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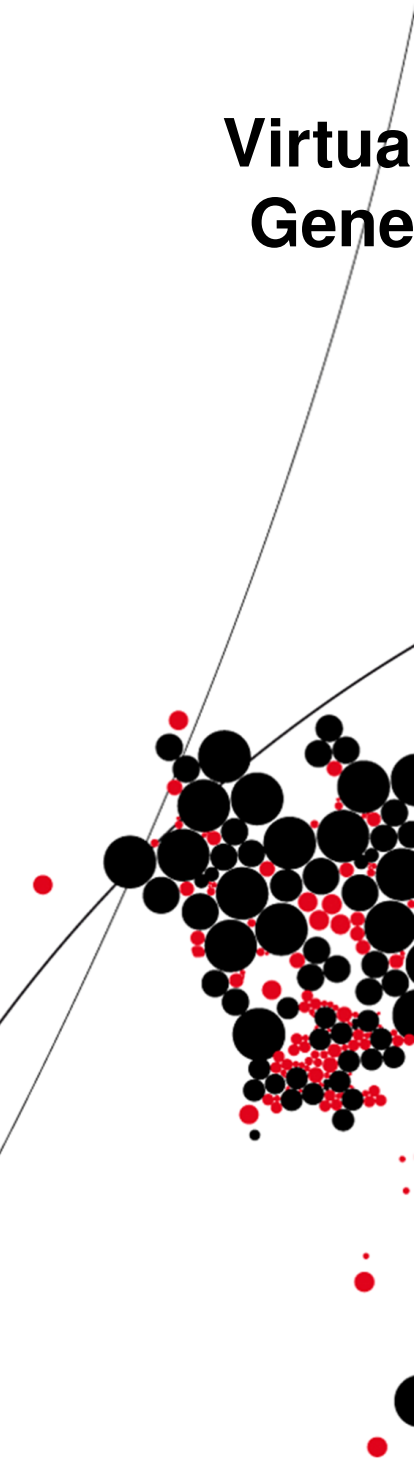
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Virtual Reality and Game Mechanics in Generalized Social Phobia Treatment

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Abstract

Psychiatric disorders are becoming a serious health challenge. Anxiety disorders are the most common - in 2011, 10.1 million people in EU were suffering from social anxiety. The treatment of social phobia can be quite costly and also complicated, given the necessity to recreate and repeat certain social situations. This is why Virtual Reality (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- Cognitive-Behavioral Therapy (CBT). Most of the research, however, focuses on specific phobias such as fear of public speaking, while social phobia is more complex and can affect any social situation. Furthermore, research up to date has not taken into account the user experience for both patients and therapists, but only focuses on the effectiveness of VR exposure. Therefore, the goal of this thesis is to investigate possible implementation of VR in exposure therapy, in cooperation with therapists and ex-patients. The program will combine a variety of social situations with some game aspects, as the leveled structure of a game goes in line with the traditional CBT, where patients are gradually exposed to the feared stimuli. The levels will vary in degree of exposure and interaction, where participants have to face avatars with friendly or unfriendly attitudes, as well as explore different parts of the environment.

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Introduction

Everybody has fears or anxieties, but once they take over a person's life, making it difficult for them to function normally, it becomes a disorder [1] [2] [3]. Anxiety disorders are the most common psychiatric disorders in the world. In the European Union alone, 69.1 million people of all ages are affected by it (year 2011), with females being more likely to suffer from an anxiety disorder [4] [1]. Social phobia alone affected 6.7 million people in 2005 and 10.1 million people in 2011 (in European Union), making it a serious and growing health challenge.

The symptoms can be very broad, however it mostly centers around the fear of performing in front of others, especially in situations where one is observed or judged. This could be eating or drinking in public, meeting new people, social situations, public speaking, or using public restrooms. People with social anxiety are constantly worried about being negatively evaluated or embarrassing themselves [5] [1]. The severity of symptoms translates into two subtypes - 'nongeneralized' and 'generalized' social phobia [6] [7]. In case of nongeneralized social phobia, patients are affected by a few phobias (like public speaking), while generalized social phobia extends to most social situations. The latter is also the most common. Therefore this study focuses on that target group.

There are two models and approaches for therapy of social phobia - Cognitive Therapy (CT) and Cognitive-Behavioral Therapy (CBT), with the latter being usually used by therapists. CT focuses on the importance of teaching patients what the process of anxiety looks like and how they should behave when it occurs (cognitive restructuring), but it excludes the in vivo (real life) exposure. CBT, on the other hand, focuses on applying the learned skills and behaviors during exposure and so teaching the patient how to deal with those fears in real life, thus making it a more effective method. It teaches the patients how to gain control over his/her emotions by overcoming their fears during exposure treatment.

CBT combines few aspects of training. Patients first have to rate his/her fears, which are then addressed starting from the least feared situation, slowly increasing the difficulty. During the exposure the patient needs to identify the negative thoughts, evaluate them and create new, alternative thoughts. Moreover, patients repeat and practice different behaviors during the exposure (social skills training) and get feedback regarding the adequacy of certain behaviors. The exposure is done using different methods, for example by role playing with the

therapist or going out to the real world, also with the therapist's assistance. However, those methods are not ideal. In case of role playing, some patients have difficulties to imagine the situation, therefore making this kind of exposure less effective. On the other hand, going out to the real world can be risky, as the situation is unpredictable. As a result, the patient can be exposed to much bigger threat than originally intended. It is important that the exposure follows the patient's fear ratings and starts from the least feared situation. This way the patient can slowly get used to the exposure and not get scared or demotivated.

To make the exposure part of the CBT easier to control, researchers and therapists have been using Virtual Reality (VR) as an alternative method. VR gives new possibilities to introduce the patient to the feared stimuli in a controlled environment, where the scenario can be easily repeated for training purposes. Moreover, it is cost effective, can be controlled by the therapist, and provide a better understanding of patient's phobias.

However, so far the Virtual Reality Exposure Therapy (VRET) has mostly been used to treat specific phobias, with public speaking phobia as the main one for social anxiety disorder. Some VR therapies focus solely on this, creating environments with a virtual podium, where the patients can give their speech [8]–[10] and the therapist can control the audience's reactions during the VR exposure [8], [10]–[12], increasing or decreasing the levels of difficulty of the exposure. Some combine public speaking with more feared tasks related to it, like entering the conference room, taking a seat at a table or introducing yourself. This kind of exposure is already more general, yet still aims at the problem of public speaking. Other projects use environments like the London underground or a wine bar [13], party [14], bus stop, train station platform, clothing shop, or a reception desk [15]. Some studies implement more CBT components in VR [10], [11], [16], where the patient first gets prepared for the exposure with the therapist (cognitive restructuring) and then applies the knowledge in the exposure. One of them [11], [16] used an interesting structure, where the environments correspond to the different aspects of treatment, rather than the environment setting itself. In other words, each environment was built to support certain part of the therapy, where behaviors and cognition are trained. Nevertheless, none of those projects approached the problem of generalized social phobia.

Beside the benefit of a controlled environment, VR can help to address other issues related to treatment of social phobia, like patient motivation. As already mentioned, during therapy the tasks or learned skills have to be repeated several times, so it is crucial that the patient stays committed to those tasks. To help motivate the patient, the VR application can be designed in a way that is more appealing and simply more fun. To achieve that, one can implement game elements, making the application a 'serious game'.

The concept of serious games (ones that are used for more than just entertainment [17], [18]) is not new and has been used in various contexts- healthcare, engineering, military and more. The sector of healthcare has been using serious games for a number of purposes: education, physical fitness, training and simulation, recovery and rehabilitation, distraction therapy, cognitive functioning, diagnosis and treatment of mental illness. The last one has been focusing on problems like ADHD or PTSD [18], but no one has yet implemented serious games in treatment of social phobia.

The goal of this project was to design a VR environment for exposure treatment of generalized social phobia. The focus on generalized type is important here, because most of the research focuses on single phobias, like public speaking. Designing for the generalized type is difficult, as it can involve any social situation. There were already environments designed for specific purposes - training assertiveness by trying to get to a building; scrutiny in a coffee shop environment, or intimacy in an informal setting with friends. This project aims at combining those different parts of therapy into one environment and application. In order to provide this diversity within one setting, aspects of games were implemented to make the application more complex and/or interesting. Moreover, the game elements aim at increasing the patient's motivation to comply with the therapy. Therefore, the research question is:

Is it feasible to build a VR system for treatment of the generalized type of social phobia, and how can we incorporate game mechanics to improve the experience?

In order to design the VR exposure, we first need to choose the tasks that are commonly problematic for social phobia patients. Therefore the first subquestion (SQ1) is: *"What tasks can be implemented? Which of them apply to a broad group of patients?"* These task have to fit in the VR and the level structure of a game. Each level of the game should have an increased difficulty, which then again has to be properly regulated, so that the transition between levels is smooth. This could be a change in the environment (e.g. more avatars in the space, more avatars gazing at the user), but also a change in the task (e.g. looking into the eyes of more avatars, having more personal conversation). SQ2: *What criteria should determine the levels of difficulty within this target group?* Beside the game technology used in VR what games aspects could help to improve the therapy and patients engagement? SQ3: *What aspects of games/playfulness can be relevant in VRET?*

To answer the research question we designed and evaluated a VR system, as described in the section below.

1.1 Methodology

This research started from the user-centered approach. We followed an iterative process, with therapists involved in each iteration. The choice of including therapists in the process was made due to 2 reasons: 1) therapists treat multiple patients and therefore have an overview of different cases (specific phobias, symptoms, therapy methods); 2) by cooperating with the therapists we ensure that the design takes into account the perspective of both stakeholders, resulting in a platform that accommodates needs of them both. Additionally, there are limitations when it comes to including actual patients in such studies. First of all, the nature of the phobia makes it difficult to approach them. Secondly, due to ethical concerns with including patients in research studies, we would not be able to comply with all the requirements in the given time. Therefore the project included ex-patients in the final phase.

Each iteration focuses on in-depth interviews. Since this is an early stage of development of such a system, we chose the qualitative method of gathering feedback to get in-depth information from the future users. This method provides better insight into the user behaviors, personal characteristics, and expectations towards the system. It creates openness and encourages users to explain why and how they would like to be using the application, based on their experiences. With this structure, we do not limit ourselves to predefined variables, but can explore this area of research and prepare a base for future studies.

In the first iteration, the experts were interviewed about the core of social phobia and treatment. The goal of those interviews was to learn more about social phobia patients and possible therapies, but also to verify the assumptions made based on the literature. The therapists were also presented with the first scenarios of the task and game. In this iteration we had 3 participants, of which two participated in the next iterations.

Based on the outcome of the interviews, in the second iteration the structure of the serious game was designed: the task, the levels, and feedback. The task that was chosen had to be feasible and fit into the VR environment. Each level can increase the difficulty by for example changing the avatar's attitude. The feedback part is the information we present to the therapist. Afterwards the structure was translated into the 3D environment, using the Unity game engine and later combined with the VR device - HTC Vive. In the first pilot trials the game was tested with the therapists who participated in the first interviews. The focus on those tests was to verify the first design of the interaction and the idea of game-like element. The test were followed by a semi-structured interview.

In the last iteration, the application was developed further and brought for another test. Once again the same two therapists evaluated the final outcome. Additionally two ex-patients experienced and evaluated the application. All of the participants were interviewed after the experiment.

Each iteration is described in a separate chapter. Therefore, for each of them there is a section on design, method for this specific test, results and discussion.

Literature Review

This chapter will cover the literature related to the topic. It will start with the analysis of Social Anxiety Disorder and available treatments. Next, the Virtual Reality will be described - available techniques and research that has already been done in the field of VR and Mental Healthcare, with a focus on social phobia. Lastly, the serious games, gamification techniques, and applications will be examined.

2.1 Social Anxiety Disorder

Everybody has fears or anxieties, but once they take over a person's life, making it difficult for them to function normally, it becomes a disorder [1] [2] [3]. Anxiety disorders are the most common psychiatric disorders in the world. In the European Union alone, 69.1 million people of all ages are affected by it (year 2011), with females being more likely to suffer from an anxiety disorder [4] [1]. Social phobia alone affected 6.7 million people in 2005 and 10.1 million people in 2011 (in European Union), making it a serious and growing health challenge.

People with social anxiety disorder can fear or even avoid social interactions and situations where they could be observed or judged by others [5]. The onset is mostly reported in late childhood or young adolescence, with mean age between 15.1 to 16.5, but could also have a peak at a younger age (younger than 5 years old) [19].

The symptoms can be very broad, however it mostly centers around the fear of performing in front of others, situations where you can be observed eating or drinking, meeting new people, social situations, public speaking, or using public restrooms. People with social anxiety are constantly worried about being negatively evaluated or embarrassing themselves (which could also be a starting point for an anxiety) [5] [1]. During diagnosis it is important to distinguish those symptoms from other disorders, e.g. avoidant personality disorder (APD) (see Figure 2.1) or depression. The diagnostic measures also vary between adults and children ages 11- 17 [5].

The division of subtypes of social anxiety disorder is not completely clear. A number of studies have investigated the possible divisions. Some distinguish two main subtypes [6] [7]: 'generalized' - where the patient feels anxious about most social situations, and 'nongener-

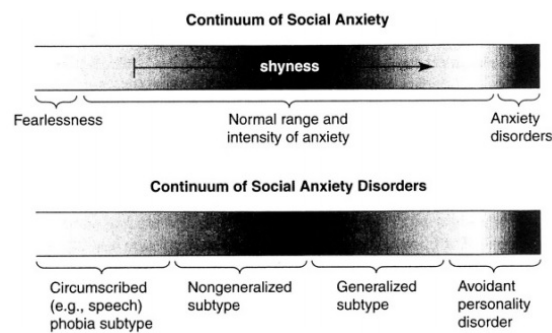


Figure 2.1: Models of social anxiety (top) and social anxiety disorder (bottom).(8)

alized' - where the patient can be affected by a few phobias, however not disabling [6] (also referred as 'circumscribed' [3]). Other studies include the 'performance/public speaking phobia' [1] as a third subtype since it is the most prevalent social phobia [20]. There was also one proposal for a different division [21]: performance type - where the patient is afraid to publicly perform tasks that he/she is comfortable with while being alone (but does not categorize as generalized type); limited- interjectional type- where the patient is anxious about one or two social situations; and the generalized type- most social situations. Nevertheless most of the research suggests that the categorization depends on severity (see Figure 2.1). Starting with one or two specific phobias, which can also correspond to the nongeneralized social phobia, ending with the generalized type. People suffering from the generalized social phobia also tend to avoid the feared situations, resembling the Avoidant Personality Disorder, by some recognized as more severe form of social phobia [7]. There are two main models that present the experience of anxiety for the social phobics: cognitive and cognitive-behavioral model. Both describe the way in which people perceive and process information (or social cues). Those models and the corresponding therapy strategies will be described in more detail in the following sections.

Cognitive Model

The most important aspect of the cognitive model [22] in contrast to the cognitive-behavioural model is that it excludes the 'exposure' as a beneficial part of therapy. To start analyzing the therapy it is important to first understand how the cognitive model describes the social phobia.

The social phobics feel like they are in danger of humiliating themselves, which will result in rejection, and loss of status or worth. As a response to the danger, which is rather imagined and overestimated, the 'anxiety program' starts - cognitive, somatic, affective and behavioral changes take place. The anxiety is a vicious circle, the somatic and behavioral changes cause even more anxiety. The social phobics focus on themselves, monitor all their behaviors and build an impression of themselves based on that, which they believe is also the way others perceive them. The image is highly exaggerated and does not take into account the actual environmental cues (e.g. eye contact with other people). The 'feeling'

equals 'being' - the way they feel must be the way they are seen by others (e.g. if they feel anxious everybody sees it). Given that the relation between the 'perceived social danger' and 'processing of self as a social object' is so strong (See Fig 2.2 by [22]), while the relation between 'perceived social danger' and 'social situation' is not, the everyday experience (exposure) will not bring many benefits in the treatment. Moreover, the social phobics use the 'in-situation safety behaviors'. They would for example rehearse their speech multiple times in order to avoid pausing in speech and therefore keep away from the problem instead of facing the anxiety. The anxiety can start a lot earlier, before they actually enter a social situation ('anticipatory anxiety'). Also after leaving the feared situation they will spend time evaluating all their behaviors, again exaggerating and perceiving it much worse than it was. The reasons why they always evaluate themselves negatively can have different sources: 1) they have too high and impossible to achieve standards for their social performance; 2) they assume that what others think of them (so rather what they believe others think of them) is the truth, 3) they have a certain 'self-schema'- they think e.g. they are weird, they are a nerd. This social-schema is unstable, it is often that social phobics think better of themselves when they are alone or with family, friends.

During treatment it is important that the therapist analyses the feared situations with the patient, makes them aware of the exaggeration and teaches them the process of managing the anxiety. The steps and methods used in cognitive therapy (CT) are as follows [22]:

- 1) '*manipulating safety behaviors*': the therapist needs to identify the safety behaviors of the patient and confront him/her with it. E.g. if the patient speaks fast and is afraid of making a pause, he/she will be asked to intentionally pause during a speech.
- 2) '*shifting to external focus processing*': the patient feels like he/she is in the center of attention, they will be asked to make an estimate of how many people observe him and have that number compared with reality, showing how much it is overestimated. They could also be asked to increase the feeling of being in the center of attention and observe the change in environment, showing that it is actually not true. In order to help the social phobics to shift their attention to others, they could be given 'visual-interrogation' tasks, where they would have to note someone's eye color, mood and fashion sense. For patients who believe their anxieties are visible, it is helpful to use video feedback to "prove" it is not the case.
- 3) '*manipulating self image*': patients can remind themselves about their positive qualities and accomplishments or create a new persona/script that will be used in social situations (keeping in mind that this could become a safety behavior).
- 4) '*testing predictions about negative evaluation by others*': in order to learn that the predictions are false, social phobics can test them in different social situations and observe the reactions, e.g. intentionally spilling the drink, introducing boring topics in the conversation or opinions nobody will agree with.
- 5) '*dealing with the postmortem*': the negative evaluation has to be banned.
- 6) '*modifying assumptions*': the negative assumptions that social phobics have about the feared situations need to be reformulated by the use of Socratic questioning (e.g. "if someone doesn't like me, it means I'm inadequate" can be changed into: "how do you know that someone doesn't like you?")

