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**DO EMPATHIC TENDENCIES PREDICT A STATE
EMPATHY AND SOCIAL PRESENCE IN VR?
A STUDY ON SOCIAL EXPERIENCE DURING
A COLLABORATIVE VR TASK.**

Faculty of Information Technology and Communication Sciences
M. Sc. Thesis
February 2023

ABSTRACT

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M.Sc. Thesis

Tampere University

Master's Degree Programme in Human-Technology Interaction

February 2023

Social platforms that allow people to interact with each other through shared immersive virtual reality (Social VR) are gaining more and more popularity. They allow users to transfer the social part of many aspects of life, such as leisure, travel, education, and collaborative work, into the virtual space since such communication is much closer to face-to-face communication than any previous social platform. As a result, it becomes critical to study the factors that can hinder the social experience of VR. The key concepts for evaluating social experience in VR are social presence and empathy. The former relates to the perceived realness of other people in VR, and the latter relates to how susceptible users are to others' emotional states. Our work aimed to determine if individual differences in a person's empathic tendencies affect their experience of social presence and understanding of others' emotions in VR. To achieve it, we designed a laboratory experiment followed by constructing regression models in which empathic tendencies were analysed as predictors of social presence and empathic accuracy. An additional predictor was the condition of the experiment that allows people to customize their avatars. With this predictor, we tested the hypothesis that conveying more social cues through the avatar's appearance could increase social presence. The uniqueness of the experiment was that it was run simultaneously by two researchers with two participants who interacted with each other only in a virtual room. The participants had to solve a collaborative spatial puzzle, which requires an assessment of the partner's perspective on a physical object in order to solve it. Unlike most experiments on empathy and social presence, this task required focusing on a third object and not on a partner, which is more in line with the realities of working in a team. The results did not find a statistically significant association between empathic tendencies and social presence or a better understanding of one's partners' emotions during this task. The ability to express oneself through avatar customization was also not significantly related to the increased social presence in dyads.

Key words and terms: Social presence, Social VR, Empathy, Coblock, IRI, Empathic tendencies

The originality of this thesis has been checked using the Turnitin OriginalityCheck service.

Preface

This thesis was written for the Gamification group as part of the POSTEMOTION project dedicated to social interaction within an immersive virtual environment. It is a 4-year project funded by the Academy of Finland (grant number 342144). The data for this thesis is taken from an experiment conducted in September-October 2022. I would like to thank my supervisor, Doctor Simo Järvelä who helped filter my ideas, criticized my work, and always provided constructive advice, and my supervisor, Doctor Bojan Kerous who helped me manage the equipment and ran the experiment with me. I am also very grateful to the whole POSTEMOTION team and, in particular, to Doctor Mila Bujić, who organized this experiment and always supported me when I had questions. Finally, I want to thank Professor Juho Hamari for the opportunity to be part of his research group and get familiar with the working process of cutting-edge scientists. Many of the skills that I have mastered while writing these theses I have acquired thanks to their examples.

Tampere, 08.02.2023

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1. Introduction

The lockdown during the Covid-19 pandemic, which made people work and communicate for a long time in isolation, has significantly increased the search for technologies able to provide authentic and meaningful social interactions over a distance (Sykownik et al., 2021). The most promising technology in this direction is immersive virtual reality, which can provide a more comprehensive range of sensations owing to Head Mounted Displays (HMD). These devices deliver visual and sound signals, replacing sensations from the actual world. As a result, users can entirely focus on the interaction inside virtual spaces. However, not all people are able to experience the same realistic experience of social interactions, and it depends on both the users' personality (Cortese & Seo, 2012) and on what information they receive about the communication partner (Von der Pütten et al., 2009). The measure of this experience is historically *social presence*, the psychological state in which a virtual social being is experienced as an actual one. From the very beginning of research on VR as a medium with social actors, social presence has been a key concept demonstrating how close the experience of communication in an immersive virtual environment is to face-to-face communication (Biocca & Harms, 2002). Although personality traits can influence the sense of social presence, they have received significantly less attention in VR research compared to external factors such as environmental characteristics or virtual agents (Oh et al., 2018). Finding personality traits that can influence social experiences in virtual reality is essential for future developments because understanding the factors that prevent some people from getting the experience they need allows systems to be improved to fit more people. This is especially true now when Social VR gains popularity in the entertainment industry and, according to Popescu et al. (2022), has great promise for companies to increase its use for employee collaboration. Understanding each other and adapting to relationships within virtual environments can significantly affect employees' productivity. Moreover, such research helps to open a new perspective on the human psychological processes in immersive VR environments and will provide a basis for future research comparing the work of psychological and social patterns in the real world and in the virtual world. Another important aspect of social experience is *empathy*, the process of understanding and responding to inferred feelings of others. Understanding other people's emotional states can be crucial to maintaining a positive atmosphere while performing collaborative tasks in a team.

This work focuses on empathic tendencies, and their relationship with the ability of people to experience social presence and understand other people's emotions in virtual reality. Tendencies in this context are personal dispositions to consider others' emotions in different situations. Research on the relationship between personality traits (Von der Pütten et al., 2010; Kim et al., 2016) empathic tendencies (Sbordone et al., 2021) and social interaction experience in VR has already been conducted. However, they were aimed at evaluating the interaction with virtual artificial agents. This may be due to organizational difficulties associated with the simultaneous operation of multiple HMDs (Yassien et al., 2020). Our research explores the social presence and empathy people experience when interacting with each other in VR using full-body avatars. It required two researchers who simultaneously facilitated the experiment for two different participants, connected only online. Social presence evaluation was done on the model of Biocca & Harms (2002), using their Networked Minds questionnaire. It is the most popular tool dedicated to the study of social presence, which allows the data obtained in our experiment to be compared to other scholars' research on this topic. Since empathy is a very broad concept, we need to clarify that we were working with empathic accuracy, the degree of how close the participant's description of their partner's emotional states was to the actual emotional states of their partners.

Our hypotheses were tested under two different conditions: one group of participants was allowed to customize their own avatar, and the other group used a default neutral avatar. In this way, we tested an additional hypothesis about the possibility of self-expression in dyads using avatar customization as a potential predictor of the level of social presence. Thus, our study expands our understanding of what personal traits can or cannot affect the social experience in virtual reality and whether it is possible to change the level of social presence by manipulating the features of the avatars.

2. Background

2.1 Social VR

Since the release of mass-market virtual reality (VR) headsets such as the HTC Vive and Oculus Rift in 2016, the popularity of Head-mounted displays that allow users to interact in immersive virtual environments has dramatically increased (Epp et al., 2021). It contributed to the development of social platforms based on this technology. "Immersive" in this context means capable of "delivering the surrounding environment, one which shut out sensation from the real world." (Slatter, 1999). Such technology opens up completely unique opportunities for social interaction. For example, they allow more non-verbal information to be conveyed through the avatars' body movement, sharing sensory experiences with others, or provide more opportunities for collaborative content creation. (Sykownik et al., 2021; Wang, 2020)

Altspace VR, VR Chat, RecRoom, and Neos VR are some examples of popular social platforms that use VR technology. Wang (2020) considers them to be a completely natural next level in the evolution of online social platforms such as Facebook or WeChat, as they provide an experience similar to offline interaction but do not have spatial constraints inherent in face-to-face communication. The term "Social VR" is often associated with these platforms and Sykownik et al. (2021) describe it as "an emerging ecology of applications that enable geographically remote users to interact with each other in shared virtual environments through VR technology, i.e., immersive head-mounted displays." A more precise definition is provided by Mystakidis et al. (2017), who use the terms multi-user virtual environments (MUVE) and social virtual reality (Social VR) interchangeably, defining them as three-dimensional computer-generated virtual spaces that offer social immersion. To Wang (2020), Social VR is "the application of VR technology in the social field."

A content analysis of users' free-text responses by Sykownik et al. (2021) shows that participation in social VR serves as a valuable substitute for social interactions in the actual world, particularly when certain circumstances restrict their opportunities to engage in offline interactions. For example, some participants in this study noted the inability to go outside and interact with others due to infection control measures during the Covid-19 pandemic. Although it indicates that the Covid-19 lockdown could cause an increase in interest in Social VR, it was not the main motivation to use it. The most common motive for using it was the basic desire to stay in

touch with other people. Finally, an important social motive was the unique experience and authenticity of communication in VR. In a Sykownik et al. (2021) study, 75% of respondents agreed that they would experience a social closeness in social VR that they cannot or do not want to experience in real life. The same proportion of respondents agreed that they cannot or do not want to experience such closeness in other social applications. They noted that the experience of the physical presence of others gives everything a more genuine feeling.

