



## Guide to the Networked Minds Social Presence Inventory

(Version 1.2): Measures of  
co-presence, social presence,  
subjective symmetry, and intersubjective symmetry

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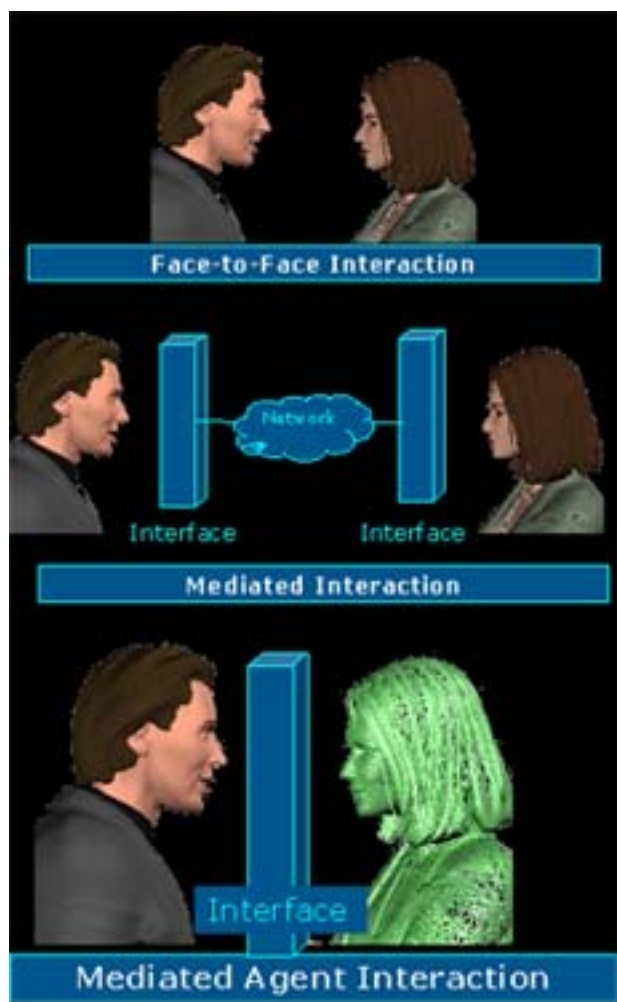
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## Abstract

*This document introduces the Networked Minds Social Presence Inventory. The inventory is a self-report measure of social presence, which is commonly defined as the sense of being together with another in a mediated environment. The guidelines provide background on the use of the social presence scales in studies of users' social communication and interaction with other humans or with artificially intelligent agents in virtual environments.*



**Figure 1.** The need to measure social presence becomes more important as we move from face-to-face to mediated interaction via networked interfaces or with non-human embodied agents.

## 1. The purpose and features of the Networked Minds Social Presence Inventory

When using media, others are not directly accessible as in the physical environment, but only experienced as representations whose affordances and capacity for interaction varies dramatically. This battery of self-report measures is used to assess the users' sense of social presence when interacting with others using a communication medium.

The user's sense of the social presence of others is a psychological state that varies with the perceptual affordances of a medium, the nature of interaction, and the individual differences in the observer and the mediated other. We can tentatively define social presence as:

Social presence is the degree to which users of a medium feel that mediated others are spatially co-present, psychologically accessible, and behaviorally interactive.

### 1.1 Suggested applications of the measure

The Networked Minds Social Presence Measurement Inventory is designed to measure users' perceptions of others experienced through a communication medium. Consider these paradigmatic examples. See Figure 1.

#### Paradigmatic examples of mediated interactions

- Users interact with others via wide screen teleconferencing technologies and feel as if the others are in the same room.
- Users experience avatars in a collaborative virtual environment, smiling and gesturing to other avatars.
- Users chat with an artificially intelligent embodied agent and feel as if they can figure out its "intentions" and "moods."

#### Examples of other contexts and potential limitations

Considered broadly and theoretically, the sense of social presence uses mechanisms



involved in what is called “mind reading” (Botterill & Carruthers, 1999; Carruthers & Smith, 1996), which occur in a variety of contexts including mental representations of others in physical environments. The Networked Minds Social Presence Inventory is designed primarily to study the effect of different interfaces on social interaction in telecommunication systems. But the inventory can be used with traditional media such as pictures, film, etc. On the other hand, the Networked Mind Measurement Inventory may not be well suited to measure the social presence of humans in non-mediated settings, but may be useful for the measurement of the perceived social presence and mental states of artificial entities such as agents and robots, as these are both forms of social media.

### **1.2 Cross-media compatability: Design of the measure for use with all media or interface types.**

The scales in the Networked Minds Social Presence Inventory are worded and designed to allow direct comparisons of social presence across-media or across-interface types and with media as diverse as books and immersive virtual environments. This was designed to remedy problems with usability and generalizability of past scales of social presence, which made limiting assumptions about media, or the tasks people were engaged in while using those media (Biocca, Burgoon, & Harm, submitted). Therefore, none of the scale items makes reference to a sensory channel (e.g., “I could see my partner”) because some media may not carry a visual signal. For similar reasons none of the items makes explicit reference to specific communication tasks such as “talking,” as some media may not include audio or outcomes of communication indicative of social presence such as attention, comprehension, mood transference, behavioral interdependence, etc. In so doing, the measure retains the ability to compare any two or more media or interfaces by using indicators of the perceived communication processes associated with social presence.

### **1.3 Status of the Networked Minds Social Presence Inventory**

The Networked Minds Social Presence Inventory was developed to provide a convenient and broadly usable set of measures sensitive to how changes in communication technology affect users’ perceptions of the accessibility and responsiveness of others. The lab needed a measure that could be applied to the experience of interaction with human avatars or artificially intelligent agents and could be used to compare the social presence performance of any two interfaces.

