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# Exploratory study into presence within a social virtual reality environment for use in exposure therapy

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## Abstract

This paper presents an explorative study investigating the prospects of using social virtual reality as a tool in exposure therapy for children diagnosed with Autism Spectrum Disorder. A 360° video of a children's musical concert was used to perform exposure therapy on children diagnosed with Autism Spectrum Disorder (ASD). The prototype allowed the teacher and the student to be present in the same virtual environment. Additionally, the child and their teacher were able to play virtual reality musical instruments along with the musicians of concert experience and communicate with each other through gestures of virtual avatars. An exploratory study was conducted on 12 children diagnosed with ASD and 4 teachers. Both parties were from a school for children with mental disabilities. From data analysis, we can conclude that the prototype provided the children with a fun and playful experience. The potentials and limitations of the social VR application is discussed in the paper.

## Author Keywords

Human Computer Interaction, Social Virtual Reality, Multisensory Experience, Copresence

## CCS Concepts

•Human-centered computing → Virtual reality; Human computer interaction (HCI); •Applied computing → Psychology; •Social and professional topics → Children;

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**Figure 1:** The digital avatar that represented both of the participants in the VE.

## Introduction

Research in Virtual Reality (VR) has seen extensive use in training and therapeutic cases [5, 8], especially in correlation with anxieties where it is highly effective in treatment [7]. By using VR for exposure therapy, virtual environments (VE) can systematically expose patients to their feared stimuli rather than through exposure in vivo (i.e., carried out in real-life situations) or imaginal exposure (i.e., carried out through imagination) [6]. Currently, Denmark and the rest of the world is seeing a prevalence in children being diagnosed with autism spectrum disorder (ASD) [4]. ASD is characterized by impairments in social interaction and communication skills [1], which often results in social anxiety. As VR equipment is in an evolutionary state, it is now possible to utilize natural sensorimotor contingencies (SC) to have subjects achieve a greater sense of presence. By designing the prototype to allow for social presence illusion, copresence illusion, and communicative salience, teachers can be inside the virtual environment, at the same time as the children who are receiving the exposure therapy, to help, guide and observe their behavior.

## A sensory experience

### *Presence through 360° video*

Video displayed through a head-mounted display (HMD) can be defined as a VE, due to being interactive, as one can rotate and change position within the displayed world. These interactive abilities can be correlated to what Slater and Wilbur [12]; Witmer and Singer [14] proposed of achieving a higher level of presence. Although 360° video can give a more natural feeling, the disadvantage is that it can limit and constrain the directing and editing phase, which in turn will change the desired focus. Additionally, there is the problem revolving around invading one's personal space. According to Sheikh [10], participants that perceive a threat, increase the boundaries of their personal space. More-

over, Bailenson, Blascovich, Beall, and Loomis [2]; Wilcox, Allison, Elfassy, and Grelik [13] states that boundaries for invasion of personal space do not differ between VR and real-life. The distance between the two participants should therefore be considered to not be an invasion of personal space in general, and if an anxiety attack occurs, should still maintain enough distance for that space to increase without feeling invaded by the other participant.

### *Presence through social interactions*

Presence does not account for any notion of social interaction in a VE. However, presence in itself has been explored widely. Copresence, social presence & communicative salience all define presence to its extent, and can be correlated to the fabricated VEs under the presumptions of being illusions [11]. The presented study should therefore strive to allow and achieve copresence illusion, social presence illusion and communicative salience for an gradually higher presence. These are defined accordingly: *copresence illusion* is the sense of being together with another being in a VE, whereas, *social presence illusion* subsequently surface from copresence illusion, and is the sense of engagement with said being. *Communicative salience* follows social presence illusion, and once the engagement is established, communicative salience refers to the perceived affordance of the engaged beings behaviour [11].

## The study

The aim of the full study was twofold: (1) implementing an immersive social VR setting where users share a virtual space and stimuli, (2) aiding children with social anxieties, through virtual reality exposure therapy (VRET). The focus of the current paper is the former. Therefore, the following sections are grounded in therapy-oriented testing, where the design has the limitations that are required when working together with children with anxieties. During the evalua-



**Figure 2:** The two 3D avatars watching the 360 video concert together in each of their local spaces.

tion, an authoritarian participant was a chaperone, guiding and helping the other participant, depending on the therapeutic aspect of the phobia or anxiety.

#### *Setting*

Test participants were provided by a treatment school in Vanløse, Copenhagen, and the test was conducted at their facility. A room was set up with two desktops, each with their own dedicated HMD. The desktops were placed side by side with a distance between them mirroring what the users would witness in the VE.

