

The Networked Minds Measure of Social Presence: Pilot Test of the Factor Structure and Concurrent Validity

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Abstract

A within-subjects experiment was conducted to explore the factor structure and concurrent validity of the Networked Minds measure of social presence. A set of eight factors consistent with the Networked Minds theory of social presence emerged. These were grouped under three areas: (1) co-presence, with the factor, mutual awareness; (2) psychological involvement including the factors: mutual attention, empathy, mutual understanding; and (3) behavioral engagement, including the factors: behavioral interaction, mutual assistance, and dependent action.

The concurrent validity of the scales was largely supported. All scales were higher in the face-to-face than mediated interactions. As predicted the co-presence, and two of the three psychological involvement factors, mutual attention and mutual understanding, were significantly different in the face-to-face interaction. There was not any significant difference in empathy. Among the three behavioral engagement scales, mutual assistance scale was significant. Reliabilities were satisfactory with an average of $\alpha = .77$. The pilot provides preliminary support for the reliability, validity, and sensitivity of the Networked Minds measure of social presence.

INTRODUCTION

The growth in networked virtual environments has increased theoretical interest and the potential evaluative value of measures of presence, defined succinctly as "the sense of being there" (Lombard & Ditton, 1997). Presence is sometimes conceptualized as composed of two related components (Biocca, 1997; Heeter, 1992):

- ? telepresence, the phenomenal sense of "being there" in the virtual environment (mental models of mediated spaces that create the illusion);
- ? social presence, the sense of "being together with another" {mental models of other intelligences (i.e., people, animals, agents, gods, etc.) that help us simulate "other minds"}.

While there have been several studies examining the issues regarding the conceptualization and measure of presence (Banos et al., 2000; Freeman, Avons, & al, 1998; Ijsselsteijn, Ridder, Freeman, Avons, & Bouswhuis, 2001; Lessiter, Freeman, Keogh, & Davidoff, 2001; Lombard et al., 2000; Schubert, Friedman, & Regenbrecht, 2001; Slater, 1999; Slater & Steed, 2000; Usoh, Catena, Arman, & Slater, 2000; Witmer & Singer, 1994; Witmer & Singer, 1998), discussions of the conceptualization, reliability, and validity of social presence measurement are far less frequent (e.g., Nowak, 2000). Most studies refer back to a seminal work by Short, Williams, & Christie (1976) and use a variation of their measure, one that involves user's judgements of properties of a medium using various semantic differential scales.

There may be limitations in the existing measures of social presence (Biocca, Burgoon, Harm, & Stoner, 2001). Therefore, to overcome these limitations we have been working on the development of theory, conceptualization, and measure of mediated social presence (Biocca, Burgoon, & Harms, forthcoming). In this article we report on a pilot study of the reliability and validity of a new measure of social presence.

DEVELOPMENT OF THE NETWORKED MINDS MEASURE OF SOCIAL PRESENCE.

We have been developing a conceptualization and measure of social presence called on Networked Minds conceptualization of social presence (Biocca et al., forthcoming). Our current definition of mediated social presence is as follows:

Mediated social presence is the moment-by-moment awareness of the co-presence of another sentient being accompanied by a sense of engagement with the other (i.e., human, animate, or artificial being). Social presence varies from a superficial to deep sense of co-presence, psychological involvement, and behavioral engagement with the other. As a global, moment-by-moment sense of the other, social presence is an outcome of cognitive simulations (i.e., inferences) of the other's cognitive, emotional, and behavioral dispositions.

At the lowest levels social presence is characterized by a peripheral sense of spatial co-presence of the other and minimal attributions of about the states of the other such as basic categorization of the other's identity, intentions, and attention. Progressively higher levels of social presence are characterized by a deeper sense of psychological involvement, access, and connection to the intentional, cognitive, or affective states of the other. Higher levels of social presence may include a sense of behavioral engagement where actions are linked, reactive, and interdependent.

Our conceptualization of social presence provides theoretical support for the Networked Minds measure. It is called the Networked Minds measure of social presence because it seeks to provide a metric to measure the degree to which individuals feel interconnected to each other through networked telecommunication interfaces.

