

**Defining and measuring social presence:
Contribution to the Networked Minds Theory and Measure**

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Summary

This paper outlines the foundation of a definition and measurement for the concept social presence. Justification for such a line of research lies in the ever-increasing use of social presence technologies and expansion of the social interactions across the Internet. A definition of social presence, based upon past literature and theory, describes several levels and dimensions of social presence by which the concept can be operationalized. Specifically, Level 1: co-presence is a necessary but not sufficient requirement for the sense of social presence. Level 2: the Subjective level, attempts to measure the psycho-behavioral accessibility of another interactant. Finally, Level 3: the Intersubjective level, assesses within and cross-interactant symmetry. The purposeful direction of this research and measurement construction is to enable researchers and designers to compare various mediated interactions as well as further theoretical inquiry.

1. Introduction

Communication networks are social environments. Measurement of their performance must be perfected according to both engineering criteria such as telecommunication bandwidth and social criteria such as group communication, what we might call social presence bandwidth. 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, 2001), education (Steeple & Jones, 2002; Hazemi & Hailes, 2001), social services, or e-commerce (Li, Daugherty, & Biocca, 2001). Examples of current systems include:

- **Collaborative work environments:** Work environments are characterized by increasingly high-levels of mediated (as opposed to face-to-face) work interactions (Covert & Thompson, 2001; Churchill, Snowdon, & Munro, 2001), and there is growth in telecommunication infrastructure (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, 2001) and the sensory and social presence of that access is increasing via mobile video telephony and other message systems.
- **High-bandwidth teleconferencing interfaces:** i.e., teleimmersive 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 with new forms of artificially intelligent beings, such as computers themselves and intelligent agents that inhabit virtual environments, act as “office assistants,” guides on websites, characters in social 3D virtual environments, and team members or opponents in computer games (Cassell, Sullivan, Prevost, & Churchill, 2000; Chorafas, 1997; Franklin, 1997; Kushmerick, 1998; Petrie, 1996; Reeves & Nass, 1996).
- **Speech interfaces:** Simulations of human speech and social interaction with the computer (Yankelovich, Levow, & Marx, 1995).
- **3D social virtual environments:** Fully mediated, social interaction in computer graphic bodies including a full range kinds of social interaction and contacts (Schroeder, 2001; Munro & Höök, 1999; Fischer, 1988; Singhal & Zyda, 1999).

While all these technologies are varied they share a common goal: Most of these technologies are designed, engineered, and manufactured to *improve social presence*. Social presence has been defined as the sense of “being with others” (Heeter, 1992), “level of awareness of the co-presence of another human, being or intelligence” (Biocca & Nowak, 2001), “the degree of salience of the other person in the interaction” (Short, Williams, & Christie, 1976), and the “feeling that one has some level of access or insight into the other’s intentional, cognitive, or affective states” (Biocca & Nowak, 2001).

For the purpose of this document we will refer to technologies that are primarily intended to increase real

time social interaction as social presence *technologies*. Typically these technologies are implemented as networked telecommunication media designed to allow remote individuals to work, communicate and interact with each other, as if they were co-present in the same environment. Although these technologies are explicitly designed to augment social presence, systematic attempts to measure, evaluate, and assess the performance of various dimensions of social presence are still in their infancy. Biocca et al. (Biocca, Harms, & Burgoon, submitted) analyzed limitations in current social presence theories and measures based on those theories. They also laid out some criteria or “scope conditions” for a theoretically rich, measurement oriented, theory of social presence. This paper builds on this earlier work and attempts to sketch a comprehensive, measurement-oriented explication of the concept of social presence.

2. **Why do people feel socially present with representations of others?: Introducing the problem of social presence**

Elsewhere we have argued that a full explication of social presence should account for the widespread and fundamental phenomena ubiquitous and frequent social responses to representations of others (Biocca, Harms et al., submitted). Aristotle was certainly not the first to observe that humans are “social animals.” We interact with others all the time, and it is believed that the demands of social interaction may have been one of the social forces behind the dramatic expansion of the cranium around 3.5 millions years ago (Donald, 1991), which marks the boundary between humans and many of the apes. But through media technologies our social interaction has not been limited to the people immediately around us: our family, workmates, local friends, and neighbors. A great deal of what is commonly called social interaction is not with physical others, but with representations of others made accessible to our senses via email, film, teleconferencing, and other media technologies. The fundamental characteristic of all mediated interactions is mediation, or interacting with spaces and people that are *not immediately present* in our physical environment. We sense and interact not with their immediate embodiments of mind, i.e., physical bodies with their actual faces and voices, but with mediated embodiments of minds, representations made of pixels, ink, stone, paper, etc. We experience the others “as if they were co-

present and socially engaged” with us. Depending on the properties of the medium, the nature of interaction, and individual differences, most of us, will experience some levels of social presence, be it fleeting and superficial or strong enough to elicit powerful emotional reactions, such as crying at films, smiling at computer characters, etc.

How is this possible? Most theorists of social presence subscribe to certain causal assumptions about presence model. One widely shared theoretical proposition is that media that better capture the interactive and perceptual properties of others (socially rich media, vivid media, immersive media (Daft & Lengel, 1984; Rice, 1993; Rice, 2001; Trevino, Lengel, & Daft, 1987)), interactive media such as immersive virtual environments, may evoke more social presence than say an email from another. For example, emails do not have facial expressions, interact, or demand attention. But does a teleconferencing system in which the other is represented in 3D provide significantly more social presence than a standard high-resolution teleconferencing system? If two people use a medium that affords higher levels of social presence, do they communicate and perform their tasks better? Are they more satisfied? Is it possible to use a medium to augment social presence even in face-to-face interactions? Why do people smile, act politely, and respond socially in many ways to computer graphic characters when they know, objectively, that these “people” don’t exist, have no real emotions, ideas, brains, or bodies? Why don’t they just ignore these representations, as they are “not real”?

Every day each one of us experiences several such moments of social presence during mediated social interactions. We may have a telephone conversation from a friend, an email from someone we have never met, or the illusion of parasocial interaction (Horton, 1956) with a character in a TV show, a newsanchor, or other media figure. Our social interaction can include rather illusory social interactions with non-entities such as characters in a book, adversaries in a computer game, computer interfaces, robots, and other media simulations of humans or animals.

The use of representations of others in ancient stone sculptures, wooden ritual masks, or computer graphic characters, suggests that the experience of mediated social presence may be ubiquitous and universal. The apparent possible exception of autistic individuals, who may not even experience social presence with other physical humans (Baron-Cohen, 2001), suggests that possibly the brain is hardwired to react to many environmental cues that suggest the presence of another, even when no physical other is really there. We will return to this issue later.

The conceptual framework that has emerged to conceptualize and measure this mediated sense of the other's presence, has come to be called social presence (Biocca, Harms et al., submitted; de Greef & IJsselsteijn, 2000; Rice, 1993; Short et al., 1976; Tammelin, 1998).