All in all, the cognitive model and CT focuses on the importance of teaching the patients what the process of anxiety looks like and how they should behave when it occurs. Because

the social phobics do not take into account the environment and do not process the social cues, but are rather self-focused, create a distorted image of themselves, and engage in safety behaviors, the in vivo (real life) exposure alone will not improve their behavior. The brief CT is shown to be more successful than exposure alone (with fluoxetine -an antidepressant, or placebo) where patients are not given any guidelines [23], or the habituation based exposure [24] and also be less costly [23]. It is important to note that in this case exposure means habituation exposure, where patients have to remain engaged in the feared situations in order to adapt. CT still requires a moderate exposure where the patients practice techniques as described above, but it mostly uses exposure to the inner self. This way patients imagine the feared situations and play the scenarios in their head, letting them experience the anxiety but in a control environment.

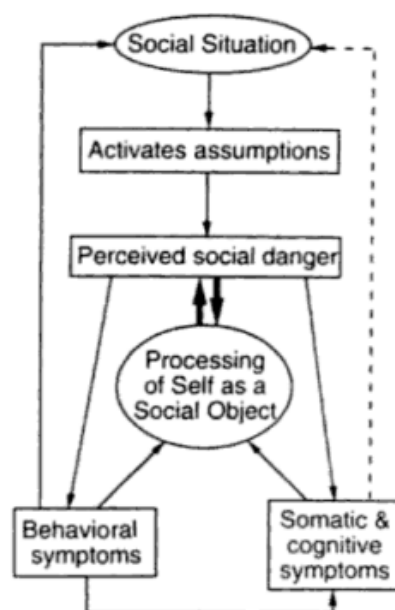


Figure 2.2: Cognitive Model of Social Phobia

Cognitive- Behavioral Model

The cognitive- behavioral model (See Fig 2.3) [25] of social anxiety does not differ much from the cognitive one. Once again, the social phobics construct a mental representation of themselves, which is a distorted image based on what they believe others think of them. The performance is usually underrated, but the 'poor' performance, on the contrary, over exaggerated and very influential in next social encounters. The focus is shifted to monitoring their behaviors and threat, rather than environment. They create high standards for themselves based on their perception of audience and its characteristics (e.g. importance). The model [25] (See Fig 2.3) underlines the importance of 'cognitive restructuring' and 'extensive role plays'. This however has developed further with time.

A paper from 2001 [26] already presents an extended version of guidelines for treat-

ment. Starting with exposure as the central component, where patients have to face the feared situations and remain engaged. Based on a rank list of feared situations, the patient can experience the exposure either by imagination, role playing with the therapist or "going out to the real world" (in vivo). Nevertheless in each case the patient has to remain engaged and fully experience the situation together with the anxiety. The second part is pretty much the same as 'modifying assumptions' in the CT - the patient must recognize the negative thoughts, reevaluate them based on the Socratic questions and create new, alternative thoughts. The third aspect of the CBT is the 'relaxation' treatment, where patients learn to tense and relax certain muscles, so they can understand the difference between the two states and consciously release their muscles when they are stressed. The last aspect is the 'social skills training', where patients repeat and practice different behaviors, social reinforcement and get feedback regarding the adequacy of certain behaviors. This part of the therapy can be combined with cognitive restructuring and exposure, also be done as a homework assignment.

CBT puts an emphasis on repetition of the tasks or learned skills and homework. The homework assignments vary depending on the stage of therapy. The first stage can include self-monitoring (negative thoughts, feared situations), the middle part can add cognitive preparation and exposure, the last would mostly focus on in vivo exposure. While the first part's compliance does not influence the outcome of the treatment, the last is strongly correlated with the success of treatment. The middle part can increase the anxiety, as it introduces the exposure. However this correlation can be due to the fact that patients who are committed to the treatment will move past that initial stage of fear and make overall progress [27]. Therefore it is important that they do not lose motivation.

All in all, CBT is a combination of CT [22] and exposure or, to be more precise, cognitive restructuring and exposure. In order to practice the cognitive restructuring the patient has to be exposed to the feared situation to some extent, so that he/she can apply the knowledge and fully understand the mechanisms. The exposure has to be increased gradually- starting with exposure to the inner self, then 'in therapy' and later in vivo. Since social phobics are afraid of their fears rather than actual situations, it is important that they learn how to overcome them and not necessarily change. The evaluation of tasks and exposure is also crucial. Moreover, the patients commitment to therapy plays an important role and homework assignments can be helpful in reaching the goal. In practice it is almost always the CBT that is used for treatment of social phobia either for groups or individuals (with the latter one being more successful) [24].

2.2 Virtual Reality Exposure Therapy

Virtual Reality (VR) is a computer technology, which enables the users to experience a computer generated world and actually feel present in this three- dimensional space. Moreover users can navigate through the space and interact with the VR world. One can say Virtual Reality works because users feel physically present in the virtual world. A study done in

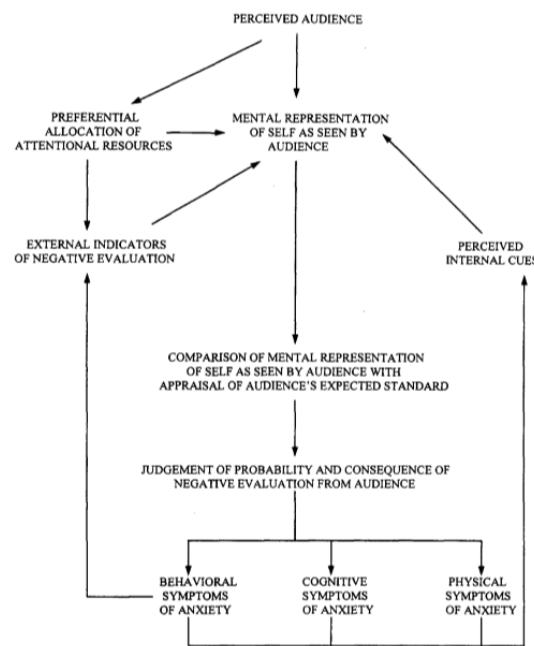


Figure 2.3: Cognitive- Behavioural Model of Social Phobia

1994 [28] already gives an interesting view on what defines this sense of presence. The three dimensional axis includes: 1) '*Fidelity and extent of sensory information*' - quality and quantity of information that is available to the user. 2) '*Consequences of participant's actions*' - how the user can interact with the environment. 3) '*Gestalt of the participant*' - participant's own perception of the world, which then reflects on the perception in VR.

Newer studies [29] on presence include more factors, such as *realness* - how much the virtual world resembles the real one. The attention users pay to the virtual world is also very important and therefore any feedback given during the exposure should be incorporated into the VR experience, using for example headphones or on-screen instruction. This separation between the real and virtual world allows for better immersion. It is however arguable whether or not the sense of presence has an influence on experiencing the anxiety. While some researchers believe it is necessary [29], [30], others do not find a correlation [31], [32]. Nevertheless the avatar's (virtual character's) behavior does influence the users. Not only the distance with the avatar [29], [33], but also sex and gaze are of importance [33]. The dialogue with avatars -positive/ negative replies- can work as a stressor and help to control the anxiety levels [34]. Overall, the higher phobics experience higher levels of anxiety during the exposure [30], [34], [35].

VR in treatment of phobias

VR is becoming a popular tool for treatment of different phobias. It has been proven to be successful in treatment of different psychological disorders - social phobia, post traumatic stress disorder, autism, OCD and even eating disorders [36]. It shows some advantages over the standard CBT treatment, however real comparison between Virtual Reality Expo-

sure Therapy (VRET) and other treatments is difficult to conclude. Some studies show it is superior to other treatments [37]–[39], while others do not find significant difference [11], [16], [40]. Nevertheless, VRET has certain characteristics which can make it better than real life exposure. First of all, VR exposure provides stimuli for patients who might have problems imagining the situation themselves and it is an easier starting point for the therapy. The exposure is more safe and cost effective [37]. The environment is controllable, can be adjusted to the patient's needs, allows to repeat the given tasks and also recreate real- life situations. It leads to not only a better suited therapy, but also gives a deeper understanding of the patient's phobias since the therapist can observe the patient's behaviors and reactions in the exact situation. Some studies show that it might encourage patients to get treatment, but it could also lead to avoidance of real- life situations [38] since the exposure in VR still feels more safe than the real world.

Virtual Reality Exposure Therapy (VRET) has been used in different research. Specific phobias in VR are studied most often, with public speaking phobia as the main one for social anxiety patients. Some therapies focus solely on this, creating environments with a virtual podium, where the patients can give their speech [8]–[10]. The audience used in the VR system is often a pre-recorded video of real people, implemented in VR [8], [9], [11], [12], [14]. Reactions of the audience are also standardized and can vary from neutral to positive or negative (interested or bored). The therapist can control the audience's reactions during the VR exposure [8], [10]–[12], increasing or decreasing the level of difficulty of the exposure. This way the exposure can happen gradually, according to the patient's ranking of feared situations. The therapist in this case is the control person of the system and can also communicate with the patient or even encourage him/her to stay in the feared situation [8], [9]. This gives a lot of freedom to adjust the therapy on the spot, however the scene can also include pre-made scenarios, where the reactions are decided and recorded beforehand.

Some studies on VRET combine public speaking with more feared tasks related to it, like entering the conference room, taking a seat at a table or introducing yourself. This kind of exposure is already more general, yet still aims at the problem of public speaking. These therapies are more tightly related to the standard CBT treatment and involve more cognitive tasks in addition to the exposure [10]. The first one is cognitive treatment, where the cognitive model of social phobia is discussed and analyzed with the patient; then the rationale for cognitive treatment, cognitive restructuring in sessions, and homework. The second one is behavioral treatment, where behavioral model of social phobia is discussed and analyzed with the patient; rationale for behavioral treatment; graded behavioral exposure (imagination in CBT or virtual environment in VRET). In this case VRET is also referred to as VRCBT, since it includes more therapy components than just VR exposure. The 12 session therapy seems to be useful when introducing more complex VRET with CBT [10], [11], [16]. The first study [10] used VRCBT strictly for public speaking. The structure of session was as follows:

session 1: description of the therapy, determining the participant's anxiety reactions, treatment contract, building anxiety hierarchy, treatment rationale and assigned homework (recording the feared situations, reactions - thoughts and emotions).

session 2: revision of homework, explanation of automatic thoughts, training on thinking

errors, homework (same as session 1, but also including thinking errors).

session 3: revision of homework, taught disputation on automatic thoughts, building rational responses, homework (same as session 2, but the patient also has to train disputing negative thoughts).

session 4-11: the 4th session still includes revision of homework, however all of the following ones focus on the exposure and preparation for it. First the feared situation is chosen from the hierarchy, then patient and therapist identify the automatic thoughts, thinking errors, dispute and develop the rational responses, rate the degree of belief in those responses and automatic thoughts. All of this is then used during the exposure, followed by evaluation of this process.

session 12: summary of the treatment and techniques.

The other study [11], [16] used similar 12 session structure in order to deal with patient's performance anxiety, assertiveness, intimacy and scrutiny. The goal of this therapy was also to teach the patients new cognition and behaviors, including more social aspects than just public speaking, like being respected, protecting one's interests, or interacting in formal and informal setting. The structure of this study, however, remained the same in all of the sessions, excluding the first introductory session and additional conclusion in the last one. The same VR exposure was repeated in two consecutive sessions. The even sessions started with introduction and clinical interview, combined with the VR exposure for assessment, homework and conclusion. The odd sessions included results of the tasks in the introduction and two VR exposure therapies, ending again with homework and conclusion. In this case, the VR exposure was also divided into stages: 1) the "assessment phase": the first experience in VR, where the therapist notes the patient's reactions in the cognitive domain; 2) the "spontaneous" phase: the patient can explore the VR and decide upon own actions; 3) the "instructed" phase: the therapist instructs the patient about reaction and behaviors relevant to the current situation, helping to adapt the behaviors, cognition and emotions.

The virtual environments built for this study also correspond to the different aspects of treatment, rather than the environment setting itself. In other words, each environment is built to support a certain part of the therapy, where behaviors and cognition are trained. They are divided as follows: *Training*: getting familiar with the VR, using joystick or keyboard - three rooms with tables and chairs, bed, pictures, plant. *Performance* : speaking in a conference room; the patient has to first enter a room with people (pre-recorded real humans), take a seat and introduce him/herself and then move to the presentation. *Intimacy* : informal setting with friends and neighbors; the patient has to make contact with the virtual humans (pre-recorded real humans) all gathered in one room, introduce him/herself, speak about the room and later on answer questions from the guests. *Scrutiny* : the patients needs to walk to a coffee shop, while all people are looking at him, look for a friend and place to sit, fix a mistake in the bill. *Assertiveness* : patient needs to get to his apartment in a building, facing different obstacles- people on the way, shop assistants repeatedly trying to sell him products etc. The goal is for the patient to learn to fight for his/her interest and be respected.

Other studies done on VRET do not include the CBT part and focus more on the exposure alone. The studies include virtual environments like the London underground and

a wine bar [13], party [14], bus stop, train station platform, clothing shop, and a reception desk [15]. There are no exact tasks given or procedures to follow in the VR, but the patients are rather supposed to experience habituation. In some cases the instructions are for example "start a conversation", "interact naturally" [13], [14]. Others include more precise directives with questions that need to be asked (e.g. which bus to take, when the train arrives) [15]. In the environments where the users can interact with the avatars, most of the time the therapist is a Wizard of Oz, choosing the pre-recorded replies of the avatars. This is however a difficult task and causes a lot of delay during the exposure. On the other hand it can make the interaction more personal and allow to really steer the conversation. The responses and behaviors of the avatars again differ - neutral, positive, negative. It is important to note that in this case mostly computer-generated avatars were used [13]–[15].

2.3 Serious Games

The gaming market has been enormously successful for many years. The sector of serious games is a multi-billion dollar industry and is still growing [17]. Serious games have developed from the educational programs and are also used in more serious contexts: healthcare, engineering, military and more. Because of their origin they are overlapping with other domains, like e-learning (distance, computer-based learning), edutainment (education through entertainment), game-based learning (type of serious games, which has a specific learning goal), and digital game-based learning (similar to game-based learning, but involves digital games). The definitions of a serious game vary, but the common denominator is that they are used for more than just entertainment [17], [18]. The important aspects of serious games are [18]: focus on problem solving, importance of learning, simulations are made based on certain assumptions and reflect natural communication. While entertainment games focus on a fun and rich experience, serious games are much more 'task' oriented. The simulation has to be thought through and assumptions correct in order for them to help reach a goal. The player needs to make conscious choices - there is no place for randomness. The natural communication and context are also important - learning in context is more effective. The sector of healthcare has been using serious games for a number of purposes and has the following classification [18]: *Education*: teaching nutrition, healthy eating, self-management skills to deal with disease, training for nurses [17]; *Physical fitness*: promoting healthy habits by e.g. dancing; *Training and simulation*: surgical training; *Recovery and rehabilitation*: helping and speeding up recovery; *Distraction therapy*: distracting patients from the pain/disease; *Diagnosis and treatment of mental illness*: used for e.g. ADHD, PTSD; *Cognitive functioning*: training memory, developing analytic or strategic skills and more; *Control*: monitoring the person's state and helping them to recognize and control certain mental states.

Others provide more broad taxonomies [41]: preventive, therapeutic, assessment (self ranking), educational, informatics (personal health records).

Games and serious games are often confused with 3D technology. While some believe

that not everything that uses game technology is a game [18], others classify VRET as a game [42]. There are however certain aspects that could differentiate standalone VR exposure with a game version of VRET. Games can be described based on the following dimensions [43]: *Fantasy* - context and themes in the game environment. Fantasies tied more closely to the learning content are better for motivations - interesting fantasy also makes the learning part also interesting. *Rules/goals*- well defined, hierarchical goals lead to bigger motivations. Clearly defined rules allow the user to find him/herself in the game world. The rules should be flexible enough to allow different game outcomes, giving space for the different types of players. The rules can be: system rules- rules of the game world; procedural - actions users can take; imported - ones that users import from the real world, common sense. *Sensory stimuli* - stimuli that brings the players to the game world, it can be visuals or audio that grab the attention. Dynamic graphics help to keep the users motivated in participation. *Challenge* - Game should have an optimal level of difficulty, not too high, not too low. It can be achieved by: increasingly difficult levels, clear goals relevant to the user, possibility of different outcomes, or feedback. *Mystery* - the user's curiosity has to be properly stimulated, both the sensory and cognitive aspects of it. It could be different visuals or audio; limited amount of information, complexity, surprise, outcomes different than expectations. *Control*- Games where learner has the control are more motivational and have better learning outcomes than games where the program is in control.

Serious games for personal healthcare aim to make a change in the user's behavior and get the users engaged in the process. This can be achieved using various methods, like adding points or feedback. The 'score' method is very common, but can bring some problems as the users realize the points are irrelevant and lose interest after a while. The other problem might be to make sure that the players play by the rules and not find loopholes in the game, in order to achieve good scores. The other challenge is to keep the users engaged also after the game. While it is easy to keep them motivated during the game, what happens afterwards? McCallum [41] argues that the serious games that are developed for healthcare are mostly poor quality from the game perspective and there is need for game designers to be involved in this development process. One can say that the previously mentioned confusion between games and 3D technology can contribute to this perceived poor quality of games. Another issue is that gamification of a certain health issue can trivialize the problem. Games allows the users to take bigger risks than they would normally do and also provide more freedom, which therefore leads to lowering the possible fear or seriousness of the task. In the case of social phobia it might be a good thing, but only if it translates to the 'real world' afterwards. As was already noted, motivation and engagement are crucial aspects of a serious game. People who are more motivated are prone to engage more in the game, which can also lead to being in a 'flow'- state where the player is so involved that he/she is separated from the outside world [43].