Presence is often used as a measure of the "goodness" of a virtual experience (Skarbez et al., 2018), as this experience can provide many benefits of direct interaction without directly interacting with actual objects. In the case of social VR, special emphasis is placed on making virtual representations of other users (avatars) perceived as actual people. Therefore, it makes sense to discuss in more detail in the next section the presence of others (social presence).

2.2 Presence and social presence

The most commonly used is the very first definition of social presence coined by Short et al. (1976): "degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships." However, it is often criticized because it is vague and very open to interpretation, which leads to conceptual pluralism. The concept of social presence is highly popular in different, often barely connected areas of research, such as information systems (Schultze & Brooks, 2019), online education (Lowenthal & Snelson, 2017), and marketing (Ying et al., 2022). As a result, a lot of modern definitions have nothing to do with each other. Kreijns et al. (2022) even call this concept a "severe case of the jingle-fallacy" because several different concepts are mistaken for the same one due to the same name causing equivocal research results. Moreover, Özto & Kehrwald (2017) ponder about the "killing" of this term because it has lost its analytical strength.

One way to solve this problem is to clearly define the term, separate it from similar concepts and integrate it into a general theory of presence. The definition of Lee (2004), which we will use as the basis of our work, seems to be the most suitable for these purposes. Social presence, according to him, is *"a psychological state in which virtual (para-authentic or artificial) social actors are experienced as actual social actors in either sensory or non-sensory ways."*

This definition is a special case of "presence" which is a psychological state in which people fail (often partially) to feel the virtuality of entities. Depending on what kind of virtual object a person perceives as an actual entity, Lee (2004) also distinguishes "physical presence" (in the case of physical objects) and self-presence (in the case of his own body). This is a convenient classification that does not differ much from modern ideas about the concept of "presence" (Skarbez et al., 2017). Another advantage of this definition is that Lee (2004) avoids "real" when he talks about objects and replaces it with the word "actual". Thus, he avoids the Cartesian Dualism between objective (physical) and subjective (mental) reality. "Actual simply means that something can potentially be experienced by human sensory systems without using technology... It does not require the existence of something independent of human mentality" (Lee, 2004). This saves us from additional reasoning about "What is real" in contrast to similar modern definitions. For example, even Skarbez et al. (2017), who have conducted the largest analysis of presence and related concepts, define "presence" as "the perceived realness of a mediated or virtual experience." Lee makes a clear distinction between natural perception and presence. Claiming that "natural perception" is "the sensory experience of actual objects." For him, if we perceive a person or other social actor through our sensory systems, this is not a presence but simply a perception since there is no technology between us that would make this experience virtual. "Virtual" for him is any object generated or represented by technology. If it is a representation of an object that exists in the physical world (our friend's virtual avatar), it's a para-authentic object. If this object does not have any authentic connection to actual objects (NPC inside the computer game), then it is an artificial object. Another important difference between perception and presence is the possibility of non-sensory experience for the latter. It means that the object does not necessarily affect the sensory systems directly. Just some information about the object is enough. For example, a person can feel the presence of game characters just by reading about them during a text-based RPG.

Lee (2004) does not provide an explanation for the "social actor." Öztok & Kehrwald (2017) explain that social actors are "potentially viable partners for social interaction", but they do not explain what kind of interaction we can call "social." In the framework of this work, we will consider the "social interactions" interactions between "sentient beings." It was used by Oh et al. (2018) in a large-scale systematic review of social presence in VR, when they described what is often meant by "another" in the most simplified and popular in HTI research definition of social presence, "sense of being with another."

Kreijns et al. (2022) tried to solve the "jingle-fallacy" by reformulating the original definition from Short et al. (1976), which was a starting point for the evolutionary branches of all modern definitions. They created a definition very similar to Lee's (2004) and considered it a convenient way of combining most existing definitions and separating related concepts.

Social presence is *"a psychological phenomenon in which, to a certain extent, the others are perceived as physical "real" persons in technology-mediated communication enabled by CMC tools and electronic platforms"* (Kreijns et al., 2022).

Even though it indeed brings some clarity into research and is in line with the purpose of our paper, we prefer Lee's definition for several reasons. First, Lee's (2004) definition does not contradict but broadens the version from "Kreijns et al. (2022)". Lee does not limit it to only computer-mediated communication and electronic platforms and thus takes into account situations that include non-electronic technologies. For example, the feeling of the presence of another during paper correspondence with them. Second, the word "real" leads to a significant complication of the concept and can exacerbate the situation due to various interpretations. Third, they use "person," which also severely limits the definition since, in today's world, there are many non-anthropomorphic agents and avatars that are also capable of social interaction. It does not interfere but rather supports the idea of Kreijns et al. (2022) that the robust theory of social presence with a single, shared understanding of it facilitates comparison of current results in social presence research and provides credibility to future experiments. Kreijns et al. (2022) also separated the definitions of social presence as a psychological phenomenon, as a characteristic of a system, and as a characteristic of a group. They insisted that only the first concept should be called "social presence".

Özto & Kehrwald (2017) came to a similar interpretation after deciding that researchers should come to a systematic theory instead of "killing social presence" since this concept is needed to consider technology-mediated social processes. They call it a "subjective feeling of being with other salient social actors in a technologically mediated space". They also discuss the importance of drawing a line between what social presence IS and what it DOES. In other words, we have to differentiate the concept and its effects. Kreijns et al. (2022) refer to such effects as "salience of communication", which then resulted in such definitions of presence as "sense of belonging," "sense of connection," and "sense of community." A sense of social presence can initiate all this,

but for us, they are separate though related concepts. All definitions that "emphasize the interpersonal connection between participants" Kreijns et al. (2022) refer to the concept of "Social space", which describes the network of interpersonal relationships embedded in a group. It is also very important to distinguish between social presence *Is* and what social presence is *Affected by*. Since we have defined social presence as a psychological phenomenon, another term is needed for the objective characteristics of the environment that can contribute to this phenomenon. Kreijns et al. (2022) suggest "sociability" as a "capacity of CMC tools and electronic platforms to allow for the expression of social presence, the experience of it."

Now that we have separated social presence from other terms, we need to find a way to measure it. The most commonly used and psychometrically validated social presence questionnaire is the Networked Mind developed by Harms & Biocca (2004). It was built on their idea of social presence as a special case of the general theory of mind. According to this concept, social presence occurs when a person starts to imagine a mental model of another's mind. This fits perfectly with our definition because for us sentient being is somebody who has a mind. Mind in turn, is a set of intentional, affective, or cognitive states and processes. The experience of social presence can be divided based on the level of accessibility to these processes in another being.

At the very first level, a person is simply aware that the virtual entity has a mind, but they do not make any effort to present a mental model of this mind. This is the most elementary level called Co-presence. This process begins when a person feels that others who have minds are close enough to be perceived without technology. This feeling is automatically triggered when a person sees morphological properties of humans and almost any stimuli that appear animate (Biocca & Harms, 2002). At the same level, the person might feel that the entity can also be aware of them. The next level is Psychobehavioral Accessibility of the other, which means that a person experiences the mental model of another entity's mind. In other words, they imagine its mental processes and, at the same time, feel the influence of these processes on themselves. First, a person pays attention to the entity to start representing the model and tries to understand if they attract the entity's attention (Attentional Allocation). Depending on the complexity of the created mental model, people try to understand and experience the entity's emotions (Affective Understanding). And finally, if the entity seems intelligent enough, people can try to understand its thoughts (Message Understanding). At the highest level, which is called Mutual Social Presence, people feel that the

entity has a mental model of these people's minds. At this level, people feel how the entity's emotions and thoughts respond to their behavior and how their emotions and behavior change depending on what the entity seems to feel or think (Emotional and Behavioral Interdependence).

2.3 Empathy and empathic tendencies

The concept of empathy is closely related to social presence because the processes of experiencing the emotions of another described at high levels of social presence are examples of empathy toward a virtual entity. In addition, it is also closely intertwined with the theory of mind. There are two main approaches to the study of empathy: The study of empathy as a communicative process of understanding and responding to the (inferred) feelings and emotions of others (Jensen, 2012) and the study of empathy as a trait inherent in a particular person. The latter can be divided into empathic tendencies (Detert et al., 2008) and empathic abilities (Leiberg, & Anders, S. 2006). Empathic tendencies include consistent patterns in the way individuals behave, feel, and think that include the elements needed to form empathy. Tendencies are determined by the frequency of certain behaviors or thoughts and do not necessarily lead to the achievement of empathy. Abilities, in contrast, is possession of the means or skill to comprehend another's feelings and to re-experience them oneself". The success of achieving empathy determines them. Although abilities and tendencies can influence each other, they should be distinguished. A person with a high ability to understand other people's emotions may not always be willing to do so (Schrooten & de Jong, 2017). On the other hand, a person who has the behavioral predisposition to pay attention to other people's emotions may be completely wrong about their state and never achieve a similar emotional state.