To develop the measuring instrument we conducted a review of existing theories and measures of social presence. The details of this review are reported elsewhere (Biocca et al., 2001). Based on a review of the existing theories of social presence and our theoretical analysis of the concept, we distilled three dimensions of social presence. These dimensions reflect the range of the concept and provided the beginnings of the face validity support for the measure:

Co-presence: The degree to which the observer believes he/she is not alone and secluded, their level of peripherally or focally awareness of the other, and their sense of the degree to which the other is peripherally or focally aware of them.

Psychological Involvement: The degree to which the observer allocates focal attention to the other, empathically senses or responds to the emotional states of the other, and believes that he/she has insight into the intentions, motivation, and thoughts of the other.

Behavioral engagement: The degree to which the observer believes his/her actions are interdependent, connected to, or responsive to the other and the perceived responsiveness of the other to the observer's actions.

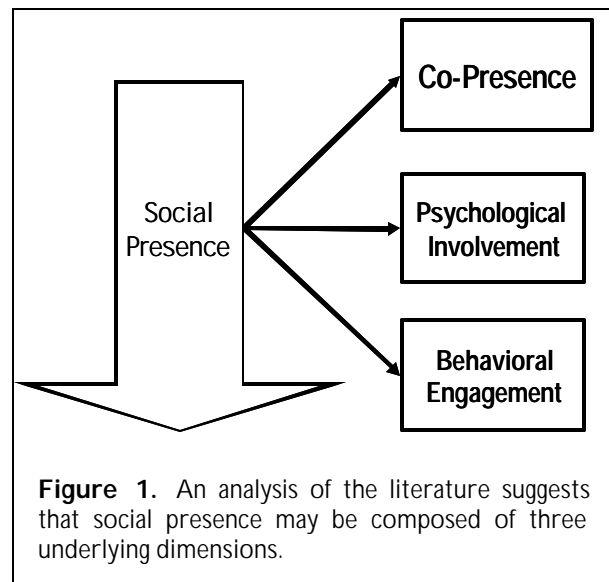


Figure 1. An analysis of the literature suggests that social presence may be composed of three underlying dimensions.

A pool of over eighty items was created. The items were analyzed for face validity and content validity to determine how well they captured the dimensions of social presence. Sixty-nine of the items were retained for the initial test pool. It was expected that following factor analytic studies of emergent sub-dimensions only 50% of these items might eventually compose the final measurement instrument.

CREATING A PILOT CRITERION TEST OF THE MEASURE: CONCURRENT VALIDITY

It is a fundamental premise of social presence theory that some media generate more social presence than others (Palmer, 1995; Rice, 1993; Short, Williams, & Christie, 1976). Among most social presence researchers, face-to-face interaction is considered the "gold standard" in social presence, especially when compared to impoverished social cues of most mediated interactions. Social presence is assumed to be highest when two people are within reach of each other, especially when they are interacting on a task (Short et al., 1976 ; Steinfield, 1986). By comparison,

most mediated interactions lack the “media richness” and many of the non-verbal cues of face-to-face interaction (Burgoon, Buller, & Woodall, 1996). Therefore, they are assumed to support less social presence.

The ability to detect the difference between face-to-face and mediated interactions should be criterion upon which we can test the concurrent validity and sensitivity of a measure of social presence. If theoretical assumptions are correct and the measure reliable and valid, then a measure of social presence should be sensitive enough to detect the difference in social presence between one face-to-face interaction and mediated interactions. Of course, most measures would no doubt be able to discriminate between face-to-face interaction and mediated interactions over low sensory bandwidth media such as a telephone. A more stringent test is required. We would expect a measure to detect the difference between face-to-face interaction and audio-video teleconferencing system in perceived social presence. This was chosen as the criterion to test the concurrent validity of the networked minds measure of social presence. Furthermore, to make the two interactions more compatible and the test more stringent, we choose a task where all the information is carried solely through voice and non-verbal expression and only two participants interacted. Participants merely discussed the rank order of items in a list. Therefore, the teleconferencing system carried most if not all the relevant information for the task.

