Participatory Design of VR Scenarios for Exposure Therapy

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ABSTRACT

Virtual reality (VR) applications for exposure therapy predominantly use computer-generated imagery to create controlled environments in which users can be exposed to their fears. Creating 3D animations, however, is demanding and time-consuming. This paper presents a participatory approach for prototyping VR scenarios that are enabled by 360° video and grounded in lived experiences. We organized a participatory workshop with adolescents to prototype such scenarios, consisting of iterative phases of ideation, storyboarding, live-action plays recorded by a 360° camera, and group evaluation. Through an analysis of the participants' interactions, we outline how they worked to design prototypes that depict situations relevant to those with a fear of public speaking. Our analysis also explores how participants used their experiences and reflections as resources for design. Six clinical psychologists evaluated the prototypes from the workshop and concluded they were viable therapeutic tools, emphasizing the immersive, realistic experience they presented. We argue that our approach makes the design of VR scenarios more accessible.

CCS CONCEPTS

• **Human-centered computing** → **Participatory design**; *HCI design and evaluation methods.*

KEYWORDS

virtual reality; participatory design; exposure therapy; workshop

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1 INTRODUCTION

Sweaty palms, a shaky voice, and trembling hands — most of us have experienced these sensations while giving a public speech. Fear of public speaking is prevalent in one-fourth to one-third of the general population [15, 40] and usually begins in adolescence [47]. When the symptoms of this fear persevere and become habitual, they may lead to unfortunate consequences such as social anxiety, depression, academic failure, and more limited employment opportunities [2].

Virtual reality (VR) is used as a tool in therapy for exposing patients with performance-type anxiety disorder to their fear of public speaking [21, 22]. Exposure therapy scenarios in VR are ordinarily designed using computer-generated imagery (CGI), which requires careful 3D modeling and animation that can be time-consuming and costly to create. Furthermore, such designs commonly feature generic environments and scenarios that take a "one-size-fits-all" approach to targeting speaking anxiety.

The emergence of affordable and readily available 360° stereoscopic video cameras has opened up a new design space. This technology allows realistic VR scenarios to be created

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based on recordings of real people [16, 24]. These 360° cameras have recently been used in VR exposure therapy [41], and according to Seol et al. [35], they provide a tool with "easier means for creating many different scenes/situations and customizing for the particular needs of the patient" [35, p. 2].

Given that fear of public speaking usually begins in adolescence [47], we argue that there is a need to tailor exposure therapy designs to this age group. Since we are targeting the exercise tool at adolescents, we have used a participatory approach [14] to create designs that are based on the lived experiences of adolescents aged 15-17 years.

To address the need for incorporating adolescents' lived experiences in design, we devised a workshop inspired by experience prototyping techniques [9, 46] in the design of VR scenarios. Over two days, fifteen adolescents – with the help of five facilitators – produced four scenarios that depict situations in which one might experience fear of public speaking. The participants played out their scenarios as live-action performances, which were captured by a 360° stereoscopic video camera. After some stitching and editing, these videos became VR prototypes aimed at exposing the user to public speaking.

We reviewed and transcribed video recordings of the participants' work process to analyze their approach and identify analytical themes [6, 7]. In this analysis, we identified themes relating to how the adolescents used their lived experiences to design VR scenarios, envisioned and composed virtual environments, and made sense of the subject matter. After the VR prototypes were completed, six clinical psychologists evaluated the VR scenarios by viewing them with a head-mounted display (HMD) and assessed each scenario's feasibility for use in therapeutic contexts. The evaluators emphasized the scenarios' authenticity and realism, stating that they considered the prototypes viable for use in exposure therapy.

Our results show that 360° video is a viable tool for designing VR scenarios and is well-suited for constructing realistic and detailed virtual environments. The primary contribution of this paper is the composition of tools and methods we present for designing such scenarios and including participants in the design process.

2 RELATED WORK

This section introduces previous research on fear of public speaking, exposure therapy, and virtual reality.

Fear of public speaking

Fear of public speaking, a subtype of social anxiety disorder, is characterized by an intense fear of humiliation and embarrassment before and during public and social speaking performances. The fear experienced is typically disproportionate to the actual threat posed by the social situation. Furthermore, avoidance-type behavior is often displayed by the individual in these public and social performance situations [2].

This phenomenon is prevalent, with one-third of the US population reporting excessive fear of public speaking [40, 47]. Social anxiety disorders, such as this fear, may lead to other anxiety disorders, major depressive disorder, and substance use disorders. Further, it is associated with reduced opportunities in academic studies and professional careers, as well as a lower quality of life due to social isolation and withdrawal [2]. Social anxiety, in general, is a serious public health concern that often goes untreated [27]. Given that fear of public speaking usually has its onset in adolescence, it is important to intervene early to prevent the condition from worsening.

