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Toward a More Robust Theory and Measure of Social Presence: Review and Suggested Criteria

Abstract

At a time of increased social usage of net and collaborative applications, a robust and detailed theory of social presence could contribute to our understanding of social behavior in mediated environments, allow researchers to predict and measure differences among media interfaces, and guide the design of new social environments and interfaces. A broader theory of social presence can guide more valid and reliable measures. The article reviews, classifies, and critiques existing theories and measures of social presence. A set of criteria and scope conditions is proposed to help remedy limitations in past theories and measures and to provide a contribution to a more robust theory and measure of social presence.

1 Introduction: The Experience of "Being with Another" in Networked Environments

A great deal of networked communication can be described essentially as a person using a medium to be with another. A set of pixels shaped like a smiling face, a voice crackling through a speaker, or a line of text emerging on a chat room screen create the sense of "being with another." Research on spatial presence (also known as *physical presence*) explores this sense of "being in the virtual place," focusing on ways in which our perceptions and actions create a sense of space. But what of the sense of "being together," the most essential part of this mediated interaction between two people? How does the medium filter and affect our representation of the other during a mediated social interaction? Beyond the "sense of the place" that spatial presence measures, there is the "sense of being with another," or quite essentially, the "sense of another through a medium." There is neurological and behavioral evidence to support that the representation of sentient others in a virtual environment involves more than just their location in space, and this cannot be fully accounted for by a theory of spatial presence (Biocca & Harms, 2002).

To begin, it might be useful prior to exploring definitions of social presence in greater detail to provisionally define social presence succinctly as the "sense of being with another." This other can be either a human or artificial intelligence. Within human-computer interaction, social presence theory studies how the "sense of being with another" is shaped and affected by interfaces. These others that we experience are primarily technologically mediated representations of other humans or forms of intelligence including mediated representations of remote humans via text, images, video, 3D avatars, and in artifi-

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cial representations of humanoid or animal-like intelligence including virtual human agents, computers, and robots.

Techniques of designing representations of others to evoke social presence have a long history, going back to the first stone sculpture to evoke a sense of some other being in the mind of an ancestral observer. Media representations and techniques have been progressively designed over time to activate these social responses (Reeves & Nass, 1996). Increasing the experience of social presence is repeatedly the design goal of various types of hardware and software engineering in areas such as high-bandwidth teleconferencing systems (Lanier, 2001), speech interfaces (Yankelovich, Levow, & Marx, 1995), social robots (Brooks, 1999, 2002), and embodied agents (Cassell, Sullivan, Prevost, & Churchill, 2000).

Although understanding social presence is sometimes the goal of research where this concept is employed, social presence research is more frequently a means to explore some aspect of technology or the effects of technology. Communication and human-computer interaction researchers are typically interested in social presence because it may mediate the effects of other variables of central concern to the researcher such as attitudes towards the mediated others, features of the interface, persuasion, illusions of reality, learning and memory, and mental health (Bailenson, Blascovich, Beall, & Loomis, 2001; Choi, 2000; Nowak & Biocca, submitted; Turkle, 1997).

The need for a well-explicated theory arises not only because researchers need to understand the role of social presence in human-to-human and human-computer interaction, but also because continued research in this area needs to bring conceptual clarity to what is currently a rather amorphous set of variables, many of which are being equated or conflated with social presence. Moreover, if we better understand social presence, then this may guide ways to operationalize it such that it is an empirical variable amenable to reliable and valid measurement. Thus, development of a systematic theory will in turn enable development of appropriate measures of social presence as conceptualized. Valid measures can be selected and differentiated from measures of other concepts.

In this article, we review the state of social presence theory and measurement and propose some criteria and scope conditions for a usable theory and measure of social presence. We hope this analysis and the criteria proposed can contribute to the development of a theory that is sufficiently large in scope, but also delimited so as to predict, explain, control, and operationalize social presence.

In the sections that follow we will

- discuss three areas of HCI research in which social presence theory and measurement can advance research;
- provide a review, classification of dimensions, and critique of current definitions of social presence;
- review and assess current measures of social presence; and
- propose criteria, scope conditions, and example scenarios that a theory of social presence would need to explain and measure.

2 Examples Where a More Robust Theory and Measure of Social Presence Can Advance Research

Why develop a theory and measurement of social presence? Where might it be useful? A usable theory and measure of social presence might provide a key contribution to the following three problem areas in networked computing.

2.1 Using Social Presence Theory to Explore the Design Goals, Social Motivations of Users, Properties, and Effects of Telecommunication Systems

The Internet is a social place. Because of growth in our telecommunication infrastructure (Internet.com, 2001), many relationships and more and more interactions with others are mediated by the telecommunication system and its properties. Increasing network band-

width, higher mobility, and more immersive designs promise to offer a better sense of access to real and virtual places, that is, the sense of telepresence. But the use of this bandwidth will rarely be focused on visiting places, virtual ghost towns devoid of other interactants. More fundamentally, most telecommunication bandwidth is used to gain satisfying and productive access to others, the thoughts, emotions, and presence of real and virtual humans (for example, the internet (see Pew, 2002), the telephone (see Fischer, 1988)). Because we are social beings, a common purpose of spatial presence is to increase the sense of social presence either as an end in itself or to accomplish a task involving many inputs.

Research in organizational communication indicates that media interface design may be selected to better accommodate activities affected by social presence (Rice & Case, 1983; Steinfield, 1986; Palmer, 1995). Users may be motivated to use media to modulate social presence for a wide range of activities including getting to know someone, exchanging information or goods, problem solving and making decisions, exchanging opinions, generating ideas, resolving conflicts, or maintaining friendly relations.

2.2 Use of Social Presence Measures to Assess the Performance of "Social Presence" Technologies

Successive generations of emerging networked interfaces are designed to mediate social communication with remote others. These communication systems and interfaces are progressively designed to improve human communication for collaborative work (Weiming & Conseil National de Recherches de Canada, 2001), education (Hazemi & Hailes, 2001; Steeples & Jones, 2002), social services, or *e*-commerce (Save, Guazzelli, & Poucet, 2001). Although all these technologies are varied, they share a common goal: most of these technologies are designed, engineered, and manufactured to increase social presence. For the purpose of this article, we will refer to technologies that are primarily intended to increase real-time social interaction as *social presence technologies*. Social presence technologies offer the user the opportunity to interact with others in a variety of ways to access the social and task information provided by others. Examples of evolving social presence technologies include the following.

- *Mediated collaborative work environments*: Work environments are characterized by increased use of varied mediated work interactions (Churchill, Snowdon, & Munro, 2001; Coovert & Thompson, 2001) that supplement or substitute for face-to-face interaction. There appears to be accompanying growth in telecommunication infrastructure to support this interaction (Internet.com, 2001).
- *Mobile and wireless telecommunication*: Mobile systems increasingly offer promise of continuous social contact across space and time via multimodal access (Brown, Green, & Harper, 2001), and the sensory and social presence of that access is increasing via mobile video telephony and other message systems.
- *High-bandwidth teleconferencing interfaces*: Examples include tele-immersive simulations of face-to-face and augmented social interactions (Lanier, 2001).
- *Agent-based e-commerce and help interfaces*: An increasing number of quasi-social relationships are emerging with new forms of artificially intelligent beings, such as computers themselves and intelligent agents that inhabit virtual environments, that act as "office assistants," guides on Web sites, characters in social 3D virtual environments, and team members or opponents in computer games (Petrie, 1996; Reeves & Nass, 1996; Chorafas, 1997; Franklin, 1997; Kushmerick, 1997; Cassell et al., 2000).
- *Speech interfaces:* These include simulations of human speech and social interaction with the computer (Yankelovich et al., 1995).
- *3D social virtual environments*: These fully mediated, social interactions in computer graphic bodies include a full range of social interaction and contacts (Fischer, 1988; Munro, Höök, & Benyon, 1999; Singhal & Zyda, 1999; Schroeder, 2001).