The process of empathy itself is also a complex hierarchical structure consisting of many processes that are united by the fact that they are all associated with the real or imagined emotions of another being (Schurz et al., 2021). In order to understand exactly how empathy, empathic traits, and empathic tendencies can be associated with a social presence, we need to describe this model in more detail. Jensen (2012) states that there is some consensus among psychologists and neuroscientists that this process consists of three different aspects.

- 1) The process of inferring what the other person feels is "cognitive empathy." It can occur in different ways. A person can analyze the expression of another and conclude their emotional state. Alternatively, they can infer the emotional state of another by analyzing the situation and using the knowledge of how people feel under such conditions. An indicator of the strength of cognitive empathy is empathic accuracy. This is the degree to which individuals accurately infer the thoughts and feelings of a target person (Clark et al., 2019). It is measured by the difference between a person's conclusions about the emotional state of another and the actual emotional state of another.
- 2) Affective empathy is the process by which the emotional state of one becomes similar to the emotional state of another as a result of a perceived, imagined, or inferred affective state of another. In other words, it is an emotional convergence elicited by the affective state of another (rather than external factors acting on one and the other). If a person is scared because they feel that the other person is scared, this is an example of affective empathy. If both people are equally scared because they are in a frightening environment, this is still an emotional convergence, but it does not meet our definition of affective empathy. The strength of affective empathy is determined by how converged emotions are, up to the absolute congruence of emotions, when a person experiences the same feelings as another. Although it is impossible to test directly, we can draw such conclusions if people experience the same physiological responses and accompany this with similar self-reports.
- 3) And finally, empathic responding, which means an emotional reaction to the emotions of another that is not accompanied by emotional convergence. It usually takes the form of sympathy (mostly positive feelings aimed at supporting or protecting the other) or personal distress (mostly negative feelings caused by the emotions of the other but not directed at them). The strength of empathic responding is determined by the strength of the emotions evoked.

All three of these processes often occur simultaneously or after each other. For example, a person can unconsciously feel the emotions of another, focus on these feelings, and draw a conclusion about the state of the other (affective empathy followed by cognitive empathy). On the other hand, a person can hear about the situation of another, imagine their emotions, and then be affected by the feelings they imagine (cognitive empathy followed by affective empathy).

The relationship between empathic abilities and empathy is established by definition. If a person cannot respond to other people's emotional states, then they have low empathic abilities. On the other hand, the relationship between empathic tendencies and empathy is not as clear-cut as tendencies simply describe the frequency of situations in which people have a chance to experience empathy.

However, research shows a clear connection between certain tendencies and empathy in actual interaction. For example, empathic accuracy may correlate with a tendency to take someone else's perspective (Israelashvili et al., 2019) or with a tendency to identify with characters of stories (Namba et al., 2021). Both of these tendencies were described by Davis (1980), and our goal is to see if these connections are also observed in Virtual Reality, where cues conveying information about the emotional state of the other are somewhat limited. First empathic tendency on our list is Perspective Taking, which Davis (1980) characterizes as a "tendency to spontaneous attempts to adopt the perspectives of other people and see things from their point of view." The more often a person makes such attempts, the higher this tendency. We call this the empathic tendency because adopting someone's perspective may be accompanied by an analysis of their emotional states, which means eliciting the process of empathy. The next tendency described by Davis (1980) is very close to the previous one. It is called Fantasy and reflects the "tendency to identify with characters in movies, novels, plays, and other fictional situations." It is also related to seeing the world through the eyes of another and is thus connected to the process of empathy.

We chose Davis' (1980) model because the tendencies he describes do not overlap with empathic abilities and can be measured through self-reports. The Interpersonal Reactivity Index (IRI) he created is also the most popular tool for tracking empathic traits (Hall & Schwartz, 2019). IRI includes four scales, each dedicated to one tendency. We will describe three of them because the fourth tendency, called "Personal distress," has little to do with the empathic response of the same name described above. It is often criticized (Hall & Schwartz, 2019) for not being correlated with other definitions of empathy and rather describes the tendencies to distress in general, whether or not the other's emotions cause it.

The last tendency from his model that we will assess as a potential predictor of social presence and empathic accuracy is Empathic Concern. He describes it as "feelings of warmth, compassion,

and concern for others undergoing negative experiences." In other words, it is the tendency to feel the sympathy described above towards those in distress.

In the next section, we will describe and justify our hypotheses about the proposed connection of these scales to actual empathic accuracy and the experience of the social presence of others in virtual reality.

3. Current research

Based on the theories and models presented above, we have established two main research questions for our study.

RQ:1. Does personal empathic tendencies predict empathic accuracy and social presence in virtual reality?

RQ:2. Does the avatar customization feature in a dyad affect the social presence in virtual reality?

To answer them, we will use six hypotheses, which we will further explain. Hypotheses related to empathic tendencies are generally based on the idea that the higher these tendencies, the more willingly a person builds mental models of others needed to feel the presence and understand other people's emotions. Practicing considering situations from another's perspective can serve to develop empathic skills, as a person eventually gets used to paying attention to the necessary signals characterizing the emotional state of another. Israelashvili et al. (2019) demonstrate this in their study in which people with high Perspective Taking have a better understanding of emotions in pictures and videos. They claim that such people get used to paying attention to important signs, such as a gaze. However, even the most advanced commercial VR avatars fail to convey emotional undertones, such as precise mimics around the eyes, so it is important to understand whether people with high Perspective Taking will be more successful in this environment.

***Hypothesis 1:** Self-reported Perspective Taking will positively correlate with empathic accuracy of all emotion dimensions (will negatively correlate with the differences between reported partners' emotional state and their self-reported state)*

Namba et al. (2021) explain the correlation between Fantasy and empathic accuracy by saying that reading stories raises consciousness of multiple perspectives and provides substrates for critical thinking. This may lead to taking into account more factors in face-to-face interaction with actual people and thus increase empathic accuracy. We assume that such people can be more successful in inferring others' emotions also in VR.

***Hypothesis 2:** Self-reported Fantasy will positively correlate with empathic accuracy of all emotion dimensions.*

Empathic tendencies always involve interaction with the mental state of another (even the imaginary one). This means that they are inextricably linked to constructing a mental model and can hypothetically be associated with social presence. Since by imagining oneself in the place of another person, one can imagine what the other is feeling, thinking, or paying attention to, we assume that people who tend to put themselves in the place of others will do the same with virtual others. In this way, they can more easily perceive their virtual partner as an actual social actor. Moreover, by imagining the mind of another, people can more strongly feel that their own thoughts and behavior are influenced by their partner.

Thus, we propose ***Hypothesis 3: Self-reported Perspective Taking will positively correlate with all dimensions of Social Presence***

Fantasy is of particular interest to us because the fictional aspect of this trait is closely related to the artificial nature of VR. People who score high on this scale are accustomed to building mental models of others in artificial worlds. Thus, we can assume that by meeting another person's avatar in the virtual world, these people will be able to feel their social presence more vividly than people with low Fantasy scores.

Hypothesis 4: Self-reported Fantasy will positively correlate with all dimensions of Social Presence.

The last empathic tendency we analyze is Empathic Concern. Increased compassion for others in distress may indicate increased sensitivity to the emotional state of others. Increased sensitivity, in turn, means increased response and may be associated with the feeling that the behavior and emotions of the participant are more influenced by the manifestation of the emotions and behavior of his partner.

Hypothesis 5: Self-reported Empathic Concern scale will positively correlate with high Emotional and Behavioral Interdependence.