HYPOTHESES: PLUMBING THE DEPTH OF SOCIAL PRESENCE.

The Networked Minds measure of social presence posits a rough hierarchy among the dimensions of social presence. It is assumed that deeper levels of social presence are likely to be based upon the activation of earlier layers of cognition. So, for example, a sense of co-presence is most likely activated for someone to feel psychological involvement. Some level of psychological involvement is likely to be activated prior to behavioral engagement.

The participants in this study met to carry out the desert survival problem (Lafferty & Eady, 1974). The task required limited cooperative verbal behavior, ranking the importance of twelve items for survival in the desert. The task involves no behavior other than verbal behavior and is not known to be emotionally engaging. This reasoning leads to the following hypotheses:

Co-presence: All co-presence factors should detect a difference between face-to-face and mediated interactions in this verbal task.

Psychological Involvement: Some of the psychological involvement scales should detect a difference between face-to-face and mediated interactions in this verbal task.

Behavioral Engagement: Because behavioral engagement is limited to verbal behavior, few if any behavioral interaction scales should detect differences between subjects.

METHOD

This study used a mixed design with one between subjects' factor, order, of the interaction medium, and one within subjects factor type mediation. Type of mediation had two levels: face-to-face interaction (no mediation) and mediated human-to-human interaction (teleconference). It used the measure in the context of human face-to-face interaction and mediated human-to-human interaction.

Participants

Seventy-six undergraduates at a large midwestern university took part in this experiment for class credit. Participants were randomly assigned to condition in 38 matched pairs.

Materials

Networked Minds social presence questionnaire version 1.0. An initial set of 69 seven-point Likert scale items measuring the degree to which one feels co-presence, psychological involvement, or behavior engagement with another. The scales were constructed based on a review of the social presence literature, an analysis of the necessary criteria and scope conditions for presence, and an emerging theory of social presence (Biocca et al., 2001; Biocca et al., forthcoming)

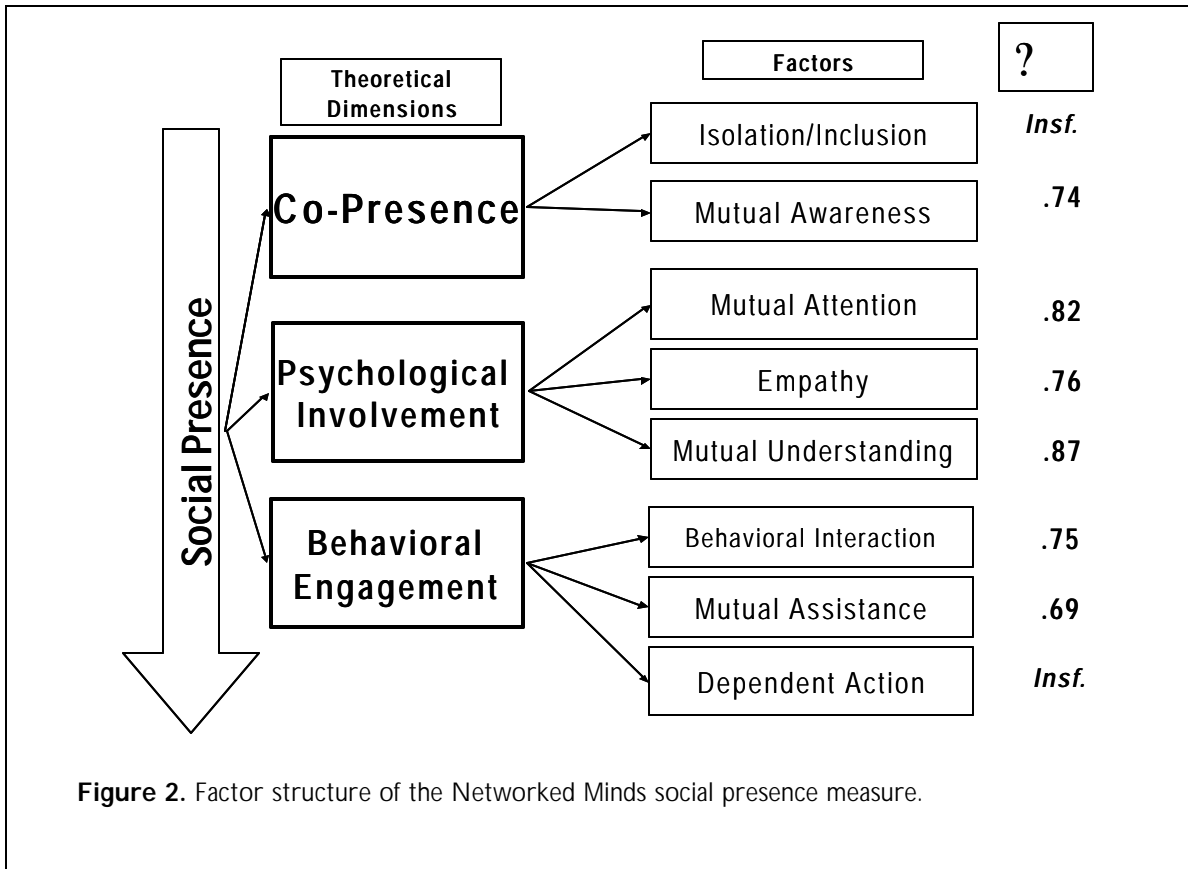
Desert Survival Task: A set of instructions for a task in which participants must rank and then discuss twelve items for their importance for survival in the desert (Lafferty & Eady, 1974).