There is an impressive amount of serious games available on the market. Each with a different goal and approach. The first example is part of the 'distraction therapy' [18], where the patients can use the VR technology to experience swimming with dolphins (a 360 video). *The dolphins swim club* (www.thedolphinsswimclub.com) is not necessarily a game,

yet it is an interesting and very trending form. Even though the makers call it "a healing VR experience", it does not include any form of therapy or intervention.

The *S.M.A.R.T. BrainGames* (www.braingames.com) combined the standard Playstation games with neurofeedback, where the user's EEG was measured to help train awareness of mental states. This idea was used to improve the focus of children with ADHD. They have used games like Pac-Man, where e.g. by concentrating the user could make the Pac-Man move.

Full Spectrum Warrior could be called the most successful game developed for treatment of mental illness. Designed for the U.S. Army, the game was aimed to train the soldiers, but was also adapted for treatment of post-traumatic stress disorder (PTSD), to help the veterans from Iraq. This project was released for Xbox, Microsoft Windows and Playstation 2 in two versions - one that could only be accessible for the army, and a commercial one for everyone. The game included an extensive plot, with a full background story and missions.

The challenger app is a phone app developed for social anxiety patients [44]. It challenges the users to complete different tasks in their real environment, aiming to improve their social skills. Users with mild SAD can use the app alone, while patients with more severe symptoms are advised to use it together with a therapist. The app allows to set different goals, challenges and personal rewards. The users can then track their progress and write reflections. It includes various techniques to enhance the experience: activity tracking, location tracking, reminders, anonymous social networks, generic digital footprints (e.g. likes), and psychoeducation.

All in all, the game based approach can help to change the user's attitude towards the problem and see it in a different way, e.g. as a challenge they can face. Many serious games have been already developed in various domains, a lot of them with purpose of educating (Studies show that users enjoy the game-based approach in learning, but this claim needs more investigation [45]). A lot of them also use 3D technology, focusing strongly on the simulation (e.g. *The dolphins swim club*) and not the game structure. There is some confusion about this - some say that it can be a simulation of a real-world that resembles a game, but does not necessarily focus on the game aspect, while others propose a distinction between games and simulations that only use the game technology [18], [42]. This might be the biggest issue with using the word 'game' to describe VR applications. Many projects use some game aspects, like giving feedback on the accomplishments [46] [44], but this is more a collection of game features, rather than a fine tuned game. *Full Spectrum Warrior* is an example of a well developed game for treatment of PTSD. It is important to note how big of a project it was and what parties were involved in the development.

2.4 Conclusion

The selected literature already shows how important the topic of social anxiety is and how promising new technologies can improve the treatment. This part of the document gives a

short summary and conclusion on each of the analyzed subtopics.

Social anxiety, just as most of the mental disorders, is a very complicated and unfortunately common problem. The symptoms and the way patients deal with them are very broad, depending on the exact fear. Overall, social phobics are very self-focused, they do not process the environmental cues, but only think of themselves. This leads to them building their mental representation of themselves, which is exaggerated and based on what they think others think of them. They are sometimes afraid of their fears, not necessarily the exact situation and might engage in safety behaviors. The most common treatment is the Cognitive-Behavioral Therapy with a strong emphasis on exposure, where patients can test and practice new cognition.

The need for exposure is why Virtual Reality is becoming so popular in the sector of mental healthcare. The feeling of presence and immersion in the virtual world allows for the patient to experience their fears as if in real life. Research has been done on the topic of anxieties in VR, with the fear of public speaking as the most common one for the social phobia. The more generalized type of social phobia is not reported as often, given the complexity of this disorder (there might be a number of different fears, all very personal).

Another 'tool' that could be interesting in treatment of social phobia are serious games. This approach has already been used in healthcare for educational purposes, physical fitness, rehabilitation and more, but not yet in context of social phobia. The other use cases, however, make it a very promising concept. Serious games for personal healthcare aim to make a change in the user's behavior and get him/her engaged in the process. Given the social phobics tendency to avoid the exposure or their fear (safety behaviors), it is important for them to stay in the situation.

All in all, the therapy for social phobia could be improved using new technologies. Virtual Reality has already been proven to be as effective as CBT, but beside that introduces new possibilities for the controlled exposure. The exposure to feared stimuli is the core of the therapy, where patients can learn how to manage their anxiety. Additionally game elements could help to make the VRET more attractive and help the patients to stay engaged. Especially when developing applications for generalized social phobia, game aspects could help to better utilize the same VR environment or situation, by telling a different story or setting another goal. This could make the exposure more interesting, while decreasing the amount of work put into developing the environment itself. Moreover the challenge set by the game can give the user satisfaction of reaching a goal. This is why this project aims at combining the VR and game elements to design a system for exposure treatment for generalized social phobia. This type of social phobia has not been widely addressed in the existing applications, making it difficult to reach a broader audience. The environments developed so far are mostly focused on one particular issue, and the designed scenarios limit the possibilities for treatment. Moreover, the studies done with VRET so far only tested whether the anxiety levels change, but did not take into the account the user experience. In this project we take the user- centered approach to design a system that will be suitable for both patients and the therapists.

Scenarios

In this chapter we aim to determine what tasks could be implemented into the VRET application, and how the difficulty of those tasks can be manipulated. We started by identifying the core of generalized phobia and the main goals of exposure therapy, based on the literature presented in chapter 2. This representation served as a basis for 3 scenarios of implementation, which are presented below. All of the assumptions were later discussed in an interview session with the therapists.

3.1 Design

Based on the literature review we tried to identify the core of generalized social phobia. The most important aspect seems to be the fact that social phobics in real life situations are very self-focused, they do not process the environmental cues, but only think about themselves. This leads to building mental representation of themselves, which is exaggerated and based on what they think others think of them. They are often afraid of their fears rather than the exact situation and might engage in safety behaviors that will help them overcome or even avoid the stressful scenarios. They underrate their good performance or success, but exaggerate poor performance. In treatment, given the social phobics self focus, it is important to redirect their attention to the task or others/environment. If they also focus on the task or other person, the anxiety symptoms and self evaluation can drop. On the other hand when they focus too much on others they might again start analyzing that persons reaction in a negative way. For example: he is yawning, he must be bored by what I am saying. If they shift focus to the task, they might imagine all the possible way, in which they could fail during that task. This is why a balanced distribution of attention is very important during exposure. This attention distribution (See Fig.3.1) is the core of scenarios presented below, and each one shows a different approach to that problem.

The first scenario (See Table 3.1) focuses on redirecting attention from self to environment (other), while also overcoming safety behaviors. In that case the safety behavior is where the patient is staying close to the door, to (hypothetically) be able to easily escape a fearful situation. The task in this environment is to walk round the virtual bar and gather abstract objects hidden around the place, which correspond to points the player collects.

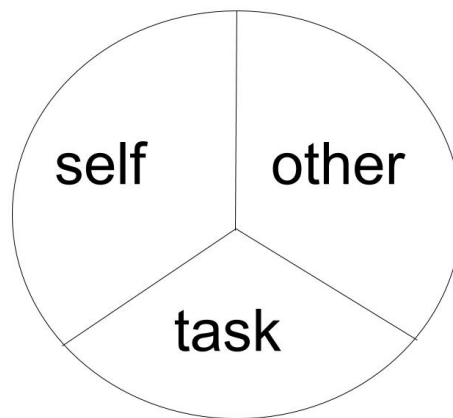


Figure 3.1: Attention distribution.

The object's value depends on where it is placed - the one's further away from the door, or are hidden behind a crowd, are worth more points. Additionally, the difficulty can be increased by making the bar more crowded, or having more avatars gazing at the user. The final feedback is a collection of points and a graph of the changes in user's heart rate (so the experienced fear). Overall, this scenario introduces a playful task that allows the user to explore the space freely, while at the same time motivates to face the fears by rewarding the user with points.

The second scenario (See Table 3.2) is a translation of a common task used during therapy sessions, where the patient needs to interact with the therapist and remember as many details about the story the therapist told, or their physical appearance. Therefore the focus here is to redirect the attention to others. The user would have to hold eye contact with an avatar, whose attitudes can differ depending on the level of difficulty (e.g. friendly, annoyed, bored). In the end the user needs to answer questions about the avatar and gets points for correct answers. The final feedback shows the amount of points and heart rate changes, as well as the amount of time user spent looking at the avatar.

The third scenario (See Table 3.3) aims to redirect attention to the task, which in this case is writing a text on a white board. The performance anxiety, like writing, drinking, or eating on front of others, is pretty common. In this scenario the user would have to write a given text, while avatars are looking at him, and can get points depending on the amount of written text. The difficulty here can be changed by varying the amount of avatars paying attention, or including comments from the avatars. The user is shown a their final rank based on how much text was written, combined with heart rate changes.

Scenario 1

Goal	Redirect attention from self to environment and overcome safety behavior (staying close to the entrance)
Environment	Bar, public space
Task	Walk around the place and collect objects hidden in different parts of the room. Some objects are placed next to a bigger group of people. Some objects are hidden further in the room, so patient needs to go away from the entrance
Points	The parts that are further away from the door could have more points (so that they need to get further away in the crowd) or they are in a more crowded part of the room
Difficulty	Place getting more and more crowded; more avatars gazing at the user
End Feedback	Points from objects collected (e.g. 10/13), heart rate over time

Table 3.1: Scenario 1Scenario 2

Goal	Redirect attention to others
Environment	Bar, public space
Task	Try to look the avatars in the eye. The avatars will turn to the person so you can return the eye contact. At the end you get asked questions about the avatars details - their eye color, special marks, hair color etc
Points	Number of features remembered
Difficulty	Avatars attitude can change, some will have more pleasant facial expressions, some will look more annoyed or bored
End Feedback	Rank based on how many features the person remembered; how much they actually looked at the person and focused on them, not themselves; heart rate

Table 3.2: Scenario 2

Scenario 3

Goal	Redirect attention to the task
Environment	School, workshop
Task	Write text on a whiteboard
Points	Amount of text written
Difficulty	User can see avatars looking at the whiteboard' more avatars paying attention; avatars commenting
End Feedback	Rank based on how much text was written; heart rate

Table 3.3: Scenario 3

3.2 Method

Since the topic of social phobia is very broad and there are many available treatment strategies, we have prepared a series of semi - structured interviews. The goal was to gather more information about the core of social phobia and, most importantly, treatment techniques that can be later on applied in VR. After the general question, the initial scenarios were verified by the experts. The scenarios were included in the interviews in order to get out of the abstract phase of discussion and evaluate concrete designs. The interviews started with a short introduction on the topic - VRET for generalized social phobia. Then the interviewees were asked to introduce themselves- what is their specialization and whether or not they have been treating social phobia patients. After that the first part of the discussion began, which were the open questions. In this part experts were asked about general social phobia problems, what the treatment looks like (especially the exposure and tasks given there), what are the safety behaviors and more. The goal of this part was to get as much information as possible, not biased by our approach or possible implementation. In the second part of the interview the scenarios and approach were discussed. The interviewees were shown the attention distribution diagram (See Fig. 3.1) as our main focus on the treatment and then the scenarios were explained. After each explanation the experts could give their opinion, hints or own ideas. Lastly, the options for feedback on the patient's performance were discussed once more, since it is an important part of the desired game like structure. The complete protocol of the interview can be seen in Appendix A

3.3 Results

A total of 3 interviews were conducted, each one of them lasting for about 45 minutes. All of the interviewees were male employees of University of Twente, who beside their work in academia are practicing psychologists. They all had experience with social phobia patients and CBT treatment.

The results were based on the notes and recordings, which were later summarized. The first part includes information about the interviewees, the second part answers to the open questions, the third feedback on scenarios, and the last one overall summary of the most

important information. This detail analysis can be found in Appendix B, while in this chapter you can see the summary of each interview. The information is selected based on the following criteria: (1) what the interviewee has reported during the session and stressed as the important aspect of the phobia or treatment, (2) what information was a new addition to the literature-based knowledge, (3) what information confirmed the assumptions made prior to the interview.

Interview 1

The first interviewee is a psychologist in Community Mental Health Center, working on anxiety disorders, mood complaints, with main focus on panic disorders. He has a bit experience with social phobia patients, did CBT.

Part 1: Open questions.

Social anxiety patients direct the attention inside, they do not interact with others, and do not pay attention to what they want to convey. The safety behaviors they engage in might be not looking someone in the eye, concentrating only on one person or one thing in the room, carrying 'distractors' (water that they can drink to calm down or medicine). The treatment has two components: task concentration (shifting focus) and cognitive restructuring (change of negative thoughts). The task given in vivo starts with first them joining the social situation at all and then slowly increasing the difficulty (number of people), while they have to interact with others and remember what they said. Then the patients write about their experiences in a diary, which are later discussed with the therapist. The breathing exercises can be used only with people who want it. Patients set goals themselves, it is important that they see progress because it helps them to stay motivated. The treatment can include a reward system - anything the person likes, e.g. ice cream.

Part 2: Scenarios.

Scenario 1 and 2 are good, but it should focus on the 'helping thought', the things that are going well. Maybe the avatar can have some critique for the patient, so they get used to it. For Scenario 2 it would be nice if the avatars change their attitude and can be more negative (would be nice to include conversation) but still end nicely to teach them that some people might be less welcoming, but it does not mean they hate them and the conversation/interaction can still be good. Possible environments: shop, gallery, theater. It would be nice if users could choose the environment. Regarding the last scenario, it is the drinking phobia that is the most common, rather than writing.

Part 3: Measurement and Feedback.

Heart rate can be used in a personalized way, because everyone is different. Some might not want to see their heart rate, some might want to evaluate it (some might want to see it right away - live stream). It could be a personalized feature, together with the breathing exercise.

Part 4: Final Reflection.

According to the first interviewee it is very important to include the 'positive thought' in the process of treatment. It could be a simple 'you can do it' or another part of cognitive re-

structuring. The same rule holds for the feedback that could be given to the patient. There should be a positive encouragement and evaluation of the progress (e.g. 'look how much you already achieved').

Interview 2

The second interviewee is a Healthcare psychologist, working with anxiety and mood complaints patients, who are referred to him by general practitioners. He did CBT with social anxiety patients.

Part 1: Open questions.

Avoidance is a big issue with social anxiety patients, so they simply do not attend social situations. However if they do attend, they get too anxious, feel dizzy, sweaty and they get afraid of those symptoms, making it hard for them to stay in the situation. The safety behaviors are often connected with the specific fear, e.g. if one is afraid of blushing, they might use more makeup. The treatment consists of task concentration, cognitive restructuring and exposure. Patients need to make a list of feared situations and start with the easiest, going to a party, talking to a stranger, going to a shop and asking info about products, asking critical questions about products, interacting online. It is better to practice in as many situations as possible, so they learn how to handle the feelings and don't attribute their feelings to one situation. Explicit rewarding seems a bit childish to some patients. It is more important to pay attention to accomplishments than focusing on rewarding. VR generally is helpful, because patients can practice in a safe environment. It would be especially helpful to work on situations that are difficult to manipulate - people being critical or angry at them, or neglecting them.

Part 2: Scenarios

The first scenario has a diagnostic value - how high avoidance is, what are physical symptoms. When doing the task concentration training you train under different conditions. So first the patient has on focus on himself, then on the environment or task. The second scenario is better for exposure. It might be easier to use the exposure theory to work out in VR: fear goes up and after time it goes down. The task you give them is to help them to stay in the situation and overcome this fear. For scenarios 1- the items to collect can be on eyesight, or closer to a bigger group. Regarding scenario 3, the anxiety to write is not too common, but trembling or placing a signature might be a thing, but only for some people. Trembling is a problem, but it is not the main anxiety. Drinking, eating, or being in situation where others drink, they only hold a cup or spoon - this might already be difficult for people (they do not even have to drink themselves), it could be in a VR restaurant

Part 3: Measurement and Feedback.

The most important is that patients are proud they stayed in situation and they get compliments. The heart rate will fluctuate over time so might be difficult to display, but the mean score can be collected and compared between different sessions. For exposure it is important that people learn that they can stay in the situation, that it is not a problem to feel anxious, but the avoidance is. It is however not a problem if the patient stops the exposure when they feel too anxious, but they need to get back to exposure. So reward them for stay-

ing in the situation

Part 4: Final Reflection.

The second interviewee had a preference for the first scenario, especially if the elements to collect are influencing the users behavior (so placing it on eye level etc). It could also be combined it with focus shift exercise. To keep patients engaged in CBT one need to advertise what they gain if they complete the task and give importance to accomplishments. Having a display with their heart rate or other scores might make them feel like they did not succeed, while already staying in the exposure should be rewarded. VR should be used in with assistance of the therapist.

Interview 3

The third interviewee is a Mental health care psychologist, mainly working with people with severe personality disorders, severe trauma. Little experience with specific social anxiety patients, but many patients he sees also have social anxiety.

Part 1: Open questions.

Social phobics tend to be negative towards their performance. They are ashamed of who they are and what others will think of them. In reality most patients with SAD also fulfill criteria for avoidant personality disorder. In reality there are no clear boundaries between those disorders. Safety behaviors are to distract or comfort them, like a cell phone they always carry around with them (to play with it or talk to friends if they feel anxious). The treatment starts with education on disorder (how it works and why do they get tense), followed by cognitive treatment (starting with learning how to monitor their thoughts and later learn to test their cognition/thoughts; what would people think of them). This is followed by exposure. Sometimes the middle step between in vivo can be the social skills training with a group of 6-8 other patients. The tasks in exposure depend on the situation the patient has an anxiety for. You need to gradually increase the stress. Together with the therapist they later discuss how it went, based on the diary/experiences, but also a form filled in before the session. To keep the patients motivated, try to select several steps that are increasingly difficult - start with the simple ones and go up (using the list of fears). You need to be very precise with those steps, not to discourage them. The small successes on the way are what keeps them going. Some patients can set a reward/punishment for themselves, but it is a personal choice. The relaxation techniques are also a personal decision.