Our last hypothesis is built on the idea that by expressing their personality through avatars, people provide more social cues necessary for a stronger experience of social presence in a dyad. Oh, et al. (2018) argue, based on research (Li et al., 2015; Choi & Kwak, 2017), that cues that

offer insight into the "true" identity of their virtual partner(s) enhance social presence. Apple et al. (2012) also argue that social cues indicating a partner's humanness may play a more significant role than the communication partner's agency. The more elements of an agent can provide information about its emotional state or intentions, the more vividly its social presence is experienced because its mental model is easier to build with more information. Such elements can be avatar features that indicate the user's identity, personal preferences, or mood. When a participant can create an avatar expressing such personal cues through its appearance, it signals the partner that they are an active social actor. Thus, it can be assumed that the possibility of self-expression through the avatar in dyads will affect the level of social presence, so we included it in our model as a potential predictor of social presence along with personality traits. We hence hypothesized that by observing other people's ways of expressing themselves, a person could feel more strongly that their partners have a certain background and more vividly imagine their motives or moods. Therefore, features for self-expression in a dyad, such as the ability to customize one's avatar, seem to be a conducive environment for increasing social presence.

Hypothesis 6: *Participants in dyads with the option to customize their avatars will have a higher score in every dimension of Social Presence.*

4. Methods

This study is a between-subject laboratory experiment that determines the relationship between empathic tendencies, social presence, and empathic accuracy under different controlled conditions (dyads that creates their own avatars versus those that use default avatars).

4.1. Participants

Sixty-six people were involved in the study in total. Eleven of them were excluded from the analysis for various reasons. Data from four people were excluded due to technical errors, four people failed the attention test, one person left the experiment before finishing the questionnaire, and two were familiar with each other. The final sample included 55 people aged 19 to 45 years (25 males, 27 females, and three preferred not to answer). The participants were randomly divided into two groups. Twenty-eight people in the experimental group had the opportunity to customize their avatars, and twenty-seven people in the control group used default avatars provided by the researchers. Participants were recruited using University mailing lists and physical flyers posted around the campus. They had to fit the following requirements: 18 years of age, normal or corrected vision, and at least B2 English level. Another requirement for analyzing data was that the participants must not know each other before the experiment since familiarity with a person can affect the experience of social presence and empathy during interaction with them (Bouchard et al., 2013). Therefore, in the instructions, the participants were asked not to reserve the same time with their friends or acquaintances.

4.2. Technical Setup

The experiment was conducted in two rooms using the HTC Vive Pro Eye head-mounted display for interaction in VR. It contained two Dual OLED screens with a resolution of 1440×1600 per eye and a refresh rate of 90 Hz. The position of the participant's body was displayed in VR space using Valve Index controllers that track the movements of the hands and fingers and HTC trackers 3.0 that track the legs and torso. The virtual space contained three rooms (a training room, a meeting room, and a main task room). All rooms contained instructions on the walls and mirrors. The last room also contained a set of red and white 3D virtual figures needed to solve Coblock

(Wikström et al., 2020). All rooms were made on the Unity engine and uploaded to the VRchat server.

Users created avatars using the ReadyPlayerMe service and directly uploaded them to VRchat. All tasks were performed inside the VRchat social platform. Everything that people saw with glasses was transmitted to the facilitator's computer screen and recorded using the OBS Studio recording program. Each participant also wore an Empatica E4 wristband to measure electrodermal activity, data from which were collected for other studies.

4.3. Experimental task

The participant had to solve the collaborative Co-block problem (Wikström et al., 2020) of arranging 3D shapes using 2D perspective cards. Both participants always see a different perspective, and the figure must match both. For example, a triangle on one card and a circle on another card means that they need to select a cone (white shapes in Figures 1, 2). Each time both participants agree that the task is solved, one of them must click on the "Finish" button and move on to the next task. Participants were given 15 minutes to complete ten tasks. However, the timer was not visible to them.

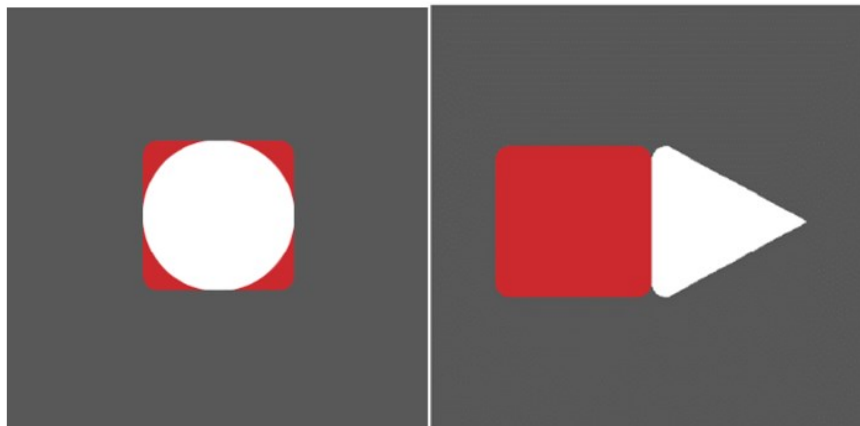


Figure 1. Perspectives for participants A (left) and B (right).

The main stimuli present in the participant's field of vision during the task is a virtual puzzle card, which demonstrates the perspective in which the participant needs to build virtual figures (Figure 1). This card moves with the participant's head and shows a two-dimensional perspective of the

three-dimensional figure to be assembled. Physical stimuli also included 3D figures -blocks that needed to be manipulated, buttons for moving to a new room, selecting tasks, and notifying about task completion.

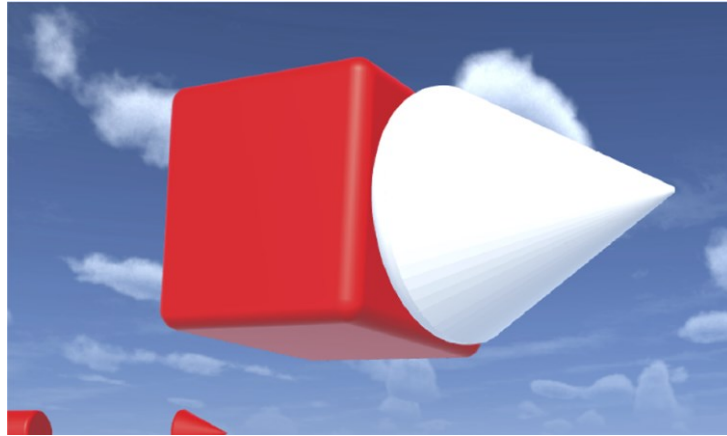


Figure 2. Example of a Co-block solution.

Also, visual stimuli are the appearance of the participant's avatar, which they can see in the mirror (Figure 3), and the appearance of the partner's avatar.



Figure 3. Reflections of the participant's avatar and their partner's avatar in the mirror.

This task was chosen for several reasons. First, this is a collaborative task that is impossible to complete without communication with a partner since only they see the second perspective of the figures. Perspective from the left shape (Figure 1) can as well be interpreted as a "cube and ball," whereas the right shape fits the description of a "cylinder and pyramid." Second, this task requires a literal consideration of the partner's perspective on a physical object. It would be interesting to know how this intersects with such an empathic trend as perspective-taking, which describes tendencies to the same process in a more general context. Finally, collaborative tasks that do not involve deliberate analysis of the thoughts and emotions of the partner are usually not used by researchers of empathy and social presence. It seems an omission since most interactions, from online games to project working collaboration, always have a common goal in addition to communication. Studying social presence and empathy towards a partner while focusing on a separate task can give us more material on what exactly to pay attention to in social VR in the future when more attention is paid to creating a healthy working environment in virtual offices.

4.4. Procedure

Before arriving at the university, participants got acquainted with the details of the experiment online. All participants were informed about the risks associated with the experimental protocol. They filled out questionnaires with demographic data and the Interpersonal Reactivity Index (Davis, 1980) through the LimeSurvey online system. After that, they ordered the preferred time of the experiment. If two participants choose the same time, they form a pair, and the experimenter notifies them that they have successfully registered for the experiment. If the pair did not form, the participant was offered another time. After arriving in the experimental room and introducing themselves to the experimenter, a participant was asked to read the informed consent. Two experimenters simultaneously carried out the experiment in two different rooms and communicated with each other in an online chat. None of the participants interacted with the partner offline prior to the experiment. When both participants were in their rooms, they were seated at the computer and asked to create an avatar using ReadyPlayerMe (Figure 4) for seven given minutes. The next step was a baseline during which the experimenter uploaded avatars and turned on VRChat.



Figure 4. Avatar creation on ReadyPlayerMe.