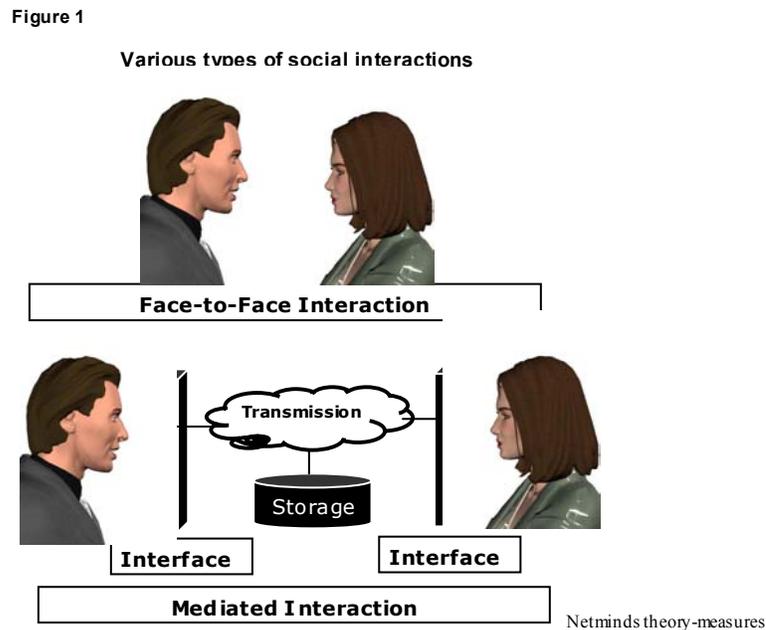
In the remainder of this paper we will:

- Describe social and theoretical motivations that make the need for a more substantial theory of social presence necessary.
- Explore the theoretical basis for conceptualizing and measuring social presence.
- Present the theoretical underpinning of the Networked Minds Social Presence Inventory.
- Introduce and define different dimensions of social presence.
- Introduce self-report and behavioral indicators of the different dimensions of social presence.

3. **Why a theory and measure of social presence?: Theoretical, social and technological motivations for explaining a fundamental psychological response to media**

Social presence research has attracted more attention of late because of the convergence of social and technological developments that make the need for an adequate theory and measure of social presence more compelling.

Figure 1: Increased use of social presence technologies for mediated social interactions



Social presence technologies continue to grow in use and capability. The number of individuals a person has access to, in addition to those individuals within proxemic range of face-to-face interaction, has increased dramatically. Relationships are maintained and even developed through mediated technologies. The ability to accurately measure differences in ftf and various media is one of the major conditions that the Networked Minds Theory of Social Presence attempts to meet.

3.1 Networked interactions: Increases in use of social presence technologies and the amount, frequency, and ubiquity of mediated social interactions.

One reason underlying the need for a theory of social presence is the perception that mediated social interactions may be increasing in frequency and type over time. We may have interactions with others we sometimes experience face-to-face, such as talking to family member on the telephone. But our mediated social interactions include purely virtual interactions with others we will never meet face-to-face. The performance of social presence technologies is increasingly important as individuals and organizations rely on them as substitutes for face-to-face interaction. Recent concerns over terrorism and delays at airports dramatically increased reliance on and demand for social presence technologies. The trend of increasing demand for teleconferencing and remote collaboration technologies is likely to continue.

- The use of collaborative servers increased 300% immediately after the Sept. 11, 2001 attack (Hamblem, Sept. 24, 2001).
- CNN reported that “National Business Travel Association showed that 88 percent of companies planned to increase use of videoconferencing” and predicted “electronic collaboration will make it big in 2002” (Lindquist, 2001, Dec. 31).
- American suppliers reported an increase of 140% in videoconferencing bookings (Bordenaro, November 19, 2001) in fall 2001. Videoconferencing stocks surged.
- Overseas, British Telecomm reported an increase of 85% in videoconferencing and 30% in audio conferencing.
- A poll by Osterman Research found 60% of business organizations had greater interest in teleconferencing; 41% reported drops in air travel (Osterman, December 03, 2001).

3.2 Design motivations: Evaluating the difference in social presence interfaces and technologies

The growth of social presence technologies are accompanied by claims of improved social communication, collaboration, social presence, and performance, although there is very little evidence to substantiate these claims. For example, although the British Video Conference Association frequently quotes Stendahl, that "The quality of life is about the quality of meeting," the quality of mediated meetings is never assessed. While the lack of measurement of social presence performance might be a lapse in a corporate service organization, the lack of clear parameters for measuring social communication can be observed in the largest NSF and NASA funded social presence project of its kind, the National Teleimmersion Initiative. Consider the claims of the chief scientist, Jaron Lanier, in an article in Scientific American:

My answer is that because tele-immersion is fundamentally a tool to help people connect better, the question is really about how optimistic one should be about human nature. I believe that communications technologies increase the opportunities for empathy and thus for moral behavior. Consequently, I am optimistic that whatever role tele-immersion ultimately takes on, it will mostly be for the good. (Lanier, 2001)

Although sophisticated in many respects, especially in the measure of telecommunication performance, this project, like many social presence technology R&D projects, *does not systematically assess the very goal of the whole technological effort, the creation of social presence and the improvement of social communication.*

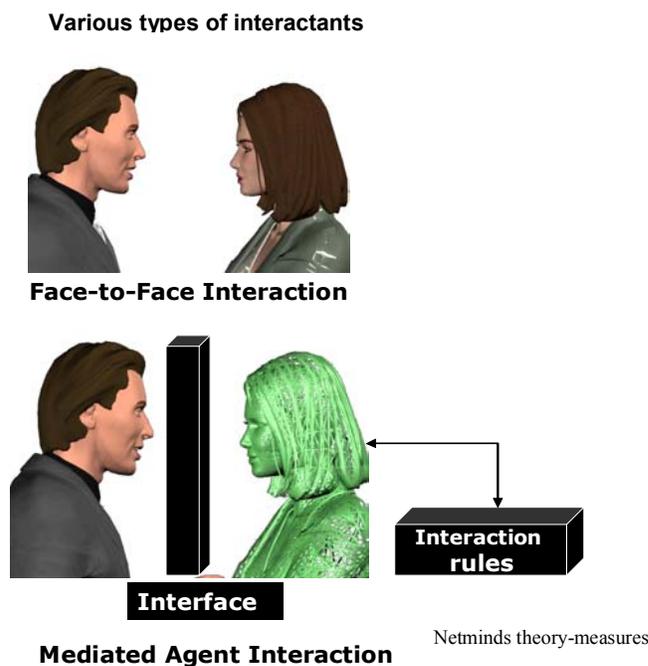
There is increasing agreement regarding the need to understand and evaluate the social communication dimension of social presence technologies. This calls for a deeper understanding of the experience of social presence through scientific, parametric, and generalizable tools to measure and assess social presence. For example, the European Commission Group on Future and Emerging Technologies has explicitly made this call in 2002:

...[due to] the increasingly social nature of interfaces and the increase in mediated communication with non-human entities (avatars, embodied agents), it becomes abundantly clear that we need to develop a deeper understanding, both in theory and in practice, of how people interact with each other and virtual others through communication of media. The experience of social presence ...thus becomes a concept of central importance. (IJsselsteijn, Harper, & Group, 2002)

The European Union report went on to specify the need to: “(1) Generate coherent, multilevel theories of presence, (2) Specify the psychological and technological parameters for basic and applied research on presence.”

