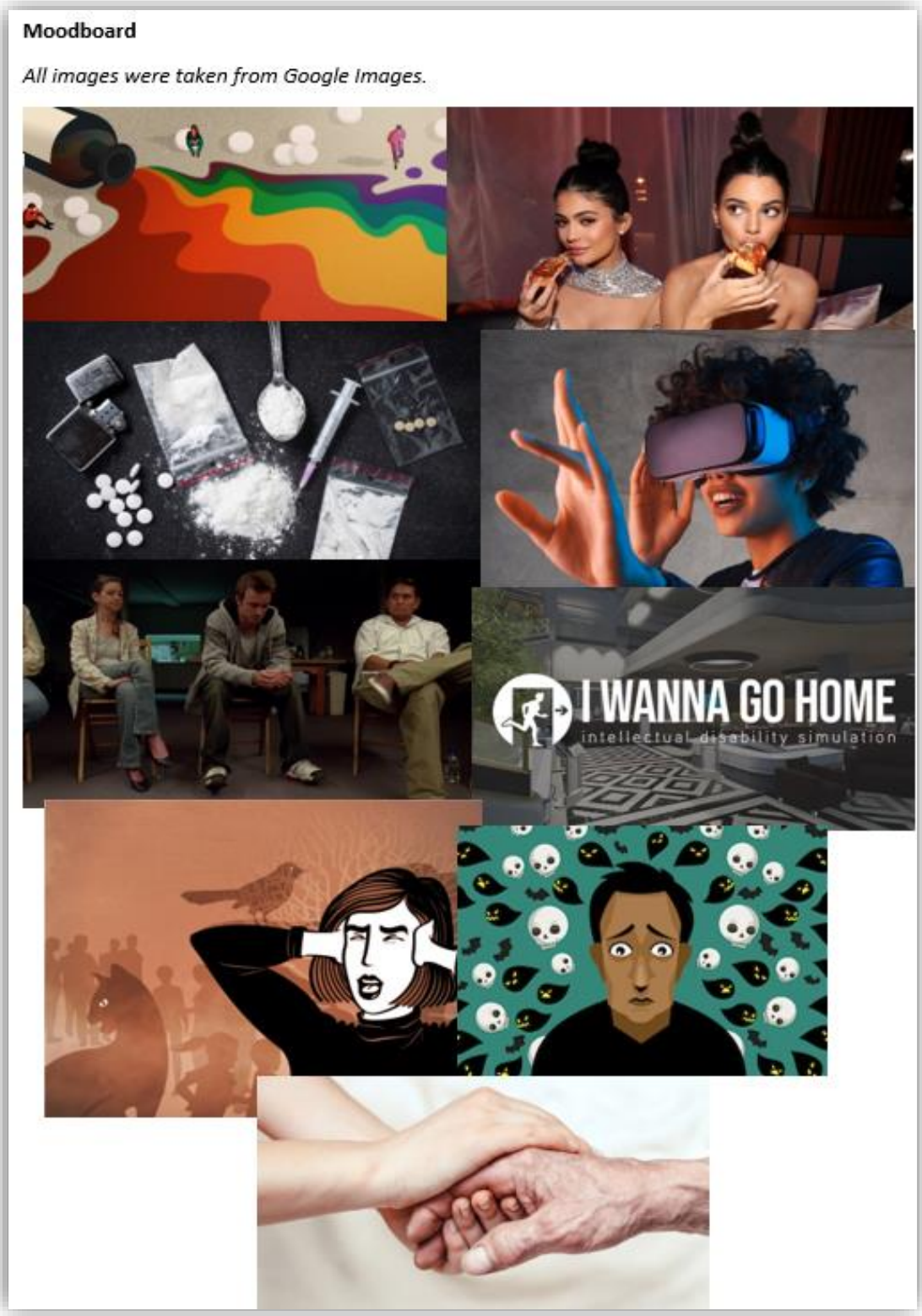


Figure C2. Moodboard (images from Google Images).