Part 2: Scenarios

The first scenarios might be more suitable for a panic disorder or agoraphobia, rather than social phobia. The difference with social phobia is the social interaction, so if they would have to interact with the avatar. The second scenario resembles the task that is done in CBT, so the nice VR addition would be the different attitudes of the avatars.

Part 3: Measurement and Feedback.

The evaluation or grading might be perceived as a social evaluation. Instead it should go into how well they did, that they managed to stay in the situation. For the heart rate, an interesting feature could be that if you see a certain rise on the level, the system could give

some soothing thoughts, not their heart rate levels. So the actual heart rate value is hidden and the values are used to adjust the system in the background.

Part 4: Final Reflection.

The last interviewee prefers the second scenario. It is more person focused, there is more interaction which the first scenario lacks. Beside that he has stressed the importance of increasing the task difficulty very gradually, not to discourage the patients.

3.4 Discussion

The interviews brought interesting insights to the topics of social phobia and the therapy. The real life examples allow for better understanding of the topic and are a crucial addition to the literature review. Overall the therapists agreed with the presented approach to attention allocation and confirmed the initial interpretation of social phobia. Moreover one of them expressed how similar the symptoms might be to avoidant personality disorder, where the safety behaviors are also very common. It is therefore important to address those in the final application.

From the shown scenarios, the first one was rated as the most fitting. It not only allows for the patient to train the initial interactions, but the therapist can also assign more tasks within that scenario (like reallocating attention within the situation). The difficulty can be easily adjusted by for example positioning the objects on avatar's eyesights, or changing the avatar's attitude towards the user. The latter one is very important to implement, to make sure there is enough variation in the social interaction, which overall needs to be strengthen in that scenario. This could be done by for example including a dialogue between the user and avatar. Lastly, this scenario might be more appealing to the patients, since it has more 'fun' or 'game like' aspects. It could also be fitting for patients with agoraphobia or panic disorder.

The second scenario was confirmed to be a direct translation of an exposure task given in session. To make sure the VR brings any advantage over the standard exposure, this scenario should include the changing behaviors of avatars. However, overall this scenario does not stand out as a new addition to therapy that could give space for both therapists and patients to train differently than is done now.

The last scenario was not received well, as this exact problem is in practice less common than initially expected.

Another important part of the given scenarios was the end feedback, which would inform the user about their progress. All of the interviewees agreed that feedback at the end of the game is a rather risky choice. While some might want to get more details about their performance, most of social phobics will take it as yet another judgment of their persona. Therefore, we need to use different methods to encourage the patients and help them stay motivated.

Overall, each interviewee had a slightly different approach, or simply underlined one specific problem. First one is to focus on the positive thought and encourage the patients

to proceed in the treatment and think positively. The second one is to pay attention to all the accomplishments of the patients and show them what they can gain if they continue treatment. The third one is to be very precise with gradually increasing the difficulty of exposure, not to discourage the patients.

Based on those observations, the first scenario was chosen as a baseline for next iteration. The simple task of collecting elements can be a good step for the first interaction in VR exposure. It can be beneficial for variety of patients, also those with agoraphobia or panic disorder. Moreover, it can help to overcome safety behaviors, very common for avoidant personality disorder. However, this scenario requires more social interaction with the avatars to be fitting for generalized social phobia. Additionally, the game aspects need to be adjusted to this group of users. The focus need to be shifted to the positive aspects of performance and play, rather than judgment of current performance. All of those points will be addressed in the design phase of the next iteration.

VR Prototype

As a result of the interviews, the first scenario was chosen as a baseline for the prototype. This means that the core of this game is a task of collecting objects hidden in different parts of a virtual environment. In this section we 1) chose the game elements, including the difference in difficulty between the levels, 2) designed the interaction between the user and the avatars. The design was then implemented into the Unity game engine and we used HTC VIVE headset for the VR experience. The prototype was later tested with two of the therapists who participated in the first iteration.

4.1 Design

To make the right design choices we need to first decide on the context of use for this application. This system is intended to be used under a supervision of the therapist as an integrated part of a therapy. This means that it will be used during a session, where the therapist can start with the standard therapy protocol, explain the exercise, and then move on to the exposure task. The therapist should be able to adjust the game to patient's needs. While the patient is wearing the VR headset and playing the game, the therapist can monitor the process - both the patient's movement and what he/she sees in the VR. After the exposure is done, they can both discuss the process.

The goal of this scenario is to redirect the attention from self to the environment and the task (See Fig. 3.1). This is why the patient has a task of collecting hidden objects in a virtual bar, while he/she has to face different avatars present in the scene. Those objects will be placed in strategic places, for example in between people, behind a big group, further in the bar (away from the door). This distribution can be random and if there are enough elements hidden in variety of places, there will always be some that cause problems for that exact patient. This task has a role of playfully engaging the patient in the process, motivating to go further in the game, and redirecting attention. Instead of implementing a point system, we focus on adding an instant reward in form of a sound effect when an object is collected. This is due to the fact that keeping score might make the patients feel like they are being judged, while the instant reward celebrates the success without comparing to the ideal outcome. As the therapists expressed in the previous iteration, this scenario might be more appealing to

the patients, because of the playful aspects, but it needs more social interactions. This is why the latter is the main focus of this iteration. The game object (that the patient needs to collect) will be placed in the middle of a group of avatars, but will not be interactive. It will serve as a reference to the whole scenario, and the user will have to approach the group as if they wanted to pick up this object, but the avatars behaviors are the center of our attention. Designing the avatar's behaviors is crucial to make the simulation more realistic. It will not only allow for the scene to feel real, but most importantly the patients will be able to experience and train social interactions with different type of characters. The process of designing the avatar behavior is described in section 4.1.1.

4.1.1 Designing avatar's behaviors

In order to make the scenario believable, but also make a usable platform for training, the virtual avatars need to display different attitudes towards the user. To make this part of interaction natural we start by designing the nonverbal communication between the user and an avatar. The nonverbal cues are the basis of communication and representation of social situations that could make people socially anxious.

Nonverbal signals have a much greater impact than equivalent verbal signals in communicating attitudes to other people

- Michael Argyle

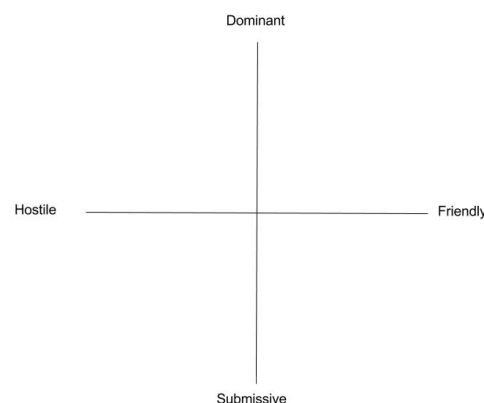


Figure 4.1: Argyle's model of attitudes.

Nonverbal communication is based on sending and receiving different cues, that could convey peoples attitude towards others. Those attitudes to other people are similar to emotions and can be conveyed in various ways (e.g. proximity, gaze). Argyle [47] proposed a two dimensional representation of the attitudes (See Fig. 4.1). In this environment we implement the friendly - hostile scale. Therefore it is important to describe what aspects of social behavior constitute each behavior. According to research already done in this field there are

three main behaviors that can influence the perception of friendliness [48]: positive facial expressions (e.g. smiling), eye contact, and interpersonal space.

The personal space model [49] (See Fig. 4.2) describes distances in which each individual interacts with others. The intimate and personal space is reserved for very close family or friends, the social space is where people interact with most acquaintances, and lastly the public space for other contacts. Those distances are almost fixed, which means people will try to dynamically adjust them, in order to keep the appropriate and comfortable distance.

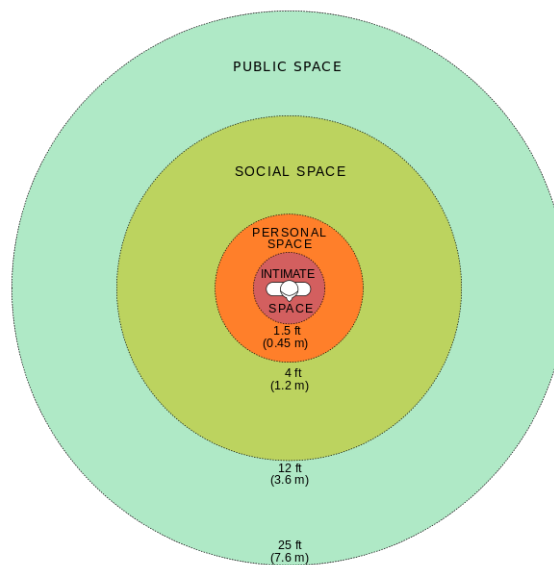


Figure 4.2: Personal space model.

In this project however, the virtual agents will mostly be standing in groups, since this is what usually happens in bars. Therefore it is important to review the general theories on group behaviors. There are few models that describe personal and group space. Human territorial organization [50] defines the space similarly for the personal space model, but for groups. The groups have a nucleus, which is the central zone; the O-space (orientational space); P-space (where the group members are located) and the Q-space for passers by (See Fig.4.3).

As Hall [49] already assumed, people try to rearrange their positions to keep the appropriate distance. The same happens in a group, but in this case the group members try to arrange themselves so that everyone has same access to the common space. This F-formation system also takes into accounts newcomers and will dynamically adjust to find an equilibrium [51]. The research on effects of groups attitude [48] used the models mentioned above to design the groups behavior. They combined the attitudes one can express within a group (in- group attitude) and the one group can express to the newcomer (out- group attitude).

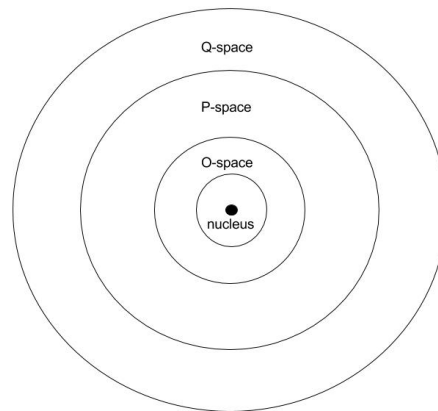


Figure 4.3: Group space.

4.1.2 Implementation

For the implementation of the first prototype we used the Unity game engine and a HTC VIVE. The environment we used for the exposure was a bar, with a total of 7 avatars, of which 3 the user could approach (See Fig.4.4). The group of avatars the user could interact with consisted of two male and one female avatar. The starting point was marked with a virtual and a physical stool. The user started the game standing next to a stool, which had a virtual equivalent in the bar. The space available for walking was only a part of the bar, starting next to the entrance. Therefore the user could not walk up to any other objects than the desired group.

The collectible element in this scenario was a green cube, placed in the middle of the group of avatars (See Fig.4.4). However, the cube was only a mark, showing what this game element could look like, and was not interactive. Instead of developing the interaction with controllers for collecting the object, we focused on the social interaction between the user and the avatars. This decision was made due to the fact that the design of social behaviors for this context of use is crucial for the project, as well as much more time consuming. The option of being able to pick up an object in VR is a matter of technical implementation and can be easily added afterwards, without the need of testing with the therapist in particular.

The behaviors of agents were based on research done by Cafaro et al. [48]. This means we had two basic group behaviors that the user can witness and experience. For now we used the 'out group' behavior, so the one that is presented by the group to the newcomers. In the environment we had groups with two possible settings and responses: 1) friendly: more gaze, smile, makes space in the groups; 2) hostile: less gaze, no smile, does not make space for the user.

To be able to control the agent's behaviors we used the Impulsion library ¹, which allows us for the creation of small groups that dynamically respond to the user based on the theories described above. Each avatar has its own personal space, but is also aware of the group's space and can rearrange positions in this group if another person joins. The avatars are

¹<http://impulsionproject.tumblr.com/>

capable of recognizing the newcomer when he/she enters the O-space, gaze at that person, and if they reach the P-space they would make place in their group to accommodate the new member. The size of the group changes dynamically. In order to design the two different groups (friendly, unfriendly) the function of reacting to the newcomer had to be overwritten. Since the unfriendly group should not gaze at the user to the extend the friendly groups does, we altered the distance at which they recognized the new person (friendly ;1,5m , unfriendly ;0,1m). Those distances had to be scaled to fit in the physical room. Otherwise the avatars would react to the user as soon as they put on the VR glasses (normally the distance is 3,6m), because the room was quite small, and also the cable of the head-mounted display of the HTC VIVE is constraining.

Due to limitations of the Impulsion project the agents used were not expressive, meaning they did not smile. Therefore this iteration only verified the influence of gaze behavior and proxemics.



Figure 4.4: VR Prototype.



Figure 4.5: Gaze Behavior.

4.2 Method

The goal of this experiment was to show a very first, early prototype to the therapists, and get their feedback. During the first interviews we discussed the plans in an abstract way, without any visuals. This is why it was so important to show them more or less what it could look like in the actual 3D environment. Hopefully putting the ideas in context and experiencing the early prototype can help verifying the assumptions we made, before the prototype was fully developed.

The most important things to discuss with the experts are the social behaviors of the avatars and how they respond to the user.

We assume that the friendly condition is easier than the unfriendly one. What we need to know is whether or not those conditions mean the same when used with social phobics. For example, does the high amount of gaze in friendly condition makes the player feel welcomed, or does the gaze make the user more stressed, and actually make this condition the difficult one? There might be a difference in attribution of friendliness and tendency to approach a group. For patients with social phobia it is difficult to make eye contact, which could make the friendly group more difficult to approach than the unfriendly one.

The therapists were able to test the interaction with both, the friendly and unfriendly group. In this session we skipped the game element. However, the element was visible in the environment. The therapists were asked to approach a group and describe how they make him feel, or how they seem to behave. Both participants first approached the friendly group, then the unfriendly one, always starting at the same position marked with a virtual and physical stool. The protocol for the test of first prototype can be seen in Appendix C. Afterwards the experts were interviewed to discuss the following topics:

1. Friendly/Unfriendly scenario - questions asked during/after the scenario.
 - How did this group seem to you? Were they friendly or unfriendly?
 - Do you think approaching such group would be easy/difficult?
 - How do you think you could make it more difficult? Or easier?
2. General questions.
 - How do you like the environment? Is this scenery good for exposure?
 - How did you feel about the groups? Did you see them as friendly/unfriendly?
 - Do you think patients will be able to face this challenge?
 - What would you like to be able to control in this game? Example 1: how long it takes before the patient can collect an element. Example 2: change the gaze/smile.
 - Do you think collecting elements is a good base for the exposure?
 - Do you think you could apply more tasks for the participant in this scenario? What tasks?
 - What do you think needs to be improved?

4.3 Results

Both of the therapists who tested the prototype have participated in the interview session, which was the first part of this project. The third participant from first iteration did not participate in further tests. One of the participants had experienced VR before, the other participant was not familiar with VR. Complete notes from the experiment can be seen in Appendix D

Even though the friendly/hostile conditions were only in the prototype phase, both participants recognized the difference. Nevertheless, they also agreed that the friendly condition needs to smile and turn their body faster towards the participant (not in speed, but they should notice the user from a greater distance). They also agreed that this is a good base for the exposure and that more tasks can be added to those scenarios. Beside that, the hostile group should be standing closer together, so they represent 'one object'. This is more difficult for the patient to approach, since the group seems to be more consolidated and therefore all 'judge' the patient together. To make it even more difficult the group should be clearly engaged in a conversation. On contrary, avatars in the friendly group should be standing further away from each other, making space for the user to join. Although the increased level of eye contact already made the friendly group seem more inviting to one of the participants.

One of the most important questions during this test concerned the controls that the therapists could have over this system. The first participant suggested controlling certain behaviors or actions, like: smile; comprehension - when the patient needs to give a negative response to the avatar's question, or decline an offer; appreciation - thank the patient for a compliment; affirmation - nodding, leaning to listen.

They both expressed interest in some dialogue system, or at least ability for the avatar to respond to some questions (e.g. yes/no answer, nodding). The first therapist preferred for the game to give instructions in VR, as not to distract the user with a dialogue.

Overall the therapists agreed that the division between friendly and hostile group should be clear and steady. This means that (1) we should stick to the standard rules and characteristics, not alter it for social phobics, (2) if the patient approaches a hostile group, all of the behaviors should be hostile (and vice versa for the friendly condition), (3) the 'mix and match' of friendly/unfriendly behaviors could be applied to the personalized treatment, and does not have to be a standard for the application.

4.4 Discussion

The experiment showed that the behaviors designed for the agents are a good base for the next iteration. Although the attitudes they express should be 'stronger' and more distinguishable. This means we need to add more animations, like smile, nod, or other movements that can be helpful to assess the attitude. This will allow for a more natural interaction, especially when the patient would have to say something to the agents. The dialogue is an important part and should be considered in the future work for such projects. For now, we focused on the nonverbal communication, which can be a base for the next projects. The body lan-

guage of avatars will be the first thing a user notices, and can already set the tone for the environment, making the user feel more anxious

An interesting outcome of the interviews was the comment on group formation. The unfriendly condition should be standing closer to resemble one object. The group should look engaged in a conversation to make it more difficult to approach. The friendly condition should be standing further apart to invite the user to join them, smile more and turn towards the newcomer.

The task and game element was overall accepted by the participants, yet one can note that it was not too inviting for an actual interaction. The patient would only have to pass by the group, while the interviewees were eager to include some form of dialogue.

All in all, the chosen task and the game element were appropriate for this user group. Therapists already experienced the friendly group as more inviting and easier to approach than the unfriendly one. Nevertheless, in the next iteration it is important to strengthen the avatar's perceived attitudes by adding more animations and adjusting the distances between group members. The game aspect should be more inviting for the user to interact with the avatars and include some form of dialogue. As one of the therapists mentioned, it could be the user asking something of the avatar. The feedback from this iteration will be accordingly implemented in the next stage of development.

Final VR System

In this iteration we focused on implementing more interaction between the user and the avatars, by altering the avatar's behaviors and the given task. We adjusted the game elements in order to get the user more engaged with the avatars, while at the same time strengthening their perceived attitudes by implementing more animations. In the final experiment the assumptions and prototype were verified by the same two therapists from the previous session, as well as by two ex-patients.

