How empathic traits affect interactions with virtual agents

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Abstract

Nowadays, virtual technology with embedded virtual agents is increasingly present in everyday life. Therefore, understanding the characteristics of psychological experience in social interaction with virtual agents can be useful for theoretical and application purposes. Here, we aim to understand whether individual differences in empathy can influence social interaction with virtual agents. To this end, we designed a correlational study comparing individual propensity towards empathic traits and the ability to take the perspective of a virtual agent (VA) to understand whether and how they are associated. In an Immersive Virtual Reality (IVR) scenario, participants had to locate a glass according to the perspective of a virtual agent. They were seated behind a circular virtual table around which, in various positions closer and further away, VAs with a glass placed in front of them could appear. Participants had to decide whether the glass was to the right or left of the VA's body midline. The results showed an association between some components of empathy and localization time: the higher the tendency to identify with a fictional character, the faster the participants were to locate the glass in all positions of the virtual agents around the table. Likewise, the higher the tendency to experience feelings of empathy, the faster they were in locating only when the VA was close to the observer. These preliminary results suggest that individual differences in empathy and the location of virtual agents help define how people experience virtual social interactions.

Keywords

Virtual agents, Immersive virtual reality, Empathy, Social interaction

1. Introduction

Nowadays, the Immersive Virtual Reality (IVR) is increasingly prevalent in different areas of daily life and scientific fields [1]. IVR is a computer-generated environment presented to the user through the head-mounted display (HMD). In IVR, people have the "feeling of being" in the virtual environment and interacting with the virtual agents (VAs) inside it [2-5]. The concept of "presence" describes this quality of subjective experience in IVR [5-8]. The sense of presence is rooted in a paradoxical state of consciousness: people, even though they know that what they see is not real, react as if it is. This happens because what we perceive is always mediated by the sensorimotor system. Therefore, even if we know that we are not really in the virtual environment and what we perceive is not real, we are "deceived" by the sensorimotor contingencies afforded by the IVR system and we respond realistically to it [5, 9]. One issue that is attracting the interest of researchers regards the extent to which we respond realistically when interacting with virtual humans. The concept of 'social presence' refers to a psychological state in which virtual humans are felt to be similar to real humans, similarly endowed with a mind and with whom one can interact [10, 11]. Technological advances are making computer-simulated agents increasingly similar in both appearance and behavior to real humans [12, 13].

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Although research has explored several factors that are associated with users' perception of virtual humans and social presence [14-17], little is known about the possible role of individual differences.

The IVR system allows the simulation of social interactions in such a way as to enable experimenters to control the appearance and behavior of VAs and the environment in which they act, while providing a high degree of ecological validity [2, 3, 18, 19]. Recent studies have shown that despite high-level awareness of being in a fictional virtual environment, we tend to attribute a "human-like reality" to artificial entities [1]. Iachini and colleagues [20, 3] have shown that virtual agents (VAs) are treated differently from objects and similarly to real humans. Behavioral and physiological evidence has shown that VAs displaying emotions cause emotional reactions that are reflected in different social distances and psychophysiological reactions [4, 21, 22]. Moreover, some studies suggest that we prefer VAs similar to our bodies and that we can form moral judgments about VAs and react to them by adjusting social distances [23, 24]. In sum, if VAs have a sufficiently 'natural' anthropomorphic appearance, we tend to attribute feelings and thoughts to them, as if we were identifying with them [11, 25, 26, 5]. In other words, we attribute to VAs what Dennett called "derived intentionality" [27, 28], i.e., we attribute human-like goals, desires and rationality to an artificial entity. Therefore, social interactions with VAs can afford a sense of "being with another" person [29, 30]. Here, we aim to understand whether individual differences in empathy can influence social interaction with virtual agents.