After the baseline, the participants were instructed about the controllers, sensors, and VR headsets. To go into VR space, participants put on headsets and sensors, which were calibrated in the virtual training room. In this room, they could read the instructions on the wall, but they also had the opportunity to communicate with the experimenter to get used to their avatar. Participants could practice grabbing 3d blocks and pressing buttons there. In the next online room, the microphone was unmuted for the participants, and they met their partners to introduce each other and go to the room to complete the task. During the entire process of completing the task, the experimenters were in the room and monitored the safety of the participants. After completing the task and saying goodbye to the partner, the participants sat at the computer to complete the remaining questionnaires in the online survey. They were asked to complete the Networked Minds questionnaire (Harms & Biocca, 2004) and report their and their partner's emotional state during the interaction using self-assessment manikins (Bradley & Lang, 1994). After completing all the procedures, the participants received a movie ticket as compensation.

4.5. Measures

The Interpersonal Reactivity Index (Davis, 1980) is the most popular measure of empathy as a trait. It has been adopted and used in many fields (Foxman et al., 2021) and translated into several languages (Keaton, 2017). This scale contains 28 statements assessed by a five-point Likert scale ranging from "does not describe me well" to "describes me well." They are divided into four subscales: Fantasy, Perspective Taking, Emotional Concern, and Personal Distress. All four subscales in the analyzed sample displayed sufficient reliability (Cronbach $\alpha > 0.7$). All items are presented in Appendix A. The main reason why we chose IRI is that it does not mix tendencies and abilities, which is not the case with many more modern empathy questionnaires. For example, Empathy Quotient (Baron-Cohen & Wheelwright, 2004) or Toronto Empathy Questionnaire (Spreng et al., 2009) ask the participant to evaluate not only their dispositions (felt subjectively) but also their ability to understand emotions (which can be objectively assessed). And assessing ability through self-reporting is a rather dubious and often criticized practice (Ilgunaite et al., 2017) People show various positive biases when reporting on their own competence (Wilson & Dunn, 2004).

Networked Minds (Harms & Biocca, 2004) is the most popular tool for evaluating social presence as a concept in computer science, as it provides a clear division of social presence into dimensions explained by theory. It consists of 6 scales, each containing six items related to the participant's feelings or thoughts about the nature of the mediated social interaction, which they need to evaluate on a 7-point Likert scale. All scales also fit the reliability requirements (Cronbach $\alpha > 0.7$) and can be found in Appendix B.

Self-assessment manikins (SAMs) (Bradley & Lang, 1994) is a pictorial assessment technique consists of three nine-point semantic differentials (arousal, valence, and dominance). This is the most convenient way to assess one's own emotions and those of a partner since it does not require much time, and the pictures are not so dependent on language interpretation. The problem of verbalization of one's own emotions is also facilitated by the fact that this technique uses a Dimensional approach to the study of emotions (Mehrabian, 1996). This approach is often used in HTI also because this form of self-reporting is easy to correlate with some objective signs of emotion, such as psychophysiological data. We adapted it for LimeSurvey using nine pictures for every row (Appendix C).

4.6. Data analysis

To test hypothesis 3- 6 for each of the dimensions of Social Presence, except Emotional Interdependence a multiple linear regression model was created with Perspective Taking, Fantasy, Emotional Concern, and Condition (Group with default avatar VS Group with customized avatar) as predictors. Emotional Interdependence was excluded because the residuals were not normally distributed ($Z = 0.126, p = 0.031$). The normality of the distribution of variables and residuals was tested using the Kolmogorov–Smirnov test. Autocorrelation in the residuals was tested using the Durbin-Watson test. Outliers outside 3 standard deviations were excluded from the analysis. For the Attentional Allocation and Affective Understanding one participant was excluded from the analysis because of outliers in the predicted values.

Data from only 50 people were used to analyze the results related to empathic accuracy since they can only be collected from participants whose partners were not excluded from the experiment. Residuals of regression models with all dimensions of empathic accuracy as dependent variables were not normally distributed, so correlation analysis instead of linear regression was chosen to test hypotheses 1 and 2. Since all scales of empathic accuracy were not normally distributed, Spearman's nonparametric correlation analysis was implemented. All calculations were carried out using the SPSS software (Version 27.0.1.0).

5. Results

As seen from Table 1, none of the linear regression models were within the range of statistical significance to suggest an association between the combinations of predictors presented and any of the dimensions of Social Presence.

Table 1
Linear regression models for Social Presence

Dimensions of SP	Predictors	Regression coefficient		R Square	Durbin–Watson	ANOVA	
		β	p			F	p
Co-presence	Perspective Taking	.067	.638	0.023	2.583	0.297	.879
	Fantasy	.062	.641				
	Emotional Concern	-.114	.546				
	Condition	-.157	.400				
Attentional Allocation	Perspective Taking	.371	.074	0.096	2.213	1.304	.281
	Fantasy	.088	.631				
	Emotional Concern	-.059	.815				
	Condition	.114	.639				
Message Understanding	Perspective Taking	.143	.532	0.037	1.931	0.481	.750
	Fantasy	-.078	.714				
	Emotional Concern	-.294	.337				
	Condition	.008	.978				
Affective understanding	Perspective Taking	.757	.008**	0.148	1.709	2.130	.091
	Fantasy	.326	.188				
	Emotional Concern	-.664	.054				
	Condition	.114	.555				
Behavioral interdependence	Perspective Taking	.272	.134	0.048	2.213	0.626	.646
	Fantasy	-.040	.810				
	Emotional Concern	-.166	.489				
	Condition	.020	.932				

Figure 5 demonstrates that all regression lines are almost parallel to the x-axis, meaning high empathic tendencies do not predict a significant increase in social presence. Slightly standing out on the graph is the model for Affective Understanding, the feeling that a user and their virtual partner are successfully capturing each other's emotional states. Since within the model describing Affective Understanding, Perspective Taking as a predictor fell into the range $p < .01$, we decided to build a separate model in which it was placed as the only predictor. According to the new model, Perspective Taking has a positive effect on Affective Understanding ($\beta = 0.468$, $p = .045$), explaining 7.5% of the variable's variability. Since the analysis contains multiple comparisons, the probability that this result is due to mere chance increases greatly, so we can only accept the hypothesis if $p < .006$ (Bonferroni correction). Thus, our hypotheses 3, 4, and 5 failed to reach the conventional threshold for statistical significance after Bonferroni correction. We found no significant relationship between empathic personal tendencies and experience of social presence.

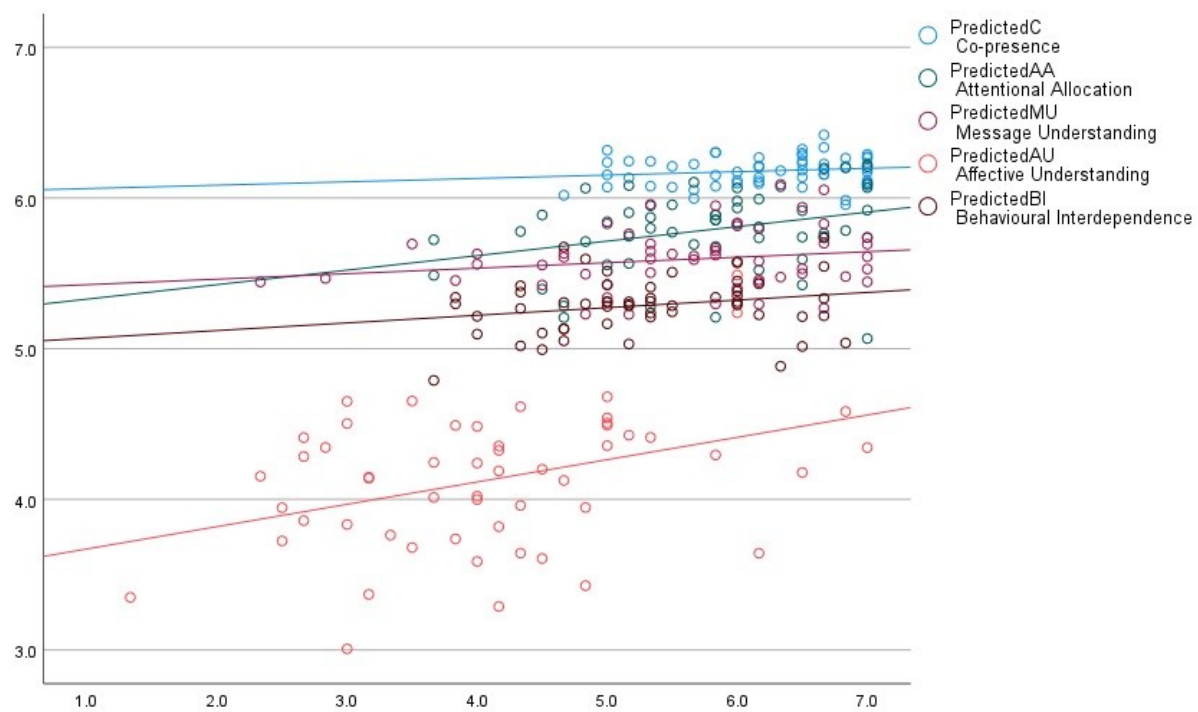


Figure 5. Regression lines for built models.

