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Factors Affecting Sense of Presence in a Virtual Reality Social Environment: A Qualitative Study

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Abstract

Sense of presence is an important factor influencing the quality of the virtual reality (VR) experience. However, there is limited understanding of what factors affect presence in virtual environments. This study uses a qualitative methodology, specifically thematic analysis, to investigate factors affecting sense of presence in a VR social environment that has been designed for psychological assessment. After experiencing a virtual bar-room that contained interactions with multiple avatars, participants ($n = 76$) took part in a semistructured interview. Eight key themes and associated subthemes were identified: emotions about self (anxiety, paranoid ideation, and detachment), emotions about others (loneliness, retrospective emotions, and recognition of self), thoughts about self (memories and social judgment), thoughts about others (paranoid ideation and narrative), physiological reactions (anxiety and cybersickness), behavior of avatars (narrative, duration of interaction, and characteristics), interactivity with environment (movement and familiarity), and environmental characteristics (restrictions). Sense of presence was facilitated when the VR elicited genuine cognitive, emotional, and behavioral responses, and when participants created their own narrative about events. Presence decreased when participants experienced diminished agency and experienced physical impediments, such as cybersickness and awareness of apparatus and body movement. Strengths of the study include rich data generated by the qualitative approach and the large sample size. Limitations include lack of follow-up measuring longer-term effects.

Keywords: virtual reality, sense of presence, social environment, psychological assessment, qualitative research, thematic analysis

Introduction

"SENSE OF PRESENCE" has been defined as a state of consciousness reliant on the perception of "being there" in virtual reality (VR) environments[1] and as "a psychological state in which virtual objects are experienced as actual objects in either sensory or nonsensory ways."[2] The ontological status of sense of presence aims to surpass simple perception of "objective" physical features of perceived reality and extend to immersion in a sociocultural web.[3] Presence is believed to govern aspects of autonomic responses and higher-level behaviors in virtual environments.[4]

Factors affecting presence in virtual environments have been studied since the 1990s. However, as VR devices and environments become more sophisticated, we need to refine and revisit this topic. Overtly social environments that aim to situate participants in sociocultural settings have rarely been used in previous VR studies on paranoid ideation, so it is important to investigate presence for such environments; qualitative methods have rarely been used in this area and may provide insights into participants' subjective experience of presence; and any newly designed VR environment will need to be validated as a measurement tool for psychological assessment.

In a previous study, participants found the VR environment elicited an acceptable quantitative measure of sense of presence; exposure to the VR environment elicited a range of cognitive, emotional, and behavioral components of social performance; and high trait paranoia participants reported higher state paranoia and greater negative components of social performance.[5] In this study, we use qualitative methodology (thematic analysis) to investigate factors affecting

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Table 1. Key Factors Affecting Sense of Presence in a Virtual Reality Social Environment