Teleconferencing system: Two PCs with camera running the teleconferencing program, NetMeeting, were used for the mediated condition.

Video recording units: Video-recording systems recorded both mediated and unmediated interactions.

Procedure

After signing a consent form indicating their voluntary participation in this experiment, participants were assigned a survival task to provide a structured interac-



tion between the participants. After reading a narrative of the survival problem (Lafferty & Eady, 1974), participants were instructed to rank order a list of objects needed to complete the survival task. Pairs of participants were then assigned to be in either the mediated condition or the face-to-face condition to discuss the first half of the survival task. After discussing half of the objects and their rankings, the participants were instructed to complete Networked Minds social presence questionnaire. After completing questionnaire 1, participants were sent to complete the interaction using the second experimental condition. After discussing the second half of the objects and their rankings, participants were instructed to again complete Networked Minds social presence questionnaire regarding the second interaction.

RESULTS

Factor Analysis of the Networked Minds Scales

Scale construction. The dimensionality of each scale was determined in two ways. All scales were evaluated together and all items loaded highest on their primary factor. Items were also analyzed on theoretical grounds. Factor analysis tests of internal consistency

were applied to each dimension. Items were dropped from their respective scales when item correlations failed tests of internal consistency. Furthermore, items whose paired question did not meet the tests for internal consistency were also dropped from the scale. Any item that did not meet all tests was removed from the scale. Of the original 69 items only 38 were retained.

The overall factor structure is depicted in Figure 2. The final number of items in each scale is detailed below. We provide a label that interprets the factor. Standardized item alpha is included for all scales.

Co-Presence

Of the 20 items originally included as indicators of the dimension of co-presence, 14 items remained in two factors, attention and awareness, after the tests of internal consistency and reliability. A third factor, isolation/aloneness, was represented by two items and requires further investigation.

isolation/aloneness

Isolation/aloneness is measured by the following two items, one matched pair.

- ? I often felt as if I was all alone
- ? I think the other individual often felt alone.

Mutual Awareness

Awareness is measured by the following six items (three matched pairs). Standardized item alpha for this factor $\alpha = .74$. Note: in this pilot study, items for isolation loaded on the factor for mutual awareness. Researchers believe isolation is a separate factor and will be investigated in future studies.

- ? I hardly noticed another individual.
- ? The other individual didn't notice me in the room.
- ? I was often aware of others in the environment.
- ? Others were often aware of me in the room.
- ? I think the other individual often felt alone.
- ? I often felt as if I was all alone.