As can be seen from Table 1, the condition was also not a significant predictor in any of the models, which gives us reason to reject the hypothesis of relationship between the ability to customize

one's avatar in a dyad (Condition) and a sense of social presence. Figure 6 shows the average scores for each measure of social presence separately in the group where people could customize their avatar and the group with the default avatar. As can be seen from this bar charts, the difference between groups is minimal for each dimension of Social Presence.

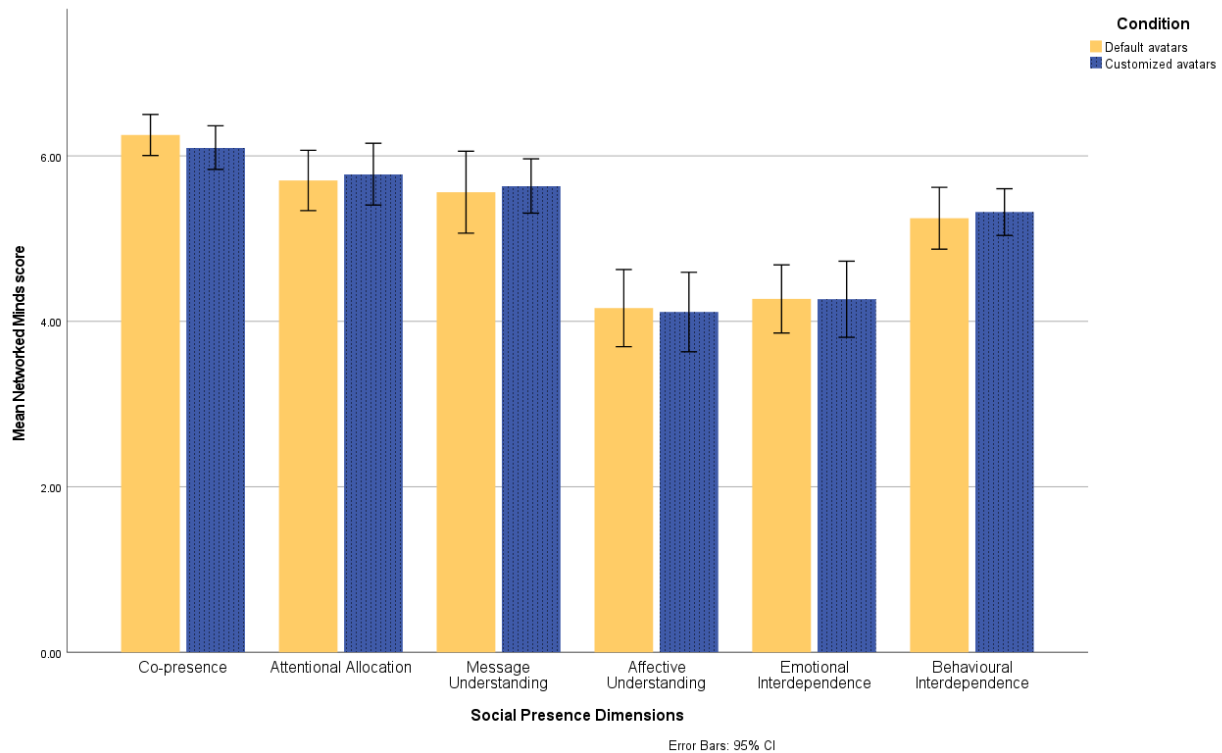


Figure 6. Social Presence dimensions means in two experimental groups.

Since not all scales fit the conditions for constructing regression models due to the non-normal distribution of residuals, we also conducted a Spearman correlation analysis (Table 2). The nonparametric test was chosen because the distribution of the Empathic Accuracy and Emotional Interdependence scales was not normal. None of the personality traits significantly correlated with a person's ability to guess another person's emotional state. Thus, we did not find the connections between the variables described in Hypotheses 1 and 2. Despite the significance of the correlation between Perspective Taking and accuracy of emotional valence (pleasantness of experience) falling into the $p < .05$ range, we cannot accept this hypothesis due to the Bonferroni correction.

Table 2*Correlations between IRI subscales and dimensions of Social Presence and Empathic Accuracy*

	IRI scales					
	Fantasy		Perspective Taking		Emotional Concern	
Dimensions of Social Presence	r	p	r	p	r	p
Co-presence	0.047	.733	0.094	.494	0.02	.884
Attentional Allocation	0.12	.385	0.342	.011*	0.201	.142
Message Understanding	-0.116	.397	0.084	.54	-0.117	.396
Affective Understanding	0.032	.816	0.254	.061	-0.05	.72
Emotional Interdependence	-0.097	.48	0.257	.059	-0.105	.448
Behavioral Interdependence	-0.05	.717	0.186	.175	-0.005	.972
Emotion dimension for accuracy						
Arousal accuracy	-0.105	.468	-0.252	.077	-0.054	.710
Valence accuracy	-0.186	.196	-0.285	.045*	-0.156	.278
Dominance accuracy	0.031	.829	-0.056	0.699	-0.12	0.407

Thus, the current results do not support any of our hypothesis. Neither the empathic tendencies nor the freedom of representation through the avatar showed a statistically significant relationship with the level of social presence during the collaborative task in VR space. Empathic tendencies also found no connection with the actual ability to correctly infer the emotional state of others in a given virtual interaction.

6. Discussion

This study considers social presence and empathy as key concepts in assessing the social experience in VR during interaction with other people. The relevance of this thesis is determined by the growing popularity of social virtual reality platforms such as VRChat, within which our experiment was conducted. Factors that can influence social interaction in such environments are critical, as their understanding will set the direction for developing these platforms and expanding their applications.

This thesis aimed to study the relationship between personal, empathic tendencies, namely Perspective Taking, Fantasy, and Empathic Concern from the Davis (1980) model, and the experience of interacting with another person in virtual reality. It builds on the ideas of Israelashvili et al. (2019) and Namba et al. (2021), who studied the relationship between these tendencies and empathic accuracy in the physical world but transferred them to the virtual space. It also tested the idea that these traits might influence the perceived presence of one's virtual partner during a collaborative task. The Coblock task (Wikström et al., 2020) provided in this study is uniquely different from previous studies in that it aims to achieve a shared goal directed at an external entity rather than each other. Such tasks are much more in line with the realities of working in a team, where the task cannot be completed without considering the partner's perspective. Finally, this study analyzed how the freedom of representation through the avatar in dyads is reflected in the social presence.

This study found no relationship between empathic tendencies with either social presence or empathic accuracy. One possible explanation for this is focus of the participants during the task. They concentrated on the object of manipulation and did not pay attention to their partner's presence or emotional state. According to Israelashvili et al. (2019), perspective-taking is a cognitively demanding task that requires time, motivation, and attentional resources. Therefore, focusing on the task without specific instructions for partner analysis can lead to ignoring the partner's state, even though considering the partner's Perspective is necessary to achieve the task.

With a larger sample, we could have noticed some minor effects. Based on the analysis, without Bonferroni correction, Perspective Taking shows significant correlations with some dimensions of social presence, such as attentional allocation or affective understanding and

empathic accuracy. Nevertheless, a correlation that can only be recognized with a large sample means that the effect of empathic tendencies is relatively small. Thus, in tasks like CoBlock (Wikström et al., 2020), which require concentration on a common goal but not on the partner's personality or emotional state, low empathic tendencies do not seem to be a decisive factor in paying attention to the partner or better understanding their feelings. Although the partner's point of view of physical object was necessary to solve the problem, the content of this view was more important for the success than the state of those who provided this point of view.

According to our results, the likelihood that Fantasy or Empathic Concern are predictors of social presence is low. No correlations between these two traits and dimensions of the social presence or empathic accuracy were even on the 0.05 significance interval. People with high Fantasy scores did not experience a higher social presence simply because they were in a virtual world, as we had expected. The lack of connection might be explained by the task type, which does not focus on the partner. Another reason for it might be the nature of the setting itself. Even though virtual space has a similar nature to fiction due to its artificiality, there are still differences between them. For example, our Co-block task was straightforward and did not provide a story or plot to follow. In the future, it would be interesting to evaluate the connection between this trait and the social presence in the task with some fictional legend that needs to be sorted out.

