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Internal Consistency and Reliability of the Networked Minds Measure of Social Presence

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Abstract

This study sought to develop and test a measure of social presence. Based on review of current definitions and measures, a synthesis of the theoretical construct that meets the criteria and dimensions [1] is proposed for a broad successful measure of social presence. An experiment was conducted to test the internal consistency and criterion validity of the measures as determined by theory, specifically the ability of the measure to distinguish levels of social presence that almost all theories suggest exist between (1) face-to-face interaction and mediated interaction, and (2) different levels of mediated interaction.

1. Introduction

Social presence was originally defined [2] as "The degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships," (p. 65) and measured individuals' perceptions of particular media. More recent scholarship of social presence has keyed in on the distinction of, "the social presence *afforded* by the [medium]" (p.73) and has measured the perception of the other with whom one is interacting [1].

Social presence for the purpose of the current research is defined in the following way: *Social presence in a mutual interaction with a perceived entity refers to the degree of initial awareness, allocated attention, the capacity for both content and affective comprehension, and the capacity for both affective and behavioral interdependence with said entity.*

2. Dimensions of social presence

Social presence has been conceptualized as including six sub-dimensions. These include co-presence, attentional allocation, perceived message understanding, perceived affective understanding, perceived affective interdependence, and perceived behavioral interdependence.

2.1 Co-presence

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

2.2 Attentional allocation

Attentional allocation addresses the amount of attention the user allocates to and receives from an interactant.

2.3 Perceived message understanding

Perceived message understanding is the ability of the user to understand the message being received from the interactant as well as their perception of the interactant's level of message understanding.

2.4 Perceived affective understanding

Perceived affective understanding is the user's ability to understand an interactant's emotional and attitudinal states as well as their perception of the interactant's ability to understand the user's emotional and attitudinal states.

2.5 Perceived affective interdependence

Perceived affective interdependence is the extent to which the user's emotional and attitudinal state affects and is affected by the emotional and attitudinal states of the interactant.

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2.6 Perceived behavioral interdependence

Perceived behavioral interdependence is the extent to which a user's behavior affects and is affected by the interactant's behavior.

3. Scale construction

Initially, three categories of social presence research were identified [1]. First, co-presence research dealt with 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. Next, psychological involvement research identified 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. Finally, behavioral interaction is the degree to which the observer believes his/her actions are interdependent, connected to, or responsive to the other and that the other's perceived responsiveness are interdependent, connected to, or responsive to the observer's actions. From these categorizations of social presence research, the six distinct dimensions of social presence identified above were established.

An initial pool of eighty-eight items was created. The items were created to reflect the identified dimensions. Some items were based on existing measures or were modified to meet the criteria for cross media generalization identified by [1]. As each item characterized a statement about the nature of the mediated social interaction, a Likert scale format would be used to measure each item.

The items were analyzed for their translation validity [3], specifically the face validity and content validity. Items were determined as to how well they captured the underlying structure and scope of the conceptualization and dimensions of social presence. A set of 5 researchers in social presence reviewed the initial item pool and specifically eliminated trait oriented items. On the basis of face validity, sixty-nine out of the original eighty-eight items were retained. Nineteen items deemed problematic due to redundancy across items and confusing wording were removed. The sixty-nine item scale was tested in a pilot study [4] using 76 participants. Although the results were inconclusive, analysis identified certain items as poor indicators and exit interviews suggested that additional items were problematic due to wording that caused confusion. This information was used to finalize 50 items. In order to measure symmetry, each of the 50 items were reflected to measure the observer's perception of the other's response. The final result was a 100 item pool.

4. Validation study

This study was designed as an initial validation of the networked minds social presence scale. It used a between subjects experimental design in which participant were randomly assigned into one of three conditions: (1) face-to-face interaction, (2) mediated interaction via text-based low affordance media (3) mediated interaction via video-conferencing high affordance media.

4.1 Participants

240 students enrolled in a communication course at a large Mid-western university participated in this study for extra-credit.

4.2 Apparatus

This study used two sets of netwroked desktop pc computers supporting either low affordance text based or high affordance audio/video based interaction. Participants used one computer to interact with a confederate on a second computer located in a remote site. Each were isolated in order to eliminate distractions from the interaction. Face-to-face interactions were conducted in a separate room to eliminate distractions from the interaction.

During the text-based low affordance media condition participants interacted with the confederates using AOL Instant Messenger. Over 95% of the students had previous experience with this application. Those who had never used IM were given instructions for the application.

In the video-conferencing high affordance media condition participants used Microsoft NetMeeting. The majority of the students had not used this application before but made easy use of the application once introduced. Two web-cams were used by the participant and the confederate along with two microphones and two headphones.

4.3 Measure

The Networked Minds Social Presence Inventory was made up of one hundred items. These items reflected the six hypothesized dimensions as well as self-report items. Participants

completed the questionnaire including the measure online on a separate computer.

4.4 Procedure

Participants were instructed to sign up for the extra-credit study at an on-line scheduling site. Students chose a :15 minute time slot that would work with their schedule.