Exposure therapy

Exposure therapy, a treatment technique within cognitive behavioral therapy, aims to combat patients' fear of catastrophic outcomes by placing them in situations that elicit their fear responses. With repeated exposure to the feared situations, patients' established fears are challenged and eventually inhibited and overridden by their new experiences, a process referred to as inhibitory learning [10]. *In vivo* exposure therapy (treatment in naturalistic settings) is effective [1, 43], but logistically complicated to implement, for patients with a fear of public speaking. In public speaking performance scenarios in particular, it is difficult for a therapist to control the stimuli and exposure while in session [22].

Virtual reality for exposure therapy

The use of immersive virtual reality (VR) in exposure therapy to treat anxiety disorders such as fear of public speaking dates back to the 1990s [22, 26]. With this technique, an HMD that shows two slightly different segments of an image is employed to present the user with a stereoscopic virtual environment. The HMD is equipped with motion sensors, which allow for constant computation of new images to sustain the presented environment and help create an immersive experience for the viewer [37].

Levac and Galvin view such applications as a tool in VR-based therapy, in that they require a therapist to "identify specific goals, determine therapy tasks, grade and progress the activity to provide appropriate challenge, monitor performance, evaluate outcomes, and enable patients to link the tasks or activities being practiced in therapy to their real-world context" [20, p. 795]. Use of VR alone does not constitute therapy. However, when viewed as a tool, VR can be understood as a therapeutic element that can enhance therapy and amplify its positive outcomes.

Using VR as a tool for exposure therapy may, depending on implementation, allow therapists to take control of the exposure level, stimuli, setting, and design of features presented to the patient. Systematic reviews of VR for exposure therapy show that the efficacy of these interventions is similar to that of *in vivo* interventions [23, 29, 30].

HMDs for experiencing VR content have recently become available on the consumer market. Due to improvements in graphical resolution, field of view, and refresh rates, these HMDs can now provide immersive experiences at lower costs. Therefore, consumer-grade HMDs are expected to change the design and use of VR for psychological treatment [22, 31].

An audience is a necessary ingredient in a virtual environment that presents exposure to public speaking. Designing animated avatars that depict human audiences, however, comes with the pitfalls of the uncanny valley effect [25, 34] and subsequent trade-offs in design between realistic and cartoonish human-like avatars [36]. Hence, designers of these treatments often opt for semi-realistic avatars to represent humans, along with simplified animation of social interactions [22].

While some efforts have been made to include 360° video in exposure therapy [41], these feature generic settings – such as an auditorium – that are also commonly seen in computer-animated VR environments for exposure therapy. We argue, in line with Hodge et al. [17] and Seol et al. [35], that there is a need to explore tailoring of treatments and ways to rapidly create new VR scenarios. The debates on realism in VR [37, 38] are often focused on pixels and sensory fidelity, but we argue that there is also a need to go beyond this and focus on what is real and authentic in terms of social scenarios, especially when conducting exposure therapy for fear of public speaking.

3 METHODS

To address how to create VR scenarios based on the lived experiences of the target audience, we organized our research into three phases. First, we planned a participatory workshop with adolescents, evaluating how 360° cameras can be used to prototype VR scenarios. Second, following the implementation of the workshop, we conducted a detailed analysis of how the participants interpreted and organized their work in making the VR scenarios. Finally, we had six clinical psychologists evaluate the four scenarios that resulted from the workshop, assess their realism, and discuss how the workshop approach could be used to make tailored VR scenarios for exposure therapy.

Participatory workshop

We engaged adolescents aged fifteen to seventeen in a process of participatory design [5, 13, 14, 42, 45], going beyond traditional user consultation and testing by seeking active contributions in the form of design proposals and alternatives. The primary motivation for involving adolescents was to have them not only engage creatively in the design process, but also produce scenarios that are grounded in their lived experiences and life-world. In line with Dourish [12] we understand life-world as "the intersubjective, mundane world of background understandings and experiences of the world. It is the world of natural attitude and of everyday experience" [12, p. 106].

Thus, we were mainly interested in adolescents' knowledge of and experience with situations that require them to speak publicly. By involving them directly in the design process, we aimed to build on lived experiences that we would not ordinarily have access to and thus achieve relevant and socially realistic prototypes. The specific way the adolescents participated in the design process was to collaborate in groups on iterative design phases for making a 360° video potentially treating fear of public speaking. They also gave feedback on other groups' work throughout the process. The researchers and facilitators, on the other hand, defined the goals and steps in the work process, provided guidance and background knowledge on central topics (*i.e.* VR, creative work processes, and fear of public speaking), occasionally offered encouragement and advice on the collaboration process, and assisted in the use of technical hardware and software.

We recruited participants from two public schools by distributing an informational flyer. We asked for participants that were between 15-17 years old and had either an interest in designing technology or first- or second-hand experience of fear of public speaking. Participants were recruited from secondary schools, as these educational institutions are settings in which social phobias commonly begin [47].