Brainstorm of 10 concepts

2 settings of VR environment: alone vs with peers

3 substances: tobacco, alcohol, marijuana

Virtual reality (VR) vs augmented reality (AR)

Technology

1. Unity
2. Cinema 4D
3. HTC Vibe Pro

Application of technology

1. Virtual environment general
2. Virtual CBT+ exercises practice
3. HoloLens (AR) for assessing in-patient readiness to out-patient
4. Virtual vertrouwenspersoon
5. Virtual therapist
6. Chatbot for relapse prevention
7. Chatbot for context in VR environment
8. Virtual group sessions – similar to AA group meetings
9. Experimental comparison of alone vs peer sessions in virtual environment
10. Experimental comparison of virtual sessions to real-life sessions

→ Virtual CBT+ exercises practice

CBT+ exercises

1. Practicing the 6 D's (distance, distraction, declare, different thinking and different acting, doing great, deals) along with the color lights (green, orange, red, blue)
2. Draw a lifeline with important moments of the patient's life
3. Role-playing exercises on how to deal with cravings
4. Exercises on how to change dangerous thoughts in helping thoughts in risky situations
5. Emergency plan on what to do in case of slip-ups or relapses
6. Sweet activity to understand cravings

Figure C3. Concept Creation.

Appendix D. Information Brochure

Extinguishing the Use

Informatiebrochure

Bachelor thesis Creatieve Technologie

Deze brochure bevat informatie over het onderzoeksproject: *Extinguishing the Use*. De brochure helpt u beslissen of u wilt deelnemen aan dit onderzoek

Onderzoeker: MaryCaroline Georges - m.f.georges@student.utwente.nl

Begeleiders: Dr. Randy Klaassen – r.klaassen@utwente.nl,

MSc. Simon Langener - s.langener@utwente.nl

Onderzoeksperiode: 1/6/2020 – 14/6/2020

Achtergrond

In de afgelopen jaren is virtual reality (VR) onderzocht voor gebruik in klinische omgevingen. Verslavingsbehandelingen kunnen verder worden verbeterd door middel van VR-technologie waardoor het mogelijk wordt om patiënten onder te dompelen in bepaalde risicovolle situaties. In deze situaties kunnen patiënten oefenen om te gaan met mechanismen voor hun verslaving met behoud van het gevoel van controle en empowerment. Patiënten met een licht verstandelijke beperking of borderline intellectueel functioneren (MID-BIF) kunnen profiteren van VR door zich uitsluitend te richten op de behandeling en niet op hun handicap. VR Technologie helpt ook klinische professionals bij verslavingsbehandelingssessies door te helpen hun patiënten te ondersteunen.

Het huidige onderzoek, onder leiding van de Universiteit Twente en de samenwerking met Tactus, heeft tot doel een prototype van een virtuele omgeving te ontwikkelen dat zelfcontroletechnieken (6D's) bevat die worden aangeleerd in het CBT+-protocol voor verslavingsstoornissen (SUD)-behandelingen. Om dit prototype te evalueren, zullen patiënten en klinische professionals een video te zien krijgen van virtuele omgevingen. Daarna stellen we u een reeks vragen, in de vorm van een vragenlijst en een interview.

Procedure

Via interviews en audio-opnameswordt informatie verzameld over gebruikersevaluaties (MID-BIF-patiënten) en stakeholder (klinische professionals) met betrekking tot de prototypes.

In deze brochure leggen we uit wat het voor u betekent om deel te nemen aan dit onderzoek, als patiënt of als klinisch professional. U bepaalt zelf of u wilt deelnemen aan dit onderzoek. Voor vragen u contact opnemen met onderzoeker MaryCaroline Georges; contactgegevens staan op de voorpagina.

Deelname

Deelname is geheel vrijwillig. U op elk moment, zonder opgave van reden, aangeven dat u niet langer wilt deelnemen aan het onderzoek. U wordt gevraagd om toestemming voor uw deelname.

Wat gebeurt er tijdens de activiteiten?

In een online Skype sessie gaan we samen de video's van het prototype bekijken. U ontvangt de video's van te voren via internet. Na het bekijken van de video's stellen we u een reeks vragen, in de vorm van een vragenlijst en een interview. De audio van het interview wordt opgenomen. Het sessie duurt ongeveer **een uur.**

Welke gegevens worden verzameld?

Voor patiënten zal uw naam anoniem zijn, uw geslacht wordt geregistreerd, uw antwoorden op de vragen en opmerkingen worden opgenomen, evenals de audio van het interview. Om u te taggen, krijgt u de letter P (patiënt) en een nummer N (aantal patiënt / 5), bijvoorbeeld P3.

Voor klinische professionals is uw naam anoniem,uw ervaring in het veld wordt geregistreerd en uw titel (d.w.z. uw beroepstitel) wordt geregistreerd. Uw antwoorden op de vragen en opmerkingen zullen worden opgenomen, evenals de audio van het interview. Om u te taggen, krijgt u de letter C (klinisch professional) en nummer N (aantal klinische professional / 2); C2 bijvoorbeeld.

