Chapter 10
The Role of Presence in Healthcare Technology Applications

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Abstract. This chapter addresses the role of presence or "the perceptual illusion of nonmediation" [26] in user responses to technologies for healthcare, with particular attention to intelligent decision support systems (IDSS). It begins by defining presence and reviewing relevant research on presence-related responses to agents, virtual reality systems, and other technologies. It then discusses the implications of presence to researchers and health practitioners with an interest in IDSS, including a series of recommendations.

Keywords: Presence, telepresence, virtual reality, agents, new media technologies.

1 Introduction

When people talk about virtual reality (VR), agents, and other new forms of media, they often mention how the technologies give users a sensation of "being there" in a media environment or "being with" mediated others. These types of reactions to media technologies are now being focused on by scholars interested in the concept of *presence* (or *telepresence*), defined as "the perceptual illusion of non-mediation" [26]. Many aspects of technology contribute to presence. VR technology, for example, typically provides users with more sensory information and interface options than other types of media [4]. Through head-mounted displays, data gloves, and other forms of sensorimotor engagement, VR makes users feel "in" virtual environments (i.e, *spatial presence*). As another example, social agents are computer software programs that exhibit intelligence and can interact with people socially [33]. By exhibiting such human behavior, agents can make users feel "with" virtual others (i.e., *social presence*). Understanding the psychological side of VR and agent experiences through presence and related concepts has tremendous value for both researchers and practitioners with an interest in technologies for health.

This chapter discusses the role of presence in responses to healthcare technologies, with special attention to intelligent decision support systems (IDSS). IDSS

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are a broad class of technologies (including forms of VR and agents) that use artificial intelligence techniques to support decision making [38]. In the health field, IDSS can help medical professionals and patients in a number of important ways, such as in making diagnoses and deciding between preventive care options. Few (if any) attempts have been made to connect IDSS to presence, however, despite natural overlaps between the two literatures. This chapter defines presence and reviews research on presence-related responses to technologies used in healthcare, chiefly VR and agents. It then discusses implications of the concept of presence to researchers and health practitioners with an interest in IDSS, including a series of recommendations.

2 (Tele)Presence: An Overview

The term *telepresence* comes from Marvin Minsky, who in 1980 used it to refer to the manipulation of remote objects through technology. In the 1990s, a number of scholars picked up on the concept to help describe what was happening to people in response to emerging media technologies such as VR [10]. At this time, Byron Reeves [30] focused attention on the feeling of "being there" that can be created by advanced media technologies. Jonathan Steuer [36] wrote about dimensions of technology (vividness and interactivity) determining telepresence, while Thomas Sheridan [32] shortened the concept to “presence” and used it to refer to feelings people have while immersed in virtual environments. VR was the subject of a book by Frank Biocca and Mark Levy [6] that discussed the potential for “goggles and gloves” technologies to immerse media users. And two years later, perhaps the most seminal work on presence was published, an explication of the concept by Matthew Lombard and Theresa Ditton [26] that inspired Lombard to start an organization devoted to inquiry into the concept.

This organization, known as the International Society for Presence Research (ISPR), endeavored to define presence as a group and settled on it being “a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience” [20]. In the first decade of the 21st century, scholars spent considerable time identifying and studying more specific forms of the concept, including involvement, immersion, social richness, and co-presence [10]. However, the two most commonly researched types have been *spatial presence* or feeling “in” a media environment [41], and *social presence* or feeling “with” mediated others [5]. A third type of presence gaining traction is *self presence*, or experiencing a representation of oneself (such as an avatar) as part of oneself inside a virtual environment [23]. In conjunction with working on conceptualizations of presence, researchers have also worked to identify causes and effects of the perception of non-mediation.

3 Determinants of Presence in Mediated Environments

When considering perception in natural environments with no mediated component, the concept of presence and what creates the feeling of "being there" is generally taken for granted: "I am here, in my environment, so I naturally feel present in this environment." The possibilities are limited to the experience of physical surroundings [36]. However, when ones tries to distinguish the experiences of individuals in natural environments from those in mediated environments, understanding what it means to feel present and what creates that feeling of presence becomes a more important issue. Characteristics of the individual as well as those of different media technologies and content interact to determine the manner in which presence is experienced in different environments.