Fifteen participants signed up for the workshop, four of whom were female. The board of ethics – The Data Protection Official for research, assessed and approved the study. Participants aged sixteen and older were allowed to personally sign the informed consent form. Three fifteen-year-old participants had their consent forms signed by parents, as required by Norwegian privacy law.

Participants received certificates of participation and compensation in the form of $120 in gift certificates.

The workshop was organized as a two-day event over a weekend. The participants formed groups on their own based on their prior acquaintance as classmates. In total, there were four groups: three groups with four participants, and one group with participants. The goal of the workshop was to produce four distinct prototypes.

Data collection and analysis

We filmed the participants and facilitators throughout the workshop. Using four cameras, we were able to capture all participants' collaboration on their scenarios. The video recordings provide a detailed view of the adolescents' work process, including how they made sense of their given task and how they understood 360° video and VR environments.

Ten hours of video recordings were transcribed verbatim. All transcribed data was entered into NVivo for qualitative analysis. We used thematic analysis [6, 7] to search for thematic patterns throughout the data corpus. The following question guided the analysis: "How do the participants make

sense of their design task and how do they work when designing VR scenarios?" The analysis was performed using a bottom-up, inductive approach, meaning that interesting data excerpts were coded for what they represented in the situational context, not how they fit into our preconceptions of fear of public speaking, design, and participation.

The first author conducted initial coding of the data, using codes such as "realism," "task understanding," "storytelling," and "sharing an experience." Then, the codes were read through and organized into possible themes. Each theme was then mapped out in a conceptual model of the data corpus, with the author ensuring the extracted codes made sense within their themes. Lastly, the themes were refined to avoid overlap and reflect the research question.

Evaluation

Viewing the prototypes in light of Levac and Galvin's perspective on VR as a tool for therapy [20], we performed an expert evaluation with six clinical psychologists. Evaluators were recruited among acquaintances and colleagues. Three of the experts had prior knowledge of and experience with VR for exposure therapy. One had practical and clinical experience using VR in therapeutic practice to address fear of public speaking.

The psychologists viewed the four prototypes using an HTC Vive Pro HMD and were interviewed before and after the viewing based on the following structure: (1) their previous experience with VR and knowledge and practice of exposure therapy; (2) their general impression of the prototypes, assessing perceived realism and how improvements may be made; and (3) the feasibility of using the prototypes as a therapeutic tool.

The goals of this evaluation were to explore both how the VR scenarios may be perceived and experienced by patients [18] and how they could be used as a tool in therapy [20]. While we have not done an evaluation with patients, we follow Doherty et al. [11], who propose that therapists can be used as proxies for patients in evaluation by providing an understanding of how a tool may be perceived and experienced by them.

4 PARTICIPATORY DESIGN OF VR SCENARIOS

In this part of the paper, we provide an account of our method for designing VR scenarios and how we applied it in a participatory two-day workshop with fifteen adolescents.

Process for creating VR scenarios

A scenario is a construction with the clear purpose of presenting and situating solutions to a problem [3]. When building a VR scenario, we understand the process to align with Bødker's view of creating a scenario for design [3], but also understand it to include a dramatic composition that can be acted out, captured by a stereoscopic 360° camera, and rendered into a video that can be experienced in VR.

To prototype VR scenarios with participants, we devised the following iterative process for design: (1) ideation, (2) storyboarding, (3) live-action plays recorded by a 360° camera, and (4) experience-based evaluation.

Ideation. When designing a VR scenario, it is necessary to construct an environment wherein the events take place. A phase of idea-generation [48] is necessary to select the elements that make up the scenario's plot and environment. This ideation is performed by discussion and building on co-participants' ideas. The outcome of this phase is a conceptualization of the selected ideas for the next phase of storyboarding.

Storyboarding. Storyboarding is a technique for integrating the conceptualized components of a scenario as a cohesive script [44]. To compose the script, one can draw comic strips on a sheet of paper. A further method to support storyboarding is the use of a circular piece of paper that illustrates the 360° environment of VR. An overlaying circular sheet with 100° of the circle cut out can be attached to this 360° storyboard to illustrate the user's field of view. This circular overlay can then be rotated to show every potential viewpoint of the planned scene.

Live-action plays. There is a tradition for using role-play as a technique to support the design of interactive experiences in HCI [4, 9, 19, 39, 42, 46]. To create a VR scenario, one can use actors and props to enact the storyboard as a live-action play, which can be captured via a 360° video camera. The recording can then be stitched and rendered as a 360° video that affords an immersive experience when viewed through an HMD. The configuration of the role-play that is captured, stitched, and rendered to a 360° video constitutes a prototype, which can be experienced, assessed, and reviewed by the designers and other interested parties.

Experience-based evaluation. The VR scenario may be viewed through an HMD for an immersive VR experience. This viewing can be organized as an experience-based evaluation [9] in which one critiques the design and highlights how the scenario may be improved. By experiencing their VR scenarios first-hand, participants can gain insight into how others may perceive the prototype.