The Networked Minds Social Presence Inventory is not fixed, but a set of evolving tools that are being iteratively designed. Currently, version 1.2 of the inventory has gone through some initial development and validation. The measure is being developed along with definitions of the scope and requirements for a successful theory of social presence and a review of existing measures (Biocca et al., submitted) and in parallel with a theoretical model of mediated social presence (Biocca, Burgoon, & Harms, forthcoming).

#### On the use of self-report scales

The Networked Minds Social Presence Inventory uses self-report scales and supports some of these with behavioral observation. Although concurrent self-reports are possible (Ericsson & Simon, 1993), they are likely to interfere with communication with the other. Therefore, retrospective self-reports are used.

#### Reliability and validity of the scales

Most of the scales have been pre-tested in several M.I.N.D. Lab studies. We are currently testing scales for reliability and validity in several studies. The measure is being circulated for use at other labs.

The self-report scales are being tested for their reliability and validity. These are discussed below for the specific scales.

The most current versions of the measure and related papers are available at



<http://www.mindlab.msu.edu/networkedmind/s/>.

#### **1.4 Companion theoretical and measurement documents**

As this paper seeks to primarily introduce the Networked Minds Social Presence Inventory, we provide only a necessary theoretical discussion and introduce the three levels of measurement.

**Guide to the Networked Minds Social Presence Inventory:** This paper provides a guide to the Networked Minds Social Presence Inventory including some of the theoretical context, guidelines for interpretation, and paradigmatic examples of situations where the measure might be used.

**The Networked Minds Scales:** Readers who prefer “just the scales themselves” with minimal discussion should consult Appendix A of the Guide.

**Theory of social presence.** Readers interested in a more detailed theoretical discussion of social presence and the current research in this area should consult the companion paper on social presence theory and the Networked Minds Model of Social Presence (Biocca et al., forthcoming).

**Measurement issues and criteria.** Finally, readers who are interested in measurement issues related to social presence should review the work below and a companion piece that defines what we feel is the scope of conditions for a useful and theoretically valid measure of social presence (Biocca et al., submitted).

## **2. Introduction to the Networked Minds Social Presence Inventory**

### **2.1 Social presence responses may be hardwired and automatically activated**

The sense of social presence from representations of others activates brain mechanisms. These respond to entities that display agency and therefore to ascribe intentional states to those entities. Mediated representations of others are believed to automatically activate users’ simulation and mental models of those parts of the

representation that appear to be agents. Users are particularly responsive to representations that perceptually resemble humans, but may also feel socially present with various non-human forms of agency such as computer agents, the computer itself, representations of non-human forms such as animals, imaginary characters, anthropomorphized forces, etc.

### **2.2 Feelings of social presence vary from low-level co-presence to strong feelings of psycho-behavioral engagement and symmetry.**

The sense of social presence is theorized to be variable ranging from the automatic determination that a representation has “agency” and is simply co-present to rather intense feelings of being psychologically, emotionally, or behaviorally interconnected with a mediated other. Because these states may represent substantially different levels and may entail different cognitive mechanisms, we refer to first order, second order, and third order social presence. See figure 2.

The inventory seeks to capture this range with two sets of scales and related analyses of the measure:

- First Order Social Presence: Basic sensory co-presence of mediated others.
- Second Order Social Presence: Perceived psycho-behavioral interaction
- Third Order Social Presence: Subjective and Intersubjective Psycho-behavioral symmetry.

These are discussed below along with the scale items .

### **3. Measurement of First Order Social Presence: Copresence with virtual others**

Co-presence may be a very primitive response and foundationally a core component of social presence. It may be measurable in many ways. Each has strengths and limitations. We begin with a basic definition and explication, provide some self-report items, and suggest some behavioral measures.



### 3.1 Definition and explication of co-presence.

Humans appear tuned to respond to the co-presence of agents, and unlike other species we respond strongly to representation of others. These detectors of co-presence may be innate, brain mechanisms that detect and respond to agency. This set of brain processes is sometimes referred to as an agency module, a module being a term to refer to a quasi-encapsulated set of processes and associated brain regions (Fodor, 1983; Hirschfeld, 1994). Evidence for mechanisms come from various fields but can be grouped into mechanisms that respond to biological motion, biological form, and, specifically, faces.

#### Primitive responses to agency, an agency module?

Neurological mechanisms may be tuned to respond to features of motion and form that may help detect the co-presence of living animate entities in the environment. The responses are selective for motion that appears to be self-generated and not influenced by other physical forces such as wind, water, collision, etc.

There also appears to be innate mechanisms for detecting visual forms associated with agents or other humans. The tendency for the visual system to extract the vertical axis of a

form, and in particular responses to symmetrical vertical forms is associated in the natural environment with other humans or animals.

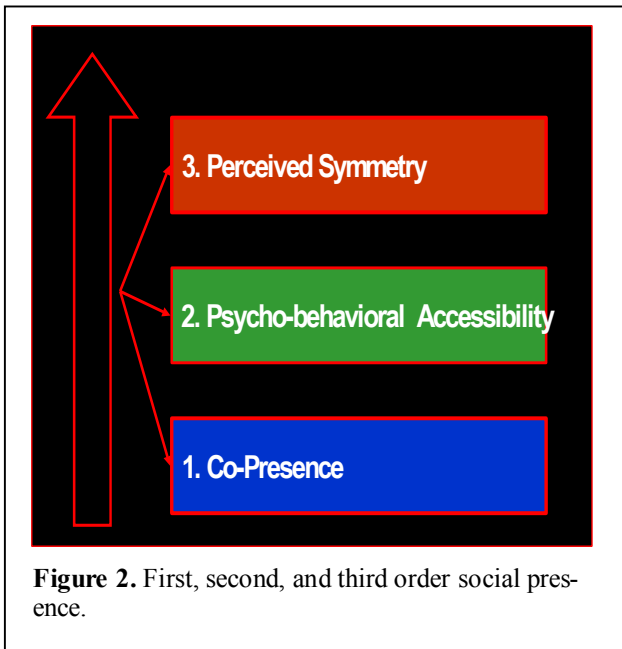
There is a lot of evidence that neonates respond selectively to the co-presence of forms that are correlated with human faces. Babies will respond symmetrical quasi-facial features of eyes and/or mouths but not to the same features asymmetrically organized.