Figure 2: Human computer interactions

Figure 2



A basic problem of social presence research and design is the ability to address interactional conditions regarding both human and non-human interactants. The evolution in computer generated intelligent agents and robots necessitate the need for research on how individuals interact with and relate to these entities.

3.3 Human-machine interaction: Need for a theoretical framework to explain human-to-agent, human-to-robot interactions

Past theories of social presence focused on the model of face-to-face interaction, comparing it to mediated interactions such as teleconferencing (Gunawardena, 1995; Rice, 1993; Short et al., 1976). But users find themselves in an increasing number of quasi-social relationships with new forms of artificially intelligent beings, such as computers themselves (Reeves & Nass, 1996), intelligent agents (Cassell et al., 2000; Chorafas, 1997; Franklin, 1997; Kushmerick, 1998; Petrie, 1996), and robots (Brooks, Breazeal, Marjanovic, Scassellati, & Williamson, 1998). This, to some degree is mediated social presence, but current theories cannot adequately explain.

3.4 Theoretical motivations: Social presence theory as a special case of the theory of mind.

Any theory of social presence must be a part of a larger set of theories of the psychology of moment-to-moment responses during human-to-human interaction. But within this larger framework, any theory of social presence must be focused on a particular subset of psychological and behavioral phenomena associated with mediated interactions. Social presence theory is a special case of the general theory of mind reading and the philosophy of mind (e.g., Baron-Cohen, Tager-Flusberg, & Cohen, 2001; Carruthers & Smith, 1996; Dennett, 1987). Within this broad area, social presence theory needs to explain (1) *intentional psychological models* of other minds during (2) interactions with *mediated representations* of other minds, especially interactive mediated embodiments of other humans, other intelligences, or artificial intelligences.

4. **Defining social presence: Establishing the parameters**

In this section we provide a shorthand and more elaborated definition that lays out the basic parameters that will be explicated and linked in greater depth and link to measures in the following section.

4.1 Shorthand Definition of Social Presence

Most succinctly defined as a “sense of being with another in a mediated environment”, social presence is the moment-to-moment awareness of co-presence of a mediated body and *the sense of accessibility* of the other being’s psychological, emotional, and intentional states.

4.2 Elaborated Definition of Social Presence:

Mediated social presence is property of people, not of technologies, but it is a moment-to-moment phenomenal state facilitated by a technological representation of another being. The state of social presence varies over the course of a mediated interaction from a low level awareness that another being is co-present to more intense sense of the accessibility of psychological modeling of the other's intentional states (i.e., the attributional modeling of the other mediated mind).

At the lowest levels social presence is characterized by perceptual awareness, a peripheral sense of spatial co-presence of the other's mediated body, and minimal, automatic attributions about the internal states of the other such as basic categorization of the other's identity, sentience, and attention. Over the course of mediated interaction, social presence may include increasing sense of the accessibility of the other, perceived as increasing psychological and behavioral engagement. Psychologically the user may have a greater sense of access to intentional, cognitive, or affective states of the other.

Finally, consider, as the level of social interaction, social presence can be characterized as subjective or intersubjective judgment of mutual accessibility of the other, such as mutual attention, mutual comprehension, shared emotional states, and interdependent behavior.

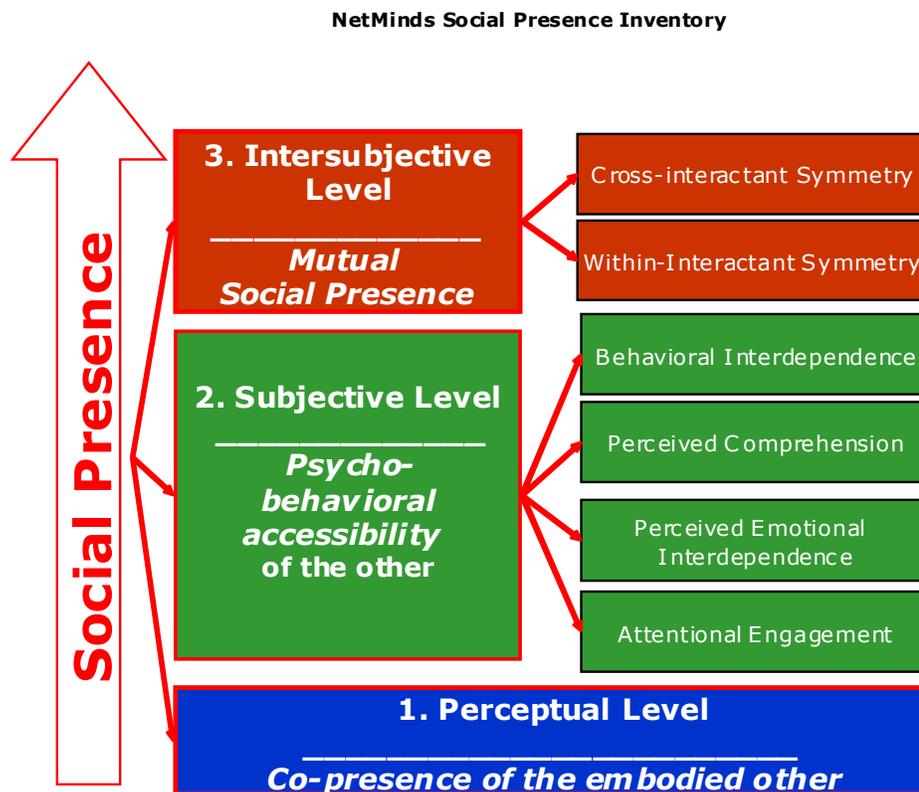
It might be valuable to make a few notes on what Networked Minds Theory of Social Presence is not. Social presence theory does not seek to provide an explanatory mechanism to explain all unmediated interpersonal communication (Burgoon & Saine, 1978; Feldman & Rimé, 1991; Hargie, 1997), rather it is a theory of the *interaction of mind and technology* focused on *mediated interaction only*, specifically *how different technological forms and mediated embodiments* of the other influence the processes and mental representations in social interaction.

Although social presence research with mediated embodiments can very well tell us something about all social interactions (Bailenson, Blascovich, Beall, & Loomis, 2001), social presence is not a general theory of social cognition (Fiske & Taylor, 1991), but a theory of how technology might affect, distort, and enhance certain aspects of social cognition.

In the following discussion of the levels and dimensions of social presence, we will unpack, elaborate, and provide research support for the key aspects of the Networked Minds definition of social presence.