Technical equipment for VR prototyping

A stereoscopic 360° video camera, Vuze+, was used for capturing the participants' scenarios. The camera records stereoscopical video in 4K resolution at 30 frames per second. We used the accompanying Humaneyes VR Studio software for stitching video, minor video editing, and rendering to H264-encoded 360° video files. For viewing the scenarios as VR experiences, we employed Samsung Gear VR HMD devices

with Samsung Galaxy S8 smartphones and headphones for achieving spatial audio.

Workshop implementation

The workshop started with a few presentations aimed at encouraging collaboration, inspiring creative thought, and familiarizing participants with the topic of fear of public speaking. The participants were then led through a series of icebreaker games and received a hands-on presentation on fear of public speaking by a clinical psychologist, demonstrations of how VR works, and an overview of how to iteratively prototype VR experiences with a stereoscopic 360° video camera. We concluded this session by setting the goal of the workshop: "Create a situation where a person may experience fear of speaking publicly."

Participants worked together in groups for 45 minutes to ideate, discuss possible directions for their scenarios, and compose storyboards. Halfway through this ideation phase, a facilitator visited each group to check on progress. The members of one group, for example, stated they had planned their scenarios around the intent to "create an intense experience that would be almost intolerable." Here, the facilitator intervened to reiterate a key point from the presentation on fear of public speaking: usually, for a person who has trouble speaking in front of others, the task of performing is difficult enough.

Following the first ideation and storyboarding phase, the groups of participants presented two ideas for VR scenarios to co-participants and facilitators, who offered feedback in an informal evaluation. In this session, each group chose one scenario to continue developing. The first day ended with taking 360° video recordings of the chosen scenarios, in which the participants helped each other by serving as actors. Four VR prototypes resulted after stitching and rendering. The post-processing of 360° video was done by the facilitators to save time and to prioritize the participants' creative process.

The second and last day of the participatory design workshop began with one of the facilitators, a clinical psychology student, reiterating the critical points of the previous day's presentation on fear of public speaking. The participant groups then continued their work by experiencing and evaluating two scenarios each (their own and one created by another group) with an HMD device for a fully immersive VR experience. One facilitator joined each group to assist the participants with navigating the interface of the VR headset and elicit constructive, critical reflections on their experiences viewing the scenarios.

After this forty-five-minute evaluation period, a joint viewing session of all VR scenarios was conducted, with each group summarizing its evaluations as feedback. Participants gave each other frank and constructive commentary. For example, one individual said, "[The scenario] was realistic, and that is good, but you could work on the actors messing around. It is easier to be drawn in if it feels truer." Following the feedback session, each group reconvened to revise its scenario based on the review. Participants drew modified storyboards, drafted new speaking lines, and rehearsed their scenarios where necessary. The majority of this day was spent capturing the revised scenarios with the 360° camera. Each group did three to four takes of its scenarios, evaluating the performances between takes, and used co-participants and facilitators as actors.

The "best take" of each group were stitched and rendered into 360° videos, shown in a final joint viewing session with all participants. Before we detail the resulting VR scenarios, we turn to an analysis of the collaboration between participants in this workshop.

5 ANALYSIS

This section presents a thematic analysis of the adolescents' design process, focusing on how they used their experiences as input for design, how they envisioned their scenarios, and how they made sense of the task at hand.

Designing from lived experiences

The participants verbally shared lived experiences to form common ground through which to explore the design challenge and generate reflections on how their scenarios may play out for a viewer. We identify two ways in which the participants shared experiences and stories that shaped the design: (1) sharing a memory of a situation in which one experienced fear of public speaking to spur discussion in the design process and (2) sharing an experience of witnessing someone's fear of public speaking to guide specific elements of the design.

First, we look at how participants used their lived experiences to open discussion in the design space:

> Lars: Every time I am presenting for my class I end up acting like a fool. Everyone thinks it is hysterical [in a good way], and then I am like, "Fuck me, every time I try to act seriously..." And then it is like, "Damn, what was I saying again?" I just crack up.

Early on in the design process, Lars shared this experience with his group and thus made the problem at hand available to discussion. Another participant, Anna, shared an experience of how an audience can make her anxious when she is giving a presentation:

> Anna: When I present in class, I do not care for chatter among the participants. It makes me feel uninteresting and makes me anxious.

While Lars shared an experience of how he can disappoint himself in public speaking situations, Anna described an experience of how audience behavior affects her during a presentation. The former establishes speaking in front of others as a theme, while the latter has the extended utility of contributing a particular variable to the design of the scenarios.

Participants also shared stories of observing other people's fears and used them as a design element.

In the example below, Ivar tells a story of how someone he worked with in class was overcome with pressure from performing a mundane task:

Ivar: So, like, the first time we got any insight to who she was, well, it was one other person and me, right, and she was merely translating "smart" to Norwegian [from English; the word is the same in Norwegian]. She could not do it. So she, like, broke down because it was too much pressure. From two other people.