#### Human responses to not just agents, but representations of agency.

Humans respond to symbols and representations. Unlike other species, we may also respond to very weak representations of agency, such as those found in 2D pictures and flat patterns of light (i.e., screens). While animals may sometimes respond to representations of other animals, humans appear to sustain attention and response to representations more so than other species. Other species may dismiss the representations as not truly co-present, therefore of little interest to the basics of fight, flight, or mating. Our ability to sit for hours in front of computer screens, books, films, and television is evidence of human's unique ability to be present and engaged with representations and the power of these representations to elicit strong psycho-emotional responses.

But the weaker or less sustained response of animals suggests the fundamental problem of mediated co-presence. For animals, we can speculate for the purposes of this argument, that the only meaningful judgment is binary, the perceived agent present-or-absent. The perceptual cues that clearly indicate that the "animal form" is just a flat piece of paper that does not smell or move renders the judgment "the agent is not present" and therefore deserves diminished attention.

While humans can distinguish with few exceptions between a representation of a human and a physical human, there is nonetheless a range of responses to representations, indicating a psychological continuum between present and absent. Within this continuum of psychological and behavioral responses to the representation of





others, the user may generate elaborate mental models of the other and exhibit emotional and behavioral responses including empathic, semantic, arousal, and other kinds of responses. These automatic responses to the mediated co-presence of others in representations lies at the very basis of the communication, entertainment, and educational power of the representation of humans and other agents in paintings, pictures, film, computer games, etc.

If co-presence is the phenomenal outcome of modules for detecting perceptual form and motion associated with agency, then co-presence can be defined as:

Users experience the phenomenal state of co-presence when they automatically detect and classify a form as another (i.e., possessing agency). The level of co-presence is influenced by the degree to which the user and the agent appear to share an environment together, that is the degree of mutual salience and sensorimotor accessibility of the user and perceived other.

Let's unpack this simple definition. Co-presence is an automatic phenomenal state, the perception of a coherent source of sensory states, what philosophers of mind call qualia, part of the properties of consciousness. Automatically classifying something as an agent means ascribing to the entity apparent self-motion, possible capacity

individual perceives form and motion associated with agency; a pattern of energy has been classified as an agent. For example, the pattern of energy might be light off a real body in a physical environment or a set of pixels on a screen that match some of the visual affordances or cues. The pixels on the screen and in the flesh human differ in co-presence by the "degree of mutual salience and sensorimotor accessibility."

The importance of a "shared environment" in the definition means that some level of physical presence is assumed, and is possibly primary. Presence plays a role, we believe in judging the "sensorimotor accessibility" of the other. Co-presence is related to the degree to which the user has a sensory impression of the corporeal (bodily) presence of the other (i.e., the sensory part of "sensorimotor"). For example we presume some automatic judgment along the lines of: "how well do I see, hear, smell, feel the other" and "how well can the other see, hear, smell, feel me." If the sense of co-presence is symmetrical (see below), the user perceives that his or her body and physical actions (i.e., the "motor" part of the definition term sensorimotor) is detectable and has effects on the other agent (i.e., the self is perceived as co-present to the other). Therefore for social presence to be possible some level of physical or telepresence is needed. The shared environment, defined as an artificial or

**Table 1**  
**Self report indicators of first order social presence: Co-presence**

The following items form the measure of co-presence, the degree to which the users feel as if they are together in the same space.

Perception of self	Perception of the other
I often felt as if (my partner) and I were together in the same (room).	I think (my partner) often felt as if we were together in the same room.
I was often aware of (my partner) in the (room).	(My partner) was often aware of me in the (room).
I hardly noticed (my partner) in the (room)	(My partner) didn't notice me in the (room).
I often felt as if we were in different places rather than together in same (room)	I think (my partner) often felt as if we were in different places rather than together in the same (room).

for sentience, and intentional states. The



natural medium for sensorimotor interaction, must exist.

### 3.2 Self-report scale of copresence

See Table 1. Networked Mind Measure of Copresence (V1.2) measures co-presence with a straightforward eight-item scale with balanced items reporting the user's states and their perception of the other's states. Although the processes that lead to copresence judgments are not available to introspection, the results of those processes and especially the salience and allocation of attention to a co-present other can be self-reported. By using a self-report scale for copresence, it is assumed that the user can report part of the qualities of continuum of copresence by reporting the degree to which the user and other share a common environment, sensory awareness of the other, and other's sensory awareness of them.

### 3.3 Other indicators of copresence

The conscious phenomenal state of perceived copresence may be measurable via other indicators than the self-report scale offered here. We briefly look at other indicators a researcher might consider using alongside or as a substitute for a self-report measure or in their use as a test of criterion or concurrent validity for the self-report measure.

#### Behavioral indicators of co-presence

Theoretically, the sense of copresence should also be correlated with behaviors like visual attention such as the tracking the other, proxemic behavior such as approach avoidance of the other, and facial communication displays such as smiling, frowning, and other non-verbal behavior (Rinn, 1991). Some theorists have suggested using these behaviors as indicators of copresence.