Evaluation of these systems typically must answer a version of the question: How well do these systems

work? Although the answer to this question might take a technical form, the answer is largely social-psychological in nature. It might take the form of the following questions: How well did one person feel connected to another through an interface? What was the appropriate level of interaction for the task? Did the user feel socially and psychologically connected to an intelligent "other" when interacting with the virtual human agent? In essence, the assessment of satisfaction with entertainment systems and with productive performance in teleconferencing and collaborative virtual environments is based largely on the quality of the social presence they afford.

Typically, claims made for the development of social presence technologies tend to emphasize some "good," that is, a positive social or communication outcome. But a moment's reflection suggests that we might not want to equate social presence with all things good and kind. For example, increased social presence can also be a hindrance and can make people vulnerable to manipulation, deception, mindless processing, and so forth. The former executive director of Bell Labs, Bob Lucky, imagined the need for a "social presence dial" that could dial social presence up or down — up for a loved one or down for a salesperson (Moyers, 1990). This underlines the often-repeated caution that "more is not always better."

2.3 Social Presence Research May be a Means of Exploring the Larger Issues in Theories of Mind, Social Cognition, and Interpersonal Communication

Unlike the physical environment, social communication in virtual environments might be built upon minimal or constrained social cues. Animated characters and even the computer interface itself can generate strong automatic social responses from minimal social cues. Social responses to computer characters, for example, are generated even though the user is quite aware that the computer is not an emotional or social agent but a machine. Such virtual environments are an experimental setting to explore the limits of human social responses and the effects of various cues (Reeves & Nass, 1996; Loomis, Blascovich, Beau, 1999; Blascovich, 2001).

Like presence, social presence is presumed to have its foundation in psychological mechanisms that have evolved for and are active during unmediated interactions (Premack & Premack, 1996). A strong theory of social presence might also provide us with insight into how people automatically respond to social cues and generate simulations or mental models of "other minds" from the physical and communication cues provided by the bodies and actions of others (Gordon, 1986; Dennett, 1987, 1996; Carruthers & Smith, 1996; Premack & Premack, 1996).

Finally, a theory of social presence may yield insights into the nature of nonverbal and interpersonal communication. By addressing issues of what essential attributes are needed to establish connection with others, we may arrive at a better understanding of how humans arrive at that sense of mutuality that underpins all communication between people and that is a prerequisite to establishing common ground. It may also focus attention on how nonverbal behaviors, many of which harken back to primordial urges and instincts, function to define and maintain interpersonal relationships.

3 Current Definitions and Conceptualizations of Social Presence

Presence is frequently presented as consisting of two interrelated phenomena (Heeter, 1992; Biocca, 1997):

- *telepresence* (also known as *spatial presence* or *physical presence*): the phenomenal sense of "being there" including automatic responses to spatial cues and the mental models of mediated spaces that create the illusion of place; and
- *social presence*: the sense of "being together with another," including primitive responses to social cues, simulations of "other minds," and automatically-generated models of the intentionality of others (people, animals, agents, gods, and so on).

Because the social presence of the other is mediated by telecommunication technology, it might be more accurately described as mediated social presence or social telepresence. In keeping with tradition in this area

(Short, Williams, & Christie, 1976; Heeter, 1992; Palmer, 1995), we will use the phrase *social presence* specifically to mean interactions in mediated environments, even though the phrase also applies to nonmediated interactions (Soussignan & Schaal, 1996; Huguet, Galvaing, Monteil, & Dumas, 1999).

The problems of how to define, measure, and control levels of spatial presence and social presence via interface design have become both challenging and practical problems in communication theory (Palmer, 1995; Lauria, 1997; Lombard & Ditton, 1997; Biocca, 2001), virtual environment design (Short et al., 1976; Held & Durlach, 1992; Barfield, Rosenberg, & Lotens, 1995), and in psychological measurement of user responses to virtual environments (Draper & Blair, 1996; Ellis, 1996; Ellis, Dorighi, Menges, Adelstein, Joacoby, 1997; Freeman, Avons, Pearson, Harrison, & Lodge, 1998; IJsselsteijn, de Ridder, Hamberg, Bouwhuis & Freeman, 1998; IJsselsteijn and de Ridder, 1998; Murray, Arnold, Thornton, 1998; Witmer & Singer, 1998; Slater, 1999; Lombard et al., 2000; IJsselsteijn, de Ridder, Freeman, & Avons, 2000; Lessiter, Freeman, Keogh, & Davidoff, 2000; IJsselsteijn, Bierhoff, & Slangen-de Kort, 2001; Novak, Hoffman, & Yiu-Fai, 1998).

Although we defined social presence as "a sense of being with another" in the virtual environment, we consider this definition a tentative, but useful, shorthand. By the end of the article, we hope to show that this typical definition may not be inadequate for the explication and measurement of social presence.

Before we review definitions of social presence, it is valuable to note that a number of theories of social presence have roots in symbolic interactionism (Blumer, 1969) and social psychological theories of interpersonal communication. The term *social presence* in the context of mediated communication may have emerged in the work of Short et al. in the 1970s. In effort to define a social psychology of telecommunication, they may have extended the use of a term that was used in social psychology to describe the behavioral effects of the spatial presence of another human being or the thought that another human being is in position to observe. This physical, nonmediated "social presence" was conceptualized simply as "another person is perceived as present or absent."Only in the telecommunication context did this notion of presence or absence become problematic. For Short et al., it was no longer binary, but more of a continuum in which mediated others could be more or less present. For this, they may have been influenced by Goffman's notion of "copresence," which we discuss in greater detail below.

The influence of the classic social psychologist George Herbert Mead (Mead & Moris, 1934) can be seen in the earliest formulations of mediated social presence, especially on the notion that the other is a symbolic construction created through interaction. A central concept for symbolic interactionism was the concept of the "generalized other," which was in part an abstraction from one's interactions with all physical others. Symbolic interactionism emphasized that symbolic representations were central to all social phenomena, that models of the other contributed to our conceptualizations of the social. In their seminal book on the social psychology of telecommunication, Short et al. (1976) drew directly on intellectual currents influenced by this social psychological tradition, such as the work of Argyle (Argyle, 1969, 1975; Argyle & Dean, 1965; Argyle & Cook, 1976), Birdwhistell (1970), and Mehrabian (1972) on the role of nonverbal communication in interpersonal interaction. For Short, et al., this theoretical foundation provided a lens through which interaction via teleconferencing systems and other media could be viewed, explained, and understood. The theoretical origins guided the emphasis of early social presence theories on awareness of and the representation of the other, the medium's capacity for social interaction, and, specifically, the presence or absence of verbal or nonverbal cues in mediated communication.

3.1 Definitions of Social Presence

Although definitions of social presence vary, they cluster around key approaches or dimensions. See Table 1 for an outline of a review of social presence definitions and theories presented in this section.