Attentional Allocation

Attention, is measured by the following eight items (four matched pairs). Standardized item alpha for this factor $\alpha = .82$.

- ? I sometimes pretended to pay attention to the other individual.
- ? The other individual sometimes pretended to pay attention to me.
- ? The other individual paid close attention to me
- ? I paid close attention to the other individual.
- ? My partner was easily distracted when other things were going on around us.
- ? I was easily distracted when other things were going on around me.
- ? The other individual tended to ignore me.
- ? I tended to ignore the other individual.

Psychological Involvement

Of the 26 items originally included as indicators of the dimension of psychological involvement, 12 items remained in two factors, mutual understanding and emotional contagion, after the tests of internal consistency and reliability (see appendix xx).

Empathy

Emotional contagion or empathy is measured by the following six items (three matched pairs). Standardized item alpha for this factor $\alpha = .76$.

- ? When I was happy, the other was happy.

- ? When the other was happy, I was happy.
- ? The other individual was influenced by my moods.
- ? I was influenced by my partner's moods.
- ? The other's mood did NOT affect my mood/emotional-state.
- ? My mood did NOT affect the other's mood/emotional-state.

Mutual Understanding

Mutual understanding is measured by the following six items (three matched pairs). Standardized item alpha for this factor $\alpha = .87$.

- ? My opinions were clear to the other.
- ? The opinions of the other were clear.
- ? My thoughts were clear to my partner.
- ? The other individual's thoughts were clear to me.
- ? The other understood what I meant.
- ? I understood what the other meant.

Behavioral Engagement

Of the 15 items originally included as indicators of the dimension of behavioral interaction, 10 items remained in two factors, mutual assistance and behavioral interdependence, after the tests of internal consistency and reliability (see appendix xx). A third factor, dependent action, was represented by two items and requires further investigation.

Behavioral interdependence

Behavioral interdependence is measured by the following six items (three matched pairs). Standardized item alpha for this factor $\alpha = .75$.

- ? My actions were dependent on the other's actions.
- ? The other's actions were dependent on my actions.
- ? My behavior was in direct response to the other's behavior.
- ? The behavior of the other was in direct response to my behavior.
- ? What the other did affected what I did.
- ? What I did affected what the other did.

Mutual Assistance

Mutual assistance is measured by the following four items (two matched pairs). Standardized item alpha for this factor $\alpha = .69$.

- ? My partner did not help me very much.