5.1 Design

In the final prototype the core of the scenario remains the same. The user's task is to collect objects from the environment. However, the game elements were slightly adjusted to accommodate the therapist's requirements of having more interaction and possible dialogue. Therefore in order to make the task more interactive than in the first prototype, the user has to speak to the avatars to get the object they are looking for. This way they cannot avoid the avatars while still completing the tasks. Moreover, the object was changed to a 'secret password' that will unlock the next level. Therefore the user can only approach one group per level, while in the first design the goal was to move around freely. The reason for changing this structure was to make sure the user does not avoid the more difficult interactions. The passwords are positive affirmations related to social phobia. To move to the next level the user has to say it out loud. The method of using positive affirmation is chosen to include the 'positive thought' which was mentioned by the therapist in the first interview (See Section 3.3), and is explained in more details in Section 5.1.1.

The levels of difficulty are determined by two factors: friendliness of the group, and location in the bar. The first one is described in more detail in section 5.1.2. We added a 'neutral' behavior to make the transition between levels more smooth. The location in the bar differs in reference to the main entrance door of the bar. As described in Chapter 3, staying close to the doors, or the need of knowing where the exit is, can often be a safety behavior. By making the location an integrated part of a level, we make sure the patients explore the other parts of environment and actually move away from the door. Moreover, as already mentioned, the user can only approach one group per level. This way we made

sure that the patient completes the task given by a therapist and does not avoid the difficult situations. While in the first prototype it was the user's choice of which group to approach. The distribution of the levels can be seen in Fig. 5.1. The difficulty is added by making the group less friendly, and by moving deeper into the bar. The therapist is the one who decides when the task is finished and can 'unlock' the password with the button press. Moreover they can choose the levels of difficulty, after each completed level. All in all, the therapist has much more control over what happens in the exposure and what type of situation the patient has to face.

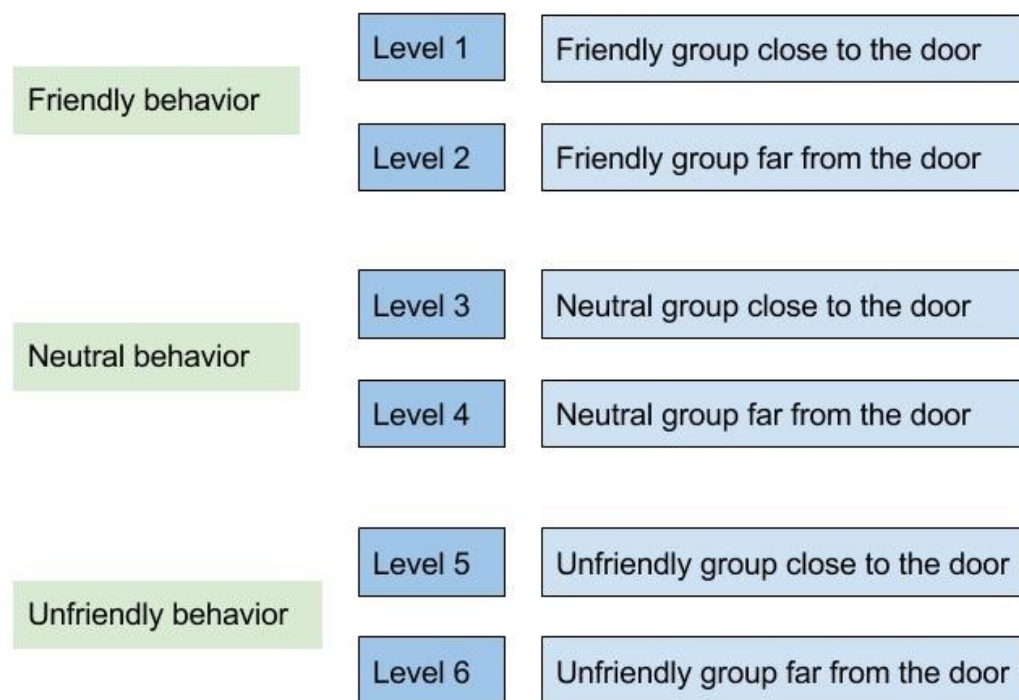


Figure 5.1: Game structure.

5.1.1 Positive affirmation as game element

Over the course of this study we have been advised by the therapists to focus on the positive aspect of patient's performance during exposure. In the first interview, one of the therapists also expressed the need of including a 'positive thought' during the process of exposure. This could be, for example, a voice saying 'you can do it!'. This exact method, however, might be slightly unnatural and could distract the patients from the task. In real life situations, patients would not have an abstract voice encouraging them to proceed with the task. This is why we decided to incorporate the positive thought within the game and player itself.

The positive affirmations are statements that a person repeats to him/herself, to gain

confidence and belief in themselves. By using positive affirmations as an integrated part of the game, we not only include the positive approach to the situation, but also encourage the patient to proceed with the game. In the context of this game, the affirmations are part of a 'secret password' the user receives if he/she completed the level. They have to first remember it, and then repeat it to unlock the next level. The part of using a password to get to the next level, assures that the patient has processed the sentence, and most importantly, said it out loud.

The affirmation chosen for this purpose focused on topic of social phobia. Each password was constructed in a different way: 1) present: "I am comfortable in groups", 2) future: "I am becoming more socially confident", 3) neutral: "Socializing is easy". The different form were used to differ between the level of involvement with the text. The neutral sentence might be easier to say than the first two, which explicitly use the word "I". On the other hand, the second password might be easier to say than the first one, since it refers to possible future.

5.1.2 Designing avatar's behaviors

In this iteration we focused on improving the nonverbal behaviors of the avatars. Since we included a form of dialogue, where the user has to speak to the avatars, it is important they react to it. Therefore we divided the attitudes into two sections: (1) when the user first sees the group and approaches it, (2) when he talks to them. Those attitudes are always the same for both states (approaching/talking) - if the groups is friendly, they are both friendly when the user is approaching, and when he/she is talking to the avatars. As discussed in section 4.3, there is no need to mix friendly and unfriendly attitudes within one level.

As described in section 4.1.1, the avatars need to convey more social cues towards the player when he/she speaks. Therefore the agents need to represent different attitudes towards the player. The attitudes will vary from friendly to neutral and hostile, to make the transitions more smooth. As Argyle [47] describes, the following cues are associated with liking: proximity (closer), orientation (more direct), gaze (more gaze and mutual gaze), facial expression (more smiling), gestures (nodding, more lively movements), posture (open with arms stretched towards other), touch (more touch, in appropriate manner), voice (higher pitch, clear tone), verbal contents (more personal, self disclosure). This project will include the first 6 points, and exclude: touching, voice and verbal contests. The chosen animations and behaviors are described in Table 5.1 and 5.2. In the friendly condition the avatars are standing further away from each other, inviting the user to join by looking at him/her and making space for them to join. When the user is talking, the avatars are engaged in listening, smile and nod (agreeing). In the neutral condition, the behaviors are the same for 'when approaching', however the avatars do not show interest while the user speaks, and stay neutral instead. In the unfriendly condition, the avatars stand in a closed formation, engaged in a conversation, not looking at the user. When he/she approaches them, they show lack of interest, look away and yawn.

Friendly (1)	Neutral (2)	Unfriendly (3)
Open formation, further away from each other	As in friendly	Closed formation, close to each other
Looks at the user		Does not make eye contact
Makes space for the user (earlier, more inviting, turns towards the user)		Does not make space for the user until he really enters the group
		Talking to each other (engaged in conversation)

Table 5.1: Behaviors when approaching.

Friendly (1)	Neutral (2)	Unfriendly (3)
Engaged in listening	Engaged in listening	Not interested in listening
Smile	No smile	No smile
Head nod	No specific movement	Look away (bored, looking around the room)
agreeing		Yawn

Table 5.2: Behaviors when talking.

5.1.3 Implementation

In the final prototype we use the same bar environment, with a total of 7 avatars present, of which 3 can be approached - two female and one male. We divided the space into two sections (invisible for the user), that determined whether the user is approaching the group, or has approached it. This allowed for playing different animations, as described in tables 5.1 and 5.2. On top of that, we again make use of the Impulsion library for dynamical group formation. The distances that determine those actions are the same as in section 5.1.2. The avatars are generated using the UMA - Unity Multipurpose Avatar, which makes it possible to add facial expressions. The starting point was again marked with a virtual and a physical stool. The user started the game standing next to a stool, which had a virtual equivalent in the bar.

In the Unity engine we set Finite State Machines (FSM) for each part of the avatar's animation: the face, gaze, gesture, and talk. The therapist, or other person in control, can set the 'friendliness' of the group in a separate FSM, which then determines what kind of animations will be played in each of the FSMs. The user's position in the room automatically adjusts the behaviors, so that the avatars either react to when the user is approaching, or when talking. When approaching the avatars will adjust the gaze and smiles based on the condition. Additionally the unfriendly group is engaged in a conversation before the user approaches. They speak different languages - Hungarian and Spanish, so that it is not understandable for the player. When talking the avatars will randomly play the animations of head nod (1), agreeing (1), smile (1) or bored (3), looking away (3). The numbers in brackets

correspond to the level of friendliness, where 1- friendly, 3- unfriendly.

In this iteration the patient approaches the group and has to introduce him/herself and ask the group for a secret password. The passwords were translated to dutch and recorded by a female (with German origin). When the patient completes the task (so finishes talking to the avatars) he/she will hear the password through the headphones. In order to get to the next level the patient needs to say the password out loud. Those passwords were positive affirmations related to social phobia: "I am comfortable in groups", "I am becoming more socially confident", "Socializing is easy". All of the commands were controlled by key presses. So each password was played after a certain key has been pressed, together with other commands to, for example, repeat the password. The person in control could also choose which level to move to next.

The levels were divided as shown in Fig. 5.1. As already mentioned, the friendliness could be set in the FSM. The location, however was already set in the scene. This means that in order to have a different location, one needs to open that particular scene, but can adjust the friendliness in each one of them. The differences in location can be seen in Figures 5.2 and 5.3.



Figure 5.2: Final VR Prototype (close to door).

5.2 Method

The original method assumed that the ex-patient and the therapist will be testing the prototype together. However due to time constraints, the two groups had to be separated. Nevertheless the ex-patient were testing the game under supervision of a psychologist to assure their safety and wellbeing.

All sessions were video and audio recorded to help analyzing the experiment. The full protocol and consent forms can be found in Appendix E.

The participants were first introduced to the game and the task they have to complete in VR, read and signed the consent form. Afterwards they were assisted with putting on the



Figure 5.3: Final VR Prototype (far from door).

VR headset and headphones. Then we moved into the 'spontaneous phases' where the participants could freely walk around an empty bar environment, the same that was used for the rest of the game. In this phase they also received instructions on how to use the VR and to what extent they could move in the space. Afterwards they were asked to stand at the starting point, next to the stool, and listened to the pre-recorded game instructions via the headphones.

The next phase was the 'instructed phase', so where the game actually took place. For that purpose a different scene in Unity had to be loaded, which caused for the participant to not see the environment for a few seconds. During that transition the users could see a gray sphere. After the scene was loaded, they were positioned next to the stool and could proceed with the task. When patient completed the task they heard the pre-recorded voice saying (in Dutch): 'Congrats! The secret password is...'. Between each level, the user was again transferred to an empty bar scene, where the system asked for password to unlock the next level.

The researcher and psychologist communicated with the patient during the process of exposure. First of all, the researcher had to ask the patient to stand next to the stool after the end of each level. The patient was also advised to think aloud and express all feelings and comments about what is happening, as he/she plays the game. Lastly, both researcher and psychologists could ask follow up questions about those experiences.

Because of the time limitations, the 'neutral' group condition was excluded from the experiment. Therefore the final structure of the game was as follows:

1. Level 1 - friendly, close to door
2. Level 2 - unfriendly, close to door
3. Level 3 - friendly, far from door

For the ex-patients the test was followed by an interview, while the therapists could first experience someone else playing the game, to assess how it fits for their original role of an

observer.

During the interview the ex-patients were asked mostly about their experiences, what it is that could evoke the anxiety, how they would imagine the difficulty increasing, and their opinion about the game elements. The therapists were additionally asked about the controls they would like to have for this application, and how they would like the information to be displayed - a way of monitoring the patient's behaviors in the game.

5.3 Results

Four people participated in the experiment. Two of them were the therapists from the previous sessions, the other two were ex-patients who are now helping others to overcome their anxieties. Both of the ex-patients were Dutch females, who had symptoms of social anxiety. One of them had agoraphobia (patient A), the other one (patient B) PTSD - her anxiety with social interaction would reoccur by flashbacks. They both described their anxiety (when they were still in therapy) as very severe, where they would either want to leave the situation or it was 'worst ever experienced'. They both stated to play computer games rather often, but only one had experience with Virtual Reality. The results of the IPQ presence questionnaire are discarded as one of the patients did not fill in one page of the questionnaire.

The results are divided in two sections - 'ex-patients' and 'therapists'. Full notes from the interviews can be seen in Appendix F.

Ex-patients

Both ex-patients understood the instructions and completed the whole game. They did not experience fear, however both could describe how they would feel if they still suffered from the phobia. Their feedback was very informative and they explained their way of thinking in detail. The sections below present results from the interviews.

First impression of the environment

Patient A focused more on the surrounding than the people and their attitudes. She kept scanning the room to see all the space and people, which made her feel more safe. This environment did not make her anxious, because there were not many people around, yet she continued to scan the room. Patient B had a very different experience of the VR. First of all she was more afraid of the interaction itself, especially with men. After she saw the group she immediately scanned the members and only addressed the female avatar on her left. In the interview she explained that normally when entering a room she would quickly scan the people and only interact with those whose 'aura' was friendly for her. This is also exactly what happened with the VR.

Group behavior and task

Both patients recognized the differences in group behavior between the friendly and unfriendly groups. However patient A did not pay attention to the faces of avatars until she was asked about them during the exposure. She still recognized all the expressions and had

them noted, just "filtered it out as not important". Patient B recognized the avatar's behaviors immediately (friendly-unfriendly), but sometimes she was not sure if it they are really unfriendly or it was just her anxiety. Even though she only talked to the women, she was aware of the reactions of the rest of the group.

Patient A was pleased with the given task, which helped to distract her from the fear and focus - "Otherwise I would still be looking around". Especially if the bar was more crowded it would really make it easier for her to have a goal. Additionally remembering the password helped her to concentrate. In the unfriendly condition she heard the people talk and was focusing on this background sound and was looking around. In the same situation patient B waited to approach them until the group stopped talking. She found it to be more polite. Patient B was also fond of the task. As she expressed she likes to approach people, but if she has a flashback of the anxiety it becomes very difficult and she does not want to do it at all. In that case she believes even the Virtual Reality would be a problem.

Game elements

Patient A said the levels of the game did made her feel challenged and if she had this application at home to use alone she would want to "see how far I can get with the levels". Patient B also expressed interest in the levels - "I would really like to try more levels and also different avatars". Both of the patients were not fond of the passwords and found them to be rather annoying. They stated the problem was that the passwords were not always expressing how they really feel, it did not feel right to say it (B), or they would not have said it themselves (A). In the last level, patient B was so focused on analyzing whether or not she actually feels that way, that she did not memorize the password for the next level. Patient A immediately noticed the exit door and kept track of where it is when she moved to the different part of the room. She has also noted that it did not say 'exit' above them, yet she recognized it as the main door. Patient B did not notice the exit door or that the position in the bar has changed, because as she explained, she was focusing on the people and not so much on the surroundings. The German accent of the voice actor was recognizable.

Overall impression and recommendations

For patient A the game would be more difficult if there was a crowd blocking the way to the door, or if she did not knew where the door was. To increase the difficulty even more, the therapist could physically push the patient to mimic the crowd behavior. Overall she underlined the importance of personalization. Different kind of stimuli can induce fear - it can be the number of people, their attitude, the fact that nobody approaches you, approaching other people. The task would have to be adjusted to the particular person.

For patient B to increase the difficulty of the game there would have to be more men than women in the environment. All in all she saw the VR as a beneficial part of treatment, underlining that it indeed should be a part of it - a step to make patients go out to the real world.

Therapists

First impression of the environment

Therapist A was optimistic about the VR and saw it as a beneficial tool - "I could really imagine it as a valuable tool and I could use it for therapies". VR seemed very real for him and he sees potential in such application. In his opinion the environment in this game could be adjusted to different subtypes of social phobia (like agoraphobia) and therefore be suited for more patients. Therapist B was also positive about the game - "went very smooth, it was clear what you are asking for". They both found it most useful for intervention, but expressed it could be used for diagnostic, as well as an effect measure at the beginning and end of therapy.

Group behavior and task

Therapist A did not pay that much attention to the reaction of the avatars, but managed to distinguish their behaviors (friendly- unfriendly). However in one case the arm movement in the unfriendly condition seemed inviting for him and he mimicked this movement. He noted that in this iteration the gaze was less scary as the avatars did not look at you straight away for a long time. Therapist B found the avatar's behaviors to be a little too settle, they should have stronger reactions for both friendly and unfriendly (e.g. more smiling).

Both therapists assessed the task as applicable for social phobia, especially when patients have problems with interaction (B). They also found the environment open and flexible enough to easily adjust the task, for example therapist B suggested the patients could also be asked to remember what the avatar is wearing, or the story it told.

Game elements

Both therapists found the passwords to be too difficult for the patients to say, and said they would have to be scaled down. The patient could say "it was not that bad" (A), or even pick the password him/herself (B).

Therapist A thought that the game elements (e.g. explicitly saying the next level) is not necessary and he could tell the patient himself that he/she will be trying something more challenging now. He would like to stop in between levels to discuss how the exercise went. Therapist A also would like to have the process to be slower than the demo - he would introduce the patient to the exercise himself and would like to communicate with the patient during the exposure. This would allow for immediate intervention and more flexible tasks - similar to the role play they do in regular sessions. The same holds for therapist B, who would prefer to give immediate feedback, or even narrate the story. This is why they both would prefer to have a more flexible version to use during session, while the more structured game-like version would be suitable for in-home use.