3.1 Technological Characteristics and Presence

As mentioned, Steuer [36] claims that the vividness and interactivity found in a medium help to evoke telepresence. *Vividness* refers to the technology's ability to produce a rich sensory environment, while *interactivity* refers to the technology's capacity to enable the user to influence the form and content of an environment. The vividness of an environment is defined by the manner in which information is presented to the senses. A vivid medium is one that is high in breadth (the number of sensory channels simultaneously activated) and depth (the degree of resolution within each sensory channel). Conventional media like print, radio and television send signals to only the auditory and/or visual channels and therefore have limited breadth. Newer media such as video games try to supplement this by activating the haptic system and basic orienting systems (those controlling body equilibrium). Some have gone so far as to engage taste and smell systems [28], though this is generally rare.

A medium with great depth delivers more information or data through each sensory channel. For example, the bandwidth and transmission capabilities of a computer showing a YouTube video provide considerably less information to the senses of sight and hearing than a large screen TV showing a high definition Blu-Ray video. A number of studies support the notion that media formal features such as screen size and screen resolution increase presence [25, 8]. Steuer [36] suggests that breadth and depth interact to create the sense of telepresence, and that simultaneous activation of multiple sensory systems can produce a strong feeling of telepresence even when signal depth is low.

An interactive medium is one that provides the user with the ability to alter the form and content of the mediated environment. According to Steuer [36], interactivity is greatly influenced by three factors: *speed* (the time required for the environment to respond to input), *range* (the number of environmental attributes that can be manipulated and the amount of alternatives available for each attribute changed), and *mapping* (how closely actions represented in the virtual environment match the natural actions used to change a real environment). Recent research has shown that mapping in particular positively affects presence, with more mapped interfaces leading to greater presence [34]. In general, real-time

interaction where the user performs natural actions that instantaneously alter a wide variety of characteristics in the mediated environment should create a high sense of presence. However, since presence is a psychological state, some users may be more affected than others. In other words, characteristics of a media user also impact presence.

3.2 Individual Differences in Experiencing Presence

Although most attempts to identify determinants of telepresence deal with characteristics of media, attempts have been made to determine characteristics of *individuals* that affect this experience. Along with fitness, alertness, and ability to focus attention, Witmer and Singer [40] consider a person's tendency to identify with characters in stories, sports or video games as a predictor of experienced telepresence. Lombard and Ditton [26] cite willingness to suspend disbelief and knowledge of and prior experience with a medium as important predictors of susceptibility. As part of their MEC model of spatial presence, Wirth et al. [41] include a number of user characteristics potentially impacting presence, including domain specific interest, or how much a person cares about a type of content (such as a film genre). Whitbred, Skalski, Bracken, and Lieberman [39] recently found that receiver apprehension or general unwillingness to attend to communication had a negative impact on presence. Clearly, there are many individual difference variables that may impact the extent to which a person experiences presence, and these should be taken into account in designing and implementing presence-inducing technologies for different populations.

3.3 Content Determinants of Telepresence

A final, understudied cause of presence is *media content*. Whereas research on technology addresses how media form or the manner in which information is delivered makes a person present, the message itself is also important. Lombard and Ditton [26] suggest that social realism (or how realistic a presentation seems in terms of characters, storyline, etc.), use of media conventions (such as on-screen graphics), and the nature of a task presented can all affect the extent to which a person feels presence. Recent research supports the idea that content matters to presence [e.g., 9].

One content feature that has received scant attention from presence researchers is artificial intelligence, which has obvious implications for the design of IDSS for healthcare. Artificial intelligence has been the basis for many medical diagnosis systems [29]. The more artificial intelligence an IDSS exhibits, the greater the social presence a user should feel, since intelligent interactions are a norm of daily life. The Computers As Social Actors (CASA) studies of Reeves and Nass [31] reveal how human beings, as a function of evolution, are hard-wired to treat machines as people, especially when they exhibit human-like characteristics such as intellect. Biocca, Harms and Burgoon [5] furthermore suggest that one of the keys to fully experiencing social presence is a sense of access to another intelligence. It may be, however, that too much intelligence detracts from social presence, if it goes far beyond what would be expected from a human. If so, then artificial

intelligence may have a curvilinear effect on presence. Future work on IDSS for healthcare should explore this linkage.