3.1.1 Nondefinitional, Binary Formulations of Social Presence. Let us begin with examples of "unproblematic" or "nondefinitional" approaches to social

Table 1. *Definitions of Social Presence*

Classification	Definition	Example studies
Copresence: colocation, mutual awareness		
Copresence: sensory awareness of the embodied other (Goffman, 1959)	• (unmediated) "experiencing someone else with one's naked senses" (p. 15) • "physical distance over which one person can experience another with the naked senses-thereby finding that the other is "within range" (p. 16) • "full conditions of copresence, however, are found in less variable circumstances: persons must sense that they are close enough to be perceived in whatever they are doing, including their experiencing of others, and close enough to be perceived in this sensing of being perceived" (p. 17)	(Ciolek, 1982; Biocca & Nowak, 1999, 2001; Nowak & Biocca 1999, 2001; Nowak 2000)
Colocation	• "the feeling that the people with whom one is collaborating are in the same room" (Mason, 1994) • "Social presence refers to the feeling of being socially present with another person at a remote location." (Sallnas et al., 2000) • "the degree of tangibility and proximity of other people that one perceives in a communication situation" (McLeod et al., 1997)	(Mason, 1994; McLeod et al., 1997; Tammelin, 1998; Sallnas et al., 2000)
Apparent existence, feedback, or interactivity of the other (Heeter, 1992)	• "the extent to which other beings in the world appear to exist and react to the user" (Heeter, 1992) • "the degree to which a person is perceived as a 'real person' in mediated communication (Gunawardena, 1995)	(Culnan & Markus, 1987; Palmer, 1995; Gunawardena & Zittle, 1997; Cuddihy & Walters, 2000)
Sense of being together	• "the sense of being together" (de Greef & IJsselsteijn, 2000; Cho & Proctor, 2001)	
Psychological Involvement		
Perceived access to another intelligence (Biocca, 1997)	• "The minimum level of social presence occurs when users feel that a form, behavior, or sensory experience indicates the presence of another intelligence. The amount of social presence is the degree to which a user feels access to the intelligence, intentions, and sensory impressions of another." (Biocca, 1997)	(Huang, 1999; Nowak, 2000)
Salience of the other (Short et al., 1976)	• "The degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships . . . it is a subjective quality of the communications medium." (p. 65) • "a single dimension representing a cognitive synthesis of all the factors" (p. 65) • "attitudinal dimension of the user, a 'mental set' towards the medium" (p. 65) • "it is phenomenological variable . . . affected not simply by the transmission of single nonverbal cues, but by whole constellations of cues which affect the 'apparent distance' of the other" (p. 157)	(Gunawardena, 1995; Huang, 1999; Rice, 1993; Galimberti & Riva, 1997; Riva & Galimberti, 1998; Tammelin, 1998)
Intimacy and immediacy	• Immediacy as "directness and intensity of interaction between two entities" (Mehrabian 1967), (p. 325) or "psychological distance" between interactants (Weiner & Mehrabian, 1968) • Intimacy (Argyle & Dean, 1965) is a function of "proximity, eye-contact, smiling, and personal topics of conversation etc." (Argyle, 1969, p. 95) and categorizes intimacy as a "dimension(s) of relationship" (p. 201) which conversational partners negotiate.	
Mutual understanding	• "social presence; that is, the ability to make one's self known under conditions of low media richness" (Savicki & Kelley, 2000)	
Behavioral Engagement		
Interdependent, multichannel exchange of behavior (Palmer, 1995)	"VR is compatible with interpersonal communication to the extent that individuals can encounter another 'social presence' or person (Heeter, 1992) in a virtual environment, and effectively negotiate a relationship through an interdependent, multi-channel exchange of behaviors" (p. 291).	(Huang, 1999)

presence. Researchers in the area of presence might be a little surprised to find that, for some social psychologists, the concept of social presence is defined in a simple and unproblematic manner. One can easily find recent social psychological studies that prominently feature social presence in their titles, but where social presence itself is largely under theorized (Soussignan & Schaal, 1996; Huguet et al., 1999). In these studies of unmediated interactions, social presence is treated as self-evident: the other simply is or is not present. This binary unproblematic definition is used. The key limitation of this approach is that social presence is not seen as a continuum, but rather assumed as another person either physically there or not there. On the other hand, there is research going back almost sixty years that indicates that the mere thought of someone else in another room or the suggestion that someone is watching has influence on behavior (Dashiell, 1935; Wapner & Alper, 1952). Note that this social presence is not a physical fact, but a psychological one. The "perceived presence" of another triggers significant psychological effects on behavior. This perceptual distinction is essential, as we identify other conceptualizations of social presence that focus on how individuals perceive the environment around them.

3.1.2 Copresence. Are there different degrees of the "presence" of another? Theories clustered around the concept of "copresence" have tended to see what we are calling *mediated social presence* as problematic. The mediated other is not simply "here or not-here," but is present to a lesser or greater degree along some definable continuum. Some early researchers in interpersonal communication argued that, even in unmediated interactions, the simple binary, here–not here conceptualization of social presence is an unsatisfactory description of a person's sense of the salience and accessibility of the other. This case was made strongly in the seminal work of the social psychologist, Erving Goffman (1959, 1963).

3.1.2.1 Sensory Awareness of the Embodied Other. Goffman provides an example of a more subtle theoretical analysis of what he called *copresence*. The concept of copresence is grounded on the basic sensory awareness of others.

> First, sight begins to take on an added and special role. Each individual can see that he is being experienced in some way, and he will guide at least some of his conduct according to the perceived identity and initial response of his audience. Further, he can be seen to be seeing this, and can see that he has been seen seeing this. Ordinarily, then, to use our naked senses is to use them nakedly and to be made naked by their use (Goffman, 1959, p. 16).

Emphasis on the senses makes this approach very amenable to mediated interaction. In mediated interactions, the senses of the user are extended to some degree by the technology. The representation of the other triggers a sensory impression of the other that exists on a continuum from the minimal to the intense. Goffman makes the additional point that the copresence "implies the reception of embodied messages" (p. 15). The body of the other is a key medium for communicating both presence and for the user to construct some model of the internal states of the other. In mediated interactions, the other is frequently embodied by some avatar, agent, or simpler representational device (Cassell et al., 2000).

Even though he focuses on unmediated perception, Goffman sees each sensory channel as a medium for experiencing social presence. He is also sensitive to the fact that social presence is influenced by subtle properties of the environment in which the interaction takes place:

> The physical distance over which one person can experience another with the naked senses–thereby finding that the other is "within range"—varies according to many factors: the sense medium involved, the presence of obstructions, even the temperature of the air (Goffman, 1959, p. 17).

In definitions that emphasize being in the same space, the notion of copresence shares some properties with spatial presence. A number of researchers use some variation of social presence as the notion of being in the

same location, space, or room (Mason, 1994; McLeod, Baron, Marti, & Yoon, 1997; Sallnas, Rassmus-grohn, & Sjöström, 2000). Limiting social presence to this sensory copresence definition closely follows the binary, unproblematic perspective already summarized but fails to introduce the subtle hues of psychological modeling of the other that a notion of social presence as continuum offers.

Goffman's sensorimotor approach to the conceptualization of copresence provides him with the basis for a subtle, elaborated, and developed approach to social interaction. Even though it dates back to the 1960s and is focused on face-to-face interaction, Goffman's emphasis on the sensory accessibility of the embodied other can be found explicitly in some social presence work (Biocca & Nowak, 1999, 2001; Nowak & Biocca, 1999, 2001).

3.1.2.2 Mutual Awareness. Goffman and others extend the notion of copresence beyond just "being in the same place" to include the attentional issues of mutual awareness: "copresence renders persons uniquely accessible, available, and subject to one another" (p. 22). The definitions of copresence move into mutual awareness when they emphasize attention to the sensory properties of the other, especially an awareness of both user/observer and mediated other. The user is aware of the mediated other, and the other is aware of the user. In Heeter's (1992) definition, awareness of the "existence of the other" is accompanied by the other's reaction to the self or user. In these definitions, the reaction of the other to the user validates that "they are there" and aware, and reflects the intellectual origins in symbolic interactionism, especially in the notion that the self is defined by the generalized other's reaction to the self.