5. Levels and dimensions of social presence

Figure 3: Levels and dimensions of social presence



Three levels of social presence are forwarded in this paper. Level 1 is a sense of co-presence. Level 2 is the Subjective level of Psycho-behavioral accessibility of the other. The four dimension that make up level 2 are: Attentional engagement, Perceived emotional interdependence, Perceived comprehension, and Behavioral interdependence. Level 3 is the Intersubjective level of Mutual social presence and involves within-interactant and cross-interactant symmetry.

Like all phenomenal states during the course of an interaction the sense of the perceptual, psychological, and interactional accessibility of the other's body and mind will likely fluctuate due to limitations in the medium, the quick or slow mental modeling of the others internal states, and the nature of task environment. See Figure 3. The sense of being with another is best conceptualized and measured at three levels:

1. Perceptual Level: Co-presence of the embodied other. This definition and measurement level deals primarily with the detection and awareness of the co-presence of other's mediated body.

2. Subjective Level: Psychobehavioral Accessibility of the other. These dimensions of social presence focus on the perceived accessibility of the other, the sense that the user has of their awareness of and access to the others attentional engagement, emotion state, comprehension, and behavioral interaction.

3. Intersubjective Level: Mutual Social Presence. The interaction between the user and one or more mediated others is dynamic. The user's sense of social presence is in part a function of how they perceive the other's sense of social presence of them. At this level Networked Minds social presence theory and measure access the degree to which one individual perceives the social presence to be mutual (within interactant symmetry), and intersubjectively the degree to which the pair of interactants share this sense of social presence among each other (cross-interactant symmetry).

We further explore the theoretical basis of each dimensions and how they might be measured.

5.1 Level 1: Copresence of the embodied other

Humans may be hardwired to respond to affordances in the environment that are correlated with sentient beings such as other humans and animals. Mediated embodiments such as pictures, computer characters, moving robots, and other representations of “apparently sentient” others may automatically trigger social presence responses. Social responses are triggered by representations that the user/viewer knows to be “false,” i.e., only a representation. Nonetheless, the representations trigger automatic mental simulation of “other minds.” (Gordon, 1986)

5.1.1 The threshold moment when inks, pixels, and marble are perceived a co-present other

We can posit some *threshold social presence moment*, when the form of a medium -- light reflecting inks, pixels, or marble -- moves from being a thing, matter, to being social, a representation of another, especially cases such as robots, avatars, or agents when technological representation is perceived as sentient. This we can theorize to be the *threshold moment of co-presence*. Automatically and without effort, a thing, technology, is suddenly perceived as somehow *being*, a mediated other. The perceptual and embodied meaning of copresence can be directly traced to the work of Goffman (Goffman, 1963). Goffman made clear that co-presence involved two moments: (1) when individuals sense that they are able to perceive others, and (2) when others are able to perceive them. In keeping with our notion that

social presence involves the sense of access to another, he wrote that, “copresence renders persons uniquely accessible, available, and subject to one another” (Goffman, 1963, p. 22). Using a spatial metaphor he indicated that others were “within range (Goffman, 1963)” and that the other is aware of me as “within range.”

“The full conditions of **co-presence**, 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. In our walled-in Western society, these conditions are ordinarily expected to obtain throughout the space contained in a room, and to obtain for any and all persons present in the room.” P.17

Notice that Goffman refers here to physical space of a room. But in mediated co-presence, physical space is typically a virtual space.¹ It would appear that the responses Goffman ascribed to the awareness of the co-presence of a physical body of the other, are now the responses to a mediated body of the other. The conditions for such a social response may make use of similar mechanisms, but the triggering of the response is clearly at a lower level for humans. While other species may sometimes respond temporarily to mediated others, we are the only species that engage *in sustained and prolonged interaction with representations of others*. In a society where mediated interaction is increasingly common, we may spend more time in social and parasocial interactions with mediated others than in face-to-face interactions with people “in the flesh.”

To a lesser or greater degree we interact with a representation as if another being, rather than ink, pixels or marble, were co-present. This automatic psychological response either small or great in which we react, model, or respond to representations of others as if they were present we will call the co-presence, the moment the *threshold of co-presence*. Unlike in the physical environment, mediated others can quickly appear or disappear, so the threshold is quickly and frequently crossed in an average day.

There appear to be two general cases where automatic social responses can be triggered in human observers. Some minimal mental simulation of cognitive and emotional states can be triggered by stimuli

that share morphological properties with humans, especially representations of faces (Bratman, 1999).

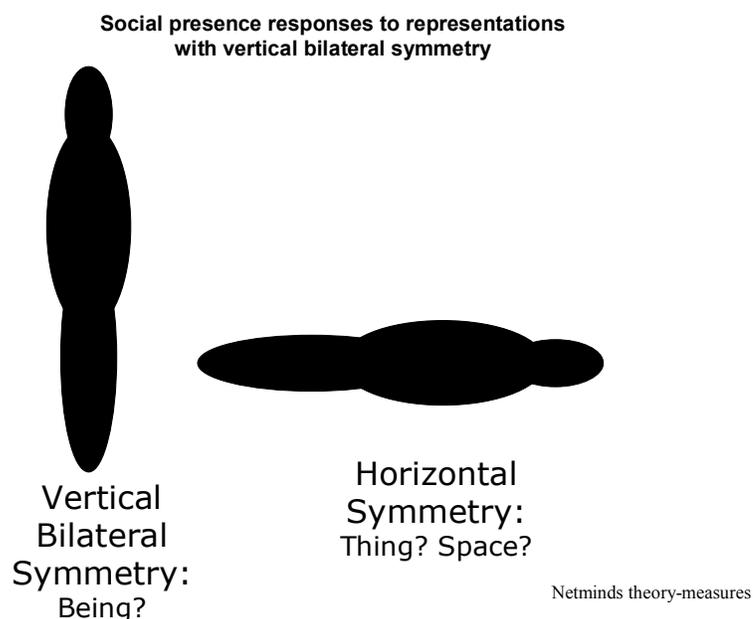
5.1.2 Candidates psychological mechanisms contribution to feels of co-presence with mediated entities

Perception of sentience: Is it living- non-living?

Media representations must reproduce hardwired cues for detecting biological beings in the environment.

There is some support for the proposition that the brain may be hardwired to code key semantic differences related to social presence, such as a module for categorizing stimuli in the environment as “living-nonliving” (Gainotti, 1995; Warrington & Shallice, 1984). What then might be some of the mediated cues that trigger the responses to some pixels, ink, or marbles as “living,” or at least co-present to some degree?

Figure 4: Selective responses to biological forms: Vertical and bilateral symmetry



Human observers appear inclined to interpret elongated forms around the vertical axis as representations of biological, sentient entities. In this image the vertical version of this form tend to be interpreted as an image of a biological entity such as a “person,” “animal” etc. While the horizontal version of the same form is more likely to be interpreted as a object.