This storytelling was used by participants to socially explore the phenomenon of fear of public speaking as a step in their design process, which in the above example led to an early idea that was later abandoned. Here, they observed that it is possible to experience fear of public speaking without being explicitly asked to speak in front of the class. The way stressful situations may occur from mundane conversations.

Envisioning and composing the virtual experience

To design a scenario, the participants had to compose a virtual environment in which it could take place. Creating this virtual environment entailed the use of design tools, as well as the proposal of a dramatic composition. In the conversation example below, the participants are using the circular storyboards described in section 4 to negotiate decisions about their design. The circular storyboards drawn up for their scenario function as a reference point to discuss the placement of actors and sequencing of dialogue. Employing the storyboards, the participants are negotiating how to incorporate elements such as audience attention to the user into their virtual environment.

Ivar: You are in the middle of the classroom, and then you get up to explain stuff?

Karsten: Yes, or your teacher is here [pointing at storyboard], and then she asks, like, a random student, like, "Yes, and you? Please tell." And then that student, maybe one of us, right, as an actor, "Yes, I am this and that, born in China," or whatever. And then, "Yes, how about you?" and she is then pointing at the student sitting there.

Here, Karsten is using the storyboard and his surroundings to explain how he envisions the scenario. The storyboard is used to situate the user, whom he refers to as the "student sitting there," within the virtual space.

The following example illustrates how the participants envision the roleplay based on their conception of what will trigger fear of public speaking. In this group's case, it is the action of someone turning around to look directly at the user. Furthermore, the specific choice they make here incorporates an element of surprise in that the teacher is seemingly randomly asking people to respond.

Ivar: And then everyone turns around.

Karsten: So he can see that everyone is staring at him, or not everyone, but some, so he must tell them something.

Lars: So it is going to be very on the spot. You are not given anything before that.

This demonstrates how the participants use the design tools to compose the virtual space and its components of actors and dialogue. It also exemplifies how choices related to the construction of dialogue and dramatic composition are based on the adolescents' conceptions of what it means to experience fear of public speaking.

Making sense of exposure therapy

Part of the participants' design process involved building an understanding of the subject matter, namely fear of public speaking and exposure therapy.

Initially, participants were unsure of what the goal of their scenarios should be, asking questions like, "What level of social anxiety are we dealing with?" By refining their scenarios, they were able to improve their understanding of the subject matter. The below transcript, taken from an evaluation of a group's first prototype, reflects how participants' understanding had developed since the workshop began.

Anna: I just realized something regarding our video. The fact that our reaction is so negative will only make the patient or person watching that has these anxieties feel even worse.

Daniel: Yes, I thought the same.

Anna: While all the others are saying something about themselves we are laughing.

Cedric: But the goal here is to make a bad ending? Because that was everyone's focus yesterday. That it should be . . .

Bendik: And that is good, right? That people get to practice?

Anna: No, it is supposed to be therapy. You are supposed to get used to talking in front of people. The point is not to make anyone feel worse.

The transcripts illustrate the joint construction of ideas about the condition of having a fear of public speaking and what experience the scenario should offer the viewer, based on a review of the first prototype. Anna makes sense of what the group's prototype is by placing it within her conception of "therapy." She identifies the negative consequences the scenario they have created may have for someone with public speaking anxiety. This sparks a discussion within the group, in which the participants collectively come to understand the purpose they are designing the scenarios for: to create a virtual environment that can help improve users' public speaking abilities. It is then understood by the group members that they should rework the tone and feel of their scenario.

6 VR SCENARIOS FOR FEAR OF PUBLIC SPEAKING

Following the analysis of the participants' collaboration to create VR scenarios, we present descriptions of each group's final prototype from the participatory workshop. A person viewing the scenarios in VR may experience fear of public speaking and practice his or her public speaking skills.

Figure 1: An equirectangular snapshot from *The introduction round.* This snapshot is cropped vertically for appearances.

The introduction round

With the viewer placed among a circle of high school students, this scenario starts with a person introducing himself as the teacher of the class, welcoming everyone to the first day of secondary school (Figure 1). The teacher shares his name and a hobby he enjoys. Each student then follows in turn, performing the same introduction. One of the students starts talking about something unrelated on his turn, leading the teacher to interrupt the student and cue the circle to continue. The last student before the viewer tells a joke about his skills in performing push-ups, which prompts all students in the circle to burst into laughter. As the collective laugh eases, the teacher asks the viewer to introduce him or herself. Twenty seconds of silence follow, with the students in different modes of attention and suggestive postures. The teacher proceeds by thanking the viewer and the round continues until everyone has introduced him or herself. The teacher concludes by thanking everyone for their participation.