To this end, we designed a correlational study comparing individual propensity towards empathic traits and the ability to take the perspective of a VA to understand whether and how they are associated. In an Immersive Virtual Reality (IVR) scenario, participants had to locate a glass according to the perspective of a VA. They were seated behind a circular virtual table around which, in various positions closer and further away, a VA with a glass placed in front of him could appear. Participants had to decide whether the glass was to the right or left of the VA's body midline. The instruction then prompted participants to put themselves in the VA's shoes. Was this ability associated with the individual propensity toward empathic traits? Answering this question could help us understand how individual differences affect the propensity to identify with VAs, i.e. an important component of social presence. To assess individual differences in empathy, participants underwent the Interpersonal Reactivity Index (IRI) [32], before being immersed in the virtual scenario. We expected that the higher the empathic propensity the faster the participants should be in locating the glass from the VA's perspective. Answering this question would have theoretical (i.e. the nature of our conscious experience in IVR) and practical (i.e. how can we favor a purported interaction with VAs?) implications.

2. Method

2.1. Participants

Thirty-eight right-handed participants (12 males) aged between 20-37 years of age (Mage = 25.32; SD = 4.09), took part to the experiment in exchange of course credit. Participants had normal/corrected-to-normal vision. Nobody claimed discomfort or vertigo during the IVR experience and reported being aware of the experimental purpose. All participants gave their written consent to take part in the study. The study was in conformity with the local Ethics Committee requirements and the Declaration of Helsinki [32].

2.2. Setting and apparatus

The experiment was carried out in the Laboratory of Cognitive Science and Immersive Virtual Reality (CS-IVR, Dept. of Psychology, Univ. Vanvitelli). The IVR equipment was installed in a rectangular room (5 m × 4 m × 3 m) and included the 3-D Vizard Virtual Reality Software Toolkit (Development Edition 4.10; WorldViz LLC). Virtual stimuli were presented through a Sony HMZ-T1 (SONY, JAP) head-mounted display (HMD) with two OLED displays providing stereoscopic depth. The stereoscopic images ran at 1280 × 720 resolution (per eye) and were refreshed at 60 Hz. The virtual scenario spanned 45° horizontally and 51.6° diagonally. The IVR system allowed participants to experience dynamic stereoscopic visual stimuli in a naturalistic way.

2.3. Virtual scenario and virtual stimuli

The virtual stimuli consisted of a 3D room (3 m × 2.4 m × 3 m) displayed with green walls and grey floor, containing a chair, a circular table and a glass on it (see Figure 1). The virtual stimuli were created by means of the 3D modeling free software SketchUp (Trimble, https://www.sketchup.com) and were imported into the Virtual Reality Software Toolkit (Worldviz LLC) and used in previous studies [33, 34]. A virtual young male adult VA was selected from a database of characters (Vizard Complete Characters, WorldViz, USA). The choice to use only male VA is based on previous studies that investigated the role of motor resources in peripersonal space with manipulable vs. non-manipulable objects [33] and in shared vs. non-shared space with other avatars [34].