Selective responses to biological forms: Vertical and bilateral symmetry

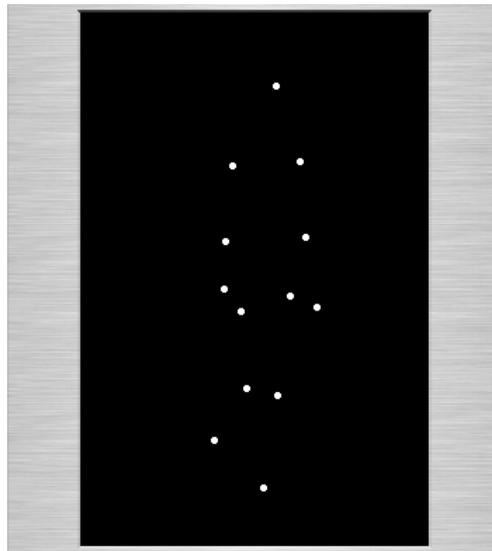
The form of a representation may correlate with a biological being, or it may correlate with the form of non-living objects or the ground of experience. Some cues are associated with foreground objects (Rock,

1983) and, specifically, biological entities (Weng & Evans, 1999; Locher & Nodine, 1973). See Figure 2. Vertical bilateral symmetry appears to be an affordance that may be used as a cue of co-presence of “another.” This response to bilateral symmetry may be related to mate selection (Thornhill, 1998) and used as a cue for physical health (Parsons, 1990). Bilateral asymmetry is associated with beauty in humans (Grammer, 1994; Rhodes, 1998) and increases the success of mating as females of several different species tend to select mates with higher levels of bilateral symmetry (Thornhill, 1998).

Figure 5: Representations of abstract biological motions may elicit social present responses

Figure 5

Representations of abstract biological motions may elicit social present responses



Netminds theory-measures

Above is a set of dots that correspond to points on the body. When stationary, the stimulus is very ambiguous. But when moving human observers can immediately detect biological motion and report the “presence” of a human form, and based on minimal information ascribe gender, number of people, emotional state, and other attributions.

Selective responses to biological motion

Motion can be cue to the co-presence of an intelligent being. In a series of classic studies

Johansson (Johansson, 1973, 1976) found that viewers of arrays of thirteen moving dots could almost immediately identify human motion when moving, but could not make out the form when stationary (See Figure 3). Though extremely impoverished in information and realism, the dynamic patterns of the few moving dots provided enough information that the viewer could identify the activity of the represented being, such as dancing (Johansson, 1973, 1976), the gender of the person moving (Kozlowski, 1977), a particular familiar individual (Cutting, 1977), the emotional state of the person represented (Dittrich, 1996), the number of people represented (Johansson, 1973, 1976), and even oneself (Beardsworth & Buckner, 1981). Similarly, in a classic experiment by Herder showit has been shown Some minimum level of social presence is an automatic response to any stimuli that appears animate.

Attentional awareness

Something in the environment must be judged as “biological” and not an object. In the Networked Minds measure of social presence, a set of items seek to identify the degree to which a user feels as if they are in a “shared” environment, whether the user and the other are co-located. Beyond mere detection, the sense to which the observer is peripherally or focally aware that the other is in the same space, and the sense that the other is aware of them. Nowak (Nowak, 1999) and Ciolec (Ciolec, 1982) emphasize the importance of attentional awareness or responsiveness to others in their discussion of co-presence. The observer’s awareness and responsiveness to other’s activity within the mediated environment may be both necessary and indicative of the movement to higher levels of co-presence. Attention to others is not solitary; it is social and reciprocal. Individual’s monitor each other’s attention. Baron-Cohen has proposed that we have a Shared Attention Mechanism in which individuals monitor attention behavior and construct a model of the attentional allocation of those around them (Baron-Cohen, 1994; Baron-Cohen & Swettenham, 1996). Baron-Cohen argues that this is a “special purpose neurocognitive mechanism” which is more primary than the development of a theory of mind, and is key

to modeling other minds. There is evidence that children learn to monitor their parent's eye gaze, and monitor it especially in conditions where interpretation of the environment is ambiguous. Baron-Cohen provides support that this mechanism is key to the creation of models of other minds. Baron-Cohen and colleagues used a measure of the Shared Attention Mechanism that assessed neonates ability to monitor the attention direction of an adult. Of 16,000 children screened at 18 months of age, those who showed little ability to monitor the attention of the other, were eventually diagnosed as autistic. So it would appear that, social presence, defined as the sense of access to the other's minds, may involve some element of attentional allocation to the other as part of this shared attentional mechanism (Baron-Cohen & Swettenham, 1996).

Social presence is not just sense of the other, but it is very much a sense of the others of "me." Mediated environment presents an odd case of this simple sensory fact. For example, an individual may easily be aware of another in mediated environments, but the other may or may not be as aware of the observer. Unlike the physical environment, mutual awareness is by no means guaranteed. An extreme case is the use of unobtrusive observation cameras. Mutual sensory awareness may be asymmetrical. For example, one individual may have a video and audio link, while the other may only have an audio connection.

But in measuring social presence we are less interested in the objective conditions as in the user's perception of the sensory awareness of them. The other may have no sensory awareness of the respondent, but the user may feel that the other is capable of observing them, thus increasing their sense of social presence of the other. For example, the gaze and eye movement of a computer agent may lead the respondent to infer some "watching" behavior, when there is no sensory or computer awareness of the respondent.

5.1.3 Measuring co-presence

Self-report measures of co-presence

Theorists of co-presence such as Goffman (Goffman, 1963) never created a measure of co-presence. In a physical setting it seemed too unproblematic to measure. But in mediated environments co-presence is problematic, and the sense of co-presence is believed to be highly variable. In keeping with the theoretical discussion above, the Networked Minds measure has items that attempt to measure the sense of co-location of the user with a biological entity. Because detection and co-location are just slightly more than thresholds of social presence, the measure includes items assessing level of awareness of the other, and the other's awareness of them. Co-presence is fundamentally is a concept involving subjective perception rather than the objective condition of being observable or the other existing within sensory range. It is well suited for self-report measure that includes items that indicate a level of awareness of the other. These are easy to administer and are exhibit to high variance.

Other measures of co-presence

Sensory awareness of the other can be easily measured by observation. For example:

- Attentional behaviors such as eye fixation on the other.
- Proxemic behavior, movement to or away.
- Physiological responses such as increased arousal.