This copresence definition is sometimes expanded into broader, if somewhat loosely explicated, versions of copresence that simply suggest mutual awareness with the phrase *being together* (de Greef & IJsselsteijn, 2000; Ho, Basdogan, Slater, Durlach, & Srinivasan, 1998). In this sense, two users are aware of each other in a virtual space, and that mutual awareness is the essence of social presence.

3.1.3 Psychological Involvement. The simple presence of another body or even awareness of it may be satisfactory to signify some minimal level of physical copresence. But does this capture all that most researchers mean by social presence? Let us take an extreme example. It is clear that an inert body, a corpse, may be physically present, but not socially present. Although this experience may be rare in the physical world, this example may be to the point and common in virtual worlds. In virtual environments such as a 3D city, for example, there can be many inert bodies, representations that are not "inhabited" by intelligence, human or artificial — virtual entities that are more like sculptures than beings, all form with no "spirit" or "intelligence" (agency) animating the body. So just the copresence of a body may not be a good definitional basis for social presence, but rather we could say that the body is a set of cues for an "intelligence" that animates it. In theories that emphasize psychological involvement, social presence hinges more on one's model of the other intelligence, with the word *intelligence* suggesting broadly the notion of intentionality and intelligent behavior relative to the environment and the self.

Therefore, some definitions extend social presence slightly beyond the notion of awareness to suggest the importance of an element sometimes labeled *psychological involvement*. Unfortunately, the concept of "involvement" has a very broad use within theories of communication, persuasion, and social psychology (Petty & Cacioppo, 1986). It can range in meaning of little more than focused attention to the more elaborate psychological dynamics of relationships. We next attempt to classify the various nuances of this general definitional approach to social presence.

3.1.3.1 Sense of Access to Intelligence. Some researchers (Biocca, 1997) have suggested that a key defining element of a theory of social presence is observers' modeling of the intentional states of the other (Dennett, 1987, 1996). In a definitional approach that seeks to connect both mediated and unmediated approaches, the body—be it virtual or physical—is conceptualized as a medium that provides cues to the intentional states of another. The actions of the body provide

cues as to the states of the intelligence animating the body. The approach, therefore, suggests that social presence is definable by the sense that one has "access to another intelligence" (Biocca, 1997). For example, in Biocca, social presence is activated as soon as a user believes that an entity in the environment displays some minimal intelligence in its reactions to the environment and the user. This definition seeks to accommodate human-to-human social interaction as well as the social interactions that have been documented with common computer interfaces (Reeves & Nass, 1996). Cognitive states associated with social presence may inevitably involve some form of mental model of the other. In the context of social presence theory, Biocca and his colleagues (Biocca, 1997; Nowak, 2000; Biocca & Nowak, 2001; Nowak, & Biocca, 2001) have emphasized that a substantial mental model of the other is activated immediately upon detection of behavior that suggests the presence of another intelligence. Like the primitive activation of approach and avoidance reactions, some modeling is necessary to reduce the uncertainty and to model the intentions of the other towards the environment and the user.

3.1.3.2 Salience of the Interpersonal Relationship. Short et al. (1976) suggest some level of psychological involvement beyond attention by including in their definition of social presence: "The degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships . . . it is a subjective quality of the communications medium . . . "(p. 65). Salience of the other was both an "attitudinal dimension of the user, a 'mental set' towards the medium" (p. 65), but also "it is phenomenological variable . . . affected not simply by the transmission of single nonverbal cues, but by whole constellations of cues which affect the 'apparent distance' of the other." (p. 157). These cues provide relational meaning of the interactants, such as their level of involvement or investiture in the relationship, to the individuals.

3.1.3.3 Intimacy and Immediacy. Rice emphasizes this aspect of psychological involvement by echoing Short et al.'s classic social psychological claim that social presence "is fundamentally related to two social psychology concepts: intimacy and immediacy" (Rice, 1993, p. 72). This work emphasized more social theories of social presence focused on "media appropriateness," and these concepts are applied to media from the social psychological work of Argyle (Argyle & Dean, 1965; Argyle, 1969, 1975; Argyle & Cook, 1976) and Mehrabian (1972) on the role of nonverbal communication in interpersonal interaction. The changing relationship of one individual to another is affected by the salience of the relational cues available to both individuals.

In a similar fashion, Palmer links presence to aspects of psychological involvement with the other:

> Although these terms (immediacy, intimacy and involvement) are typically used to describe behaviors, it is not difficult to imagine that they also describe a cognitive state in which individuals feel more or less directly "present" in the interaction and in the process by which relationships are being created (Palmer, 1995, p. 284).

3.1.3.4 Mutual Understanding. Most mediated social interactions occur over time; therefore, the mental model of the other and the sense of social presence must be evolving and not fixed. The logic suggests that there should evolve some sense that the observer has some understanding of the other. In cases of higher social presence, this understanding might be mutual. For Savicki (Savicki & Kelley, 2000), the definition of social presence emphasizes the ability to project a sense of self through the limitations of a medium. Emphasizing this dimension of social presence, Nowak (2000) used the measure of "homophilly," or perceived similarity in emotions and attitudes, to measure social presence. Although this approach is problematic in that one may experience social presence with another without holding similar views, it is insightful that some level of mutual understanding may be negotiated through the restrictions of a medium.

3.1.4 Behavioral Engagement. Social interaction involves behavior. Some definitions of social pres-

ence include implicit or explicit references to some level of behavioral engagement, especially behavioral interaction or synchronization either as the essence or an indicator of social presence. The emphasis on interactive behavior is a more recent component of social presence theories. Most social presence research until the mid-1990s dealt primarily with low-bandwidth media, textual media, or teleconferencing systems (Short et al., 1976; Steinfield, 1986; Rice & Love, 1987; Rice, 1992, 1993; Walther, 1992, 1996; Walther & Burgoon, 1992; Walther, Anderson, & Park, 1994; Rice & Tyler, 1995; Tidwell & Walther, 2000). Therefore, behavioral variation was limited and rarely extended beyond text-based verbal behavior and a narrow range of nonverbal communication behaviors. Most tasks such as text chat were highly symbolic and relied heavily on verbal interaction. Nonetheless, although social presence like presence itself is largely a phenomenal state, it is sometimes defined as including a behavioral component. Reference is made to levels of behavioral engagement such as eye contact, nonverbal mirroring, turn taking, and so forth.

Immersive virtual environments and computer games opened a much wider range of potential channels for behavioral interaction. Writing in the context of early VR, Palmer's (1995) definition of social presence builds on Heeter's (1992) emphasis on reaction and interactivity. These seem to acknowledge the desire to include a behavioral component in the definition. For Palmer, the definition of social presence includes "effectively [negotiating] a relationship through an interdependent, multi-channel exchange of behaviors" (Palmer, 1995, p. 291).

4 Measures of Social Presence

Measures are born of the conceptualizations of social presence. Various measures have been proposed for various conceptualizations, but there is as of yet no widely accepted operationalized measure of social presence. This is perhaps due to there being no generally embraced conceptualization of social presence. In our following analysis, we suggest that a more robust definition and explication of social presence may be required to support the development of a measure that has satisfactory content and construct validity. Table 2 identifies a variety of ways in which researchers have attempted to measure social presence.