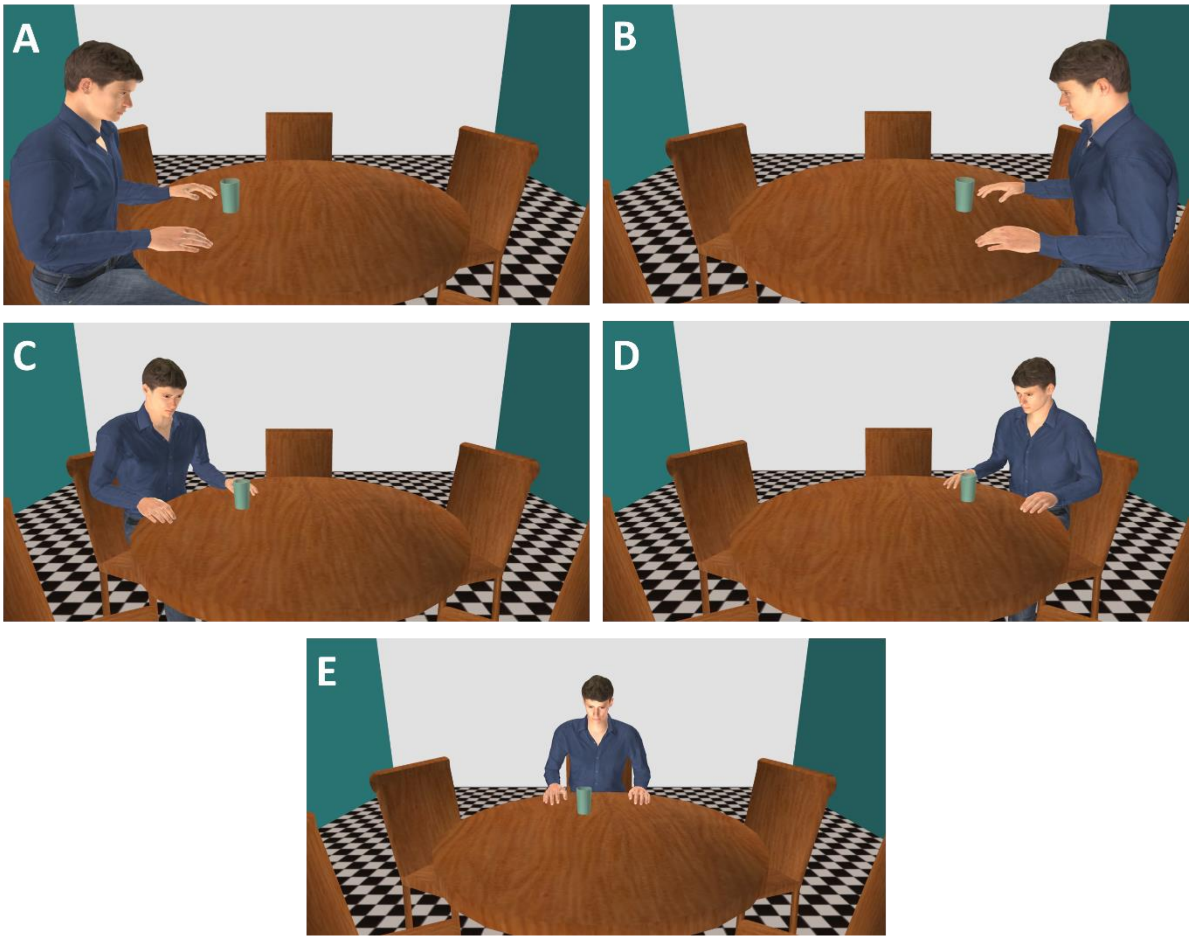

Figure 1: The figure shows the virtual agent in the five different positions according to the participant's point of view: A) close on the left side; B) close on the right side; C) far on the left side; D) far on the right side; E) far in front.

2.4. The interpersonal reactivity index (IRI)

The IRI [32] measures on a 5-step Likert-type scale (from ‘‘never true’’ to ‘‘always true’’) various facets of dispositional empathy through four subscales (7-items each): Perspective Taking, tendency to adopt the psychological point of view of others (e.g., ‘‘I sometimes try to understand my friends better by imagining how things look from their perspective’’); Fantasy, tendency to identify with a fictional character (e.g., ‘‘After seeing a play or movie, I have felt as though I was one of the characters’’); Empathic Concern, tendency to experience feelings of sympathy and compassion for unfortunate others (e.g., ‘‘I often have tender, concerned feelings for people less fortunate than me’’); Personal Distress, tendency to experience discomfort in distress situations (e.g., ‘‘Being in a tense emotional situation scares me’’).

3. Procedure

After completing the IRI scale, participants were instructed about the task, invited to sit on a comfortable chair, to wear the HMD, to rest their head on a chinrest, and to put their left hand on a mouse. Before starting the experimental session, participants underwent a training session aimed at clarifying the entire procedure and making them familiar with the IVR devices. If everything was clear, the experimental session started. In the virtual room, the participant saw the circular table, the VAs and the glass in front of them (see Figure 1). Sitting in the virtual chair was simulated with the participant actually sitting in a chair in the laboratory. The VAs could appear in five positions in relation to the participants: 40 cm away on their left or right side, 150 cm away on their left or right side or in front of them. The glass always appeared close to the VAs, 20 cm from them. The glass could appear on the right or left side in relation to the midline of the VA's body-midline at four different distances on each side: 4 mm, 8 mm, 12 mm or 16 mm, as already used in previous studies [33, 34]. Participants had to judge whether the glass appeared to the right or left of the VA's body (left/right localization judgement). The glass could appear in eight right/left positions, each repeated twice (total = 80trials).