Behavior can be a strong indicator of copresence and is used often to measure social responses. For example, consider this extreme example for the purposes of illustration. An observer will conclude "the presence of a hallucination" when an individual appears to be responding socially to a location in space where the observer cannot see or hear an agent, (i.e., as when a

schizophrenic "hears" and "talks" to disembodied entities). In a similar way users may smile, talk, and otherwise interact with pixels of light on a screen. Their behaviors can be used to indicate that "an agent" is perceived as socially present.

Researchers have discussed the importance of non-verbal cues in mediated social interaction (Burgoon et al., in press; Walther & Burgoon, 1992; Walther, 1996), but implementation of objective non-verbal measurement as an indicator of social presence has not been evident in mediated social presence research. Several non-verbal cues, as previously mentioned, could be useful as support for the self-report measure discussed here, however the ability to generalize across studies limits their use to specific research.

This example also suggests a limitation to behavior measures of copresence. When animated and observable forms of social communication behaviors are part of the sense of social presence, the behaviors can be good indicators of social presence. But what about lower levels of copresence and behavioral responses? For example, users' responses to pictures, characters in books, etc? With these media there may be few gross non-verbal behaviors. Users may have a strong sense of social presence to mental imagery created by a book, for example, but have few observable behaviors while reading. So a phenomenal state of copresence may exist, but few behaviors may be present. In such cases behavioral responses may be weak or inconsistent indicators of the sense of copresence.

Therefore, we conclude that verbal or non-verbal behaviors can be good indicators of copresence and sources for concurrent validity testing for self-reports of copresence. But they may not be good indicators across the full continuum of copresence responses, especially for the lower levels of copresence.

#### Physiological indicators of co-presence

There appear to be some measurable brain correlates of the detection and responses to agency using various brain imaging techniques such as functional magnetic resonance imaging (fMRI) (Atlas, 2002;



Jackson & Gillespie, 2000). In some cases where arousal is present, other physiological measures such as skin conductance, pupil dilation, etc. may be indicative as well (Blascovich, 2000).

Measures such as fMRI and electroencephalography (EEG) can be quite useful for theoretical work and for providing criterion or concurrent validity checks for self-report measures. But these may be less practical for many interface design studies, as they are expensive, may require restricted motion, and may limit the media tested. For example fMRI cannot be used simultaneously with metal interfaces such as the typical head-mounted display.

Other physiological measures such as heart rate and skin-conductance may be less expensive and easier to use. But they may be sensitive indicators to only part of continuum of responses to agency. For example, heart rate or pupil dilation may only be indicative of more elevated arousal to social cues and not be a sensitive indicator to lower levels of social presence. These indicators may be responsive to so many other phenomena as to make them ambiguous indicators of social presence specifically.



#### **4. Measuring Second Order Social Presence: Psycho-behavioral accessibility**

Beyond co-presence, researchers of social presence have focused on what might be called the "social" part of social presence. This measure of social presence seeks to provide indicators of what we call Second Order Social Presence, the sense of psycho-behavioral interaction triggered by "being together" in an environment (Biocca et al., forthcoming).

##### The sense of the "social" in social presence

For users co-presence can elicit modest to strong social responses. The sense of "being together" implies more than physical proximity, but also some minimal level of social communication. Even the most minimal social communication requires representations of the other's intentions, discursive topics, etc. Automatically assessing "Is he looking at me" or "where is he going" involves sophisticated judgments of intention, predictions of action, etc., even without explicit communication exchange. Among cognitive scientists and philosophers of mind this process of modeling others mental states is referred to as "mind reading" (Botterill & Carruthers, 1999; Carruthers & Smith, 1996). The process appears to be automatic, driven primarily by innate mechanisms, although there is likely to be some cultural variation in the interpretive processes.

So at the very moment that another is deemed "co-present," we believe some level of "mind reading" is innately, automatically triggered. As communication is engaged, the effort and amount of mind reading is much higher as the mental states of the other becomes more socially present and perceived to be accessible to the user/observer. Emotional responses are, of course, likely to be triggered by affiliative, empathetic, or aversive reactions to the other.

Therefore, a measure of social presence must seek to develop indicators of this psychological and behavioral accessibility of the other. Although a lot of psychological engagement and behavioral interaction is activated in any act of communication, the

measure limits its scope to self-reports of "mind reading." This way the research can assess the relationship between levels of co-presence and related effects psycho-behavioral component of social presence.

Please consult table 2.



**Table 2**  
**Self report indicators of second order social presence: Psycho-behavioral interaction**

Second order social presence: Psycho-behavioral interaction

These items seek to measure the user perception of attention, emotional contagion, and mutual understanding with their partner or participant.

*Perceived psychological engagement*

Perception of self	Perception of the other
<b>Perceived attentional engagement</b>	
I paid close attention to (my partner).	(My partner) paid close attention to me
I was easily distracted from (my partner) when other things were going on.	(My partner) was easily distracted from me when other things were going on.
I tended to ignore (my partner).	(My partner) tended to ignore me.
<b>Perceived emotional contagion</b>	
I was sometimes influenced by (my partner's) moods.	(My partner) was sometimes influenced by my moods.
When I was happy, (my partner) tended to be happy.	When (my partner) was happy, I tended to be happy.
When I was feeling sad (my partner) also seemed to be down.	When (my partner) was feeling sad, (my partner) I tended to be sad.
When I was feeling nervous, (my partner) also seemed to be nervous.	When (my partner) was nervous, (my partner) I tended to be nervous.
<b>Perceived comprehension</b>	
I was able to communicate my intentions clearly to (my partner.)	(My partner) was able to communicate their intentions clearly to me.
My thoughts were clear to (my partner).	(My partner's) thoughts were clear to me.
I was able to understand what (my partner) meant.	(My partner) was able to understand what I meant.