4.1 Subjective Self-Report Measures

4.1.1 Subjective Social Richness of the Medium. Because Short et al. (1976) popularized the use of the term *social presence* in telecommunication, theirs is the most commonly used measure of social presence. They use a self-report measure of "the subjective quality of the communications medium" (p. 65) to measure social presence. Their approach uses a set of semantic differential scales that seek to tap into some of the social and emotional capabilities of the medium. It is important to note that users are not asked to judge their experience of the other, but to instead indirectly assess the effect of the medium. The use of indicators that ask the respondent to assess the "experience" rather than the "medium" is more typical of presence measures. In the Short et al. measure, the respondent is asked to directly pass judgment on the medium itself. Short et al. appear to believe that they are measuring a relatively stable " 'mental set' towards the medium" (p. 65). The equivalent approach for a presence measure would be to ask, "How realistic is this medium?", as opposed to, "How realistic was the experience?" We will return to this important distinction in the section on limitations.

4.1.2 Involvement, Immediacy, and Intimacy. Short et al. built their theory on the contemporary social psychological theories of interpersonal communication. This literature identified key properties of interpersonal communication labeled as involvement, intimacy (Argyle & Dean, 1965), and immediacy (Weiner & Mehrabian, 1968). These were the qualities of social interaction that media high in social presence could evoke during a mediated social interaction. Although they referred to these constructs, Short et al. did not claim to explicitly measure them. Measures of the constructs of involvement, intimacy, and immediacy have been used in interpersonal and nonverbal communication literature

Table 2. *Subjective Self-Report Scales Used to Measure Social Presence*

Classification (key cite)	Description	Example social presence studies
Perceived social richness of the medium		
Social Presence (Short et al., 1976)	• Social presence is measured using the semantic differential technique (Osgood, Suci, & Tannenbaum, 1957). Pairs of items included unsociable-sociable, insensitive-sensitive, cold-warm, and impersonal-personal. • "Media having a high degree of Social Presence are judged as being warm, personal, sensitive and sociable" (Short et al., 1976, p. 66). • Multiple conditions (FtF, audio/video, audio only, written)	(Steinfield, 1986; Rice, 1992; Sallnas et al., 2000)
IPO Social Presence (de Greef & IJsselsteijn, 2000)	• Measured social presence according to Short et al. by using a semantic differential technique on bipolar items such as (in)/sensitive, cold/warm, (im)/personal, (un)/sociable, including items that Short et al. (Short et al., 1976) called *aesthetic appeal* (small-large, closed-open, colorless-colorful, ugly-beautiful). • Seven-point Likert scale on agreement with user's comments	
"Social presence" of voices (Lee & Nass, 2001)	• Four-item scale measuring responses to computer voices: "as if someone talking to you," "how involving," "how vividly," "how much attention" (*alpha* = .89)	
Involvement, Immediacy, or Intimacy		
Immediacy, Intimacy, and Involvement (Burgoon & Hale, 1987)	• Likert, five-point items in three scales of indicators for intimacy, involvement, and immediacy. Measure whether the other is perceived to be involved, interested, or emotional about the conversation. • Tends to be oriented toward conversational interaction and includes items on whether or not the interaction partner made the conversation seem superficial or created a sense of distance between the interaction partners.	(Nowak, 2000)
Immediacy of the medium (Gunawardena & Zittle, 1997)	• Longitudinal study using Short et al. (1976) bipolar scales to measure "intimacy" of the medium: "social presence scale . . . embodied the concept of "immediacy" as defined in the literature" (p. 8).	
Social judgments of the other		
Social attraction: Homophily (McCroskey et al., 1975)	• Seven-point metric measures homophilly, or social attraction was modified for the purposes here • Includes questions about the extent to which they feel the other person could "be a friend," was "pleasant or offensive" and whether or not the participant "desired a future interaction"	(Choi, 2000; Nowak, 2000)
Single or two item measures		
Sense of being together (Ho et al., 1998)	• Subjects interacted through a collaborative online game with a confederate. • Measured "sense of being together" with the two-items 1–7 scale.	

to define and assess the maintenance of interpersonal relationships (Burgoon & Hale, 1988). In the typical study, two or more strangers meet in a room to discuss a topic or complete a task while some aspect of the interaction is manipulated. Respondents use semantic differential or Likert-format scale items to judge statements about their partner in an interaction.

If one considers all social presence to be variable whether mediated or not, then measures from face-to-face communication could be usable for mediated communication. Many measures such as intimacy, immediacy, or other similar constructs can be used to partially measure social presence. Making this assumption, Nowak (2000) adapted the Burgoon and Hale (1987) measure explicitly for use in mediated communication in virtual environments. Gunawardena and Zittle (1997) measured intimacy by blending the kinds of semantic differential scales used by Short et al., but structuring them to focus on the intimacy construct. Some of these measures reflect their origin in face-to-face interpersonal communication: in some cases, the language of items assumes a vocal interaction and emphasizes judgments of the other.

Other work on computer-mediated communication and human-computer interaction has adapted these kinds of measures of interpersonal communication to assess the extent to which interactivity is achieved behaviorally and perceptually (Burgoon et al., 2000; Bonito, Burgoon, Dunbar, & Ramirez, 2000; Stoner, 2001; Ramirez, 2001; Ramirez & Burgoon, 2001; Burgoon, Bonito, & Kam, in press; Burgoon, Bonito et al., 2002). To the extent that interactivity fosters social presence and/or social presence is one marker of interactivity, these measures—which include constructs such as involvement, identification, and multiple facets of mutuality (connectedness, similarity, receptivity, and coordination) — may tap into dimensions of social presence. Other communication qualities, such as composure, spontaneity, positivity, richness, and evaluation may represent not social presence itself, but rather markers of the quality of communication that transpires when social presence is realized or not.

4.1.3 Social Judgments of the Other. Whereas measures of involvement, intimacy, and immediacy involve judgments of a specific interaction or the other's general communication abilities, some measures are very explicitly attributional measures of the other or broad evaluations of the relationship with the other.

In an effort to specifically move away from judgments of the medium, Nowak (2000) and Choi et al. (2001) used a measure of perceived similarity, labeled *homophily* (McCroskey, Richmond, & Daly, 1975) to measure the user's perception of avatars and agents in virtual environments. This measure attempts to capture the sense of feeling similar to the other in attitudes, behaviors, or emotions. This relates to social presence in that it involves the individual making assessments of the other's cognitive state.

4.2 Behavioral Indicators

Behavioral measures are common in studies of face-to-face interactions (Coker & Burgoon, 1987), where they are used as measures of interrelated variables such as involvement and immediacy. Some of the verbal or nonverbal indicators (such as voice inflection or facial expression) may be indicative of social presence.

The assumption behind the use of behavioral indicators is straightforward: if the user is engaged in X and/or Y social behavior, then they must feel that the other is socially present. The presence or absence of behavioral indicators, their frequency, or some variable property of the behaviors may be used to construct a behavioral measure of social presence.

We can find few examples of the use of behavioral measures explicitly as a measure of social presence, although the coding of behavior is common in studies of interpersonal communication. Heeter (1992) measured the percentage of participants who preferred games against the computer only, with or against another person, and what type of experiences respondents would prefer with other social entities. Heeter's study of choice behavior was explicitly interested in media selection as an indicator of social presence.

More recently, Baileson and colleagues (Bailenson, Blascovich, Beall, & Loomis, 2001) explored approach-

avoidance behavior (proxemics) in the context of social presence, but they did not explicitly use the behavior as an indicator of social presence but rather as a correlate of self-reported social presence.