Therapist B mentioned the patients could be even given points, only not between 0-10 because it is like getting a mark.

Controls and monitoring

The ideal way of presenting the VR to the therapist A would be to have the real and virtual worlds combined. He said that if he could see the patient acting 'in context', it would be a lot easier to process than looking at the patient and screen. In this version, having the mirror screens combined would already be very helpful. Therapist B would like to see what the patient sees, and also his/hers position in the room.

Both therapists would like to be able to communicate with patients at all times. Therefore they both prefer the open structure and more control.

Therapist A also mentioned that for some patients it might be challenging to act when they know someone is watching them. After starting the discussion, therapist B also expressed concern with having the therapists watching the patient while he/she is in VR. He mentioned the aspect of stress, but also an issue from a rather ethical point of view. This could be solved by for example having more therapists or patients in the room at the same time, to ensure there is no kind of 'misuse'.

5.4 Discussion

The ex-patients who participated in the study were very different from each other, yet for both of them the environment showed promising possibilities. The first participant showed more problems with crowd (agoraphobia), while the other was afraid of men, and more interaction rather than just number of people (social phobia with PTSD). Even though they focused on such distinct parts of the application, the task was still relevant for both of them. For each of them the task meant something different - for the first person it was a distraction from the fear, for the other one it meant to face the fear. Therefore the task helped to redirect their attention.

The virtual environment allowed to mimic real life situations surprisingly well. The virtual bar made the users feel like they were there. The fact patient A noticed the door and processed this information in the same way, shows a lot of potential. Not everyone reacted to this change in the environment, but this is due to them not doing this in real life. It only shows how a small detail can already change so much for an individual in VR, and how easily those features can be manipulated. Patient B was also using the same safety behaviors and avoidance mechanisms as she does in real life. She chose the person she found to be friendly and avoided the male avatar. This again shows a lot of potential for such applications, also for generalized social phobia. With one environment we were already able to address very different patients.

The therapists also saw the task and the environment as applicable for different social phobia patients. They were especially interested in making this environment more open and flexible, so that they could talk to the patient throughout the exposure. This was an interesting feedback regarding the game aspects. All participants agreed that the more structured form of the game could be used at home, by the patients alone. Even though the environment did not include specifically competitive aspects, the patients were interested in going further with the levels and exploring the environment. For 'in session' use the open

structure would be preferred. The passwords used in this version should be altered to either more personal affirmations or other less provocative alternatives, regardless of the tense. Moreover, the open structure could allow for the therapist to easily change the passwords, or even exchange them with a different task, for example remembering what the avatar was wearing.

Lastly, the monitoring of the process requires a therapist to be present in the room. The therapists expressed that they can get used to watching the monitor and the patient at once, after training and gaining experience. However the fact that they are watching someone perform, while that person cannot see them, can be a problem. This might feel especially uncomfortable for some patients with generalized social phobia. Being separated from the physical space, with the VR goggles, makes the user vulnerable to action undertaken by the other person present in that room. For the therapists it raised concerns about the privacy issues. However this could be resolved by for example moving the therapist to another room.

Conclusions and recommendations

In this project we presented an iterative and user-centered approach to designing a VR system for treatment of generalized social phobia, where we took into account the needs of both stakeholders - therapists and patients. We added game elements to give a more fun and engaging experience for the patients, as well as provide control over the system for the therapists. The process of designing started with interviews with therapists and first scenarios, followed by a first prototype tested by the therapists, with the final prototype evaluated by both, therapists and ex-patients. In this chapter we conclude the experiments and design choices, as well as give recommendations for future work.

6.1 Conclusions

This project started with a different approach than most studies done in the area of VRET. From the beginning we have involved actual users in the design process, while most studies did not take the user experience into account. By including therapists in the process we made sure to get as much information as possible about the patients and treatment. The knowledge and experience they had with various patients was the key element to making the system for generalized social phobia. Even though the initial hypothesis expected it to be very challenging to design for such a broad group, it turned out to be quite straightforward and feasible. Given a social context one can already train a lot of different situations, especially with avatars responding in a more natural way. The study also showed that VR can mimic the real world quite well, and that the mechanisms that social phobics use to avoid certain situations translate to VR. Furthermore, this application can extend to people with social phobia as a symptom, and not as a primary disorder. As we have seen, PTSD and agoraphobia patients could use this application just as well. Therefore we can conclude that designing a system for treatment of generalized social phobia using VR and game mechanics is feasible. There are, however, certain difficulties and limitations with reaching that goal, which are further described in section 6.2.

The task of finding a secret password implemented in the game was found applicable for both user groups. For the patients this task was helpful to either face their fears, or be a distraction from the initial fear. The first one applied for patient with PTSD, who was afraid

of the interaction itself and therefore could shift focus from self to task. The latter one, for the agoraphobia patient, who feared the crowd and kept looking around. It helped her to redirect focus from others to the task. She mentioned that "Otherwise I would still be looking around". The therapists found this scenario to be a good initial interaction between the patients and avatars. They also noted that it was open enough to apply more tasks within this game, specific for each patient. The passwords were presented in form of positive affirmations. The choice of affirmations needs to be reevaluated, with preference on making them personalized for each patient.

The levels of difficulty were determined by the avatar's attitude and location in the bar. All participants noticed the difference between the avatar's behaviors, however, the therapists mentioned it could be strengthened. The change in location was only noted by one patient, for whom it is a relevant and used safety behavior. The patients often focused on different parts of the environment, which reflected their initial phobias. Therefore, the treatment needs to be more personalized to fit the exact need of the patient. For the first patient who experienced the environment, the change of difficulty could be determined by the amount of men in the room, while for the agoraphobia patient - by the overall amount of people in the environment.

The game-like features added to this application were less transparent than the standard tools used in such applications, like the *Challenger app* [44]. Based on the feedback from therapists, we decided not to include features that would require any form of comparison or judgment, like point systems or any form of scoring and sharing the results. This is due to the social phobics already being afraid of judgment. VR should be a platform they feel comfortable using, without additional stress. Therefore the tools we used were naturally blending therapy techniques into the game. We focused on the user's accomplishments and always congratulated them for completing the level. Beside that we used the positive affirmation as passwords that opened the next part of the environment. This solution playfully engaged the patient and already showed to be appealing to the users, who expressed they would want to "see how far they can go with the levels". Moreover this structure helped to utilize one environment better. With this task and ability to 'unlock' another part of the environment, we save time and work on developing different environments. With such predefined structure, the levels require fewer adjustments.

As already mentioned, the task implemented in this game can be applied to a broad group of patients. It can, however, be adjusted to specific needs and levels of difficulty. Given a more open platform, where the therapist can talk with the patient through the process, he/she could easily guide the patient to face more exact fears. For example in the case of the patient, who was afraid of men, the therapist could ask her to speak directly to the male avatar. It is very crucial to know the theory about the patient's fear, to adjust those levels of difficulty. The presented division between friendly and unfriendly groups is one step, but as planned the therapist should be able to give another task on top of this game. To improve the experience and make the exposure more effective, there should be more communication between the patient and the therapist during the game.

6.2 Recommendations

First of all, in the next stage of developing this application it is important to decide on the level of involvement of the therapist in the game structure, and the options he/she could change or regulate. This could be for example the amount of people in the environment, the degree of friendliness, or the environment itself. The set of options available is crucial in making this system applicable for a broad audience. As we have seen in the final test, with only two participants, the set of needed controls is already rather broad. As discussed with the therapists, what also needs attention is to what extent the game elements should be present in the version that can be used 'in session'. The ex-patients expressed interest in using this application at home, in which case the game might need more structure. This kind of treatment might not be as successful as the 'in session' use, if there is no supervision of what the patient actually does. For example the patient could finish the level (if they asked for the password), but use safety behaviors while doing so (like addressing only the avatar they feel comfortable with). Moreover, the patient would not be able to receive feedback and guidelines, which can significantly decrease effectiveness of this kind of therapy.

Another interesting aspect mentioned in the interview is the actual presence of another person in the room while the patient is in VR. Some people might have problems performing in such circumstances, but it might not be recommended in general. With the VR goggles on, you cannot know what the other person in the room is doing, or if your privacy is being respected. Of course this should not be the case for the therapists, yet patients have the right to feel uncomfortable in such setting. This is why it would be useful to look into different streaming techniques. It could be helpful to see the patient in context of VR, so a mixed reality VR setup could be a solution. In that scenario, the patient could actually be alone in the room. For diagnostic purposes, the application should also include some kind of measure of stress level, like a heart rate sensor.

All in all, VR applications for exposure therapy show a lot of promise. Even though one can see the environment is not real, it is real enough to make the users feel like they were there. For social situations the level of realism is already high enough to make the the users feel anxious. It is important to focus on developing more natural interaction, with various animations. Additionally, the next iterations should include more dialogue. This part is rather complex, but as the therapist expressed, they could narrate the story themselves, and also 'talk through the avatars'. Nevertheless, the application as presented here could already be used for the beginning of therapy, and the further you go with the treatment, the more specific the environment could get. However, it is important to test the application with more users, patients and therapists. Including both user groups in the design is challenging, yet necessary to develop a useful application. Up to this point we did not notice contradictions regarding the evaluation of the system, but both groups focused on different parts. In the next stage it might be useful to divide which parts of the system are evaluated with which group of users.

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Iteration 1 Protocol

1. Introduction.

- Introduce myself and the research topic: Welcome. My name is Karolina Niechwiadowicz and I'm a master student from HMI. I grouped with the psychology department here to work on my master thesis. The topic is Virtual Reality Exposure Therapy for patients with social phobia, the more generalized type. I'm now in the first stage, where I explore the topic in order to make design choices, hence meeting with you.
- Consent for recording the interview.
- What is your specialization?
- Do you have any experience with social phobia patients?
- Did you do any form of therapy for social phobia patients?

2. Open questions.

- What are the social anxiety patients like? What are their biggest issues? What could be the common problem? Focus on generalized social phobia
- How do you proceed with the treatment?
- What could be the tasks given for the patient in the in vivo exposure? What kind of instructions do you give to the patient? Possibly without dialogue
- What could be the safety behaviors patients have? How would you try to overcome those safety behaviors?
- How do you evaluate the exposure? What kind of feedback do you give?
- Are there any relaxation/ breathing exercises in use?
- What methods do you use to keep patients engaged?
- How do you motivate the patients for exposure and homework?
- Do you have any ideas for VR interventions that could be useful?

3. My approach.

Now I would like to describe a bit how I understood the social phobia and what might be the aspects I found till now. Please correct me at any time.

- Social phobics are very self focused, they do not process the environmental cues, but only think of themselves. This leads to building their mental representation of themselves, which is exaggerated and based on what they think others think of them.
- They exaggerate the social cues and interpret it negatively
- Good performance underrated, poor exaggerated
- They are afraid of their fears, not necessarily the exact situation
- They are afraid of making a mistake
- They engage in safety behaviors
- This is the diagram depicts of how the attention should be distributed during a given task in vivo. This is the approach I'd like to take in designing the VR task.

4. VR scenarios

Now I'd like to move to the application itself.

For the VR experience the patient will have to wear the goggles and headphones, which provide the best feeling of presence and immersion. Beside that I'd like to add a sensor for detecting heart rate or skin conductance, which could determine patients anxiety levels. The exposure could be done in few stages:

- Assessment phase: first experience in VR, baselining for the anxiety levels, reactions in cognitive domain
- The spontaneous phase: patient can walk around freely and do whatever he/she wants
- The instructed phase: the game and tasks start.

The idea is that the exposure is done in form of a game. The instructions are given within the environment and the patient has to complete different levels. There could be different game elements implemented, like points for completing a task, certain goals and more.

The therapy can be done with the therapist, so that he/she can have control over the actions.

Scenario 1

- Goal : redirect attention from self to environment and overcome safety behaviours (staying close to the entrance)
- Environment: bar or where would you send your patient?
- Task: walk around the place and try to remember as many details about the bar as possible. At the end of the exposure you need to answer few questions about the place Or collect objects from around the place

- Points: the parts that are further away from the door could have more points (so that they need to get further away in the crowd) or they are in a more crowded part of the room
- End feedback: based on the questions you get a rank of how much attention you paid to the surroundings + your heart rate over time
- Difficulty (1): 1st few people not looking at the player; 2nd more ppl, not looking; 3rd same amount of ppl, some looking ; more ppl looking
- Difficulty (2): place getting more and more crowded

Scenario 2

- Environment: bar??
- Task: Try to look the avatars in the eye. The avatars will turn to the person so you can return the eye contact. At the end you get asked questions about the avatars details - their eye colour, special marks, hair colour etc
- End feedback: Rank based on how many features the person remembered, hence how much they actually looked at the person and focused on them, not themselves
- Difficulty: avatars attitude can change, some will have more pleasant facial expressions, some will look more annoyed.

Scenario 3

- Focus on the task - writing
- Environment: DesignLab or similar workspace. People working in groups around
- Task: write some text on a whiteboard. There is quite some of it so the player can finish when theyre feeling bad
- Difficulty: you can see the ppl behind your whiteboard and some looking at you.

Iteration 1 Results

B.1 Interview 1

1. Part 1: Information about the interviewee:

- *Specialization*: psychologist in Community Mental Health Center: anxiety disorders, mood complaints. Main focus on panic disorders.
- *Experience with social phobia patients*: A bit of experience with social phobia.
- *Form of therapy done (for social phobia patients)*: CBT.

2. Part 2: Open questions

- *General Information about social phobia patients, common problem*:. Bad experience in the past made them anxious; attention inside, what will others think of them; they notice their heartbeat and wonder if they will perform well; they do not interact well with others, pay no attention on what others want to convey, only to their own anxiety.
- *Treatment for SAD*: Treatment with 2 components: task concentration (focus shift from inside to outside - notice things from surrounding, repeat a story), 2nd component is cognitive restructuring - change the negative thoughts, not everyone thinks badly of you, it is not a disaster if you make a mistake; positive thoughts - not thinking disaster. Breathing exercises can also be used sometimes, but only with some people- personalized element
- *Tasks given in exposure*: Tasks in vivo: interact with others and remember what they say; first important task is that they go somewhere at all (gradually increasing difficulty - first with small groups of people they know, then bigger groups etc.)
- *Safety behavior*: Not looking people in the eye (look above), only concentrate on one person or one thing in the room, have things with them (like water, so they drink it to calm themselves down, medicine).
- *Evaluation of exposure*: Patients write a diary - what exercise they did where, how long, how did they do and what they learned.

- *Relaxation/ breathing exercise*: Only for some people, it is personalized.
- *Engagement in the therapy, motivation for exposure and homework*: seeing progress is important and helps them to stay motivated, they set the goals themselves; they can get a reward - anything the person likes (like ice cream); important to focus on the things they managed to do.
- *Ideas for VR interventions*: Task concentration - one person tells the story and then the patient needs to repeat it. Exercise the social situations. You could also let the user read the characters thoughts about the user/conversation so does they know not everyone thinks badly of them. Table with 4-5 chairs, you sit down, hear people talking, need to say something about yourself.

Scenario idea: exercise where you recreate the onset situations, so the patient can fight the bad experience and change his/hers story, usually done at the end of the treatment.

3. Part 3: Scenarios

- *Scenario 1*: Sounds good. Possible environment: shop, gallery, theater, would be nice if users could choose the environment.
- *Scenario 2*: Focus on the helping thought! What has been told. Maybe the avatar can has some critique for the patient, so they get used to it. The avatar could still smile in the end so even if the interaction was more critical (?) it still ends nicely.
- *Scenario 3*: Drinking is the most common.
- *Measures/ End feedback*: Heart rate - use it in personalized way, because everyone is different. Some do not want to see their heart rate, some might want to evaluate it (some might want to see it right away - live stream). Another personalized feature could be the breathing exercise.

4. Part 4: Summary

- Include the helpful thoughts: you can do it and so on (part of the cognitive restructuring).
- Environment where they could overcome their initial fear - so the onset. They could then face the situation again and react with the knowledge they have now - change the story.
- Reward systems: progress stimulation (point and their progress summary- look how much you achieved now, what works best for you etc); physical reward like ice cream or whatever they like (used in CBT).
- In CBT they use the task concentration and cognitive restructuring.
- VR provides better feeling than the imaginary exposure.
- CBT exposure tasks: go somewhere; talk to people (ask a question during lecture and so on, personalized).

- In VR it would be cool to choose the environment where you play. It could be theater, shop, something normal that people go to. Party or bar can be the next stage.
- For Scenario 2 it would be cool if the avatars change their attitude and can be more negative (conversation would be cool) but still end nicely to teach them that some people might be less welcoming, but it doesn't mean they hate them and the conversation/interaction can still be good.

B.2 Interview 2

1. Part 1: Information about the interviewee:

- *Specialization:* Health Care psychologist: anxiety, mood complaints (referred by general practitioners).
- *Experience with social phobia patients:* Yes.
- *Form of therapy done (for social phobia patients):* CBT.

2. Part 2: Open questions

- *General Information about social phobia patients, common problems:* Avoidance is the biggest issue, they just do not go to places/situations. Even bigger problem is that they go, but get too anxious, feel dizzy, sweating and they get afraid of those symptoms, making it hard for them to stay in the situation. They are afraid of the symptoms themselves, not only that they will be visible.
- *Treatment for SAD:* First explore the problems then choose methods. First task concentration - focus on task or surroundings. Other intervention is cognitive therapy - learning it is not a disaster if someone finds out that you are anxious. Third interventions is exposure in vivo.
- *Tasks given in exposure:* Make a list of feared situations, that the patient wants to work on, choose the easiest one to start, e.g. going to a party, talking to a stranger, going to a shop and asking info about products, asking critical questions about products, interacting online (some people are afraid to get more personal info, online training might be the first step). It is better to practice in as many situations as possible, so they learn how to handle the feelings and do not attribute their feelings to one situation.
- *Safety behaviors:* Safety behaviors are often connected to specific fear of that person, e.g. if someone is afraid of blushing, they might use more makeup; avoiding eye contact; they try to sit so that others do not look directly at them. There is a big overlap with safety behaviors and avoidance. There are two types of avoidance - active (someone already is afraid and does something to decrease the fear) and passive (someone tries to prevent getting anxious). Safety behaviors are the passive avoidance. Most important is that patients practice in situation, in

session talk about personal topics, therapist would also go with them to shopping mall. You have to motivate them to do something difficult - what they will gain from doing the exercise (also to keep them engaged).