Regarding avatar customization, no relationship was found between social presence and the ability of the dyad to express themselves using the appearance of their avatar during the collaborative task in VR. Like other hypotheses, the rejection of the hypothesis about the relationship between social presence during interaction and avatar customization may be related to the type of task. Although the participants had time to meet and evaluate each other's appearance, they did not pay much attention to it when completing the task.

Based on the results obtained, the ability to customize an avatar does not significantly impact social presence during collaborative tasks aimed at a common goal.

The limitations of this study are primarily the same as those of any other self-report-based study. There are always multiple biases affecting self-reporting. Even though people were fully informed about anonymity, the importance of their sincerity, lack of consequences, and social desirability factors could still influence some of the answers. This is especially true of the Empathic Concern. A possible limitation could be the participants' experience in VR. More than half of them either

had no experience in VR or rated their experience as very little. It seems reasonable to test our hypothesis in the future only on advanced users. Since they need less energy to get used to VR control, they may have more resources to pay attention to each other. Another limitation of the study was that most of the participants in the experiment were students or university employees recruited from a pool. Therefore, extrapolating these results to the entire population must be done cautiously and with remarks about it. Finally, a significant limitation is the sample size, which was not large enough to detect a small predictor effect. Furthermore, 11 people were excluded from the study due to various obstacles, such as technical difficulties or failing attention test.

Based on the results of this study, we cannot claim that in most modern collaborative tasks aimed at external objects, empathic tendencies will be reflected in the level of social presence or in the understanding of the partner's emotions. However, these results can change in more specific tasks that require deliberate focus on the partner rather than on the information they provide. It gives grounds for conducting a similar experiment in the future with a new type of task that requires an understanding of the internal states of the partners.

To conclude, our research is one of the first works that explore aspects of social presence simultaneously with two live human participants in an immersive virtual environment. This approach holds great promise due to the increasing availability of head-mounted displays and the transition of more and more aspects of our lives to VR. To assess the impact of empathic traits on the interaction experience, we chose the Coblock task since it creates conditions typical for many workflows where objects are collaboratively manipulated. Although this task requires consideration of the partner's perspective on a physical object, we found no relationship between Perspective Taking and the level of social presence or understanding of the partner's emotions when performing this task. The other predictors also did not show a significant relationship with these aspects of social experience in VR. Nevertheless, it does not mean that there is no connection. Our task was intentionally not focused on the partners, and we assume that the result might differ in more social situations, such as dating or negotiation. For future research on the influence of personality on experience in VR, we propose to conduct a similar experiment with other, more social types of tasks that require focusing on a partner's personality, appearance, or internal state. Understanding conditions in which the personality has or does not have a significant impact on the experience during interaction in the virtual space will determine which functionality in the rapidly

growing industry of social VR will be most in demand in the future. Research on this topic can reveal situations requiring special attention to make different people equally satisfied with interactions within the virtual space. The current study has taken one of the first steps in this direction.

References

1. Appel, J., von der Pütten, A., Krämer, N. C., & Gratch, J. (2012). Does Humanity Matter? Analyzing the Importance of Social Cues and Perceived Agency of a Computer System for the Emergence of Social Reactions during Human-Computer Interaction. *Advances in Human-Computer Interaction, 2012*, 1–10.
2. Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34*(2), 163–175.
3. Biocca, F., & Harms, C. (2002). Defining and measuring social presence: Contribution to the networked minds theory and measure. *Proceedings of PRESENCE, 2002*, 1-36.
4. Bouchard, S., Bernier, F., Boivin, É., Dumoulin, S., Laforest, M., Guitard, T., Robillard, G., Monthuy-Blanc, J., & Renaud, P. (2013). Empathy Toward Virtual Humans Depicting a Known or Unknown Person Expressing Pain. *Cyberpsychology, Behavior and Social Networking, 16*(1), 61–71.
5. Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry, 25*(1), 49–59.
6. Choi, J. J., & Kwak, S. S. (2017). Who is this?: Identity and presence in robot-mediated communication. *Cognitive Systems Research, 43*, 174–189.
7. Cortese, J., and Seo, M. (2012). The role of social presence in opinion expression during FtF and CMC discussions. *Commun. Res. Rep.* 29, 44–53.
8. Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *JSAS: Catalog of Selected Documents in Psychology, 10*, 1–17
9. Detert, J. R., Treviño, L. K., & Sweitzer, V. L. (2008). Moral Disengagement in Ethical Decision Making: A Study of Antecedents and Outcomes. *Journal of Applied Psychology, 93*(2), 374–391.
10. Epp, R., Lin, D., & Bezemer, C.-P. (2021). An Empirical Study of Trends of Popular Virtual Reality Games and Their Complaints. *IEEE Transactions on Games, 13*(3), 275–286.
11. Foxman, M., Markowitz, D. M., & Davis, D. Z. (2021). Defining empathy: Interconnected discourses of virtual reality’s prosocial impact. *New Media & Society, 23*(8), 2167–2188.
12. Hall, J. A., & Schwartz, R. (2019). Empathy present and future. *The Journal of Social Psychology, 159*(3), 225–243.
13. Harms, C., & Biocca, F. (2004). Internal consistency and reliability of the networked minds measure of social presence. In *Seventh annual international workshop: Presence* (Vol. 2004). Universidad Politecnica de Valencia Valencia, Spain.
14. Ilgunaite, G., Giromini, L., & Di Girolamo, M. (2017). Measuring empathy: A literature review of available tools. *Bollettino Di Psicologia Applicata, 65*(280), 2–28.
15. Israelashvili, Y., Sauter, D., & Fischer, A. (2019). How Well Can We Assess Our Ability to Understand Others’ Feelings? Beliefs About Taking Others’ Perspectives and Actual Understanding of Others’ Emotions. *Frontiers in Psychology, 10*, 2475–2475.

16. Janssen, J. H. (2012). A three-component framework for empathic technologies to augment human interaction. *Journal on Multimodal User Interfaces*, 6(3), 143–161.
17. Keaton, S. A. (2017). Interpersonal Reactivity Index (IRI). In *The Sourcebook of Listening Research* (pp. 340–347). John Wiley & Sons, Inc
18. Kim, K., Bruder, G., Maloney, D., & Welch, G. (2016). The influence of real human personality on social presence with a virtual human in augmented reality. *International Conference on Artificial Reality and Telexistence and Eurographics Symposium on Virtual Environments, ICAT-EGVE 2016*, 115–122.
19. Kreijns, C., Xu, M., & Weidlich, J. (2022). Social Presence: Conceptualization and Measurement. *Educational Psychology Review*, 34(1), 139–170.
20. Lee, K. M. (2004). Presence, Explicated. *Communication Theory*, 14(1), 27–50.
21. Leiberger, S., & Anders, S. (2006). The multiple facets of empathy: a survey of theory and evidence. *Progress in Brain Research*, 156, 419–440
22. Li, S., Feng, B., Li, N., & Tan, X. (2015). How Social Context Cues in Online Support-Seeking Influence Self-Disclosure in Support Provision. *Communication Quarterly*, 63(5), 586–602.
23. Lowenthal, P. R., & Snelson, C. (2017). In search of a better understanding of social presence: an investigation into how researchers define social presence. *Distance Education*, 38(2), 141–159.
24. Mehrabian, A. (1996). Pleasure-Arousal-Dominance: A general framework for describing and measuring individual differences in temperament. *Current Psychology*, 14(4), 261–292
25. Mystakidis, S., Berki, E., & Valtanen, J. (2017). Toward successfully integrating mini learning games into social virtual reality environments: Recommendations for improving open and distance learning. In *EDULEARN Proceedings*. IATED Academy.
26. Namba, S., Kabir, R. S., Matsuda, K., Noguchi, Y., Kambara, K., Kobayashi, R., Shigematsu, J., Miyatani, M., & Nakao, T. (2021). Fantasy Component of Interpersonal Reactivity is Associated with Empathic Accuracy: Findings from Behavioral Experiments with Implications for Applied Settings. *Reading Psychology*, 42(7), 788–806.
27. Oh, C. S., Bailenson, J. N., & Welch, G. F. (2018). A systematic review of social presence: Definition, antecedents, and implications. *Frontiers in Robotics and AI*, 5, 114–114
28. Öztok, M., & Kehrwald, B. A. (2017). Social presence reconsidered: moving beyond, going back, or killing social presence. *Distance Education*, 38(2), 259–266.
29. Popescu, G. H., Ciurlau, C. F., Stan, C. I., Bacanoiu, C., & Tanase, A. (2022). Virtual Workplaces in the Metaverse: Immersive Remote Collaboration Tools, Behavioral Predictive Analytics, and Extended Reality Technologies. *Psychosociological Issues in Human Resource Management*, 10(1), 21–34.
30. Sbordone, F. L., Orti, R., Ruotolo, F., Iachini, T., & Ruggiero, G. (2021). How empathic traits affect interactions with virtual agents. *CEUR Workshop Proceedings*, 3100.
31. Schrooten, I., & de Jong, M. D. T. (2017). If you could read my mind: The role of healthcare providers' empathic and communicative competencies in clients' satisfaction with consultations. *Health Communication*, 32, 111–118.