4.3 Psychophysiological Measures

Although psychophysiological indicators such as heart rate, skin conductance, or fMRI have been used to measure social psychological responses such as the processing of affect and motivation (Blascovich, 2000), we are unaware of their use explicitly to measure mediated social presence. This may be due to the difficulty in identifying a consistent physiological signature simply for the presence of another, even though interaction with others may elicit various psychophysiological responses depending upon context and interaction. As Blascovitch warns, "a one-to-one correspondence between specific behaviors and unitary physiological responses rarely exists . . . invariant indexes, whether subjective or objective, of social psychological constructs often prove illusive because target constructs; for example, risk-taking, love, prejudice, self-concept, themselves prove difficult to define" (Blascovich, 2000, p. 119–120). This problem applies to social presence as well. On the other hand, research on the theory of mind suggests some potential indicators of social presence such as so-called mirror neurons and other indicators of the process of generating mental models of the other (Frith & Frith, 2001).

5 How Might Current Conceptualizations and Measures of Social Presence Limit Their Usefulness and Effectiveness?

Do existing theories and measures of social presence provide adequate guidance for research on social interaction in virtual environments and for evaluating and measuring the relative social psychological impact of different interface design technologies? The work shines light on the problem in many ways, but existing theories and measures may not be developed adequately to fully support research on social presence in mediated environments.

Although deceptively intuitive, the concept of social presence can be hard to explicate in a way that best supports the range of phenomena that fall within its domain and the needs of measurement. Vague definitions, confounding the boundary conditions, medium-oriented measures, and assumptions of media capabilities all present problems for measuring social presence.

5.1 Vague, Overly Broad, or Circular Definitions of Social Presence

A common limitation affects several definitions of social presence. Many may be stated too broadly and too vaguely to provide adequate guidance on the measurement of social presence. For example, we and others have sometimes defined social presence as "the sense of being with another" or the "sense of being together" in a virtual environment. Although this can be useful as a shorthand communication, it is inadequate as a definition. It merely replaces the phrase *social presence* with a new, limited set of terms that do not significantly advance the explication of the construct. The lack of explication, especially the failure to specify the dimensions of the construct, does not provide enough guidance to prepare and delimit the scope of the concept for successful operationalization and measurement.

5.2 Confounding of Boundary Conditions for Social Presence with the Correlates or Effects of Social Presence

What is the difference between social presence and the effects of social presence? Most researchers would likely agree that the psychological state of social presence should be different and separate from the correlates and effects of being in a state of social presence, but the clear delineation of this line between social presence and its effects may be hard to draw. Therefore, it remains unclear in several theories.

We assume that, like presence, social presence is a phenomenal state varying during the course of an interaction. It is a fleeting, variable judgment of the nature

of interaction with the other, as limited or augmented by the medium. But clearly there is a boundary between this temporary and fluctuating state over the course of an interaction and some longer-term judgment one might make about the other. What individuals feel, for example, about a media figure such as an actor or politician should be independent on how present they might feel with the individual should they have the fortune of communicating with the person via an email, a telephone call, a teleconference, or a face-to-face meeting. Measures of longer-term attitudes about the interaction agent need to be kept independent of temporal judgments of social presence with the interactant. Put differently, social presence is a highly dynamic and transient state that is defined in relation to another, but it is independent of judgments about the other.

Some measures, including ones that we ourselves have used, may cross the line toward representing variables that are correlates or effects of social presence rather than social presence per se. The use of measures of user-other similarity (for example, homophily (McCroskey et al., 1975)) provides an example. If such measures are used to assess transient judgments about how connected a person is feeling toward a target entity, it is probably tapping into the social presence construct. But if it is merely measuring a summative judgment about whether the target has characteristics similar to the actor, it is probably better regarded as a social judgment. The intent of the researcher would determine the nature of the measure's use.

5.3 Social Presence as Measurement of a Medium Versus a Phenomenal State

When we measure social presence, what are we measuring: the fluctuating phenomenal properties of a communication interaction and the relationship it establishes between actor and target, or the stable properties of a medium and/or target? Many telecommunication and human-computer interaction researchers are interested in the latter, but we submit that social presence should be conceptualized as a transient phenomenological state that varies with medium, knowledge of the other, content of the communication, environment, and social context.

Consider the most widely used measure of social presence (Short et al., 1976). This is explicitly a measure of the medium. This outcome may have been the result of the funding and the desire to rate media, rather than a reflection of the theoretical conceptualization of presence. The UK post office, Department of Transportation, General Electric, and other organizations funded their earlier studies to determine the relative effectiveness of different media channels for social communication. After discussing the social psychological states of users of these telecommunication technologies, Short et al. proceeded to operationalize their concept of social presence as a business consumer's "attitude about a medium" and its use for negotiation, persuasion, and other forms of organizational communication. This is based on the reasonable assumption that individuals have certain attitudes toward media channels and what they consider appropriate for social presence. For purposes of measurement, they considered social presence to be a unidimensional "quality of the medium" and not the result of interaction of individual differences, task, and environmental context. They stated that social presence, "is conceived of as unidimensional but considered to be a perceptual or attitudinal dimension of the user . . . [and thus is] a subjective quality of the medium" (Short et al., 1976, p. 650). Therefore, the measure asks respondents to directly evaluate the properties of medium for social presence.

But there may be two reasons why this approach to measurement may limit the usefulness and effectiveness of a measure of social presence. Can users reliably access the properties of a medium that might affect their behavior? And is social presence just an attitude towards a medium? It has been demonstrated in several studies (Nisbett & Ross, 1980) that respondents cannot reliably identify the cause of their attitudes. It is not clear that they can directly introspect to make a judgment of how well this or that medium "causes their social presence." If the goal is to get a direct measure of the medium, it is likely that such a measure would not be valid as self-report measures are indirect and potentially problem-

atic, depending on accurate introspection and articulation. Various other aspects of the interaction are likely to color the respondent's perception of the "social presence capabilities" of the medium.

The Short et al. measure of social presence appears to be concerned with the extent to which an actor perceives a medium as capable of allowing a sense of social presence. The judgment being made is to what extent the actor perceives the medium as unsociable-sociable, insensitive-sensitive, cold-warm, and impersonal-personal. But this may be a social judgment about a medium, not a judgment about one's state within the medium. Media appropriateness (Rice, 1993) appears on face value to be a more accurate fit than social presence, as this measure is a global judgment of the medium based on one's total experience with it.

If social presence is conceptualized as a fluctuating phenomenal state, then measures of the fixed properties of a medium may not appropriate operationalizations. In such cases, then, social presence is a feature of the communication interaction with the individual's perception determining the extent to which it exists, and the medium is one causal variable shaping that social interaction. The medium may influence a fluctuating level of social presence, but social presence will not be specifically directing attributions about the medium per se.

5.4 Problems Created by Measures that Include Embedded Assumptions About the Technology Used in the Social Interaction

Most researchers would agree that social presence is a phenomenon that is independent of a specific technology and that one can experience some level of social presence with most media. Therefore, a usable measure of social presence should be able to measure social presence across most media. But almost all self-report measures of social presence are constructed by researchers to address an issue in a specific technology: F2F interaction (nonmediated), email systems, teleconferencing systems, or virtual environments. Researchers may create a theory or, more typically, develop a self-report measurement instrument that is specifically suited to the technology they are studying.

A fundamental problem with these measures is that the items are constructed so that they make assumptions about technology:

- assumptions about sensory channels supported by the technology (display devices) (that is, "How well did you see the other." "I could see the other on the screen.");
- assumptions about input devices ("The other listened to what I said." Assumes audio input);
- assumptions about the virtual environment ("I felt close to the others in the virtual room.").

These items and measures constructed from them cannot be easily generalized to use with other media. They effectively preclude cross-media comparisons, and therefore defeat one of the key goals of the social presence theory and research: the evaluation and relative effectiveness of social presence technologies or interface techniques.