Worden de gegevens bewaard?

De gegevens worden veilig bewaard en anoniem verwerkt volgens AVG-richtlijnen. Volgens de VSNU-richtlijnen worden onderzoeksgegevens minstens 10 jaar bewaard.

Wie heeft toegang tot de gegevens?

De onderzoekers en de begeleiders hebben toegang tot de gegevens. Als het nodig wordt geacht dat meer personen toegang krijgen, wordt u eerst gevraagd.

Hoe worden de gegevens gebruikt?

De gegevens zullen worden gebruikt als de evaluatie van de prototypes in een rapport.

Worden de gegevens openbaar gemaakt?

Het rapport wordt beschikbaar gesteld op de database van de Universiteit Twente. De gegevens van de respondent blijven echter anoniem met behulp van de eerder genoemde methoden.

Kunnen ik mijn gegevens laten verwijderen?

Als u tijdens of direct na (tot 24 uur na deelname) een activiteit besluit dat u niet (meer) wilt deelnemen, worden al uw gegevens uit die sessie verwijderd. Zodra het onderzoeksmateriaal anoniem is gemaakt, kunnen ze niet meer aan u worden gekoppeld en kunnen ze dus niet meer worden verwijderd.

Meer informatie en onafhankelijk advies

Wilt u onafhankelijk advies geven over deelname aan dit onderzoek of een klacht indienen? Dan u contact opnemen met de Ethische Commissie (ethics-comm-ewi@utwente.nl). Het bestaat uit onafhankelijke deskundigen van de universiteit en is beschikbaar voor vragen en klachten rond het onderzoek.

Voor vragen u contact opnemen met de onderzoekers, contactgegevens op de voorkant van deze folder.

Figure D1. Project Information Brochure.

Appendix E. Consent Form

FORMULIER TOESTEMMINGSVERKLARING (INFORMED CONSENT) FORMULIER

Onderzoeksperiode: 1/7/2020 – 30/7/2020

Procedure Information

Beste deelnemer,

De Universiteit Twente en het bedrijf Tactus onderzoeken het gebruik van virtual reality (VR) om de verslavingsbehandeling bij patiënten met een licht verstandelijke beperking of borderline intellectueel functioneren (MID-BIF) te verbeteren zoals uitgelegd in de informatiebrochure "Extinguishing the Use" die u gekregen heeft bij dit formulier. Patiënten en klinische professionals krijgen video's van virtuele omgevingen te zien. Door middel van deze video's laten we zien hoe de patiënten zouden kunnen omgaan de omgeving en bepaalde oefeningen (zelfbeheersingtechnieken volgens de 6D's als onderdeel van de CBT + protocol). Zowel patiënten als klinische professionals zullen individuele interviews houden waarin ze een reeks vragen over de prototypevideo zullen beantwoorden.

Contactgegevens

Heeft u klachten over dit onderzoek, stuur deze dan door naar de secretaris van de Ethische Commissie van de Faculteit Elektrotechniek, Wiskunde en Informatica van de Universiteit Twente, Postbus 217, 7500 AE Enschede (NL), e-mail: ethics-comm-ewi@utwente.nl.

Informatie over de onderzoeker: MaryCaroline Georges, e-mail: m.f.georges@student.utwente.nl, telefoon: +31624196049

Onderzoek: Blussen van het gebruik – Prototype evaluatie

Ik verklaar hierbij het volgende:

☐ Ik verklaar hierbij dat ik volledig op de hoogte ben van het onderzoek. Het doel van het onderzoek en de methoden zijn mij uitgelegd, waar ik de ruimte heb gehad om vragen te stellen.

☐ Ik begrijp dat ik mijn deelname op elk moment mag en kan beëindigen, zonder opgave van reden, zonder enige reden, zonder enige consequentie.

☐ Ik geef toestemming aan het publiek om het *anonieme* onderzoeksmateriaal beschikbaar te stellen dat tijdens de deelname aan het onderzoek is verzameld.

Het verzamelde materiaal wordt alleen onderzocht door de onderzoeker, hun begeleiders, en het bedrijf Tactus en zal nooit openbaar worden gemaakt en/of getoond aan derden voor demonstratie of rapportage doeleindes. Al het onderzoeksmateriaal wordt verwerkt en opgeslagen in overeenstemming met de AVG-regels en -richtlijnen.