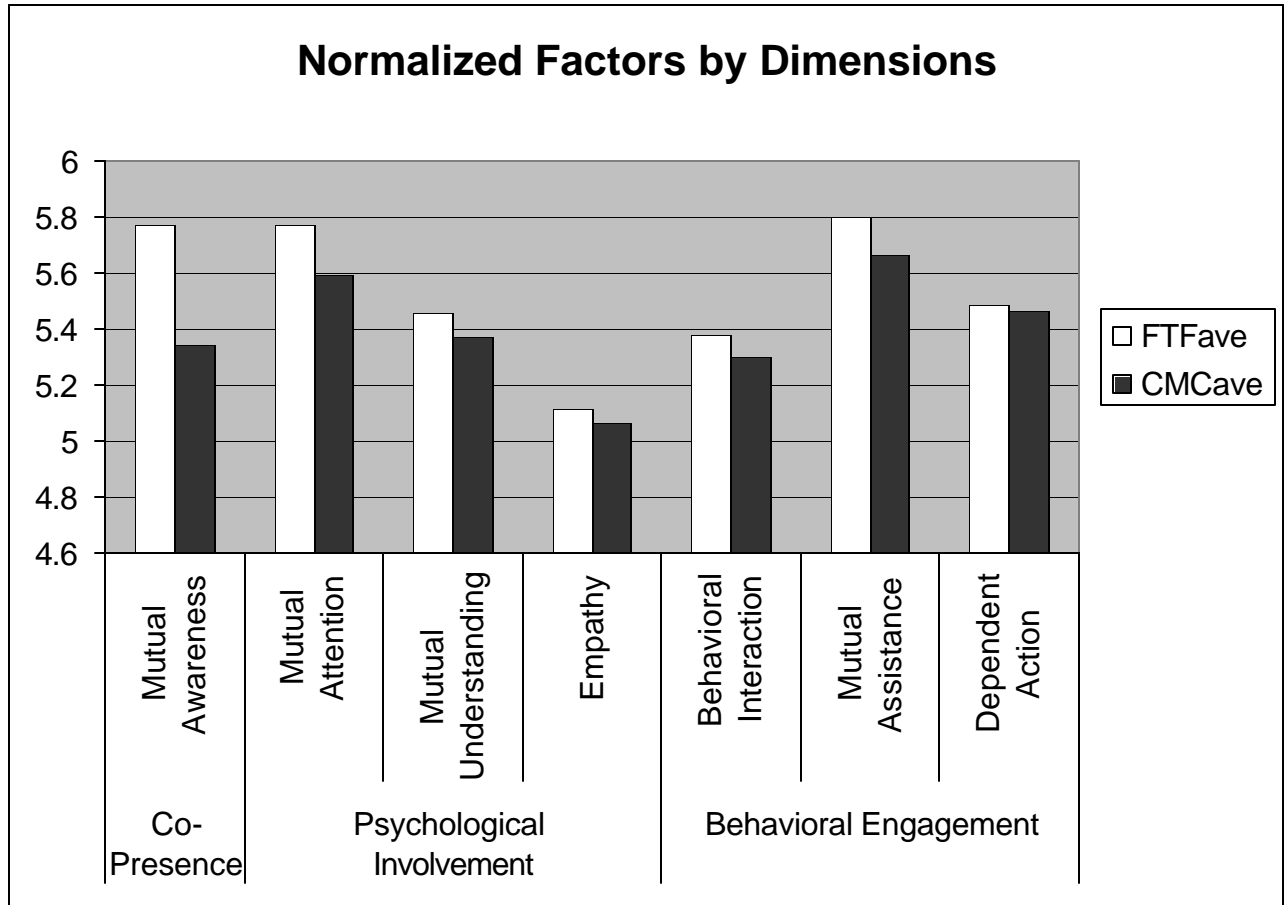


Figure 3. Mean differences between face-to-face versus mediated interaction for each of the eight scales in the Networked Minds social presence measure.

Dimensions	Factors	FTF mean	CMC mean	F	df	P
Co-Presence	Mutual Awareness	34.6	32.1	40.2	1.00	0.00
Psychological Involvement	Mutual Attention	46.2	44.7	10.2	1.00	0.00
	Mutual Understanding	32.8	32.2	2.7	1.00	0.11
	Empathy	30.7	30.4	0.6	1.00	0.43
Behavioral Engagement	Behavioral Interaction	32.3	31.8	1.5	1.00	0.22
	Mutual Assistance	23.2	22.7	4.1	1.00	0.05
	Dependent Action	11.0	10.9	0.0	1.00	0.84

Table 1. ANOVA table of the effect of independent variable condition (face-to-face versus mediated interaction) by each social presence scale.

- ? I did not help the other very much.
- ? My partner worked with me to complete the task.
- ? I worked with the other individual to complete the task.

Dependent action

pendent action is measured by the following two items, one matched pair.

- ? The other could not act without me.
- ? I could not act with the other.

Test of concurrent validity

To test the concurrent validity of the emerging factors, the factors' scores were submitted to analysis of variance to see which factors would discriminate between face-to-face interaction and mediated video interaction.

The analysis of variance results are summarized in Figure 2 and Table 1. As predicted, the co-presence factor, mutual awareness, was significant. Some of psychological involvement scales were significantly different. There was a difference in mutual attention between the two groups.

There was a significant interaction for the mutual understanding scale. There was less mutual understanding at the end of two interactions, regardless of the order of the two conditions. The drop in mutual understanding was greater when the computer-mediated interaction followed the face-to-face interaction. There was no difference in empathy between conditions. Finally, there was a significant difference in the mutual assistance scale between conditions. But participants did not report any difference in behavioral interdependence and their level of dependent action.