Interruptions in the classroom

The viewer is placed at a desk in the middle of a classroom with students sitting at their desks. To the left, a fellow student is introducing himself to the class. In front of all the desks, a person easily identified as the teacher thanks the student and instructs the viewer to present a self-introduction. Silence follows for ten seconds, with the students in front of the viewer turning toward him or her in their chairs. Suddenly, the door opens, and a person walks halfway into the room. "Does anyone know where the big auditorium is?" the person asks. "Yes, down the hall and the last door on your left," a student on the viewer's right responds. The person leaves and closes the door. Mild laughter follows, with the teacher breaking through the laughter to say, "Please continue." After five seconds of silence, students on the viewer's right become inattentive. The teacher quickly disciplines them, saying, "Please pay attention." Thirty seconds of silence follow, giving the viewer an opportunity to speak to the class.

Reminiscing about the weekend during recess

The viewer is placed within a group of friends sitting on couches, casually discussing their weekend during recess. Several conversations are occurring at the same time while music is heard from a phone, making it difficult to follow any one discussion. The subject among the friends is a party they attended the previous weekend. "Everyone was at the party, right?" one person distinctly asks the others in the group. A person to the left of the viewer confirms this. The music goes silent. "Yes, everyone was at the party," declares a girl in front of the viewer. Immediate silence follows. The boy next to her asks the viewer, "Were you there? I cannot remember seeing you at the party." Silence follows for ten seconds, while the group of friends pays some attention to the viewer. The focus then diverts from him or her and the conversation picks up again.

Presenting a field trip in class

The viewer is situated behind six students sitting at their desks, with three students behind desks to the right. At the front of the room, there are large sheets of paper, on which are written key words about a field trip. A seemingly disgruntled teacher mentions something about the field trip and asks the viewer to come forward to summarize it for the class. A fade-to-black sequence follows and the viewer finds him or herself in front of the class with the task of presenting a summary of the trip. The teacher prompts the viewer by saying, "Yes, please begin." Facing the students, the viewer must improvise a summary of the field trip based on the key words, which are no longer visible. The students look inattentive. After fifteen seconds of silence, one student exclaims, "Please speak louder!" Some students start giggling and the teacher quickly reprimands them. Twenty seconds of silence pass. Suddenly, the sound of a school bell is heard, prompting the students to get up and leave the room for recess.

Having presented each group's final prototypes, we now turn to the expert evaluation by six clinical psychologists that was carried out after the participatory workshop.

7 EXPERT EVALUATION

The psychologists' feedback is categorized according to the following themes: (1) presence and realism and (2) their feasibility as a tool in therapy.

Presence and realism

In VR, presence refers to the subjective sense of being present in the virtual environment [38]. Describing the experience of the 'introduction round' scenario (Figure 1), one evaluator said, *"It felt like I was there, physically, in the group. It felt like it usually does in real life. It's not like I've just had VR glasses on. It was quite convincing."*

Another evaluator appreciated the anticipatory effect of waiting for one's turn in the same scenario, saying, *"You can feel it coming. One step closer, one step closer. I could feel it in my body that there was an activation."*

The evaluator with previous experience using VR for therapy highlighted the more nuanced content that 360° video is capable of capturing compared to CGI. He said, *"Although this is similar to my prior experiences with VR, where you are presenting, this is so much more . . . realistic, down-to-earth. . . . Because you have the adolescents, with their body language, which I think people with fear of public speaking will find quite disconcerting."*

The evaluators reported being impressed by the realism of the prototypes, noting the actors' naturalistic performances. One evaluator said, *"If these people [in the scenarios] were actors, then they did a really good job."* After seeing "The introduction round," another evaluator asked, *"Is this real? Or are they actors?"* The evaluators responded to the situations depicted in the scenarios as experiences that they were familiar with from their own memories of school.

One evaluator suggested that each scenario could first be introduced from a bird's-eye view perspective or that the role of the viewer could first be as an invisible bystander, saying, *"I was thinking about how to introduce this more mildly. I would have one [scenario] where I was outside the situation and just observed the group. Then you would know what's about to happen."* This psychologist had prior experience in doing *in vivo* exposure therapy and was familiar with the method's progressive, hierarchical framework [28].

Although stereoscopic 360° videos provide depth of field when viewed via HMD, finer details of features (such as facial expressions) may be blurred in the case of actors who are situated far from the camera. Noting this lack of fine details in distant actors, one evaluator remarked, *"There was a certain 'filter' that made their faces harder to see. It is important that facial expressions are visible to make the experience as realistic as possible."* Other evaluators also noted the same visibility issue. However, the resolution was still high enough to sustain the perceived realism of the scenarios.

Feasibility as a therapeutic tool

Overall, the evaluators were positive about the potential of using VR scenarios like those prototyped through this study in exposure therapy. Most argued that they would not be useful as stand-alone tools, but had the potential to enhance therapy if combined with psychoeducation and specific practice tasks.