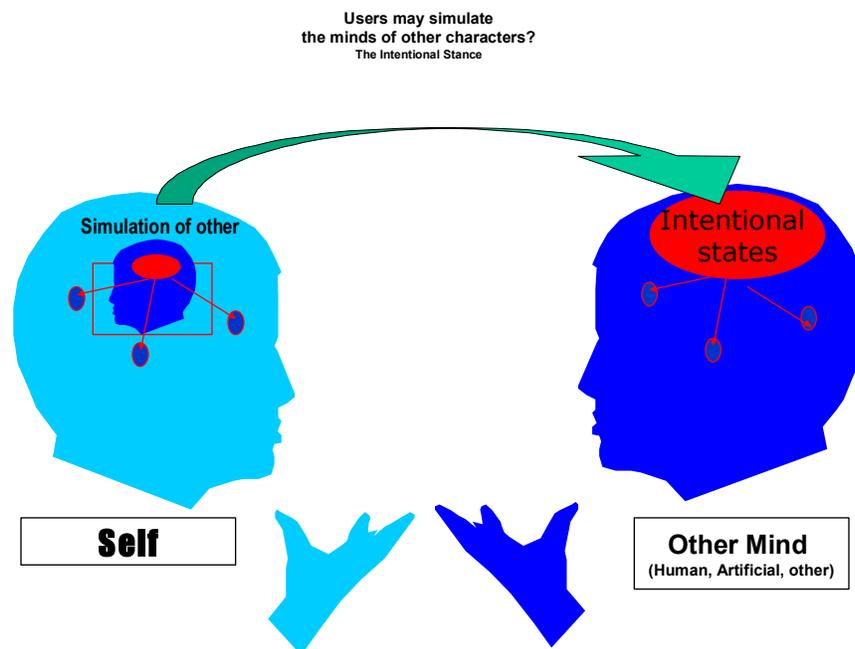
Such measures suffer from a number of problems: (1) they are hard to collect, (2) awareness of the other may not involve the behavior, for example an eye fixation, (3) the measure is essentially binary, the participant notices or does not notice the other. But co-presence in mediated as opposed to un-mediated environments is considered to be variable, not a binary here or not here. Physiological responses such as measures of arousal detect many other phenomenal states other than mere co-presence, so interpretation may not always be clearly partial to co-presence only.

5.2 Level 2. Subjective Level: Psychobehavioral accessibility of the other

Determining whether another is co-present is a necessary, but not sufficient condition for social presence. Consider the detection of another from an evolutionary psychological perspective. Detection that another is living is not enough. It tells the perceiver little about the behavior of another. There would be strong evolutionary need to model and predict the future behavior of the other. To put it in classic philosophical terms, the moment a sentient is detected it would be critical to model the intentional states of the other (Dennett, 1987, 1996). People develop and use models of other minds during their face-to-face or mediated interaction. How then to approach this process for a theory of social presence. How then do users model the presence of other minds in mediated environments? Is it likely that they both simulate other minds and apply rules from a general theory of minds?

5.2.1 Simulation theory of other minds

Figure 1: Simulation theory of other minds



Current versions of the simulation theory of mind postulates that the observer simulates the intentional states of the other using a general theory of mind and the user's own body and position in space.

Because virtual humans and characters are simulations of other bodies and minds, it seems appropriate to

consider a simulation theory approach to people's models of other minds (see also debates in Carruthers & Smith, 1996; Davies & Stone, 1995; Gordon, 1986). Users may adopt a simulation strategy for modeling the emotional states and attention, of others. Because individuals do not have direct access to other minds, they may be simulating the minds of others 'as if' the other person were them, there, in that situation. This simulation process need not be self-reflective. Simulation may be active in empathic reactions to the facial displays and affective body motions of agents and avatars.

Why simulate other minds?

The models reduce uncertainty in relationships (Berger & Calabrese, 1975; Planalp & Honeycutt, 1985), and when they appear to be consistent and predict behavior we feel that have insight or access to other minds. This sense of access might include feelings of access to judgements or perceptions of the shared reality with the other, access to emotional states of the other (i.e., dispositional states of the other mind) or access and interaction with the body (i.e., the embodiment, the physical or virtual manifestation of the other mind). This sense of "access to other minds" may be the origins of our feelings of mediated social presence.

Evidence for automatic simulation of other minds

Below we theorize possible dimensions and discuss measures of Level 2 social presence, that is the product of the modeling of the mediated other's intentional state that results in social presence, the perceived accessibility of the emotional, understanding, and behavioral states of the other. As soon as the user-observer goes beyond the simple assessment of being co-located with a living, sentient entity, they enter into psychobehavioral modeling of the other. The research reviewed below suggests that the "reading of other minds" is an automatic process.

Because social presence involves complex perceptions of the dispositional states of mediated others, it a multidimensional construct. The goal of the work is to provide a measure that satisfactorily covers the

content validity of the concept, but that is convenient, robust, medium and task independent, and particularly sensitive at discriminating the effects of different media on social presence. A satisfactory measure of social presence should tap a broad range of dimensions, but it is not necessary, nor is it expected, that it can or would exhaustively capture all nuances in moment-to-moment dispositional judgements.

5.2.2 Measureable dimensions of Level 2 Social Presence: Psychobehavioral accessibility of other minds

Below we discuss briefly proposed dimensions of the sense of the accessibility of the other.

Attentional engagement

Accessibility of the other begins with some level of attention. Co-presence is based on awareness of the other, but building a model of the other's intentional states requires some attention to bodily cues. Then attentional engagement is the user's sense of the degree of perceptual and focus mental effort allocated to building a mental model of the mediated other.

Perceived emotional interdependence

The affective state, be it the emotional state or more simply, the mood (Schwarz & Clore, 1988) an individual enters into any interpersonal interaction with has an impact on the other individual (Cunningham, 1988). One's ability to decenter and understand the emotional quality of another's perceptions is important in establishing and maintaining a connection with another person. Empathy is the imaginative intellectual and emotional participation in another person's experiences (Bennett, 1972). Individual differences in the ability to empathize with others obviously exist (Goleman, 1995). At the same time, individuals able to effectively perceive the emotions and feelings of other are vulnerable to the affective state of the other having an impact on their own emotions and feelings. When listening to a friend tell about a very tiring and frustrating day, one's response tends to be more subdued and patient.

The emotional state of the friend molds the paralinguistic behavior of the other interactant. The perceived emotional interdependence (Sullins, 1991) becomes almost “infectious” as emotions are transferred between individuals.

Perceived comprehension

Psychobehavioral accessibility includes some sense of the intentional states of the other, i.e. what might be called issues of relevance and reference, what they are referring to, the topic under discussion, etc. This dimension might be called perceived comprehension. It can be defined as follows:

The degree to which the observer feels that he/she believes they have insight into the intentions, motivations, and thoughts of the other.

We emphasize that this is *perceived comprehension*, as the user has few objective means of assessing true comprehension, but only has the *illusion of access* to the other’s meaning, although this perceived comprehension is frequently tested during the course of the conversation (Grice, 1989).

Perceived behavioral Interdependence

In any interactive setting, a key sense of access to the other is based on the degree to which the other appears to interact with the user, i.e., their verbal and physical behaviors are linked. For example, I speak; the agent-other speaks. I approach; the other retreats. I wave; the other waves, etc. Burgoon et. al. refer to this as *reciprocity* (Burgoon, Buller, & Woodall, 1996). These are various examples of very explicit behavioral interdependence, but can include non-explicit and automatic responses such as eye contact, yawning, etc., termed *motor mimicry* (Burgoon et al., 1996). Such motor mimicry has even been thought of as an objective empathy (Lipps, 1907). This interactional interdependence relates closely to the aforementioned psychological reactance (Brehm, 1972) in that one’s actions/behaviors may not be independent, but result from behaviors of the other. The dimension labeled “perceived behavioral interdependence” is defined as follows:

The sense to which one's actions are reactions to or interactions with the other's behavior.