*Perceived behavioral interdependence*

Perception of self	Perception of my partner
My actions were often dependent on (my partner's) actions.	(My partner's) actions were often dependent on my actions.
My behavior was often in direct response to (my partner's) behavior.	The behavior of (my partner) was often in direct response to my behavior.
What I did often affected what (my partner) did.	What (my partner) did often affected what I did.

**4.1 Perceived psychological engagement**

In mediated interactions, the mediated body is all that is available to construct a model of the other. The mediated body is a set of cues from the verbal (i.e., sound or graphemic voice) and the non-verbal (represented body form and actions from an emoticon to full 3D representation). Psychological and behavioral

interaction is transmitted by a telecommunication system with the limited or enhanced version of the other's body. The interface (i.e., images and sound) may eliminate, substitute, and/or distort many of the communication cues. The social presence of the other and the psychological and behavioral interaction is therefore filtered through the lens of the interface. This may



influence the perceived social presence of the other by affecting the user's perception of the communication with the other.

We use the term "perceived" in all of dimensions because these are self-reports of introspective states of the user, and not objective statements of actual attention, actual emotional contagion, or objective comprehension. User's interactions with computer agents makes clear that attributions of mental states to the other and shared social interaction are objectively illusory and may be so in interactions with mediated humans as well.

Finally, the items in the scales are designed to be used with most media and with most communication contexts to allow for cross media comparisons. So, to allow for generalizability, the items focus on basic psycho-behavioral interaction and not on task specific emotional, semantic, or behavioral states.

#### Perceived attentional engagement

One of the most primitive social presence and communication responses is shared attention. Once an agent is deemed as co-present, humans automatically register gaze direction, especially whether the gaze involves them (Burgoon, Buller, & Woodall, 1996). Neonates respond almost immediately to the gaze direction of faces, and when they have control over their eyes and head movements they will track the attention of those they interact with. Just as elemental is the level of attention to the other, as a stimulus in an environment.

The indicators seek to measure the degree to which the users report attention to the other, and the degree to which they perceive the other's level of attention to them.

#### Perceived emotional contagion

There is some evidence that people may model the mental states of another, by simulating those mental states on their own body. This is part of the simulation theory of mind (see theoretical paper for more discussion). Neonates will often mimic the facial expression of other faces. If simulation is part of the process of modeling the mind of

the other, then emotional states of one person can affect another. There is some evidence of automatic empathic responses while viewing film, for example.

These items ask for a self-report of the perceived emotional contagion, that is the transfer of emotional states from the user to the other, or the other to the agent.

#### Perceived comprehension

Most communication, even that as primitive as simple shared attention, is about *some thing*: that is it refers to an object in the environment, or a metaphorical "object" such as an abstract topic, an action, etc. Co-orienting on a shared topic is a key aspect of social presence. For example, if the other seems unable to focus on the same object of communication, users will say that the "person just isn't here" or "is on the different planet." The inability to co-orient to similar discursive objects is associated with a break down of social presence. At the highest level, the absolute transparency and perception of shared meaning "I see what you mean" is associated with high levels of psychological engagement and a deep sense of the other.

The items elicit some introspective self-report of perceived comprehension with the mediated other.

### **4.2 Perceived Behavioral Interdependence**

When a medium makes others co-present, it opens up the possibility for social interaction. Social interaction can take the form of shared or interdependent behaviors. These can involve cooperation such as in shared work environments or competitive behaviors as in gaming environments. The key feature for social presence is that one's behavior is to some degree dependent on the actions of the other, and that the other's behavior is to some degree dependent on my actions. The action or behavior is somehow synchronized with ours. Passive media such as books do not support any behavioral interaction, or at most a one-way behavioral interaction. For example, someone watching a TV exercise program may be asked to engage in a behavior in synchrony with the people on the screen, but this "interaction" is one way. The



screen “others” cannot sense or respond to the user’s actions.

#### Self-report scale of behavioral interaction

One can define and measure behavioral interaction objectively as an outside observer. (We discuss this in the next section). But we suggest that an essential element of social presence like presence is a perception of others. This applies to behavior as well. A medium may support very little actual behavioral interaction, but features of the medium or the user may lead them to perceive far more behavioral interaction than is observable by an outside observer. Alternatively, the medium may support all kinds of behavioral interaction but the user may perceive these as limited.

Table 2 includes a short set of items that provide some indicators of the user’s perception of behavioral interdependence.

#### Behavioral indicators of interdependence as validation and additional measures

Human behavior exhibits all kinds of synchronous and interdependent patterns from contagious yawning, to talk-silence patterns, to movement correspondences. These are well documented in the literature on interpersonal communication (Burgoon et al., 1996). We can make the theoretical claim that increases in interdependent behavior is a good indicator of increased feelings of the social presence of others.

Interdependent behavioral interaction and self-reports of perceive behavioral interaction should be highly correlated. These are being used to validate the self-reports of behavioral interaction.