One of the potential advantages of 360° videos lies in the readily available, realistic recreation of challenging situations. In the words of one evaluator, *"In a therapy situation, we often play [roleplaying] games where, as a therapist, I play out situations and practice a little with the patient. But this [prototype] is much more varied. It could somehow cause anxiety [more easily]. It is closer to the situation. It is more real than what a therapist can do with exercises and plays. I think the anxiety will go up. And that's good; that's what we want. [It's good] [t]hat we get the patient activated in the therapeutic room, that they get the anxiety activated, that they can get into that situation."*

Another evaluator said that the prototypes in their current form could be very challenging for patients, but still useful as a therapeutic tool, explaining, "If you have been bullied in school, I think this can be really uncomfortable and evoke unpleasant memories." There is an upside to this effect, however, as painful memories and feelings may be difficult to evoke and examine in conversation alone. Patients often have difficulty remembering and articulating exactly what causes the experience of fear in a particular situation and the prototypes can make fear-producing situations immediately available. The use of 360° video in VR was regarded as a hands-on, direct approach that could be useful in therapy.

The absence of control within the virtual environment raised a concern with one of the psychologists. If the scenario becomes too uncomfortable for the person using the HMD, there is no option within the interface to regain control by adjusting the stimuli.

8 DISCUSSION

Our method for participatory design of VR scenarios presents both opportunities and challenges for designing VR exposure therapy with adolescents. In this section, we discuss each phase of the iterative design process and present reflections on using 360° video in exposure therapy for this age group.

Participatory design of VR scenarios

As explained in section 4, a scenario is a construction that presents and situates a solution to a problem [3]. To realistically construct and situate a solution in a VR scenario, there is a need for a clear description of the environment (including potential actors and props), a storyline, and an understanding of how the environment and storyline can be integrated as a live-action play. The scenario can then be developed into

an experience prototype [9] when captured with 360° camera and subsequently viewed through an HMD.

Ideation. The goal of the first phase, ideation, was to generate ideas of situations in which one could experience fear of public speaking. Using their lived experiences as a resource for developing ideas, the participants created potential scenarios that included surprising elements.

In this phase, it is essential to ensure that the participants stay focused on the task at hand. In participatory design, there is a trade-off in facilitator intervention: steering the process towards the desired goal of the workshop versus letting the participants creativity roam freely. Svanæs and Seland [42] discuss this trade-off and ask, "To what extent do the scenarios and ideas originate from the users, and not from the facilitators or developers?" [42, p. 485]. The appropriate balance can be achieved by: (1) clearly stating the intended goal of the workshop, (2) providing the participants with the necessary information to carry out their work, and (3) directly intervening in the creative process if participants lose track of the workshop goals. While this may be relevant for all phases, it is particularly important to keep participants focused on the overall goal in the ideation phase. Facilitators should ensure they guide participants in conceptualizing and choosing between ideas for further development.

Storyboarding. In their collaborative process, the participants used storyboards, as detailed in section 4, to negotiate the composition and storyline of their scenarios. Our thematic analysis addresses how the storyboard can function as a shared reference participants can employ to situate their ideas and envision their scenarios in a virtual environment. The circular storyboards have a certain pedagogical value in that they aid participants in understanding how scenes need to be arranged to be filmed in 360° video. The camera is situated at the center of the circle and the overlays only allow visibility of 100° at a time, helping illustrate how a viewer might navigate the virtual environment. Some groups in our study, however, had a more dialogue-based storyboard focused on generating the speaking lines for the actors. The main outcome of this phase is a detailed script of how the storyline will be acted out, which can be represented in different ways through the use of comic strips, circular cards, or written lines [44].

Live-action plays. Live-action plays, role-playing, and design theater have been used to explore design concepts [9], generate concepts for design [19], and embody and act out design ideas [42]. In our process, however, the plays also served a more concrete purpose in producing a virtual environment. The iterative process helped refine these plays and the participants needed several rounds of rehearsal and up to four takes to get the results they wanted.

Having the adolescent participants perform as actors in their scenarios added to the authenticity and realistic qualities of the prototypes. Although the participants were not professional actors, they played roles that were familiar to them.

Experience-based evaluation. The experience-based evaluation session, in which the participants experienced their scenarios first-hand with an HMD, provided an opportunity for the adolescents to see how their ideas and acting played out in VR. As shown in section 5, this prompted Anna to consider how the scenario should be designed to help the viewer "get used to talking in front of people." This demonstrates the value of these evaluation sessions in improving emphathy for viewers and assessing to what extent the prototype conforms with the ultimate goal.

In assessing the quality of outcomes of a workshop for developing scenarios, Svanæs and Seland [42] ask a pertinent question: "Are the scenarios accurate in their description of the situations being studied?" [42, p. 485]. This question refers to the produced scenario's truthful relation to the real world [42]. Experience-based evaluation as incorporated in our method is one way of assessing this quality, as it allows the participants to evaluate the realism of what they have designed.