#### *Virtual Environment*

A rehearsal of a children's concert was recorded with the Insta360 Pro 2 and Sennheiser Ambeo VR microphone at DR Koncerthuset in Copenhagen. The 360 video and audio was imported into a VE, developed in Unity3D. As seen on Figure 1 and 2, each user had their own space and 3D avatar, depicting a cartoonish child, which was rigged to move along with the HMD and controllers. Networking was setup through a networking library for Unity3D, to allow for the two users to see each other move and interact with

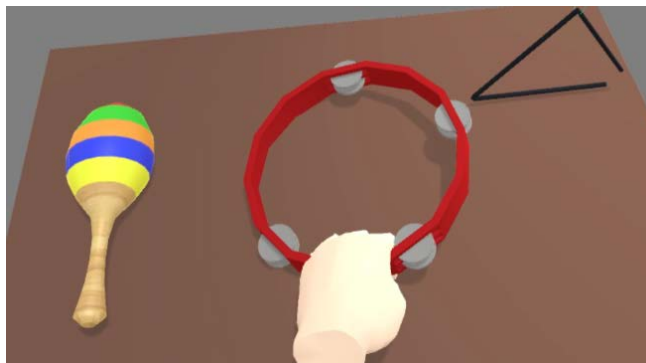
virtual reality musical instruments (VRMI) [9]. The three playable VRMIs can be seen on Figure 3.

### **Participants & Procedure**

A total of 12 children and 4 teachers from the treatment school participated in the study. The participants were recruited by the teachers from the school. Participation occurred over one day during school hours. The teachers conducted the study without the presence of the researchers to create a more comfortable environment for the children suffering from social anxieties. The teachers made sure that the study followed all the ethical principles of their school. The children were evaluated through a quantitative smiley-based Likert-scale questionnaire with 13 questions. 4 of the questions were given before the stimuli, 4 during, and 5 after. The questions delved into presence & copresence, but also the experience in relation to their anxiety. Afterwards, the teachers were evaluated in a semi-structured interview session, which explored different subjects: the children's and their experience, as well as the potential of implementing VRET at the treatment school.

### **Results & Discussion**

One of the prominent features was the ability to produce all states of copresence and social presence illusions, as this is evident throughout all the teachers statements collectively, in correlation with the answers from the children. However, the teachers desired more interaction between the participants themselves and with the surrounding VE. The statement is understandable as there is no difference between the two participating players and their interactive abilities. By incorporating different interactive abilities, which prompts cooperation and a reactive VE system, it could contribute to a richer and enhanced experience. In turn, this can lead to a more personalized stimuli exposure, as the teacher can direct the experience to match the par-



**Figure 3:** The 3 VRMIs that could be played while watching the experience.

icipating child's needs. In the perspective of therapy, one of the benefits of using a social VR is that it creates a stronger bond of empathy, as both parties experience the same stimuli. Therefore, the two parties have a mutual understanding of what was witnessed when they talk about the experience afterward. Additionally, precise verbal communication can be hard for diagnosed children. Hence it was easier for the child to visually communicate concerns in regards to specific areas in the stimuli with the rigged avatar, which can lead to optimized treatment of the phobia or anxiety.

Usability issues of the social VR experience had an impact on the overall presence, as the following elements distracted the children: Alternating audio levels between high and low, the possibility to place a VRMI in the virtual space that defied gravity, and a sound delay when playing the interactive VRMIs. Collectively it became a significant issue as inconsistency can be categorized as distraction, and can easily change the desired focus. Children with ASD have a hard time keeping attention to subjects that are not of their

specific interest and like to point out inconsistencies [1, 3]. While the children felt they had both presence and copresence, they were not fond of sharing the space. The cause of this could be that the teacher was in there with them, as a representative of an authority figure and the fear of being judged. A proposed solution is to have a conversation in regards to the lower score of sharing space, which hopefully can shed light if there is a correlation to presence.

## Conclusion

The aim of the study was to explore how a 360° virtual reality experience would fare itself as an exposure therapy method for children diagnosed with ASD and social anxiety. The prototype used interactive VRMIs in combination with the social possibility of having both a child and their teacher inside the same VE (see a video presentation of the social VR application [here](#)). Tests were conducted on children and teachers from a treatment school and the data was analysed through a qualitative method and triangulated with a quantitative questionnaire.

This paper provided an investigation into diagnosed children's motivation with novel technology. The prototype managed to have the children achieve copresence and enjoy a social scenario, through the social interactions and representation of an avatar with moving head and hands and interactive VRMIs. The possibility of social interactions inspired the teachers to come up with methods on how they could use or build upon social features to guide the children further in their therapy sessions.

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