Discussion

The primary goal of this study was the first test of the new Networked Minds measure of social presence. We sought to confirm the factor structure of the dimension and sub-dimensions of the measure, determine the reliability of the scales, and test the concurrent validity of the measure.

Factor structure

The three dimensions have yielded a set of coherent sub-dimensions illustrated in Figure 3. The subdimensions appear to be theoretically coherent and reflect underlying structure of self-perceived psychological involvement and behavioral engagement. The structure has a satisfactory fit with the social presence literature

and the emerging theory. The factor analysis is limited by the inadequate ratio of items to subjects and the small subject sample, and, therefore, should be interpreted cautiously.

Reliabilities

The sub-scales appear to be reliable. The average Cronbach alpha reliability is $\alpha = .77$. The range is between .69 and .87.

Concurrent Validity

The test of concurrent validity seems to support the ability of the measure to detect differences in social presence across media. All scales showed a greater score for the face-to-face condition. As predicted, the co-presence scale indicated a significant difference between the media. Participants felt where higher levels of mutual awareness in the face-to-face condition.

Also as predicted, most but not all the psychological involvement scales showed significant differences across the media. Psychological involvement involves more than just the influence of the medium but is also affect by the talk, the partner, and setting. Participants reported an increase in mutual attention, but in this largely unemotional task, report no significant increased in empathy. There was a significant interaction in mutual understanding (See Figure 4). It appears to reflect changes in understanding that is a logical outgrowth of the task. Subjects are negotiating the priority of a list of items and slowly reveal differences in agreement/understanding over time. When face-to-face interaction followed mediated interaction where was more perceived mutual understanding than when it preceded.

Unlike our prediction, one of the subscales of be-

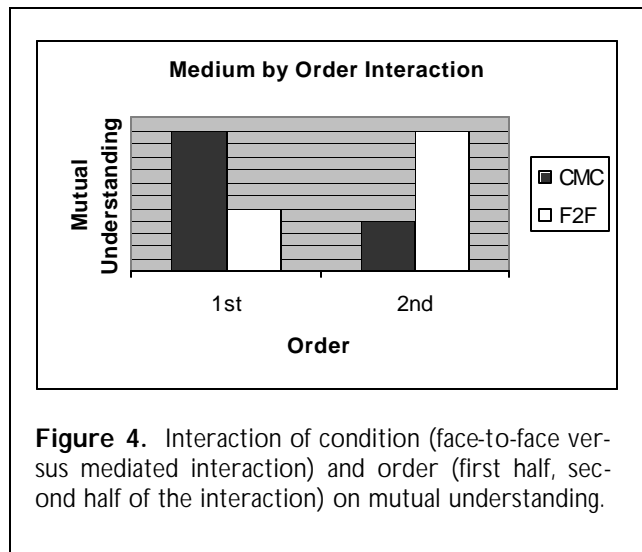


Figure 4. Interaction of condition (face-to-face versus mediated interaction) and order (first half, second half of the interaction) on mutual understanding.

havioral engagement indicated that participants felt higher levels of mutual assistance in the face-to-face condition. It is possible that the non-verbal immediacy of the other in the face-to-face condition led to a greater sense of camaraderie and a sense that the pair was helping each other in the task. But the participants did not feel any behavioral interdependence or that their actions were dependent on the other.

CONCLUSION

The Networked Minds measure is theoretically grounded on a review of the social presence literature. The factor structure is coherent and consistent with theory. The results of this first pilot test and the first iteration of the measure suggests that it might be valid in cross media comparisons. The measure exhibited concurrent validity showing a consistent pattern of results in a direct comparison of face-to-face and mediated interactions. The results indicate that the measure may also be sensitive to task properties. All the subscales had satisfactory reliability. Although these results need to be confirmed and extended in further studies, this pilot provides an indication that the measure may have the required validity, reliability, and sensitivity to be of value in measures of social presence in cross-media comparisons.

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