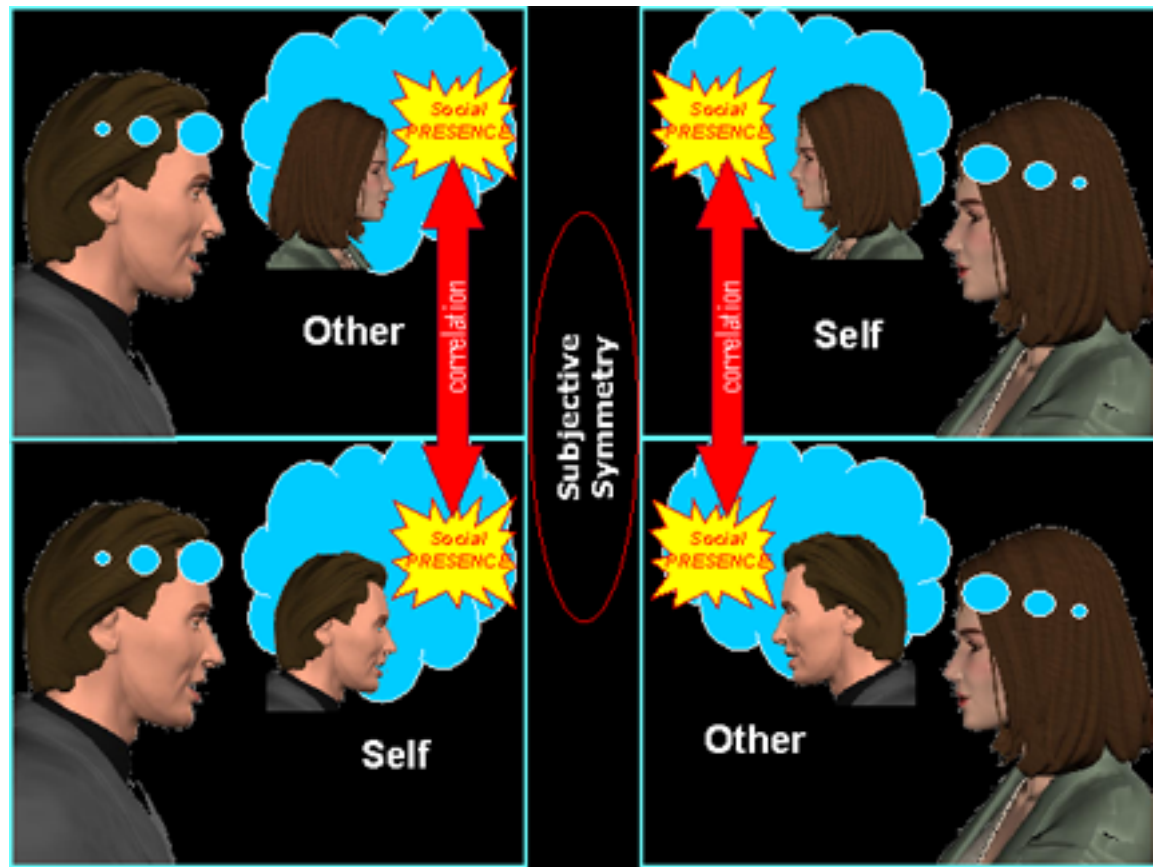
But as we mentioned in the previous section, we would predict several instances where the user will perceive more or less behavior interaction than is truly the case, but these may be the exception rather than the rule when it comes to correspondence between perceived behavior interaction and observable behavioral interaction.



### 4.3 Third Order Social Presence 3: Perceived Subjective and Intersubjective Psycho-behavioral Symmetry: A potential measure of concordance

Although the measures of first-order and second-order social presence seek to capture several dimensions of social presence, there is still a component of the conceptualization of social presence that

can be derived. When two or more individuals are co-present and socially present to each other, there remains the possibility for high levels of connection between two or more interactants. This perception of higher levels of social presence is indicated in common phrases used to describe social interaction such as "we were in sync," "I really connected with that person," "we seemed to be of one mind," "we moved together like a hand in a glove," etc. These phrases are expressions of a perception of what we will call "psychobehavioral symmetry." Higher levels indicate a increasing levels of "concordance" with another, the degree to which one individual perceives a kind of psychological and behavioral correspondence between themselves and another during an interaction, what we call subjective symmetry, and the degree to which this perception is truly shared with the other, what we will call intersubjective symmetry.



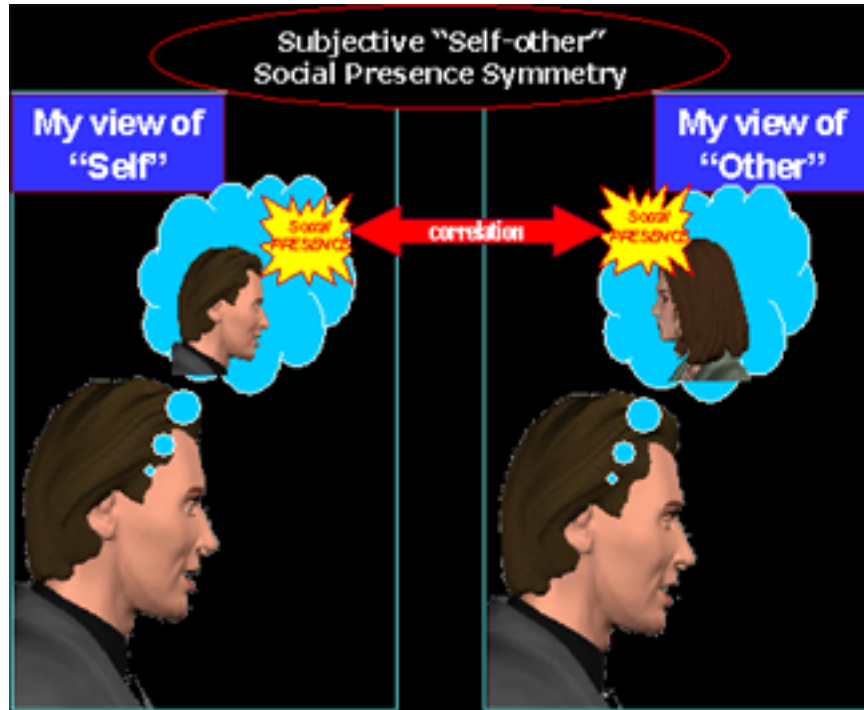
**Figure 3.** Subjective symmetry is the degree of symmetry or correlation between the user's sense of social presence and their perception of their partner's sense of social presence.