5.2.3 Measuring the dimensions of Level 2 Social Presence: Psychobehavioral accessibility of the other

Self report measures of psychobehavioral accessibility of the other

The user's sense that the other is or is not accessible to them is a phenomenal state open to introspection. Although some of the mechanisms such as attention and behavioral mimicry may be in part driven by automatic responses, the outcomes are still accessible to introspection. Self-report items of attentional engagement, perceived mood state, perceived comprehension, and behavioral engagement are open to self-report. The Networked Minds measure proposes self-report items to access these responses.

Behavioral or psycho-physiological measures psychobehavioral accessibility of the other

By definition psychobehavioral accessibility suggests a link between phenomenal states and behavior. For example, attentional engagement can be measured by self-report of the phenomenal state, but also by correlated behaviors such as eye tracking, body postures such as leaning forward, etc. These can be used to validate a self-report measure, or can be used as indicators themselves. As in all measures, there are advantages and disadvantages of any selection. We briefly suggest some issues by dimension.

Attentional engagements. There are a number of physiological and behavioral measures of attention used in mediated environments such as eye movement, tracking body motions, etc. But with behavioral or physiological measures of attention, the issue becomes one of partialing out the level of attention that is specific to a particular stimulus, the other. Behavioral-physiological measures of attention might be global measures of attentional effort. In this case, we are particularly focused not on attention as a whole, but attention on a specific point in virtual space, the location of the other, and attention allocated specifically to modeling the other. This may only be a small part of attentional allocation, especially in environments

that are complex, include many others, or involve attention-demanding tasks. Eye fixation may be an indicator of attention. But this measure fails to meet a key scope condition for a cross-media measure of social presence (Biocca, Burgoon, & Harm, submitted). Eye fixation, for example, could only be used with media for which visual tracking of stimulus is present. In some mediated environments such as the telephone or radio, there may be no visual cues of the other. Therefore, the measure could not be generally applied to such cases. This omission would limit our ability to compare across media.

Perceived emotional interdependence. Transfer of emotion via interaction may be observable at times. A behavior such as mimicry of facial expressions or posture might be observable. The extent to which an individual perceives this change in affect might be most effectively assessed by direct self-report. Separating the emotional interdependence and its effects on an individual's behaviors, or behavioral interdependence, as discussed later, is difficult. Psychological reactance (Brehm, 1972) is a term that has been used to describe the sense that one's personal freedom of action has been threatened. Interacting with another person can change one's emotional state and result in particular behavioral changes. Self-report items allow for subjective evaluations of these emotional changes. Physiological measures of a user's emotional state cannot directly tell us how much this state is the result of the co-presence of the other.

Perceived comprehension. Perceived comprehension may be inherently only accessible via self-report measures. It might be measured behaviorally with negative indicators such as the frequency of conversational repairs. Other types of behavior may be identified to be improved or to be correlated with comprehension of a message (Rogers, 1978), but the presence or absence of behaviors are not reliable indicators of perceived comprehension. For example, a user may nod while another speaks, suggesting comprehension, but may be doing so to comply with politeness rules, while feeling as if they comprehend little of what the other is saying.

Measurement of behavior interdependence. Behavior interdependence is inherently behavioral. Because we are measuring social presence, we are focused on the user's *perception* of behavioral interdependence and not the objective fact. Measures of behavioral contagion such as motor mimicry, patterns of turn taking, and other coordinated activity can provide indices of objective behavioral interdependence.

5.3 Level 3. Intersubjective level: Mutual social presence.

Social presence is social, based on sense of mutual interaction. So even with the user interacting with an agent, there is still some modeling of the agent's sense of them, how socially present the other is to them. Social presence involves interaction between multiple interactants and is a social phenomenon. If interacting with another human being this distinction seems blatantly obvious, but interaction with a computer generated intelligent agent or robot blurs the seemingly simple statement. To the extent the human interactant perceives the other, be it human or non-human, as being aware, allotting attention toward and interacting with them, is this not a social interaction? As Goffman stated, "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.*" (Goffman, 1963) The final part of that statement specifically refers to what we are calling the intersubjective level of social presence, the extent to which the perceptions of one interactant and the other are symmetrical both within either one's mind, as well as across both minds.

As most individuals interact with another they have the ability, which assists but is not a necessity, to take two perspectives. The first is their own perspective of the situation, the context of the interaction, and the other is an ego-based subjective perception. At the same time, one is able to decenter and to make an informed guess of the same issues from the perspective of the other. This is also a subjective perception, but intersubjective in nature in that it is an assessment of the other's perceptions. To say that this is simply an informed guess is inaccurate in that there is an interdependence that exists between the two

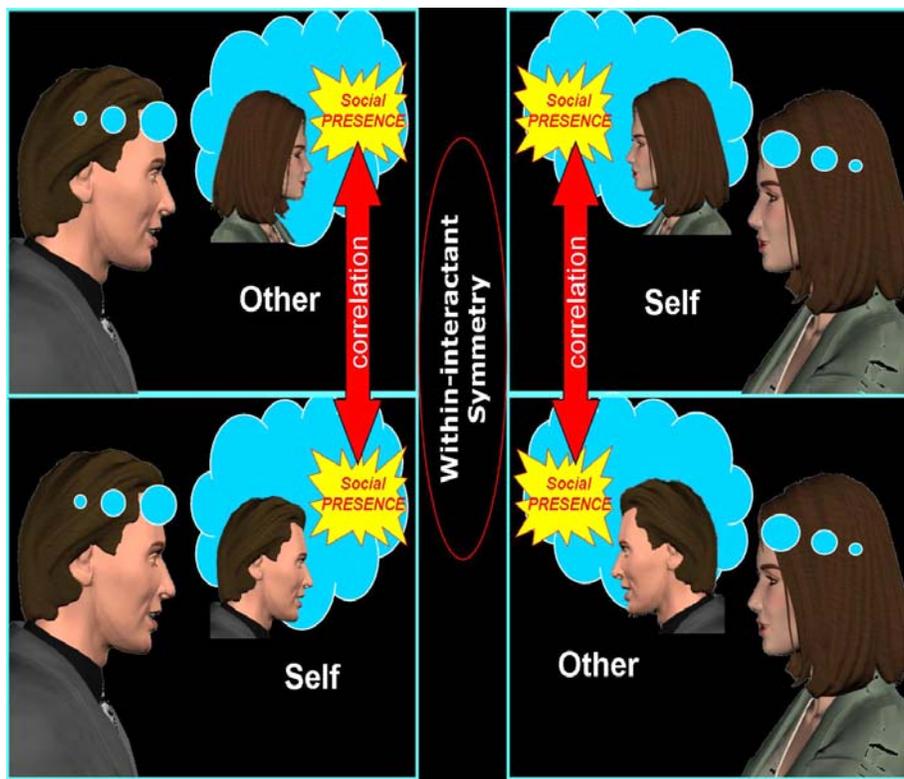
interactants and thus a symmetric synergy is developed. This occurrence can exist in face-to-face interactions as well as mediated interactions. Assessing the corresponding perceptions within an interaction can give researchers a greater understanding of the interaction itself.