5.5 Overcoming Limitations in the Range of Social Interactions that can be Accommodated by a Measure of Social Presence

Much research on social presence is done in settings in which impression formation or organizational tasks such as collaboration are the norm. As a result, some theories and measures assume a specific class of interactions: collaboration, task performance, creating attraction and liking, and so forth. If the measurement of social presence is tailored to a specific kind of goal, social interaction, or task, then the same measures cannot be used to measure social presence in other types of interactions, goals, or tasks. For example, is it not possible to feel that the other is very socially present in hostile or competitive interactions such as those found in some computer games? If someone is five feet from you in an immersive virtual environment, sneering and pointing a gun directly at your head, can we say that the individual was not "so-

cially present" because the measure indicated that you, the respondent, did not "like them," "feel as if you could cooperate with this person," or "would like to repeat this interaction"? Such measures fail to satisfy content and construct validity requirements in measuring social presence.

5.6 Summary: Is There a Common Root to Current Limitations in Social Presence Theory and Measurement?

We have reviewed some of the conceptualizations and measures of social presence and discussed some possible limitations. We have suggested that the following problems affect some or all of the current theories.

- definitions that tend towards vague, overly broad, or circular definitions of social presence, and that tend to blur the logical distinction between the psychological state of social presence and the psychological or behavioral effects of social presence;
- concepualizations of social presence as a fluctuating psychological state of users matched to measures of social presence as a stable property of a medium; and
- limitations in the wide application of measures because of assumptions about the technology used in the social interaction, and assumptions about the range of social interactions that give rise to social presence.

Many of the limitations can be traced to problems in specifying the range and scope of the phenomena:

- defining the limited scope of psychological phenomena that constitute social presence,
- defining the scope of social behavior that elicits social presence and that clearly indicates a social presence state as opposed to an effect of social presence, and
- setting criteria for measurement that are broad enough to cover the full range of media technologies and types of social interactions.

We next propose the need for a theory of social presence that explicates and works toward operationalizing the concept in such a way that it provides the basis for understanding, explaining, predicting, measuring, controlling, and designing for appropriate levels of social presence.

6 Toward a Theory and Measure of Social Presence: Suggested Criteria, Scope, and Example Scenarios

The beginning of this article indicated that various areas of HCI research might benefit from a theory of social presence that can support greater explanatory power and, possibly, generate a more predictive and usable measure. How might social presence researchers — among which we include ourselves — move past what we have identified as potential barriers? In this section, we try to provide a contribution towards a more solid grounding for social presence research by seeking to ground the fundamental theoretical question of social presence in a framework that might expand its explanatory power, and by defining the scope of the social communication phenomena that might specify the scope of behavior that a theory of social presence could legitimately address if it is to have broad explanatory power.

6.1 Search for the Fundamental Theoretical Question Addressed by Social Presence Theory and Measurement

Having disassembled existing theories of social presence into parts, it may be wise to start to "rebuild" a theory of social presence. A good start is to look for the basic question at the very heart of the research enterprise. One fundamental question that drives researchers' understanding of social presence is "What are the properties of representations of other beings that elicit social responses from users-viewers?" We will call this the *technology question*, as it is concerned with changes in properties of interface design and drives much of the social presence research. Designers have manipulated

social responses for centuries via representations of people in paintings, sculpture, and numerous other media. It is understandable that the technology question would be the most natural starting point for most design-oriented researchers such as Short et al. (1976).

But this technology question is implicitly married to what we will call the *psychological question* of social presence: "What properties of humans elicit attributions of cognitive states to representations, as if those representations contained minds?" All the dimensions of social presence used by researchers such as "intimacy," "involvement," and "mutual understanding" circle one basic phenomenon: that social presence may be the product of the process of "reading a mind" behind a representation. Of course, these cognitive mechanisms have their origins in more basic social communication processes.

The psychological questions of social presence may be part of the larger issue of the "theory of mind" or how individuals have "knowledge of other minds," or, more specifically, infer intentional states to others (Gordon, 1986; Carruthers & Smith, 1996; Premack & Premack, 1996). The philosopher of mind, Daniel Dennett (1987, 1996), has suggested that the tendency to infer agency and mental states to inert entities, what he calls the *intentional stance,* may have evolved as a successful strategy to reason about the environment.

When people experience social presence, are they using bodily cues or technological representations of bodily cues (such as facial expressions) to infer the psychological states of others? Social presence, the sense that one is together with another, may be the by-product of reading or simulating the minds (mental states) of virtual others. When interacting with agents or robots, for example, users "read minds" and respond socially, even when they know that no mind or social other really exists. Fundamentally, when responding to all social representations, we know that the "other" is just ink on paper or patterns of light on a screen, yet the social responses are automatic. Discovering how to better trigger, sustain, and enhance these social cues becomes part of the design outcomes of social presence theory.

A theory of social presence, how we generate mental models of virtual others in mediated communication, is a subset of this larger research challenge. The fundamental theoretical question of how one comes to "know other minds" has a long, complex, but interesting history in the fields of philosophy and psychology (Carruthers & Smith, 1996; Dennett, 1987, 1996; Rosenthal, 1991). It may be that a full understanding of social presence may benefit from being informed by a larger theory of how we automatically interpret physical forms and nonverbal and verbal codes to simulate and infer the content of other minds. A theory of social presence may need to simultaneously address both the technology questions about media form and the psychological question about reading minds in representations. When this approach has been adopted, the results have been enlightening (Reeves & Nass, 1996), although Reeves and Nass limit their theoretical exploration of the psychological question to a very general reference to the operation of an "old brain" designed to accept the sensory input of technological simulation as real. Social presence theory may benefit by seeking to forge a deeper link between the brain, the properties that read minds in representations; and technology, the properties that simulate agency in inanimate things such as pixels, paint, and clay.

6.2 Focus on Mediated Interaction and Technological Differences?

How broad should a theory of social presence be? What should be the scope of the social interactions it seeks to explain and measure? There may be a danger for theories of social presence to drift too far towards overly broad theories of all social interaction instead of being theories of mediated social interaction. Although we believe a theory of social presence should yield some insight into fundamental epistemological issues in the "knowledge of other minds" (Gordon, 1986; Dennett, 1987, 1996; Carruthers & Smith, 1996; Premack & Premack, 1996) or social psychological issues in person perception, all human interaction is not the scope of phenomena to be explained. The scope of social presence theory is the explanation of technologically mediated human interaction specifically. This focus is how

technology provides filters that add or subtract cues found in unmediated social interaction.

A central concern of social presence theory has to be whether technologically mediated social interaction is or is not different from unmediated interaction. If mediated interaction is different than unmediated interaction, in what way is it different and what is it about technology that causes this difference? Although mediated and unmediated social interaction may draw upon the same cognitive mechanisms, there is an assumption in all presence research that "technology has an effect." To support human-computer interaction studies and mediated communication studies, the theory of social presence is likely to be a theory of how differences in technological connection, representations, and mediated access affect, distort, or enhance the perception (mental model) of others' intentional, cognitive, and affective states and behavior resulting from those perceptions. Because social interaction is increasingly mediated social interaction, a theory of social presence is likely to be able to contribute to philosophical and psychological theories of other minds and theories of interpersonal communication.