Theoretical basis for the constructs of subjective and intersubjective symmetry

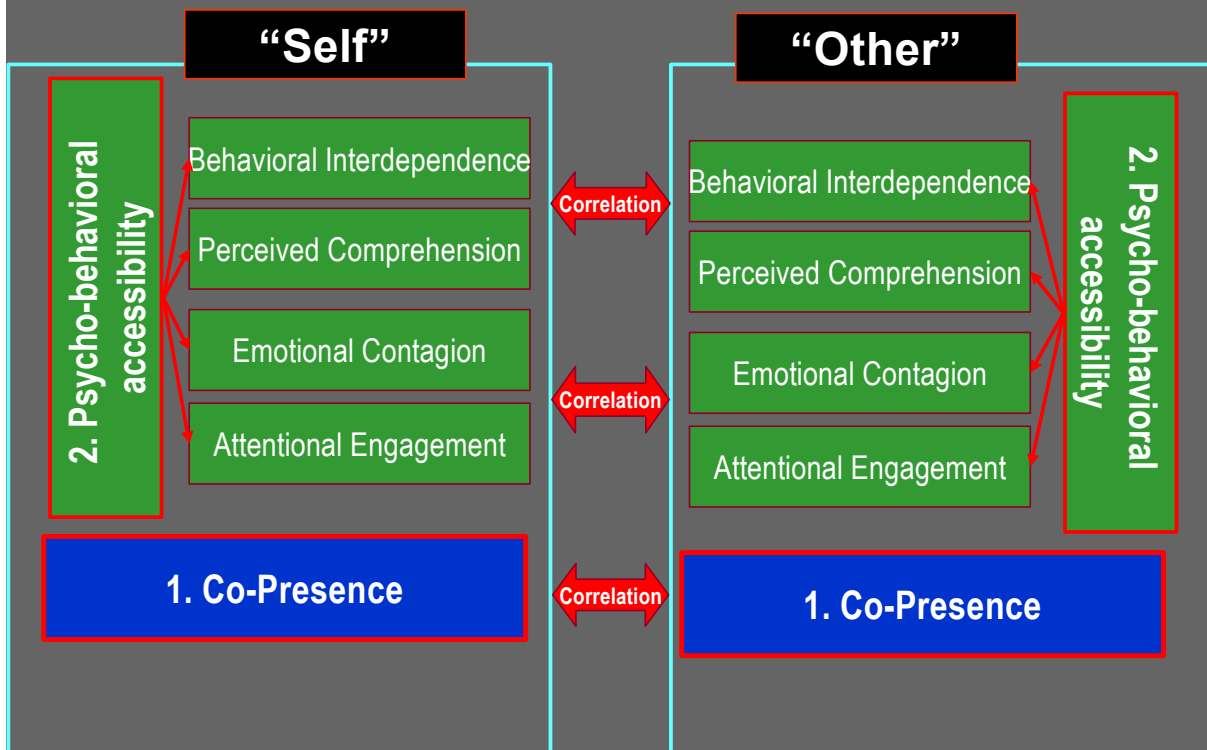
#### Subjective symmetry of social presence

The measure of subjective symmetry is derived from the first and second order measures of social presence. See Figure 2. It measures the degree to which the user perceives that the other shares the same state of social presence. The measure can be used to diagnose the user's perception of their mediated interaction with the other.

The user's sense of subjective symmetry may occur in one or more of the scales of co-presence or social presence. Symmetry is assessed as a correlation between the items that assess the self and those that assess the other's perceptions. As in all correlations symmetry can vary from a minimum of 0 to a maximum of 1.



### Technique to assess self-other social presence symmetry and asymmetry





### Intersubjective symmetry of social presence

The measure of intersubjective symmetry is derived from the first and second order measures of social presence. It measures the degree to which the user perceives that the other shares the same state of social presence. See Figure 2

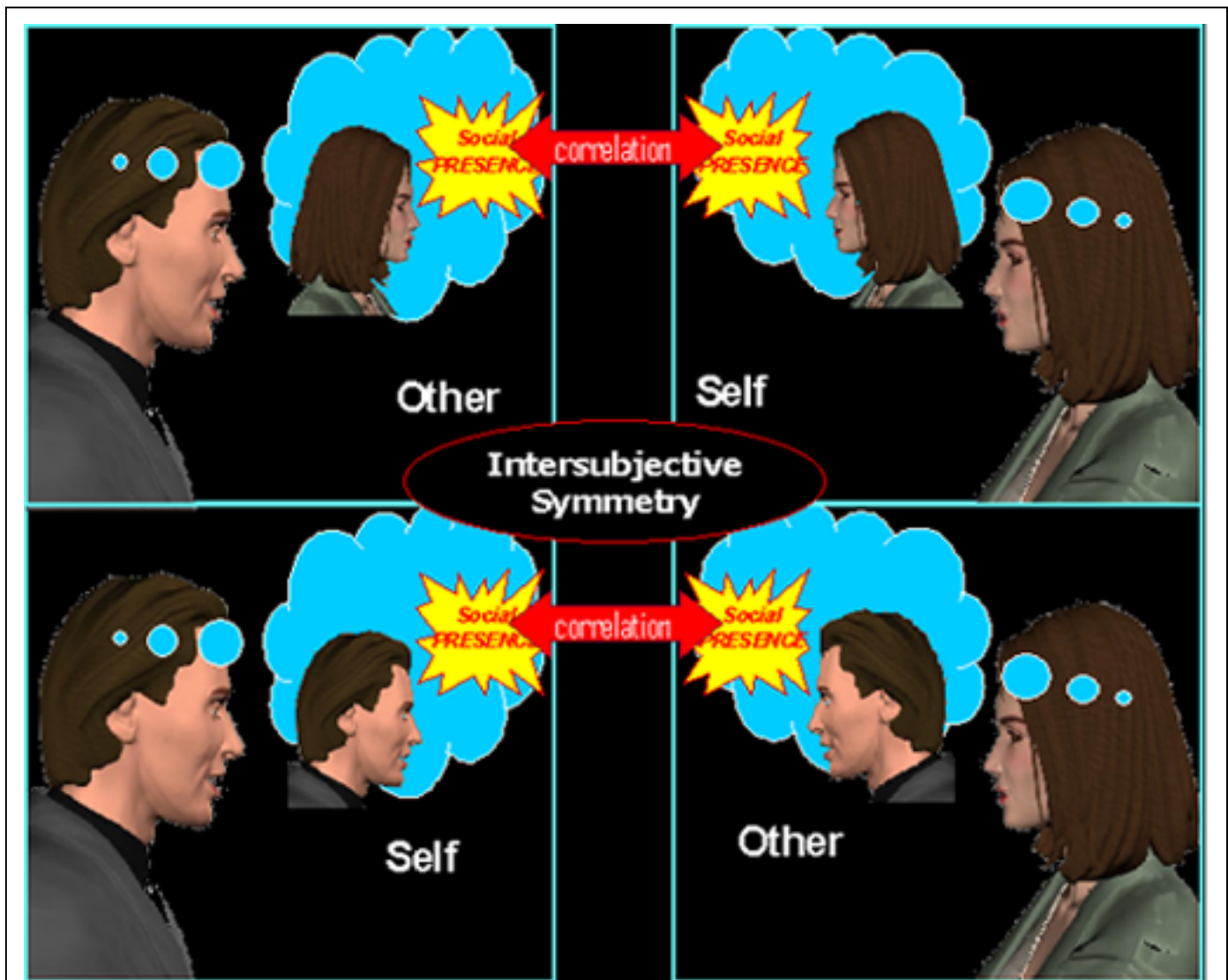
### Paradigmatic examples for the use of the measures of subjective and intersubjective symmetry