Beyond pixels and sensory fidelity in VR scenarios

The participatory process was crucial to creating scenarios that appeared to be authentic social situations. In the analysis of the participants' work process, we can see how they concretely discussed their own lived experiences and gave accounts of others' experiences from their daily life, and how they used this as a resource in the design of their respective scenarios.

When making VR scenarios using CGI, a major challenge is virtual character design [34] and avoiding the uncanny valley effect. In the case of VR scenarios generated using 360° video, however, the main challenges are tied to whether the situation that is portrayed in each scenario seems believable and socially realistic, along with how well the script and storyline are acted out.

While the scenarios feature real people displaying realistic body language as characters, they are still limited by the fact that the interaction is scripted. This highlights an additional challenge with scenarios that have a somewhat complicated storyline and composition of actions. In particular, the difficulty relates to how the participants in the scenario can address the viewer and how the script can be timed to fit what the viewer says and when he or she speaks.

The way turn-taking is accomplished in social interaction [33] depends on micro-pauses and the timing of details such as gazes and gestures. This is challenging to accomplish in a VR scenario, since the actions of the viewer are unknown. While an actor in the scenario can address the camera as a

proxy for the viewer, it is difficult to, in a realistic way, signal when the viewer is supposed to stop talking. The technique of addressing the camera was used in all our scenarios. Further research into how to overcome the challenge of having a realistic interactive experience in VR scenarios based on 360° video is needed. In the context of exposure therapy related to public speaking, several possible techniques could be explored. For example, one might include a graphical overlay with a progress bar indicating the speaking time the viewer has available or, alternatively, display a script of speaking lines for the viewer in the form of subtitles in the virtual environment [8, 32]. A key point when designing VR scenarios is to make the storyline clear in terms of when the user is supposed to say something or when a particular action is expected.

Tailoring VR scenarios for exposure therapy

One of the themes identified in the analysis was that the participants had to make sense of the concept of exposure therapy. There are challenges tied to including adolescents in the process of creating content for therapeutic tools. It was not straightforward for the participants to create scenarios that aligned with the therapeutic makeup of exposure therapy – neither were they expected to or tasked with designing *therapy*. The facilitators intervened to guide some of the groups' processes away from creating situations that elicit as much fear as possible to instead design scenarios in which the viewer could experience conditioned fear responses in a realistic situation.

The expert evaluators found the scenarios convincing in portraying situations that are well-suited to reproduce relevant feared stimuli for adolescents with a fear of public speaking. The evaluators highlighted the social nuances and body language of the actors as key features for making the scenarios realistic and authentic. They further saw the value in using the scenarios as a component of exposure therapy. Still, having realistic scenarios, with familiar scenes, is not necessarily enough to make exposure therapy successful. The idea of using VR as a *tool* in exposure therapy [20] means thinking of the VR scenario as only one of the necessary elements of treatment. To use VR scenarios in therapy would, for example, require a therapist to compose accompanying tasks for the patient. Then, the therapist can monitor performance and evaluate outcomes of the therapy.

Furthermore, therapists could, following our method, even tailor 360° video content for specific social phobias that match the patient's condition. This tailoring would enable the therapist to provide appropriate challenges and specific goals based on the needs of the specific patient, but would require access to equipment and someone to act out the plays.

In this study, we have seen that adolescents are capable of participating in a design process and that the produced scenarios have the qualities of being realistic and portraying scenes from a familiar social and cultural context. Thus, they are recognizable for the target group. The main strength of the method is that it can help capture those qualities. The goal of the outlined process is not necessarily to make ready scenarios for use in therapy, but to prototype and materialize ideas and suggestions that are grounded in the lived experiences of the target group—in this case, adolescents. In this sense, the scenarios can function as prototypes that capture ideas and experiences that can be used in a continuing design process. Moreover, the participatory design process can be used to tailor treatments for different target groups and to provide scenarios portraying relevant experiences. This can help frame design solutions specific to particular cultural contexts, social situations, and therapeutic needs.

9 CONCLUSION

This paper has presented a participatory approach to prototyping virtual reality scenarios for exposure therapy to address fear of public speaking. In our study, we demonstrate how adolescents can be involved in the design of VR scenarios enabled by 360° video recording. We also show how the participants draw on their lived experiences when creating these scenarios. The paper illustrates that 360° video is a viable tool for making the design of immersive VR experiences more accessible, as it requires far less advanced technical skills than creation of CGI-based environments and is less time-consuming. Further, the expert evaluation phase in our study highlighted the authenticity and realism of the scenarios, which were seen as being potentially useful in a therapeutic context. This approach to designing VR scenarios with 360° video offers the potential to tailor VR experiences to many different situations and to specific fears. Our participatory method demonstrates how it is possible to design VR scenarios relatively rapidly and we expect that therapists could build on our approach to design such scenarios and potentially include patients in the process of tailoring VR environments to help address their specific fears.

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