- *Evaluation of exposure:* —
- *Relaxation/ breathing exercise:* Almost never used, there is no evidence that it works. If patients have good experience with it, they are allowed to use that.
- *Engagement in the therapy, motivation for exposure and homework:* Sometimes making contact in time between sessions - send e-mail, make a call; contacting relatives, asking them to come in the session or asking how they could help the patient. Explicit rewarding seems a bit childish to some patients. Some plan in front of him to make some rewards, but then they do not use it. Some of them think that if I get less anxious it is already a reward for me. For some people it works. It is more important to pay attention to accomplishments than focusing on rewarding.
- *Ideas for VR interventions:* VR generally is helpful, because patients can practice in safe environment. It would be especially helpful to work on situations that are difficult to manipulate - people being critical or angry at them, neglecting them. People with status - police officer etc might be stressful to talk to. If they can handle this in VR then easier situations in real life should be manageable.

3. Part 3: Scenarios

- *Scenario 1:* It has a diagnostic value - how high avoidance is, what are physical symptoms. When doing the task concentration training you train under different conditions. So first the patient has to focus on himself, then on the environment or task. Better for diagnosis.
- *Scenario 2:* Better for exposure. Research on exposure: when patients have the task in exposure is just as effective as without the task. Maybe while being in the task, the person stays longer in the situation so that the fear can decrease.
- *Scenario 3:* The writing is not too common, but trembling or placing a signature might be a thing, but only for some people. Trembling is a problem, but it is not the main anxiety. Drinking, eating, or being in situation where others drink, they only hold a cup or spoon - this might already be difficult for people (they do not even have to drink themselves), it could be in a VR restaurant.
- *Measures/ End feedback:* The most important is that patients are proud they stayed in situation and they get compliments. The heart rate will fluctuate over time so might be difficult to display, you can give mean score and compare between different sessions, for exposure it is important that people learn that they can stay in the situation, that it is not a problem to feel anxious, but the avoidance is. If you feel anxious it means you are doing the right exercise. It is however not a problem if the patient stops the exposure when they feel too anxious, but they need to get back to exposure. So reward them for staying in the situation.

4. Part 4: Summary

- Problem is that social phobics avoid the social encounters and facing their fears.
- Scenario preference: number 1. If you can manipulate the behavior with where it is placed. Maybe combine it with focus shift exercise.
- In CBT: task concentration, cognitive restructuring and exposure.
- Safety behaviors are the passive avoidance
- Safety behaviors are connected to specific fears; example no eye contact, not facing someone while sitting.
- To keep patients engaged in CBT: advertise what they gain if they complete the task, contact between sessions (also with family), giving importance to accomplishments, explicit rewarding (like the sweets etc) seems childish to some of them.
- The avatars in VR could have behaviors like being critical, angry, neglecting to teach the patients how to cope with that. People with status can also be intimidating.
- In CBT the task concentration is a task when the patient has to for example listen to a story and 1st focus on himself, then on the task, then on the environment. The goal is that he can see how he feels in each one of those scenarios (it is indicated by the percentage of their attention directed at self/other/task in each case) and determine what he needs to work on or what the goal is.
- For the scenario 1 the elements they need to find could be on eye level of the avatars.
- With the heart rate feedback it could be discouraging if their heart rate did not drop; already staying in the exposure should be rewarded.
- For the fear of eating/drinking they do not have to actually eat or drink, but already balancing a fork or lifting a glass, while others at the table are also having coffee, can be challenging.

B.3 Interview 3

1. Part 1: Information about the interviewee:

- *Specialization*: Mental health care psychologist, mainly work with ppl with severe personality disorders, severe trauma.
- *Experience with social phobia patients*: Little experience with SAD patient, 'it has been a while' , many patients he sees also have social anxiety.
- *Form of therapy done (for social phobia patients)*: CBT.

2. Part 2: Open questions

- *General Information about social phobia patients, common problems:* Social anxiety patients most often have difficulty speaking to bigger audiences, sometimes they're scared to perform out in the open - go to meetings, school meetings for children. It is difficult to say where the social phobia stops and agoraphobia begins. Sometimes they have trouble even staying in the waiting room of the clinic. They might worry that people start noticing them. They tend to be negative towards their performance. Social phobics are ashamed of who they are and what others will think of them. In reality most patients with SAD also fulfill criteria for avoidant personality disorder. In reality there are no clear boundaries between the disorders.
- *Treatment for SAD:* Starts with education on disorder: how it works and why do they get tense, followed by cognitive treatment, starting with learning how to monitor their thoughts and later learn to test their cognition/thoughts (what would people think of them). This is followed by behavioral experiments - exposure where you test those beliefs. It might start with social skills training with a group 6-8 social anxious people, so they all work together. Those are structured exercises, and it might not be a standard treatment, but it is a middle step before going in vivo.
- *Tasks given in exposure:* The tasks depend on the situation the patient has an anxiety for. You need to gradually increase the stress - small settings, speak up with their husband, then in a sport team they are in etc. So you increase the time they need to talk to them and number of people.
- *Safety behaviors:* They would carry around their cell phone to contact people that could soothe them when they panic or to distract themselves. They might get angry/uncomfortable when they do not have it with them. They often go into the avoidant part: call in sick etc.
- *Evaluation of exposure:* They are asked if they were able to go to the situation, were you able to start the conversation, how did it go, what were the difficult parts; include the cognitive part, so they would have to fill in a form with how they felt before during and after.
- *Relaxation/ breathing exercise:* They often teach them relaxation techniques, but before starting the treatment, that they focus on different parts in the room and relaxing, but it might lead to them not paying attention to what's happening.
- *Engagement in the therapy, motivation for exposure and homework:* The motivation is already within them, what keeps them motivated is that they try to select several steps that are increasingly difficult - start with the simple ones and go up (using the list). You need to be very precise with those steps, not to discourage them. Not really using rewarding systems, sometimes have an agreement with the patient (if they want to) - if you do not succeed you need to do something

you do not really like - clean the house, clean the windows etc. So mostly house chores that are needed anyway. If you succeed you can get yourself something nice.

- *Ideas for VR interventions:* Set the level of difficulty step by step, otherwise they get bad experience and do not want to continue. They have to succeed in the situation, so make the steps small and set a goal: what is the success in this situation for you? Drinking one coffee? Or staying longer? Or talking to people? Small steps.

3. Part 3: Scenarios

- *Scenario 1:* It might be more for a panic disorder or agoraphobia, rather than social phobia. The difference with social phobia is the social interaction, so if they would have to interact with the avatar. You can include an environment where a party is going on, or that they would have to start a conversation and hold it for as long as the meter is running. One patient with SAD was afraid to go on the bus: step 1 go on the bus and get the ticket, then get the ticket with more money so she had to wait for the change; then have a lot of change and she had to drop the money so everyone looked at her
- *Scenario 2:* this is one of the exercises they do in therapy before they go out: sitting back to back, first therapist talk about vacations, then they talk about their vacations, they you turn around; afterward they have to reproduce the story; then turn around and answer questions about how the therapist looked like. It might be more important if the avatars look more accommodating or judging, disapproving or yawning or something. Safety behaviors are more typical for panic disorder, they are afraid of getting panicked - when you panic you make a bigger fool of yourself.
- *Scenario 3:* Not discussed.
- *Measures/ End feedback:* The statistic, it might not be that good to display end results 1/10 score or something, it might make them feel like they are being judged by me/the program. If they know their heart rate is measured, this might make them even more anxious. The judgment or grading might be perceived as a social evaluation (how you did, I am watching you), instead it should go into how well they did, that they managed to stay in the situation. For the heart rate maybe the feature is that if you see a certain rise on the level, they you could give instant feedback on soothing thoughts, not on their heart rate. So the actual heart rate value is hidden, but you use it for the positive

4. Part 4: Summary

- Proffered the second scenario, which is more person focused, there is more interaction, which the first scenario lacks.

- I mentioned the comic style thoughts - which he liked and mentioned himself that it might be good to have some kind of reassuring.
- In CBT: education, monitoring, testing new thoughts, social skills training (therapy group), exposure.
- First exposure tasks usually concern going to some small social events (birthdays etc).
- Safety behaviors: having cell phone always around, so in case they can focus on that and text with a friend, which soothes them.
- It is crucial that the exposure is done in small steps with gradually increasing difficulty. It has to be very precise so that the patient does not get to scared at first, which might discourage them to continue with the treatment.
- Patients need to have the cognitive tools that they can use during exposure - first cognitive training then exposure.
- The goal for exposure has to be very clear and realistic.
- No rewards systems really used, patients can set those upon agreement, e.g. if I succeed I will buy myself something nice, it not i have to clean the windows.
- The first scenario resembles more intervention for panic disorder or agoraphobia. There should be more social interaction for it to be applicable for SAD patients. E.g. patient could start a conversation at a b-day party and there is a timer running for how long he needs to stay in this conversation.
- For the second scenario the avatars could have those attitudes: accepting, judging, less interested, disapproval.
- The end feedback with points or heart rate graphs might again lead to the patient's feeling judged and could be more discouraging than helpful.
- Heart rate implementation: during the game if the patients heart rate increases relaxation? Redirect focus.
- Scenario 3 was not discussed because it was voted not that interesting before.

Iteration 2 Protocol

1. Introduction.

- Welcome the participant; short reminder about the goal of the project: As you might remember, I'm working on Virtual Reality Exposure for treatment of social phobia. Last time we met to discuss the possible scenarios and since then I've been working on putting it all into practice, so the Virtual Environment. First of all I'd like to shortly explain you what is now the goal and how I'm trying to handle this project.
 - Introduce the new goal: The idea of this project is to design a platform for VR exposure which is open for variety of patients and tasks that the therapist might want to train with them
 - Introduce the experiment: So today I'd like to show you the environment, where this game will take place. I have put there some groups and, you can interact with one. I would like to discuss some final decisions today I think it's important that you can actually experience the VR. Please remember that this is just a first prototype. The avatars do not yet have facial expressions that we need for the final test. You also cannot collect the element now, but more about it later.
- tem Consent form: I would also want to ask for your consent to record this session. I will only need it for myself to make sure I can analyze this experiment. Please fill in the consent. I'm also asking there in case you're OK with me using a screenshot/short clip of you using the VR. It will be anonymous, but if you're not OK with this, please just don't check the window.

2. Test

- Explanation: You will not put on the goggles and headphones. Please tell me everything you feel or think in the process. You can first experience it with sound, but in case you don't feel comfortable talking at the same time, feel free to take off your headphones. Try to approach the group as if you were to pick up the element. After that I will stop the game, so when you see a blue screen, you can take off your goggles.

- Position the user next to the bar stool.
 - Put on the goggles and headphones.
 - Start the game.
3. Friendly/Unfriendly scenario - questions to ask during/after the scenario.
- How did this group seem to you? Were they friendly or unfriendly?
 - Do you think approaching such group would be easy/difficult?
 - How do you think you could make it more difficult? Or easier?
4. General questions.
- How do you like the environment? Is this scenery good for exposure?
 - How did you feel about the groups? Did you see them as friendly/unfriendly?
 - Do you think patients will be able to face this challenge?
 - What would you like to be able to control in this game? Example 1: how long it takes before the patient can collect an element. Example 2: change the gaze/smile.
 - Do you think collecting elements is a good base for the exposure.
 - Do you think you could apply more tasks for the participant in this scenario? What tasks?
 - What do you think needs to be improved?

Iteration 2 Results

D.1 Participant 1

The participant is the second interviewee from the previous interview session.

1. Part 1: Friendly group

- They do not seem too friendly
- They are not smiling, look a bit scared
- They do not turn towards me too much

2. Part 2: Hostile group

- They seem less friendly, because they're communicating with each other and not with me.
- Looks like they're thinking there is something wrong with me
- They might even be afraid themselves
- This group was more difficult to approach

3. Part 3: General questions

- *How do you like the environment?* Is this scenery good for exposure? The sound was important. I like it, it's a good environment, not too many people, so you can focus on the people who are there.
- *How did you feel about the groups? Did you see them as friendly/unfriendly?* The friendly group should turn more towards the user and should not communicate with each other that much. Smiling is also important but not too much of it, because too much smile might seem hostile too
- *Do you think patients will be able to face this challenge?* Yes, but is it possible to simulate more interaction? Like talking? It might help patients to give them another task, like asking the avatars about something.

- *What would you like to be able to control in this game?* The facial expressions of the avatars; smile/ no smile; some action - getting a drink (when the user asks you to do bring one)
- *Do you think collecting elements is a good base for the exposure.*
- *Do you think you could apply more tasks for the participant in this scenario? What tasks?* Yes, saying 'no'/ declining would be a good task, so the patient needs to say no if they ask him if he wants a drink, or go to a different bar (reaction: comprehension, understanding, "the oh, OK gesture"). Giving a compliment to one of the avatars, and the avatar also shows a reaction (reaction: thank you). The focus allocation task would work in this environment as well
- *What do you think needs to be improved?* (1) Having the controls for the avatar's reactions would be useful. (2) The instruction should be give in VR, if the therapist talk it might be distracting. (3) In friendly level the reactions should be friendly, in hostile - unfriendly. This should be explained to the patient before (so they know it's a hostile behavior). (4) The "mixed" behavior could be used for personalized treatment, but not as a standard (so when the group looks hostile, but hen reacts friendly). It's better when the group starts from neutral, but then gets hostile (so OK to approach, but when the patients says something, they might start laughing).

D.2 Participant

The participant is the third interviewee from the previous interview session.

1. Part 1: Hostile group

- They are looking a bit serious.
- Not really friendly, or inviting, but also not that hostile.
- They look at me when I approach them.
- The experience is good, when I try to keep distance or approach them.
- The experience is real enough to get the real experience of social interaction.
- They're a bit apart, so it makes it easier to approach - there is space to interact.
- It's not really inviting, but also not that dis inviting.

2. Part 2: Friendly group

- The girl is already glancing at me.
- The girl looks a bit scared, when I approached her.
- They make more eye contact already from the distance, and initially it makes ti easier for me to approach them. They make the contact from distance so it feels inviting.
- This groups seems less difficult to approach than the previous one.

3. Part 3: General questions

- *How do you like the environment?* It was nice, but at some points it was a bit blurry, like when looking more down. Bar is generally a challenging environment, but you it is where the real social situations happen so you can really improve your skills.
- *How did you feel about the groups? Did you see them as friendly/unfriendly?* The hostile group should be positioned differently - more with their back towards the user. They should be closer together so they form one cohesive form in a room, so it's more difficult than if the group is spread and looks more like different individuals. It's harder to approach people if you can clearly see that they're in a conversation together, engaged and focused on each other. With the friendly group the smile was missing, and when you get closer together the woman backed off. It looked like she was backing off in a less inviting way (like leaning back). The gesture for invitation should be different - you can make a step back, but also make a gesture with the hand to invite the user. They social phobics are more afraid to approach a group than an individual. You could also implement ti so that a group is standing further away (so easier to approach), but then comes all closer when the user joins. When people lead towards you or nod, they seem more friendly.
- *Do you think patients will be able to face this challenge?* They will be some patients that are afraid of the technology itself and it will be a challenge for them. This however depends on the individual, but once they are more familiar with it, it should not be a problem anymore. This might also change when VR becomes a common technology, but now some might not want to apply for some treatment, because of tis fear.
- *What would you like to be able to control in this game?* It would be nice to be able to add more people, so for example you have to approach a single agent, but when you start to walk up there is another person joining as well. You could also control whether or not the agents talk to each other, so when you join they all start talking to each other, or stop when you show up. This way you could quickly lower the level if the patient cannot handle the situation. You could also control the avatar's reactions, like looking away from the user, looking towards, nodding. It might be also interesting to control the level of realism of the avatar - so you first approach avatars that look less realistic, and then ones who look more real. I was really impressed with the level of realism.
- *Do you think collecting elements is a good base for the exposure.* Yes, this would a first good step for exposure. so the therapist could first talk it all through with the patient, then go experience it in VR. If as the therapist you could influence the way they interact, it would be great.
- *Do you think you could apply more tasks for the participant in this scenario? What tasks?* approach the avatar. Come up and talk to the avatar (as described above).

Start with the easier/friendlier group and then go up to more unfriendly people. It might be easier to approach a smaller group looking inviting first. In a bar setting it might be easier to approach a single person than a group.

- *What do you think needs to be improved?* (1) It would be good if you can see your hands.

Iteration 3 Protocol

E.1 Protocol for Ex-patients

Introduction

1. Today we will be trying the VR game. Your task is to come up to a group of people introduce yourself, and ask for the secret key (eg. i am looking for the secret key)
2. You will have instructions in the game, but I will be also be telling you what to do.
3. You will try 3 levels, with different groups - friendly and unfriendly.
4. In case you feel uncomfortable: the VR makes you dizzy, or the scenario is too frightening, please let me know straight away and we can stop the game.
5. I want your permission to video and audio record the experiment. Those materials are only available for me to analyze the experiment, and will never be shared anywhere. After the analysis I will delete everything.
6. No please fill in the consent form.
7. If you have any questions, Let me know.

VR phase 1 and 2

1. This is the headset/VR goggles and headphones.
2. You will be hearing some instruction through the headphones.
3. Can you also hear me when I speak?
4. This is the net that will show up when you reach the limit of the physical space. Do not go further than this.
5. The chair is the starting point. I will tell you later when you need to go back to the chair, then please stand next to it, so its on your right hand side.
6. Please, if youre more comfortable, you can hold the cable in your hand.

7. Now try to walk around and see how you feel.
8. Please say out loud anything you think about the environment and whats happening around you.
9. Now you will hear the instructions once again. After that I will load the next level, so the screen might disappear for a second. This will happen after each level.