Naamonderwerp:	Handtekening:
.....	.....
Naam Onderzoeker:	Handtekening:
MaryCaroline Georges	
.....	.....

Figure E1. Project Consent Form.

Appendix F. Questionnaires

	Yes → Maybe → No 1 2 3
1. Do you have enough knowledge about technology to learn how to use the virtual reality headset and controller (equipment)?	
2. Can you learn what is being taught in the video?	
3. Can you figure out what to do in the virtual environment from the video instructions?	
4. Can you understand what each of the 4 virtual situations are supposed to represent?	
5. Can you decide what color each of the virtual situations are in terms of riskiness to smoke marijuana (green, orange, red)?	
6. Can you choose what self-control techniques (6D's) to use if you feel triggered to smoke marijuana in each of the virtual situations?	
7. If you practice using these virtual situations during your treatment sessions, can you develop self-control for your marijuana addiction?	
8. If you practice in the virtual situations, will you be able to use self-control techniques in the real world in similar situations?	
9. Are you confident you can finish your addiction treatment with the use of this virtual exercise?	
10. Do you believe your ability to control your marijuana addiction will grow if you practice in the virtual situations?	
11. Do you believe practicing in the virtual situations will help you with your addiction?	

Figure F1. Self-Efficacy Patient Questionnaire Form A1.

	Yes → Maybe → No 1 2 3
1. Do you have enough knowledge about technology to setup the virtual reality program and help the patient use the virtual reality headset and controller (equipment)?	
2. Do you have enough knowledge about and understand the CBT+ protocol?	
3. Do you understand what is being taught in the video?	
4. Can you figure out what to do in the virtual environment from the video instructions?	
5. Can you understand what each of the 4 virtual situations are supposed to represent?	
6. Can you help patients decide what color each of the virtual situations are in terms of riskiness to smoke marijuana (green, orange, red)?	
7. Can you help patients choose what self-control techniques to use if they feel triggered to smoke marijuana (6D's) in each of the virtual situations?	
8. Do you believe that the virtual situations will help patients develop self-efficacy and practice self-control techniques?	
9. Do you believe that the virtual reality program will add value to CBT+ protocol sessions for patients and therapists?	
10. Do you believe that the self-control techniques patients practice in the virtual situations will help patients in real world situations?	

Figure F2. Self-Efficacy Clinical Professional Questionnaire Form A2.

	Yes → Maybe → No 1 2 3
1. Does the video show the virtual environment in good quality?	
2. Do the virtual rooms look like places that you have been?	
3. Did you feel like you were only seeing pictures?	

4. Were you aware of the surroundings in the virtual world (i.e. sounds, lights, colors, furniture, etc.)?	
5. Did you pay full attention to the virtual environment in the video?	
6. Were you completely captivated by the virtual world in the video?	
7. Did the virtual world look real?	
8. Did the virtual world seem more realistic than the real world?	
9. Were the 4 virtual world situations consistent with your real-world experiences?	
10. Were you distracted by certain objects or colors in the video?	
11. Did you notice a difference in colors depending on the object (i.e. marijuana & joints had less color and were less appealing than a book or game)?	
12. Did you want to be in the virtual world?	

Figure F3. Realism Patient Questionnaire Form B1.

	Yes → Maybe → No 1 2 3
1. Does the video show the virtual environment in good quality?	
2. Do the virtual rooms look like places that you have been?	
3. Did you feel like you were only seeing pictures?	
4. Were you aware of the surroundings in the virtual world (i.e. sounds, lights, colors, furniture, etc.)?	
5. Did you pay full attention to the virtual environment in the video?	
6. Were you completely captivated by the virtual world in the video?	
7. Did the virtual world look real?	
8. Did the virtual world seem more realistic than the real world?	
9. Were the 4 virtual world situations consistent with your real-world experiences?	

10. Were you distracted by certain objects or colors in the video?	
11. Did you notice a difference in colors depending on the object (i.e. marijuana & joints had less color and were less appealing than a book or game)?	
12. Did you want to be in the virtual world?	
13. Does the video show the virtual environment in good quality?	

Figure F4. Realism Clinical Professional Questionnaire Form B2.