The co-orientation model of interaction (McLeod & Chaffee, 1973) suggests that communication can be assessed by comparing subjective and intersubjective responses to a stimulus. Participants of an interaction have a shared experience that they orient their attention and understanding toward. By developing a mental model (Senge, 1992) of the other interactant, an individual can provide an intersubjective perspective of the other. Comparing both individuals' subjective and intersubjective perceptions of the other allows for several correlations to assess a higher-level sense of social presence. Such an assessment will allow for an understanding of how asymmetrical media usage affects an individual's sense of social presence. Though a balance exists between the two persons, the amount of awareness, attention, and understanding each individual allots or is capable of perceiving may differ resulting in an imbalance across the interaction/communication.

The perception of another has historically been concerned with perceiving that individual in a FTF setting. Although new perspectives involving technology have developed recently, these original works are a necessary part in understanding social interaction in technologically mediated interactions. Two similar, yet very different perceptions of symmetry within an interaction exist. In this context we will refer to these as within-interactant social presence symmetry and cross-interactant social presence symmetry.

5.3.1 Within-interactant social presence symmetry

Figure 7: Within-interactant social presence symmetry



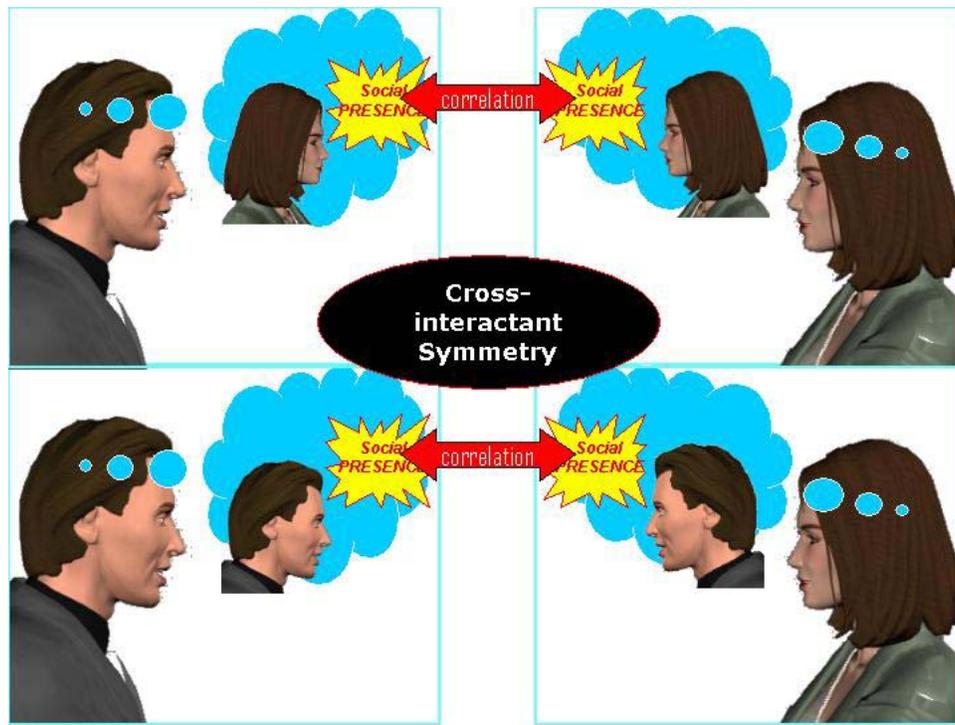
Within-interactant symmetry is the degree of symmetry or correlation between the user's sense of social presence and their perception of their partner's sense of social presence. This is assessed by comparison of an individual's reciprocal scale items.

First, within-interactant symmetry is the degree of symmetry or correlation between the user's (A) sense of social presence and their perception (A->B) of their partner's sense of social presence. This is the assessment of the interaction from one side and can be easily calculated by comparing answers given by a single individual ((A) I paid attention~(A) My partner paid attention). Within-interactant symmetry is important from the individual's own construction of the interaction as it guides the successive interaction. I understand the other, but does the other understand me? If they don't, do I clarify what I meant and how I meant it? Placing the emoticon [;-)] to symbolize you are winking and that the last statement had a

sarcastic twist may not be necessary if the medium being used allows an auditory channel. A user's perception of the other's ability to perceive exists.

5.3.2 Cross-interactant social presence symmetry

Figure 2: Cross-interactant social presence symmetry



Cross-interactant symmetry is the degree of symmetry or correlation between the user's sense of social presence and their partner's perception of user's social presence. This is assessed by comparison of each interactants' corresponding reciprocal scale items.

Second, cross-interactant symmetry is the degree of symmetry or correlation between the user's (A) sense of social presence and their partner's (B) perception of user's social presence. Assessing cross-interactant symmetry involves comparing both interactants' corresponding answers to the reciprocal items ((A) I paid attention~(B) My partner paid attention). The sense of social presence which exists between two individuals interacting via a medium involves not only similar attention toward the other, but as framed from a theory of mind perspective requires a level of access to another's emotional state and intentions. It is by decoding the content of the interaction, as it exists in the context of the other

individual's affective state, that a level of connection or understanding (Purine & Carey, 1999) is reached.

A reciprocal measure along with the corresponding "self" and "other" items allows for a more rich detailed evaluation of the mediated interaction. Measured comparison across types of interaction and media can be done to assess differing levels of fidelity and medium affordances necessary for particular interactions. Collaborative work, education, or simply maintaining relationships may differ in the necessity of social presence between individuals.

6. Summary and conclusions

The modeling of media others captured by the word, social presence, is more complex than originally conceptualized in the pioneering work of Short, William, and Christie (1976). There social presence was an enduring property of the medium measureable with a few items about the medium. As we have seen above, social presence cannot really be conceptualized as a fixed property of medium. Rather it is best conceptualized as a property of individual perceptions of mediated others, that likely fluxates during interactions, tasks, and individual differences.

In this article we have begun the process of laying out what we hope is a more textured and multilayered theory and measure of presence. We have attempted to remain true to the scope conditions for a successful theory of social presence. In these scope conditions we determined that social presence theory should be focuses on comparative media measurement and should be robus enough to accommodate the following criteria:

- Span different classes and generations of communication technology.
- Accommodate various kinds of mediated interactions.
- Span interactions with human and non-human others.
- Apply to "real" and "illusory" social interactions.

Many of the criteria deal with explanatory scope of a theory. Determination of the explanatory force of a

theory and the validation of a measure of social presence is needed. The testing and validation of a Networked Minds Measure of Social Presence, is underway in our labs. For now, this emerging model hopefully provides a useful framework for conceptualizing social presence.

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