Each trial started with a gray fixation cross. Participants had to fixate the cross (100 ms), followed by a blank screen (1000 ms) and then stimuli were presented (300 ms). Once the stimulus disappeared, they had to locate the position of the glass by pressing the corresponding right or left mouse button. The participants were instructed to respond as accurately and quickly as possible. Response time (ms) of correct responses (RTs) measured the performance. The overall accuracy of the performance was quite high (91%). At the end of the experimental session, participants were asked to report whether they encountered difficulties in the task, whether the stimuli were easily discriminable and whether or not they could touch the glass and the VA (on the use of verbal reports to assess the perceptual experience in IVR see [35]). Participants reported that they did not encounter any difficulties in the task, that VAs and glass were easily discriminable and reachable in nearby space and were easily discriminable but unreachable when they were far away.

4. Results

Mean RTs of correct responses for each of the five VAs' positions around the table were calculated. Pearson's correlation analysis was performed between these mean RTs and the means of the four IRI sub-scales. A negative correlation between the subscale Fantasy and RTs emerged: the more the participants reported a tendency to identify with fictious characters (Fantasy), the faster they were in locating the glass in all VAs' positions around the table (see Table 1). In addition, the more participants rated themselves as being empathic with other people (Empathic Concern), they located faster the glass but only when the VA was near to them (see Table 1). The Perspective Taking and Personal Distress sub-scales showed no significant correlation with the RTs.

Table 1.
Correlation between the IRI subscales and mean localization times (ms) for spatial judgments provided for the five VA positions (N=38).

	Near - Left	Near - Right	Far - Left	Far - Right	Front - Far
Fantasy	**-.394***	**-.477***	**-.503***	**-.333***	**-.405***
Empathic concern	**-.375***	**-.526***	-.232	-.164	-.154
Perspective taking	-.255	-.247	-.138	-.212	-.142
Personal distress	-.187	-.223	-.183	-.133	-.220

*FDR-corrected *p* value. Asterisks indicate a significant value (at least $p < .05$).

5. Discussion

The presence of VAs in IVR environments increases user engagement and the realism of the virtual experience and facilitates interaction [16]. The present study aimed to explore the relationship between individual differences and social interaction with virtual agents by assessing whether individual propensity towards empathic traits is associated with the ability to assume the perspective of a VA. Participants were seated behind a circular virtual table around which VAs with a glass in front of them could appear in various near and far positions.

The results confirmed the hypothesis that the ability to assume the point of view of a VA is associated with specific individual empathic traits. Indeed, a negative correlation between the tendency to identify with a fictional character (Fantasy) and RTs emerged: the higher this tendency the faster participants were to locate the glass in relation to VAs appearing in all near and far positions around the table. This is not surprising since the virtual scenario and the characters acting in it can be seen as a kind of theatrical medium [36]. Clearly, the user is at the center of the experience in virtual interaction, unlike in theatre or cinema. However, our results suggest that alongside the credibility and technological quality of the virtual simulation, our general propensity to identify with the fictional characters also plays a role in the "social presence" in IVR.