Theme	*Subtheme*	*Illustrative quote*	*Explanation*	*Effect on presence*
Internal factors				
Emotions about self	Anxiety	*"It makes you more anxious because no one was talking to me and I didn't know whether I should go." (#14)*	Participants reported that the environment elicited the genuine sensation of anxiety	Increased
	Paranoid ideation	*"The paranoia really kind of heightened when you went closer to people" (#240)*	Participants reported that the environment elicited the genuine sensation of paranoia	Increased
	Detachment	*"It never felt completely real…it felt like I was sort of playing with emotions a little bit like, you know, if you were acting…you're also playing with the emotions. You know it's okay deep down…there's some safety underneath it all, whereas in real social situation…there's a real feeling of 'Oh my god I could actually be excluded from this group, this has implications', whereas this doesn't have implications." (#58)*	Some participants reported that the environment seemed unreal and this led to a felt sense of performance with a lack of implications, rather than genuine involvement in the environment	Decreased
Emotions about others	Loneliness	*"I feel like I tried to…be myself in the situation but it felt like…I was being ignored…and I felt like…there was some hostile acknowledgement…if they talked to me and said 'we really don't want you to be here' that would feel less awkward than just hearing nothing and complete isolation." (#122)*	Participants reported feeling ignored, isolated, and receiving a hostile response	Increased
	Retrospective emotions	*"Even though I know it wasn't real it still kind of triggered memories of times when you're worried about that, or times when you've been in situations where they aren't as stark as that but you have had time where you've felt like you're not relevant to the conversation or they're not really bothered about including you" (#141)*	Participants reported experiencing memories and retrospective emotions despite diminished presence	Both increased and decreased
	Recognition of self	*"They said 'What was…your favourite TV show at the moment?' That was the moment that I sort of felt 'I have to say something interesting.' That's…how I'd feel in a social situation." (#4)*	Participant acknowledged that their responses were identical to how they would be in real life	Increased
Thoughts about self	Memories	*"There's another thing about the structure of the memory which I think would of stood out for me as well because it felt like a real memory but thinking back about it, it felt all very real." (#240)*	Participants observed that the recall of events occurred in a similar way to recall of a real-life event	Increased
	Social judgment	*"When I first went into the bar and that guy Patrick he was saying 'hello' to me and everyone said 'hi' to me, I thought everyone was being welcoming" (#183)*	Participants made social judgments about avatars and allocated characteristics to them	Increased
Thoughts about others	Paranoid ideation	*"One person who came right up to me…before he spoke, you wondered if he was about to attack you" (#1)*	Some participants experienced paranoid ideation about intentions of the avatars	Increased
	Narrative	*"I wondered how they knew Patrick and more importantly how I knew Patrick." (#500)*	Participants reported curiosity about the characters, which led to them creating their own narratives	Both increased and decreased
		"More plot development because…you walk into a pub with people you don't know and you try to interact with them…I see…tables with their own social group…so maybe get a bit background on who the people at each table are…" (#147)	Other participants reported a lack of narrative in the social situation and wanted more information about people at the party	

(*continued*)

Table 1. (Continued)

Theme	*Subtheme*	*Illustrative quote*	*Explanation*	*Effect on presence*
Physiological reactions	Anxiety	*"I felt quite anxious and then I got warmer because of being anxious and the lens thing steamed up and then and so that just intensified my social anxiety." (#13)*	Participants reported getting hot/sweating due to the environment eliciting anxiety while at the same time this brought their attention to the VR apparatus	Both increased and decreased
	Cybersickness	*"I had a bit of motion sickness" (#11)*	A small number of participants reported mild cybersickness	Decreased
External factors				
Behavior of avatars	Narrative	*"It didn't seem too foreign in how people acted in a pub at least early on the evening, just people standing around, chatting…it just seemed like normal people drinking at a pub." (#508)*	Some participants created a narrative to explain why the avatars behaved the way they did	Increased
	Duration of interaction	*"I really wanted to talk to them I don't know what I must do with them because there was, there was running to the next situation…there was no position, no possibility to stay longer there" (#555)*	Some participants felt the short duration of the interactions prevented more involved discussions	Decreased
	Characteristics	*"The facial expressions of the people and the way they talked felt unreal" (#11)*	Some participants felt that the voices and facial expressions were unrealistic	Decreased
Interactivity with environment	Movement	*"I was aware that it was not real…there was difficulty moving around" (#4)*	Some participants found movement difficult	Decreased
	Familiarity	*"I thought it was like walking in a pub in Camberwell, it was like I was walking into the Phoenix pub after work and seeing you know a whole diverse bunch of people in different crowds." (#89)*	The perceived familiarity of environmental characteristics triggered memories	Increased
Environmental characteristics	Restrictions	*"I wanted to go and get a drink. My initial instinct was to go, and would be to go get a drink from the bar and stand around and look around and size people up. That's what I would've done in a real situation. I wouldn't have walked up to people straight away but…obviously I was forced to go to a group." (#137)*	Some participants reported restricted control over their actions due to limitations of the environment	Decreased

VR, virtual reality.

presence in a newly created VR social environment designed for psychological assessment of paranoid ideation in social situations.