Levels

1. Press I for instructions.
2. Now please stand next to the chair.
3. Press 1 for level 1/2/3.
4. Load scene Close FINAL
5. Set friendliness to 1/2/3
6. Press play
7. When user finishes talking press C for congrats
8. Press P for the first password /B/D
9. Stop the game

Interview Now I would like to discuss your experience. Please remember that this is just a prototype and concept, so it does need more work. Do not be afraid to share all your experiences and opinions!

1. What did you think about the VR?
2. Do you think this would be a good part of therapy?
3. How did the groups seem to you?
4. Which one was friendly/unfriendly?
5. What about the scene when you were further in the bar? How did that feel? Was it more difficult than the beginning?
6. What about the password method? Did that appeal to you?

Questionnaire

Questionnaire

I kindly ask you to fill in this questionnaire, which will help me analyze this experiment and draw conclusions. Please feel free to ask questions if you need help, or some parts are unclear.

General

1. Your gender _____
2. Your age _____
3. Your nationality _____
4. Have you (in the past) participated in therapy for social phobia

☐ Yes ☐ No

If yes:

- a. When did you finish the therapy? _____
- b. For how long were you in therapy? _____
- c. How severe would you say your anxiety used to be (what levels it would reach)? Please mark it on a scale below.

0	25	50	75	100
No anxiety Calm	Mild anxiety, able to cope	Moderate anxiety, some trouble focusing	Severe anxiety, thoughts of leaving situation	Very severe anxiety, worst ever experienced

5. Are you experienced with Virtual Reality?

1	2	3	4	5
Not experienced at all				Very experienced

6. How often do you play computer games?

1	2	3	4	5
Never				Very often

E.2 Protocol for Therapists

1. Introduction - today we will be testing the final prototype of VR for social phobia.
2. The game:
 - Bar scene
 - the task for the patient is to come up to a group of people introduce yourself, and ask for the secret key (eg. i am looking for the secret key).
 - The secret key is a positive affirmation. The patient needs to remember it in order to get to the next level.
 - To unlock the next level, you need to say the password
 - There are 3 levels, with different groups - friendly and unfriendly.
3. I want your permission to video and audio record the experiment. Those materials are only available for me to analyze the experiment, and will never be shared anywhere. After the analysis I will delete everything.
4. No please fill in the consent form.
5. If you have any questions, Let me know.
6. In the first phase you will be trying out the application yourself so you can see how it looks/ works. In the second phase you can observe someone else play it, so you get the feeling of how it could look for you during the therapy.

Interview

1. Can the task in the game can be applied is treatment of social phobia?
2. Is the task is relevant for generalized social phobia?
3. Can a broad group of patients use this application?
4. Do the game leave space for additional tasks within the one given structure?
5. Was the difference between levels relevant?
6. Was the difference between friendly/unfriendly groups relevant?
7. Was the difference between the location (close or further away from the door) relevant?
8. Is the control of the levels relevant to the therapy?
9. Is it easy to control the system and monitor the patient at the same time?
10. Is it better for actual therapy or for diagnostics?
11. Observing it from outside - is it enough?

Informed consent form

This document gives you information about the study "Virtual Reality Exposure in treatment of generalized social phobia". Before the study begins, it is important that you learn about the procedure followed in this study and that you give your informed consent for voluntary participation. Please read this document carefully.

Aim and benefit of the study

The aim of this study is to explore the possibilities of combining game elements with Virtual Reality for exposure treatment in social phobia. During the session you will be able to share all your thoughts and experiences with the presented application, which will help developing and improving the system.

Procedure

The experiment will consist of 4 phases:

1. VR assessment phase - first experience in Virtual Reality and instructions how to use it.
2. VR spontaneous phase - you can walk around freely and experience the surroundings.
3. VR instructed phase - this is where the game starts. You will be in a virtual bar where you need to approach a group of avatars, introduce yourself, and ask for help in finding a secret key. Once you accomplished that, you can move to the next level. The groups of avatars will display different behaviors: friendly, neutral, or unfriendly. You will be asked to think aloud and express all your opinions at the spot.
4. Survey and Interview - you will be asked to fill out a short survey, followed by an interview where we all discuss how the test went.

Risks

Some find it uncomfortable to be in Virtual Reality. If at any point you feel uncomfortable, you can stop the experiment (i.e. by notifying the researcher and/or taking of the Headset).

Duration

The study will last approximately 1 hour.

Participants

You were selected, because you either experienced social phobia yourself, or you are a therapist familiar with this disorder. Thus, you were contacted in person or via an email, based on convenience sampling by the experimenters.

Voluntary

Your participation is completely voluntary. You can refuse to participate without giving any reasons and you can stop your participation at any time during the study. You can also withdraw your permission to use your experimental data up to 72 hours after the study is finished. All this will have no negative consequences whatsoever.

Confidentiality

All research conducted at the Human Media Interaction group adheres to the Code of Ethics of the NIP (Nederlands Instituut voor Psychologen – Dutch Institute for Psychologists). We will not be sharing personal information about you to anyone outside of the research team. When physiological, audio, and video recordings are made, they will not be distributed and will not be looked at in the presence of persons other than the researchers. The material will be used only for scientific analysis. The information that we collect from this study is used for writing scientific publications and will be reported at group level. It will be completely anonymous and it cannot be traced back to you. Only the researchers will know your identity and we will lock that information up with a lock and key.

Further information

If you want more information about this study, or you would like to attend the final (graduation) presentation you can ask Karolina Niechwiadowicz (contact email: k.j.niechwiadowicz@student.utwente.nl) If you have any complaints about this study, please contact the supervisors r Dirk Heylen contact email: d.k.j.heylen@utwente.nl), or Ernst Bohlmeijer (e.t.bohlmeijer@utwente.nl).

Certificate of Consent

I, (NAME)..... have read and understood this consent form and have been given the opportunity to ask questions. I agree to voluntarily participate in this research study carried by the Human Media Interaction research group at University of Twente.

Participant's Signature

Date

UNIVERSITEIT TWENTE.

Iteration 3 Results

F.1 Patient 1

1. During the game:

- Its an empty room, comfortable for me
- I have agoraphobia
- Full bar would bring me into panic, but this is quite nice
- Level 1 - That group was pleasant, only 3 people, one behind
- Level 2 - This scenario was not different from the previous one. Ernst - did you look at the faces? -Yes, this ones are not as kind as the first ones

2. Interview

- Its realistic, but youre watching the scene and not people. When Ernst mentioned the faces, she could recall them, but first didnt pay any attention to that
- She was scanning the room to feel safe, because of the agoraphobia
- There werent too many people there, was relaxed enough
- She was still checking the environment instead of checking people facing her
- She knows clients that would look more at the faces, her phobia is mostly for the number of people, not the exact persons. She knows clients who would first recognize faces, but its not scary
- When you have difficulty to make contact with other people, this environment is useful
- For her, the difficulty would lie in the amount of people, so this environment wasnt scary. The increasing number of people, them getting closer
- The VR was real, so that the crowded room would make her anxious. Then she would focus on the faces, to appoint herself to something and not look at the crowd
- The task was helpful, otherwise I would still be looking around, I think.

- First group was no problem, the second group was talking different languages and she focused on that. She first checked the room and heard people speaking different language and then she approached and saw their faces. Their faces were more angry.
- The task did lead her to doing the exercise. If the bar was crowded and she was anxious, the task would make it more easy for her, because she would be distracted from the people. It also helped her concentrate when she had to remember the passwords
- The passwords were annoying- the text was annoying, because she would never say that, she does not feel comfortable with groups, she does not feel socially insured. It doesnt fit to her personally. The last one was easiest to say.
- It would be more realistic for her if there was a big crowd and she would get some pushes from the side. The the task would still be helpful to help get the attention away
- The exit was on the left side. It did not say exit on top of that. She saw the door and thought OK, this is the way out. Normally when she goes out she first scans the room for the door, and it also made her feel the same way, When the environment was moved further, she also was aware of where the door was. She still felt comfortable, it was close enough, cause she could see the door and knew where it was. If there were people in between, or she couldnt see the door, or she didnt know which door was the exit (and not for example bathroom) - she would be much more anxious. She needs to know where the exit door is
- There are so many different ways to get anxious for people with social phobia, there are many situations. It has to be very specific for that person. For other people she talks with, theyre all different - for on its the crowd and pushes, for one pushes, for one to approach, when nobody approaches them...so the task has to be altered specifically to that person.
- If this was a home game in between sessions, she would think its helpful. She could try it when shes calm enough and see how far I can get with the levels. If its too much she could take it off and then try again. She would still feel motivated to use it at home. The social isolation is difficult for her, while her friends are out having fun, she stays at home.
- The levels of the game make her feel more challenged. To make it more difficult for her, she would like to have the physical pushed when training with the therapist. So the VR some of the group members are pushing her, and then she gets actual pushes
- She didnt pay any attention to the groups, until she got the task to approach them. She went there and did her task, then after Ernst asked about the faces, she only then realized. But she still detected emotions they showed.
- The accent of the voice (German accent) was recognizable.

F.2 Patient 2

1. During the game: -

2. Interview

- She could see that the avatars are avatars and not real people, but the surroundings of the bar were very real
- The avatars sometimes had (1st or 2nd) was looking very angry. She turned away from him and looked at the one who looked less angry
- The woman on the left was the one she always talked to. She looked at the others, but she felt more comfortable with that particular avatar and so talked to her only. Her overall appearance and attitude, composure was more appealing, the physical appearance and aura is what she looks for. The other avatars sometimes had friendly faces, but the radiation of them said something different. When she met the man for the first time and he had this attitude, she was more reserved
- She sees the vr as a beneficial treatment. Its important that you face your fears, because then you can go through them
- Her main anxiety in this scenario would be : if she was in a crowd with more men than women.
- She saw the group behaviour straight away. Thats also when she made the choice of who she will be approaching.
- The task was ok. When shes in her right state of mind - she likes to approach people. When she had a flashback of anxiety of depression she wouldnt want to approach anyone, even in the virtual reality.
- When talking she was focusing on the woman of the left hand side, but she was still noticing the other avatars reactions. She isnt sure if they were unfriendly when she was talking or it was just her anxiety
- The password thing was a little bit odd. The first sentence was OK, the second was OK, but the third one was difficult to say because: if shes in the right state of mind its true, otherwise it doesnt apply. Then she would like to say something that is more realistic. She doesnt feel like this is true, that she is lying. She prefers to say how she feels
- She didnt really notice that the environment has changed(level 3 when it moved). She has been focusing more on the group, she filtered it out as not important. At some point she became curious of the environment and started to look around. Then she saw a person at the bar and that made her a little bit more confident - im not the only one here, there are also other people here.
- She didnt notice where the exit door was.
- She could see it as helpful for training at home, but it would have to be a tool to help, to get out to the real world. Its important that this is a part of treatment, but that its only a step to make them go out to the real world.

- She has a client with social anxieties and she does exposure with him, if it would be possible to use it for him, he would go flying through this, but getting out to the real world would be really challenging. So for example during a visit you could go first go into the VR , then to practise it outside the door
- i would really like to try more levels and also different avatars
- She did hear them talk, but it was normal that people talk to each other. She waited a bit before she started talking, cause she thinks its rude to interrupt. So when he stopped talking, thats when she started approaching them.
- At one point she didnt hear the password. It was because she was focused on what is happening, what shes seeing. Also the sentence made her uncertain - yea, sometimes its true. But she first started to analyze the sentence, if she agrees with it, instead of remembering.
- The anxiety during the experiment wasnt high.

F.3 Therapist 1

1. During the game:

- Its also a memory training

2. Interview:

- I really have a feeling of being there. I know its not real, but you kinda forget
- The screen could be combined so not the standard mirror from the SteamVR
- Looking at both (person and screen) is ok, but would be better to have it combined
- How comfortable were patients with someone watching them be in VR? For really socially anxious people this could be a problem that you sit and watch them perform. If theyre aware of being watched; in the VR you can forget that youre being watched.
- I could really imagine it as a valuable tool. I could use it for therapies. This is a fitting medium, way to train.
- This is a good platform, opens up a lot of possibilities. You can do here lot of exercises youd normally have to do in groups. Here you can do it in a simulated environment, and that makes it more realistic in a sense- you really feel youre in a bar. Especially for generalized social anxiety there could be more environments and situations. You can ask for a drink, or a change (like the bus example), or like now for the password.
- He did see a difference between the groups. To be honest I didnt pay that much attention to the exact reactions. I noticed the movement (arm waving) in the second scenario. I started doing it as well, it seemed kind of inviting. In the last round I tried looking at the lady, but she didnt look back- that wasnt friendly.

- He didnt really notice that the location in the bar has changed.
- The levels and explicitly saying youre in a different level is trying to really gamify it. For me being in VR environment was like a real environment, I saw it more like an old fashioned task, like an exercise or a task, not a game. I would experience it more like a victory it was more of a real situation and not just a game. The VR itself feels like real practising
- It could be used for both diagnostic and training. As it is now you could really use it for training. I would then introduce it to the patient as youre going in a bar now, lets try it out, if it works out.. I would say the levels, but just tell the patientwell make it more challenging now, not explicitly saying it this and this level.
- He would like to be able to communicate with the patient throughout the exposure. In the traditional way of doing such exercises its the way it goes - while in exercise (like group setting, playing out a scene), if one get really tense or freezes then someone would pet them on a shoulder, give advice or encourage to go further.
- It would be interesting to have like a walkie.talkie with the controllers, so if you push the button and can talk to the therapist.
- It would be good to have a small pause in between - you normally practise, stop for a second, discuss what happened, then go back to the bar, this time it will be more difficult.
- This application could be used alone at home in between sessions. It would be really great if the therapist could be still available to actually talk with the patient while playing at home.
- He could recognize the accent in the password. You can hear the german accent.
- The passwords themselves could be ok, but they were a bit belittling. It was too much, you can easily say such things, but its more difficult to do. They do practise patients to say good things about themselves. Those passwords would have to be scaled down a bit, eg this wasnt so bad. It was too far from the actual personal experience, youd have to do it in smaller steps.
- It would be cool to see an avatar of the patient in the VR, so you could see the whole body and face in combination with VR. It would be even more ideal than switching between screen and looking at the patient. Also then you could watch it remotely,so you dont have someone watching you (the patients dont feel like theres someone watching them). It could however be breaking the magic if you correct the patients posture or something (eg. put your shoulders back), then theyre really aware of someone watching them. Maybe its something to get used to as a therapist. For me its a bit of like watching the making of of crazy movies, when you see actors on the green screens. It would be nicer to have a video stream of the patient in VR, but maybe it just takes some getting used to. However for recommendation for future work, that would be an important thing to have.

- Remembering the passwords can induce some stress, that you have to remember it. If its already arousing to do the exercise, it might be difficult to remember the line. If you would expand the VR game, there could be another task to remember another feature - like the avatar. In therapy there is a task then the therapist talks about his vacation and patient needs to remember that. This could be another task you can use in this setting
- I think it really has potential.
- It could work for different subtypes and for generalized social phobia
- Agoraphobia is a combination of the two - panic disorder and social phobia. Its still more related to panic disorder, but with agoraphobia its because they lose control over the environment, as theyre afraid of the crowd. With social phobia its just more individuals that can judge them.
- This environment and this game can easily be adapted for agoraphobia.
- As long as there is social interaction in the environment its possible to making it usable for different subtypes of social phobia.
- The gaze was less scary this time, cause before they looked at you straight away

F.4 Therapist 2

1. During the game

- Tried more dialogue with the avatars, but they didnt reply

2. Interview

- Wonderful, how nice, well done, went very smoothly, very clear what youre asking to do
- It was nice to get positive feedback well done
- It made me curious what would happen next
- I think its very applicable for people with social phobia disorder, more for people who have problems with interaction; it could be used to train assertiveness. Maybe you can adjust it for people who have problems with aggression - when avatars react in an unfriendly way, the patient should remain calm
- He didnt find the difference between the avatars behaviours to be that distinguishable; the friendly-unfriendly attitude should be stronger, in both ways. Positive should have more smiling and more turning towards you, maybe giving more reaction; maybe they could repeat parts of the sentences oh youre looking for a key? Of course I want to help you. Generally there could be more conversation
- You could adjust the task for different patients, rg. They have to greet people and get points for it, they can see the points they collect; at the beginning of the game

you can get the points more easily, but the further you go the more difficult it is to get them - they have to greet more people, or speak louder.

- Getting points could be a reward for people; you should avoid giving points between 0-10 because thats like getting a mark. But it could be beneficial to see oh i have 82 points, only 18 more to go and I finish this level.
- The control by seeing the patient exercising and the screen with the position in the room, what the patient sees. Then if you see the patient looking particular direction you can ask them to look at a different avatar (eg look at the male. What kind of clothes hes wearing)
- I would like to have the game more flexible, so I can give feedback immediately, or maybe even narrate the story - what the avatars are thinking (wow thats a nice guy standing there, im interested in what hes thinking and then i could say to the patient maybe you could give a reaction, what could you ask her?). If the environment is too strict it becomes more difficult to apply it, theyre all on different levels. This could be used at a role-play but in a more realistic world.
- This application could be used to be played at home, but you would need much more structure. I think there could be more flexible version for the therapist, and more structured game for when patient plays alone
- For some people it might (PTSD) be difficult to play this game with the presence of therapist. For PTSD patients closing eyes is already frightening in the presence of other people, but I think its a minority. Its not a problem that you see the patient on the screen, but that youre watching them, but they dont see you so they dont know what are your reactions. Maybe there should be like 2 therapists in the room, or another patient, so there is some sort of control, and they can be sure that theres no kind of misuse or stare at the patient, while he/she cannot see it. It indeed can be an issue for some patients.
- This solution is good for intervention, the diagnosis is also possible. Often patients report their complaints, but maybe you can use it as effect measure - do it at the start, monitor how often they for example make contact.
- The passwords were funny because they were also about social phobia, but I liked them. They were a bit strong to start with, you could use sentences that they picked themselves and then apply to the game.
- The situation felt more natural when the avatars were talking, because you expect this sound.