Moreover, a negative correlation was found between the tendency to experience feelings of empathy (Empathic Concern) and the time to locate the glass but only when the VA was close to the observer, not far: the higher this tendency the faster participants were to locate the glass in relation to near VAs. This finding can be interpreted by considering literature showing that the space near our body reflects the degree of intimacy or comfort we feel with other people [37-39], and that the capacity to quickly encoding stimuli close to us would facilitate appropriate approaching or defensive reactions [23, 34, 40]. In other words, the space near our body is connoted by the emotions aroused by other people and can therefore be linked to the feelings of closeness, sympathy or concern that we tend to have for others. By contrast, the tendency to adopt the psychological viewpoint of others (Perspective Taking) and the tendency to experience discomfort in dangerous situations (Personal Distress) showed no significant association with the time to locate the glass from the Vas' perspective. However, the current study presents limitations and further studies are needed to understand, for example, why specific empathy components are associated to social experience with VAs and if the effect of the gender of the VAs may influence participants' subjective tendencies.

In sum, individual differences play a crucial role in interactions with VAs. Therefore, if we want to enhance the engagement and efficacy of virtual social interactions, we need to take them into account and pay attention to where VAs appear in the virtual environment.

6. References

[1] F. Morganti, G. Riva, Conoscenza, comunicazione e tecnologia: aspetti cognitivi della realtà virtuale, LED Edizioni Universitarie, 2006.

[2] J. N. Bailenson, J. Blascovich, A. C. Beall, J. M. Loomis, Interpersonal distance in immersive virtual environments, Personality and social psychology bulletin (2003) 819-833. https://doi.org/10.1177/0146167203029007002.

[3] T. Iachini, Y. Coello, F. Frassinetti, V. P. Senese, F. Galante, G. Ruggiero, Peripersonal and interpersonal space in virtual and real environments: Effects of gender and age, Journal of Environmental Psychology (2016) 154-164. https://doi.org/10.1016/j.jenvp.2016.01.004.

[4] G. Ruggiero, F. Frassinetti, Y. Coello, M. Rapuano, A. Schiano di Cola, T. Iachini, The effect of facial expressions on peripersonal and interpersonal spaces, Psychological Research (2017) 1232-1240.

[5] M. Slater, Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments, Philosophical transactions of the Royal Society B (2009) 3549–3557.

[6] M. Slater, S. Wilbur, A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments, Presence: Teleoperators and Virtual Environments (1997) 603-616. https://doi.org/10.1162/pres.1997.6.6.603.