4 Presence and Mediated Healthcare

Most presence scholars in communication, psychology, and related fields are not just interested in presence as an outcome of media exposure, but also in how presence may impact further outcomes of interest in particular domains of study, including entertainment, persuasion, and health, the focus of this chapter. Advanced, presence-inducing technologies have been used for healthcare in a number of ways. As Lombard [24] notes, presence principles are currently being used for e-health purposes such as distance surgery, remote medical care, rehabilitation, and phobia treatment, to name a few. A handful of studies to date have explored the relationship between presence and health technology use outcomes. These may be divided into health studies using (1) VR and (2) agents and other technologies.

4.1 Health Research on VR Technology and Presence

One of the first research initiatives to address the relationship between presence and health outcomes is the EMMA (Engaging Media for Mental Health Applications) project [1]. The goal of the EMMA project has been to investigate how presence-inducing VR technologies may be used for non-addictive, mood stabilizing experiences. Through understanding the relationship between presence and emotions, the researchers hope to develop "mood devices" providing innovative ways of coping with distressing emotions, such as affective, anxiety, and adjustment disorders, and restricted mobility.

Cognitive rehabilitation has also been examined. Castelnuovo et al. [12] have looked into the potential for VR technology to help individuals with traumatic brain injuries. This research has been concerned with testing the added value of VR over traditional approaches to assessment and rehabilitation of cognitive functions. In this research, the core characteristics of a virtual environment that make it useful for mental health applications have been assessed by measuring presence.

In a more targeted, applied study, Brown, Nunez, and Blake [11] created a VR environment to provide nutritional information to HIV positive women in South Africa. Specifically, the environment was a house in which users interacted with others for social support, while also learning about food groups and cleanliness/hygiene issues. Participants in the study who navigated through this high presence-inducing VR system found it usable and enjoyable. Despite finding the amount of information lacking, they thought the information was of high quality, leading the authors to ultimately conclude that this type of system is a useful way to disseminate medical knowledge.

Finally, a number of clever, innovative VR and health studies have been conducted by Jeremy Bailenson and colleagues. This research calls attention to the potential for VR technology to not only replicate real-world experiences but also to surpass them. Bailenson et al. [3], for example, investigated aspects of presence-inducing VR technology that are unique from a media interactivity

standpoint, including the ability to capture and review physical behavior and the ability to see an avatar rendered in real time from third-person point of view. Two studies were conducted that allowed users to either learn Tai Chi through viewing a video of an instructor (traditional method) or through seeing a captured image (avatar) of themselves doing moves next to the instructor doing moves, as if they were performing the actions together (VR method). Learning was better in the VR conditions, showing the potential for self-presence inducing VR to serve as a tool for such health applications as physical therapy and exercise.

In related follow-up research, Fox and Bailenson [14] further examined health applications of self presence-inducing VR technology. They conducted three studies testing how virtual representations of the physical self affected exercise behaviors. Specifically, they made realistic avatars of study participants do things like gain weight and perform exercise and found that participants exposed to such avatars (versus control conditions) were significantly more likely to exercise themselves. In another study, Fox and Bailenson [15] focused specifically on presence (an untested assumption in some of this research) and avatar eating. Participants were shown photorealistic avatars of themselves eating healthy and unhealthy foods in a virtual world, to see how it would affect their real-life eating. Results were moderated by sex, with men who felt high presence in response to an avatar being more likely to eat unhealthy food, whereas women who felt high presence were more likely not to eat candy.

Taken as a whole, the reviewed research streams and findings in the area of VR and presence have interesting implications. First, they show the diversity of topics in health that may be addressed using VR. Second, they point to the importance of considering presence (chiefly spatial presence and self presence) in this research as a measure of technological effectiveness. Third, they show the potential of VR as a tool for creating high levels of presence with equally strong impacts on healthcare outcomes. For IDSS, the work on VR and presence for health suggests that creating high presence-inducing VR experiences can make users feel more in virtual spaces and connected to avatars, potentially making them more motivated to use the systems and also increasing the ability to do so. Research on these connections can help identify the extent to which VR applications for IDSS create presence leading to further outcomes of interest.