32. Schultze, U., & Brooks, J. A. M. (2019). An interactional view of social presence: Making the virtual other “real.” *Information Systems Journal (Oxford, England)*, 29(3), 707–737.
33. Schurz, M., Radua, J., Tholen, M. ., Maliske, L., Margulies, D. ., Mars, R. ., Sallet, J., & Kanske, P. (2021). Toward a hierarchical model of social cognition: A neuroimaging meta-analysis and integrative review of empathy and theory of mind. *Psychological Bulletin*, 147(3), 293–327.
34. Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. Wiley.
35. Skarbez, R., Brooks, J., & Whitton, M. (2018). A Survey of Presence and Related Concepts. *ACM Computing Surveys*, 50(6), 1–39.
36. Slater, M. (1999). Measuring Presence: A Response to the Witmer and Singer Presence Questionnaire. *Presence : Teleoperators and Virtual Environment*, 8(5), 560–565.
37. Spreng, R. N., McKinnon, M. C., Mar, R. A., & Levine, B. (2009). The Toronto Empathy Questionnaire: Scale Development and Initial Validation of a Factor-Analytic Solution to Multiple Empathy Measures. *Journal of Personality Assessment*, 91(1), 62–71.
38. Sykownik, P., Graf, L., Zils, C., & Masuch, M. (2021). The most social platform ever? A survey about activities motives of social VR users. *Proceedings - 2021 IEEE Conference on Virtual Reality and 3D User Interfaces, VR 2021*, 546–554.
39. von der Pütten, A. M., Krämer, N. C., & Gratch, J. (2009). Who’s There? Can a Virtual Agent Really Elicit Social Presence? In *International Workshop on Presence (PRESENCE)*, 2009 1-7
40. von der Pütten, A. M., Krämer, N. C., & Gratch, J. (2010). How Our Personality Shapes Our Interactions with Virtual Characters - Implications for Research and Development. *Intelligent Virtual Agents*, 6356, 208–221.
41. Wang, M. (2020). Social VR : A New Form of Social Communication in the Future or a Beautiful Illusion? *Journal of Physics. Conference Series*, 1518(1), 12032–.
42. Wikström, V., Martikainen, S., Falcon, M., Ruistola, J., & Saarikivi, K. (2020). Collaborative block design task for assessing pair performance in virtual reality and reality. *Heliyon*, 6(9), e04823–e04823
43. Wilson, T. D., & Dunn, E. W. (2004). Self-knowledge: Its limits, value, and potential for improvement. *Annual Review of Psychology*, 55(1), 493–518.
44. Yassien, A., Elagroudy, P., Makled, E., & Abdennadher, S. (2020). A Design Space for Social Presence in VR. *ACM International Conference Proceeding Series*.
45. Ying, T., Tang, J., Ye, S., Tan, X., & Wei, W. (2022). Virtual Reality in Destination Marketing: Telepresence, Social Presence, and Tourists’ Visit Intentions. *Journal of Travel Research*, 61(8), 1738–1756.

Appendix A

Interpersonal Reactivity Index**Davis (1980)**

Instruction: The following statements inquire about your thoughts and feelings in a variety of situations. For each item, indicate how well it describes you by choosing the appropriate number between 0 and 4, where "0" means "Does not describe me well" and "4" means "Describes me very well".

Fantasy Scale**Cronbach α = .805**

- 1 I daydream and fantasize, with some regularity, about things that might happen to me.
- 5 I really get involved with the feelings of the characters in a novel.
- 7 I am usually objective when I watch a movie or play, and I don't often get completely caught up in it. (-)
- 12 Becoming extremely involved in a good book or movie is somewhat rare for me. (-)
- 16 After seeing a play or movie, I have felt as though I were one of the characters.
- 23 When I watch a good movie, I can very easily put myself in the place of a leading character
- 26 When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.

Perspective Taking Scale**Cronbach α = .828**

- 3 I sometimes find it difficult to see things from the "other guy's" point of view. (-)
- 8 I try to look at everybody's side of a disagreement before I make a decision
- 11 I sometimes try to understand my friends better by imagining how things look from their perspective.
- 15 If I'm sure I'm right about something, I don't waste much time listening to other people's arguments. (-)
- 21 I believe that there are two sides to every question and try to look at them both.
- 25 When I'm upset at someone, I usually try to "put myself in his shoes" for a while.
- 28 Before criticizing somebody, I try to imagine how I would feel if I were in their place.

Empathic Concern Scale**Cronbach α = .728**

- 2 I often have tender, concerned feelings for people less fortunate than me.
- 4 Sometimes I don't feel sorry for other people when they are having problems. (-)
- 9 When I see someone being taken advantage of, I feel kind of protective toward them.
- 14 Other people's misfortunes do not usually disturb me a great deal. (-)
- 18 When I see someone being treated unfairly, I sometimes don't feel very much pity for them. (-)
- 20 I am often quite touched by things that I see happen.
- 22 I would describe myself as a pretty soft-hearted person.

Personal Distress Scale**Cronbach α = .722**

- 6 In emergency situations, I feel apprehensive and ill-at-ease.

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- 10 I sometimes feel helpless when I am in the middle of a very emotional situation.
 - 13 When I see someone get hurt, I tend to remain calm. (-)
 - 17 Being in a tense emotional situation scares me.
 - 19 I am usually pretty effective in dealing with emergencies. (-)
 - 24 I tend to lose control during emergencies.
 - 27 When I see someone who badly needs help in an emergency, I go to pieces.
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Appendix B

Networked Minds Social Presence Measure

Harms & Biocca (2004).

Co-presence	Cronbach α = .811
1 I noticed (the other player).	
2 (The other player) noticed me.	
3 (The other player's) presence was obvious to me.	
4 My presence was obvious to (the other player).	
5 (The other player) caught my attention.	
6 I caught (the other player's) attention.	
Attentional Allocation	Cronbach α = .772
7 I was easily distracted from (the other player) when other things were going on.	
8 (The other player) was easily distracted from me when other things were going on.	
9 I remained focused on (the other player) throughout our interaction.	
10 (The other player) remained focused on me throughout our interaction.	
11 (The other player) did not receive my full attention.	
12 I did not receive (the other player's) full attention.	
Perceived Message Understanding	Cronbach α = .892
13 My thoughts were clear to (the other player).	
14 (The other player's) thoughts were clear to me.	
15 It was easy to understand (the other player).	
16 (The other player) found it easy to understand me.	
17 Understanding (the other player) was difficult.	
18 (The other player) had difficulty understanding me.	
Perceived Affective Understanding	Cronbach α = .897
19 I could tell how (the other player) felt.	
20 (The other player) could tell how I felt.	
21 (The other player's) emotions were not clear to me.	
22 My emotions were not clear to (the other player).	
23 I could describe (the other player's) feelings accurately.	
24 (The other player) could describe my feelings accurately.	
Perceived Emotional Interdependence	Cronbach α = .848
25 I was sometimes influenced by (the other player's) moods.	
26 (The other player) was sometimes influenced by my moods.	
27 (The other player's) feelings influenced the mood of our interaction.	
28 My feelings influenced the mood of our interaction.	

29 (The other player's) attitudes influenced how I felt.

30 My attitudes influenced how (the other player) felt.

Perceived Behavioral Interdependence

Cronbach $\alpha = .800$

31 My behavior was often in direct response to (the other player's) behavior.

32 The behavior of (the other player) was often in direct response to my behavior.

33 I reciprocated (the other player's) actions.

34 (The other player) reciprocated my actions.

35 (The other player's) behavior was closely tied to my behavior.

36 My behavior was closely tied to (the other player's) behavior.