Appendix G. Questionnaire Answers

	Yes → Maybe → No 1 2 3
1. Do you have enough knowledge about technology to setup the virtual reality program and help the patient use the virtual reality headset and controller (equipment)?	3 But I could figure it out if I am helped and shown how at first.
2. Do you have enough knowledge about and understand the CBT+ protocol?	1
3. Do you understand what is being taught in the video?	1
4. Can you figure out what to do in the virtual environment from the video instructions?	1
5. Can you understand what each of the 4 virtual situations are supposed to represent?	1
6. Can you help patients decide what color each of the virtual situations are in terms of riskiness to smoke marijuana (green, orange, red)?	1
7. Can you help patients choose what self-control techniques to use if they feel triggered to smoke marijuana (6D's) in each of the virtual situations?	1
8. Do you believe that the virtual situations will help patients develop self-efficacy and practice self-control techniques?	1

9. Do you believe that the virtual reality program will add value to CBT+ protocol sessions for patients and therapists?	1
10. Do you believe that the self-control techniques patients practice in the virtual situations will help patients in real world situations?	1

Figure G1. Clinical professional 1 Self-Efficacy Questionnaire Form A2 answers.

	Yes → Maybe → No 1 2 3
1. Does the video show the virtual environment in good quality?	1 No other people. People can be a big trigger. Maybe instead have people looking not directly at the patient so to not frighten the patient.
2. Do the virtual rooms look like places that you have been?	2 The doors are strange and there are no people.
3. Did you feel like you were only seeing pictures?	3 Because of the rotation.
4. Were you aware of the surroundings in the virtual world (i.e. sounds, lights, colors, furniture, etc.)?	In the coffeeshop, the green leaf caught my eye. No distractions. Focus was on where the camera showed.
5. Did you pay full attention to the virtual environment in the video?	1
6. Were you completely captivated by the virtual world in the video?	2
7. Did the virtual world look real?	1
8. Did the virtual world seem more realistic than the real world?	3
9. Were the 4 virtual world situations consistent with your real-world experiences?	1 Yes, besides the doors and lack of people.
10. Were you distracted by certain objects or colors in the video?	3

	But the joints did not look like joints.
11. Did you notice a difference in colors depending on the object (i.e. marijuana & joints had less color and were less appealing than a book or game)?	3
12. Did you want to be in the virtual world?	1 For the treatments.
13. Does the video show the virtual environment in good quality?	1

Figure G2. Clinical professional 1 Realism Questionnaire Form B2 answers.

	Yes → Maybe → No 1 2 3
1. Do you have enough knowledge about technology to setup the virtual reality program and help the patient use the virtual reality headset and controller (equipment)?	1
2. Do you have enough knowledge about and understand the CBT+ protocol?	1
3. Do you understand what is being taught in the video?	1
4. Can you figure out what to do in the virtual environment from the video instructions?	1
5. Can you understand what each of the 4 virtual situations are supposed to represent?	1
6. Can you help patients decide what color each of the virtual situations are in terms of riskiness to smoke marijuana (green, orange, red)?	1
7. Can you help patients choose what self-control techniques to use if they feel triggered to smoke marijuana (6D's) in each of the virtual situations?	1
8. Do you believe that the virtual situations will help patients develop self-efficacy and practice self-control techniques?	1
9. Do you believe that the virtual reality program will add value to CBT+ protocol sessions for patients and therapists?	1

10. Do you believe that the self-control techniques patients practice in the virtual situations will help patients in real world situations?	1

Figure G3. Clinical professional 2 Self-Efficacy Questionnaire Form A2 answers.

	Yes → Maybe → No 1 2 3
1. Does the video show the virtual environment in good quality?	1
2. Do the virtual rooms look like places that you have been?	1
3. Did you feel like you were only seeing pictures?	3 Because of the rotation.
4. Were you aware of the surroundings in the virtual world (i.e. sounds, lights, colors, furniture, etc.)?	See the details.
5. Did you pay full attention to the virtual environment in the video?	1
6. Were you completely captivated by the virtual world in the video?	2
7. Did the virtual world look real?	1
8. Did the virtual world seem more realistic than the real world?	3
9. Were the 4 virtual world situations consistent with your real-world experiences?	Good except for lack of people. Gym would definitely trigger cravings due to the loud noises, but you wouldn't go to the gym if you have a marijuana addiction.
10. Were you distracted by certain objects or colors in the video?	3
11. Did you notice a difference in colors depending on the object (i.e. marijuana & joints had less color and were less appealing than a book or game)?	3 But now that you mention it yes.
12. Did you want to be in the virtual world?	1
13. Does the video show the virtual environment in good quality?	1

Figure G4. Clinical professional 2 Realism Questionnaire Form B2 answers.