6.3 Operationalizing Social Presence

Researchers use social presence theory for both explanatory and diagnostic (predictive) aspects of science. Typically, researchers in human-computer interaction and telecommunication may use presence theories and measures to directly compare different media. Researchers may come to focus on social presence because they want to explore how the communication or task performance of users of different interfaces affects how they perceive and behave in their communication with collaborator(s) using the different systems. Thus, theories of social presence tend to be primarily focused on developing metrics that allow these comparisons of technological differences, and less focused on individual differences among users, task differences, and so on. To achieve direct comparisons of the communication effectiveness of increasingly slight differences in media technology, a theory of social presence would need to be tied to very precise measures of user responses to mediated others. Therefore, the theory may need to define the phenomenon of social presence in a way that is suitable to precise measurement. Unfortunately, some conceptulizations of copresence/social presence do not lend themselves easily to measurement because the concepts are presented too vaguely to support measurement, they are overly simplified by being reduced to a single dimension, or they are defined too narrowly. The literature reviewed points strongly to social presence, like spatial presence, being multidimensional. Therefore, of theory of social presence would need to specify the dimensions of the construct in a way that can guide multidimensional measurement of it.

6.4 Where and When Does Mediated "Social Presence" Occur?—Defining the Boundaries of Mediated Social Interaction That Would Need to Be Measured and Explained

If the goal is a conceptualization of social presence that supports a robust measure of social presence and enlightens the design of social presence technologies, it might be valuable to specify what, when, and where the behavior to be measured exists, basically to specify criteria and scope conditions for a theory and measure of social presence. By scope conditions we mean

- specify the range of phenomenon we seek to understand,
- delimit the range of causal relationships of the phenomenon we seek to explain,
- determine what behavior or attitudes the theory and measure may seek to predict,
- determine the range of predictions potentially supported by the theory, and, finally,
- suggest how the theory may provide guidance for the design of environments that control qualities of social presence that users experience.

Theories and measures are scientific tools designed to understand, explain, predict, and control a set of phenomena. If we assume that there is a coherent and delimited set of phenomena for which we use the term *social presence,* then we should be able to define the

scope of phenomena that they seek to explain and criteria for assessing the value of a social presence theory and measure.

In Table 1, we examined definitions of social presence and organized them by the dimensions that appear to be underlying current conceptualization of social presence. Thus, one criterion for judging any theory and measure of social presence is the extent to which it differentiates among these various dimensions and makes explicit which are being included or excluded.

In Table 3, we expand upon the criteria for conceptualization and measurement by identifying what might be thought of as the range of phenomena that a theory of social presence should be able to explain or measure. To flesh out and better specify the research purpose for these criteria, we provide explications and specify the scope of the phenomenon. The example scenarios illustrate the range or the kinds of interactions that need to be understood and potentially accommodated by one set of measures. In some cases, these example scenarios provide extreme cases that stretch the range of conditions, interactions, and experiences that a theory of social presence should allow us to explain and measure.

7 Summary and Conclusions

We have proposed that a robust and detailed theory and measure of social presence could greatly contribute to our understanding and explanation of social behavior in mediated environments, allow researchers to predict and measure differences among media interfaces, and guide the design of new social environments and interfaces, collaborative systems, virtual environments, video conferencing systems, embodied agents, and other technologies of simulated or mediated social interactions. Unfortunately, a review of the theory and measures suggests the current state of the art may not adequately support the broad explanatory power of mediated behavior required and may provide measures that are usable but limited in scope. Specifically, our review suggests the following.

- Current definitions may tend toward vague, overly broad, or circular definitions of social presence, and may blur the logical distinction between the psychological state of social presence and the psychological or behavioral effects of social presence.
- The literature shows some confusion as to whether social presence should be conceived of and measured as a property of a medium or a phenomenal state of users.
- Measures may not support theory development or cross-media comparison because they implicitly embed assumptions about the technology used in the social interaction and assumptions about the range of social interactions that give rise to social presence.

We ended by proposing a set of criteria and scope conditions that might begin to lay the foundations for a more robust theory and measure of social presence. Specifically, we proposed the following.

- *Technology + psychology requirement:* A theory of social presence with broader explanatory power would need to simultaneously address the technological question of what features of a medium elicit social responses and the psychological question about the properties of human cognition that "read minds" in both people and things.
- *Focus on mediated social presence:* Although informed by general issues in social cognition and communication, a theory of social presence must be fundamentally a theory of how technology mediates social interaction.
- *Explanatory scope and range conditions:* To overcome the tendency for social presence theories and measures to focus too narrowly on a subset of social presence behaviors, we have proposed a range of mediated social interactions that a robust theory and measure of social presence should be able to both explain and measure.

We hope that this provides some modest contribution toward building a foundation for theory and measure of social presence with greater explanatory and predictive power.

Table 3. *Criteria, Scope Conditions, and Example Scenarios for a Theory and Measure of Social Presence*

	Explication	
Criterion	Scope Conditions	Example Scenarios
Span different classes and generations of communication technology.	Ideally, the same measurement instrument should be able to measure social presence across a very wide range of media from the least interactive (pictures, voice recordings) to high-bandwidth telepresence systems that simulate face-to-face interaction. To ensure the ability to support cross-media and cross-interface comparisons, the social presence measure should be usable without need for significant alteration or adaptation to be used with any interface—old, new, or not yet created.	• *Media comparisons:* A person feels a change in social presence from cell phone to video teleconferencing. • *Social presence in older non-interactive media:* An individual feels social presence while observing sculpture. • *Interaction of mediated and unmediated social presence:* An individual feels enhanced social presence in a face-to-face interaction while wearing technology that gives them access to the physiological responses of the other such as their heart-rate, blood pressure, skin-conductance, and so forth. • *Mediated social presence with nontraditional interfaces or atypical mediated behaviors.* A haptic device is used in a mediated-sexual interaction.
Accommodate various kinds of mediated interactions	The theory and associated measure should accommodate and measure social presence for a wide range of interactions: from the casual-and-passing to the formal-or-intimate; from collaboration-to-struggle; from one-to-one, as well as one-to-many interactions, et cetera. The measure should not break down at the extremes of interaction such as social presence in very familiar or intimate interactions such as two lovers communicating in an immersive environment or in highly hostile interactions such as a predator-prey interaction with a virtual character in a computer war game.	• *Mediated social presence without prior unmediated experience:* A work team tries to get to know each other via a virtual environment at the beginning of a project. • *Mediated social presence of very familiar interactions:* Two old friends meet in an immersive virtual environment. • *Social presence during conflict:* A child feels terror at the presence of a monster in a computer game.
Span interactions with human and nonhuman others	Media transmit representations of all kinds of seemingly intelligent entities. Therefore, a theory and measure of social presence should accommodate an individual's sense of social presence with all forms of mediated intelligence: humans, humanoid artificial intelligence, robotic devices, nonhumanoid characters, agents, and beings.	• *Social presence with socially designed nonhuman others:* User feels social presence when interacting with automated ticketing agent at an e-commerce Web site. • *Social presence with nonhuman others not explicitly designed to be social:* A user feels that his personal computer has a personality and "mind of its own."
Apply to "real" and "illusory" social interactions.	A theory and measure of social presence should be applicable to an individual's sense of social presence not only in willed social interactions, but even when there is no interaction, when the individual is "communicating" (parasocial interaction) with an imagined other or when "no other" or no intelligence is objectively aware, present, or responding to the interactant.	• *"Illusory" social interaction with noninteractive media:* An individual talks to a character on his TV set. • *Social presence in conditions of fluctuating, changing, or unstable agency:* An individual continues to feel an avatar is interacting when the human controlling the avatar is no longer connected to his embodied shell. • *Feeling of social presence during interactions with nonmedium — a technology or process with no intended communication design:* An individual feels the presence of another or being (such as a god) in a pattern of smoke, clouds, pixel noise, or so forth (or any entity that may or may not be there in a medium).

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