Methods

Participants

Participants were recruited from a larger study ($n = 609$),[5] and had been selected for a VR substudy based on scoring high ($\geq$85th percentile) or low ($\leq$15th percentile) in trait paranoia, as measured by the Green et al. Paranoid Thought Scales.[6] Participants were included if aged 18–65 and fluent English speakers but excluded if they self-reported diagnosis of a serious mental health condition, a neurological disorder, learning disability, or epilepsy.

Procedure

Participants completed a VR task and then took part in a semistructured interview consisting of seven open questions on their thoughts, emotions, and behaviors in VR (e.g., ''What did you think about your VR experience?''; ''Do you think the people in the social situation had any intentions towards you?''), with one question specifically evaluating sense of presence (''How did you think the virtual social situation compared with your experience of being in real social situations?''). This question aimed to evaluate a state of consciousness reliant on the perception of ''being there,'' rather than just the similarity judgment between real and virtual social situations. The interview template was designed for measuring persecutory ideation in VR environments and was adapted from previous VR research.[7,8] Participants were allocated a participant number based on their participation in a larger study. They were paid £10. Interviews were audio recorded, transcribed, and anonymized.

VR environment and apparatus

Participants wore an Oculus Rift Developer version 2 head-mounted display, with noise canceling headphones, and moved in the VR with a combination of a computer control pad and by physically turning their body direction. The virtual social scenario was a party in a bar-room, lasting $\sim$5 minutes. Following previous research, participants were given the following instruction: ''While you are in the bar please try to get an impression of what the people in the bar think about you and what you think about them. If someone asks you a question, try to reply to them.''[9] The bar was populated by female and male avatars that appeared to be in their 20s or 30s, and represented various ethnicities. In the bar, participants were initially met by the host of the party and were asked to introduce themselves. In response, avatars turned toward the participants and greeted them. There were then four brief group interactions. At the final interaction, participants were asked about their favorite television program by a male avatar.

Analysis

Interviews were analyzed using Nvivo11. Thematic analysis was employed with the aim of understanding factors affecting presence. Themes were distinguished into internal and external factors.[10] Researchers determined whether presence was increased or decreased based on subjective experience reported by participants. Subjective experiences that indicated increases were cognitive, emotional, or behavioral responses that appeared to be reliant on their perception of ''being there'' in the virtual social situation. Decreases were indicated by equivalent deficits in perception of ''being there.'' On this basis, an evaluation of ''increased'' or ''decreased'' presence was recorded. Three researchers (S.R., S.E., and L.V.) independently coded transcripts for themes. Analysis was regularly discussed among researchers and identified themes compared until a consensus was reached.

Results

There were 76 participants and the mean age was 31.45 (*SD* 10.706, range 18–65); there were 49 women and 65% were of white ethnicity. Eight key themes with associated subthemes were identified: emotions about self (anxiety, paranoid ideation, and detachment), emotions about others (loneliness, retrospective emotions, and recognition of self), thoughts about self (memories and social judgment), thoughts about others (paranoid ideation and narrative), physiological reactions (anxiety and cybersickness), behavior of avatars (narrative, duration of interaction, and characteristics), interactivity with environment (movement and familiarity), and environmental characteristics (restrictions). Table 1 provides details of themes and subthemes.

Discussion

The aim of this study was to investigate factors that affect sense of presence in a virtual social environment, which had previously been shown to generate acceptable sense of presence.[5] These more-detailed qualitative findings suggest that presence was facilitated when the VR elicited genuine cognitive, emotional, and behavioral responses; and when participants created their own narrative about events or situated themselves in a sociocultural web[3] integrated with memories. Emphasis on narrative is consistent with research that highlights the connection with immersion in VR,[3,11,12] and may be an important area for future research. These findings confirm the potential of VR as an adjunct to therapy to elicit real-time emotional, cognitive and behavioral responses similar to real life.[13]

Presence decreased when participants experienced diminished agency and physical impediments, such as cybersickness and awareness of apparatus and body movement. Body movement[14] and cybersickness[15,16] are well-known target areas in the design of new apparatus. Strengths of the study include the large sample size and rich data generated by semistructured interviews employing a qualitative approach so that we could gain insight into participants' subjective experience of presence. Limitations include lack of follow-up measuring longer-term effects.

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Author Disclosure Statement

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