4.2 Health Research on Agents/Other Technologies and Presence

Agents have been the focus of a handful of presence and health investigations to date. David, Cai, Lu, and Jeong [13] looked at the effects of gender on responses to an anthropomorphic computer help agent. Specifically, they were interested in how the match (or mismatch) between agent gender and respondent gender affected social presence dimensions and other outcomes. They found that agent gender did not have a strong effect on males, but for females a female agent was rated significantly higher on co-presence, attention, and understanding. The female agent was also rated higher by females than an interface without agent cues. This suggests that agent design and corresponding social presence can have an effect on healthcare, by affecting outcomes such as attention to and understanding of health messages.

Huang [18] examined how the interactivity and expressiveness of agents impacted dimensions of social presence along with memory, attitude, and behavioral intention toward a health message focused on drunk driving. Findings were mixed, with both expressiveness and interactivity impacting presence dimensions. Interactivity of an agent also impacted learning, though expressiveness did not. Attitude change and behavioral intention were not affected by either manipulation, contrary to expectations.

In a similar study that attempted to better explain variable relationships using theory, Skalski and Tamborini [33] investigated the social presence and persuasion effects of a health interactive social agent, using information processing theory as a guide. They predicted that an interactive social agent (versus one that passively communicated information) would cause users to experience more social presence. Social presence was then expected to compel listeners to process health information more centrally, leading to a more positive attitude and behavioral intention toward a health issue (blood pressure checkups). Findings were generally in line with expectations, showing the potential of computer agents to serve as effective communicators of health information.

Additional studies, focused on technologies other than agents, provide further insight into the relationship between presence and health outcomes. Hawkins et al. [17] explored how interactivity relates to social presence, in response to a variety of interventions directed toward breast cancer patients. They found that an Internet-based system scored low on both interactivity and social presence, while a system involving a human "Cancer Mentor" scored the highest. This highlights deficiencies in current technologies, though these should diminish over time as the technologies improve. Alem, Hansen, and Li [2] tested a telemedicine system that allows a specialist at a major hospital to direct teams in smaller, remote hospitals. Their findings indicated that, while individual differences played a role in clinician presence, there may still be a relationship between presence and outcomes such as ease of technology use and satisfaction with video quality. Bouchard, Robillard, Marchand, Renaud, and Riva [7] investigated how closely patients and therapists bond during videoconferencing sessions. They found that presence related positively to bond strength, suggesting the concept's importance in telepsychotherapy. Sponselee, de Kort, and Meijnders [35] found mixed results however when testing the role of presence in relieving stress through mediated restorative environments.

As a final note, Sundar, Oeldorf-Hirsch, and Garga [37] advance an intriguing overall framework for exploring and explaining connections between technology and presence, known as the MAIN model. It suggests that affordances of technology (i.e., Modality, Agency, Interactivity, and Navigability) transmit cues that trigger cognitive heuristics leading to presence. This model sheds further light on how technologies such as IDSS may induce presence. For example, if they have agency, the agency can trigger the *social presence heuristic*, which says "I can sense the other, therefore I am present with him/her" [37, p. 225]. The navigability of the system can create another *browsing heuristic* that further facilitates presence through exploration. The research reviewed in this section on agents and other healthcare technology applications suggests that they have an impact on

presence (specifically social presence in the case of agents), and that this presence can be increased through affordances such as interactivity. Moreover, the findings once again show how presence has a positive impact on health communication outcomes, further cementing the concept's importance to achieving them.

5 Conclusion and Recommendations

The experience of presence is a complex process depending on the interaction of media form, content, and user characteristics. Nevertheless, it holds tremendous value as a tool for understanding IDSS and other healthcare technologies. The advantage of considering the human, psychological side of technology use (i.e., presence) over just hardware or technologies themselves is that presence is a common, measurable outcome of *any* media experience, with predictable results. Instead of having to account for the potentially limitless number of features that might differentiate current and future technologies along qualitative dimensions, focusing on presence allows researchers to concentrate on a single enduring aspect of human experience that varies along a continuum. Presence measures can be used to experimentally compare across different manipulations of media form and content, such as options for IDSS, to determine which combinations lead users to perceive the most "naturalness" or "realness." In that sense, presence functions as a "manipulation check" for technological effectiveness, expected to relate positively to dependent variables of interest.