We see this analysis as diagnostic, as it gives

the researcher a tool to look at cases when the medium may act as a barrier or a facilitator to interaction.

The measures are particularly appropriate in the following measurement situations:

- Settings where users are interacting in imbalanced media connections, for example, one user with a telephone connection is interacting with a user with a video and audio connection.
- Settings where users may vary in acquaintance prior to the mediated interaction.



**Figure 5.** Intersubjective 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.



- Settings where the medium remains fixed where tasks vary such as cooperative versus competitive actions, etc.

## 5. Summary

The Networked Minds Social Presence Inventory is an evolving set of self-report scales for assessing various levels of social presence from simple co-presence to more intense feelings of psychological and behavioral accessibility and interaction. The measures are designed for assessing interaction with others, be they human avatars or artificially intelligent agents, in mediated environments. The scales are constructed so that the measures can be used broadly for comparisons of the social presence across different media, tasks, and interaction settings.

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## 6. Appendix A

### 6.1 Networked Minds Social Presence Inventory: Self-report scales

#### First order social presence: Co-presence

The following items form the measure of co-presence, the degree to which the users feel as if they are together in the same space.

Perception of self	Perception of the other
I often felt as if (my partner) and I were in the same (room) together.	I think (my partner) often felt as if we were in the same room together.
I was often aware of (my partner) in the (room).	(My partner) was often aware of me in the (room).
I hardly noticed (my partner) in the (room)	(My partner) didn't notice me in the (room).
I often felt as if we were in different places rather than together in same (room)	I think (my partner) often felt as if we were in different places rather than together in the same (room).

#### Second order social presence: Psycho-behavioral interaction

These items seek to measure the user perception of attention, emotional contagion, and mutual understanding with their partner or participant.

##### *Perceived psychological engagement*

Perception of self	Perception of the other
<b>Perceived attentional engagement</b>	
I paid close attention to (my partner).	(My partner) paid close attention to me
I was easily distracted from (my partner) when other things were going on.	(My partner) was easily distracted from me when other things were going on.
I tended to ignore (my partner).	(My partner) tended to ignore me.
<b>Perceived emotional contagion</b>	
I was sometimes influenced by (my partner's) moods.	(My partner) was sometimes influenced by my moods.
When I was happy, (my partner) tended to be happy.	When (my partner) was happy, I tended to be happy.
When I was feeling sad (my partner) also seemed to be down.	When (my partner) was feeling sad, (my partner) I tended to be sad.
When I was feeling nervous, (my partner) also seemed to be nervous.	When (my partner) was nervous, (my partner) I tended to be nervous.
<b>Perceived comprehension</b>	
I was able to communicate my intentions clearly to (my partner.)	(My partner) was able to communicate their intentions clearly to me.
My thoughts were clear to (my partner).	(My partner's) thoughts were clear to me.
I was able to understand what (my partner) meant.	(My partner) was able to understand what I meant.



*Perceived behavioral interdependence*

<b>Perception of self</b>	<b>Perception of my partner</b>
My actions were often dependent on (my partner's) actions.	(My partner's) actions were often dependent on my actions.
My behavior was often in direct response to (my partner's) behavior.	The behavior of (my partner) was often in direct response to my behavior.
What I did often affected what (my partner) did.	What (my partner) did often affected what I did.

Third order social presence

Third order social presence is derived from the scales used for first order and second order social presence.

*Subjective Symmetry*

Notes on the use and analysis of the scales

*Contextualizing the scale with substitutions for "my partner" and "the room" terms*

To prevent confusion, difficulty, and to make questions clear it is preferable that users respond to concrete references rather than abstract references. Therefore the words in brackets indicate phrases to be substituted for appropriate terms relevant to the mediated interaction.

Example substitutions for the **agent term** holder,  
"my partner" = the other, participants, robot, player, opponent, guest, "Alicia," etc.

Example substitutions for the **place term** holder,  
"the room" = office, city, screen, virtual environment, etc.