[7] J. Steuer, Defining Virtual Reality: Dimensions Determining Telepresence, Journal of Communication (1992) 73-93. https://doi.org/10.1111/j.1460-2466.1992.tb00812.x.
[8] G. Riva, J. Waterworth, D. Murray, Interacting with Presence: HCI and the Sense of Presence in Computer-mediated Environments, Walter de Gruyter GmbH & Co KG, 2014.
[9] M. V. Sanchez-Vives, M. Slater, From presence to consciousness through virtual reality, Nature Reviews Neuroscience (2005) 332-339. https://doi.org/10.1038/nrn1651
[10] K. M. Lee, Presence, explicated, Communication theory (2004) 27-50.
[11] K. L. Nowak, F. Biocca, The effect of the agency and anthropomorphism on users' sense of telepresence, copresence, and social presence in virtual environments, Presence: Teleoperators and Virtual Environments (2003) 481-494.
[12] E. Brent, G. A. Thompson, Sociology: Modeling social interaction with autonomous agents, Social Science Computer Review (1999) 313-322.
[13] D. C. Dryer, Getting Personal with Computers: How to Design Personalities for Agents, Applied Artificial Intelligence (1999) 273-295.
[14] J. V. Draper, D. B. Kaber, J. M. Usher, Human factors, Telepresence (1998) 354-375.
[15] J. Steuer, Defining virtual reality: Dimensions determining telepresence, in: F. Biocca, M. Levy (Eds.), Communication in the age of virtual reality, Lawrence Erlbaum, Hillsdale, 1994, pp. 73-93.
[16] K. Nowak, Defining and differentiating copresence, social presence and presence as transportation, in: Proceedings of 4th Annual International Workshop on Presence, Philadelphia, PA, 2001.
[17] R. E. Rice, Media appropriateness: Using social presence theory to compare traditional and new organizational media, Human communication research (1993) 451-484.
[18] J. Blascovich, Immersive Virtual Environment Technology as a tool for Psychological Science, Psychological Science Agenda (2001) 8-9.
[19] J. M. Loomis, J. J. Blascovich, A. C. Beall, Immersive virtual environment technology as a basic research tool in psychology, Behavior research methods, instruments, & computers, (1999) 557-564.
[20] T. Iachini, Y. Coello, F. Frassinetti, G. Ruggiero, Body space in social interactions: A comparison of reaching and comfort distance in immersive virtual reality, PLoS ONE (2014) e111511.
[21] G. Ruggiero, M. Rapuano, A. Cartaud, Y. Coello, T. Iachini, Defensive functions provoke similar psychophysiological reactions in reaching and comfort spaces, Scientific Reports (2021) 1-12.
[22] M. Rapuano, A. Ferrara, F. L. Sbordone, F. Ruotolo, G. Ruggiero, T. Iachini, The appearance of the VA can enhance the sense of co-presence during virtual interactions with users, in: Proceedings of the 2nd Symposium on Psychology-Based Technologies, Naples, Italy, 2020.
[23] G. Ruggiero, M. Rapuano, T. Iachini, Perceived temperature modulates peripersonal and interpersonal spaces differently in men and women, Journal of Environmental Psychology (2019) 52-59.
[24] T. Iachini, S. Pagliaro, G. Ruggiero, Near or far? It depends on my impression: Moral information and spatial behavior in virtual interactions, Acta Psychologica (2015) 131-136. https://doi.org/10.1016/j.actpsy.2015.09.003
[25] K. L. Nowak, F. Biocca, Understanding the influence of agency and anthropomorphism on copresence, social presence and physical presence with virtual humans, Presence: Teleoperators & Virtual Environments, (2001) 481-494.
[26] G. Riva, C. Galimberti, Computer-mediated communication: identity and social interaction in an electronic environment, Genetic Social and General Psychology Monographs (1998) 434-464.
[27] D. C. Dennett, Brainstorms MIT Press, Cambridge, Mass, 1978.
[28] D. C. Dennett, The Intentional Stance Cambridge, Mass, 1987.
[29] F. Biocca, J. Burgoon, C. Harms, M. Stoner, Criteria and scope conditions for a theory and measure of social presence, in: Proceedings of 4th Annual International Workshop on Presence, Philadelphia, PA, 2001.
[30] F. Biocca, C. Harms, J. K. Burgoon, Toward a more robust theory and measure of social presence: Review and suggested criteria, Presence: Teleoperators & virtual environments (2003) 456-480.
[31] M. H. Davis, Measuring individual differences in empathy: Evidence for a multidimensional approach, Journal of Personality and Social Psychology (1983) 113-126. doi:10.1037/0022-3514.44.1.113.

[32] World Medical Association, World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects, JAMA (2013) 2191–2194. doi:10.1001/jama.2013.281053.
[33] T. Iachini, G. Ruggiero, F. Ruotolo, M. Vinciguerra, Motor resources in peripersonal space are intrinsic to spatial encoding: Evidence from motor interference, Acta psychologica (2014) 20-27.
[34] T. Iachini, G. Ruggiero, Can I put myself in your shoes? Sharing peripersonal space reveals the simulation of the action possibilities of others, Experimental Brain Research (2021) 1035-1045.
[35] J. M. Loomis, J. M. Knapp, Visual perception of egocentric distance in real and virtual environments, Virtual and Adaptive Environments (2003) 21–46.
[36] H. Rheingold, Virtual reality, Seeker and Warburg, London, 1991.
[37] E. T. Hall, The hidden dimension, Doubleday, NY, 1966.
[38] L. A. Hayduk, Personal space: Where we now stand, Psychological Bulletin (1983) 293–335. doi:10.1037/0033-2909.94.2.293.
[39] S. F. Lourenco, M. R. Longo, T. Pathman, Near space and its relation to claustrophobic fear, Cognition (2011) 448e453.
[40] M. Graziano, The Spaces Between Us: A Story of Neuroscience, Evolution, and Human Nature, 1st ed. Oxford University Press, Oxford, 2018.