Presence also functions as an organizing concept for research on new technologies like VR and agents. It has been studied by scholars in diverse fields, including engineering, computer science, communication, media studies, and psychology. Theory and research on presence helps unite these traditions as they work toward common goals, such as understanding the distinctions between real and mediated experiences and manufacturing mediated experiences that seem real. Important issues like these cannot be fully addressed simply by testing relationships between technologies and outcomes. For example, it may be that certain types of IDSS are more effective, but why? Answering this question requires the inclusion of mediating variables such as presence in research, which are necessary for the construction of explanatory models. Models, in turn, help build theory and accomplish the goals of science, i.e., description, explanation, and prediction [16]. Explanation makes prediction easier by pinpointing variables that can cause a particular outcome (e.g., presence). Given the obvious value in predicting outcomes such as how to more effectively deliver healthcare information, explanation and prediction should be considered in tandem. Following are some additional recommendations concerning presence and IDSS for healthcare:

- *Consider presence dimensions separately and only focus on relevant ones*: There are many types and sub-dimensions of presence that have been advanced over the years. Although some researchers have indexed these to create an overall measure of presence, separate dimensions of the concept should be treated separately, as recommended by Bracken and Skalski [10]. One reason for this is that the types may not relate the same

to independent and dependent variables of interest in a study because their conceptual meanings are different. This is especially true for spatial presence, social presence, and self presence, which represent distinct experiences. IDSS through VR technology would probably affect a user's spatial presence or self presence, whereas IDSS agents would probably affect a user's sense of social presence. The choice of presence type should depend on the type of technology being investigated and other variables of interest. And when in doubt, it is fine to consider multiple types of presence, provided that they are treated separate from one another.

- *Measure presence using established methods*: Presence measurement has been a major subject of inquiry for scholars studying the concept, resulting in the development of many validated scales and other suggestions for measurement [e.g., 21, 22]. These measurement tools are freely available, for the most part, and their use is encouraged. They not only remove the hardships involved in developing new measures but also allow for easy cross-study comparisons.

- *Draw upon the large accumulated body of presence literature when needed*: In the short history of presence scholarship, an impressive body of knowledge has accumulated. Lombard and Jones [27] identified more than 1,400 articles addressing the concept. These range from the very technical articles typically appearing in the journal *Presence: Teleoperators and Virtual Environments* to conceptual pieces appearing in journals such as *Communication Theory*. Research findings on presence provide a useful springboard for determining, for example, technology form and content variables that can maximize presence. The presence literature can therefore suggest ideal designs for new IDSS or ways to make existing ones more effective.

- *Remember the advantages of VR and agents as "superhuman" technologies*: As shown in the work of Jeremy Bailenson and colleagues, VR can not only be used to simulate real life but also to surpass it. Students training to be heart surgeons, for example, might benefit from a simulator that allows them to operate on a virtual heart with a specific problem, to learn how to repair it without risk to a patient. Such a simulator might also allow the user to instantly change to another type of problem, or even another organ, making VR superior in some ways to other forms of education. Computer agents, likewise, far exceed a human's capacity for information storage and retrieval. They can surpass any medical professional in information sharing. These systems are therefore of tremendous value as healthcare tools, especially if they are designed with presence in mind and users can interact with them in natural, lifelike fashion.

- *Conduct research on how IDSS technologies and variables relate to presence*: A final and important step is to conduct research to empirically

establish the connection between presence and IDSS technologies and variables. Power [29] traces the development of decision support systems (DSS) and identifies a number of historical types, including model driven DSS, data driven DSS, communications DSS, document DSS, knowledge-driven DSS, and Web-based DSS. Research on Communication and Web-based DSS are obvious linkage points between the media-focused presence literature and the IDSS literature. In addition, IDSS scholarship calls attention to the importance of variables such as artificial intelligence, which may also impact presence in the manner discussed earlier. Understanding how healthcare technology applications affect presence can be valuable for physicians and patients alike. Early research on computer-based clinical decision support systems, for example, revealed that the systems have been useful in some areas, such as drug dosing and preventive care, but lacking in others, such as diagnosis [19]. The inability of certain technologies to induce presence may have played a role in these outcomes; accounting for presence may help improve their effectiveness.

In addition to giving an overview of the concept of the presence and its causes, this chapter demonstrates the benefits of considering presence in health research using advanced technologies such as VR and agents. It also suggests areas for further inquiry by IDSS scholars. It is relatively easy to add presence measures to IDSS studies, and doing so can reveal much about users' psychological reactions to intelligent decision support systems for healthcare. As Lombard and Ditton [26] suggest, presence is central to our understanding of the relationship between people and technology, "at the heart of it all."

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