Upon entering the lab, participants were greeted and seated. Participants were then given an instruction sheet and consent form. The instruction sheet had four steps. First students were instructed to read through and sign the consent form. Second, students were informed that they would be interacting with another student for approximately 5 minutes. The third point instructed the participants that this was simply a "get-to-know" interaction, but their partner's major, how their partner likes school, and what their partner does for fun in his/her free time were provided as information they might try to acquire. This was done both to give similar structure to the interaction as well as providing ideas for types of questions students could use initially in the interaction. The fourth step instructed participants that they would be moved to another computer upon completion of the interaction to complete the questionnaire.

Participants were randomly assigned to one of three conditions: (1) face-to-face, (2) text-based low affordance media (3) video-conferencing high affordance media. In the video conferencing condition care was taken to ensure that the participant could see and hear the confederate. This required slight adjustments to the web-cam. Once the interaction had started a timer was also started.

After five minutes the participants were told to wrap up their conversations. Participants were then moved to another computer to answer the Networked Minds Social Presence Inventory of items. Participants were provided instructions both on the questionnaire itself and by the investigating researcher.

5. Results

5.1 Confirmatory Factor Analysis

In order to effectively estimate the parameters of the measurement model it is appropriate to conduct confirmatory factor analysis [5]. Confirmatory factor analysis, though not a sufficient test for construct validation, surpasses Exploratory Factor Analysis which often produces fewer factors than there are underlying variables in the data and disguises errors for bad items (p. 273). Here, I used confirmatory factor analysis to test whether the factor structure of the Networked Minds Social Presence scale was consistent with the dimensional structure suggested by the theoretical analysis of the social presence construct.

5.2 Internal consistency

Examining individual scale items for deviation from a particular factor tests the internal consistency of that scale. Items from a single construct will cluster together as indicators of the specified underlying construct. A factor is considered internally consistent when participants' responses to one item in the factor are similar to their responses made to the other items hypothesized to be part of the same factor. A factor may be considered internally consistent if 5% or less of the deviations between the predicted and observed matrix are p=.05.

5.2 Parallelism

A test of external consistency, parallelism tests relations between items measuring one factor and items measuring other outside factors. Tests of parallelism are stringent tests set at the p=.05 level of significance to assess deviations between the observed and predicted correlation matrices. Tests of parallelism allow one to identify scale items that may demonstrate a significantly varied pattern of correlation with other measures rather than a "flat" structure as required.

5.3 CFA results

CFA was used to test hypothesis one that social presence would form six separate factors. Specifically, this study used four criteria to determine the quality and dimensionality of the social presence scale: face validity, reliability, internal consistency, and parallelism. Of the 100 items tested, 64 items were deleted in total to acquire an optimally sized scale. Items were removed due to low reliability, poor pair matching, and confusing wording as mentioned by participants in exit interviews. Support was found for hypothesis one in that social presence was found to form six separate factors based on the literature. After deleting problematic items and items with low reliabilities, 36 items were retained. These passed tests of internal consistency producing errors no greater than 0.18 and parallelism producing only 6

errors greater than .20 and none greater than 0.24. No trends were evident in the error matrix. Tables 2-7 provide all scale items retained for this study, their factor loading and descriptive statistics. A valid set of indicators was obtained for all six factors of social presence.

5.4 Reliability of the sub-scales

Chronbach Alpha tests indicated that the subscales identified by the factor analysis were internally consistent. Retained *Copresence* scale items yielded an alpha reliability of .83. Retained *Attentional Allocation* scale items yielded an alpha reliability of .81. Retained *Perceived Message Understanding* scale items yielded an alpha reliability of .87. Retained *Perceived Emotional Understanding* scale items yielded an alpha reliability of .86. Retained *Perceived Emotional Interdependence* scale items yielded an alpha reliability of .85. Retained *Perceived Behavioral Interdependence* scale items yielded an alpha reliability of .82. All scale means are on a scale from one to seven. [see Table 3]

5.5 Criterion-Related Validation Test

First, a test was conducted across confederates to ensure that there was no significant difference between any confederates. No significant difference was found across confederates on any of the six factors. Also, no trends among confederates was evident.

An analysis of variance was used to test the first criterion-related validity test of predictive validity; the ability of the measure to distinguish between levels of social presence experienced between unmediated face-to-face social interactions and mediated social interactions. The comparison of face-to-face interactions and mediated interactions across the six dimensions of social presence showed partial support. [see Table 1]

A second analysis of variance was conducted for the second test of criterion-related validity test concurrent validity, specifically the ability of the measure to distinguish between social presence experiences in low affordance textual media and high affordance audio/video media. In the factor *Perceived Behavioral Interdependence*, text or the low affordance media (M=4.46, SD=0.84) was greater than the audio/video condition or high affordance media (M=4.08, SD=0. 99), $F(1, 158)= 2.61$, $p < .01$, $eta^2 = .14$. *Perceived Message Understanding* also resulted in text (M=4.82, SD=0.88) scoring higher than audio/video (M=4.42, SD=0. 97) for mediated interactions $F(1, 158)= 2.74$, $p < .01$, $eta^2 = .06$. [see Table 2]

6. Discussion

The confirmatory factor analysis support a factor structure made up of six distinct factors. The scale was consistent with the structure suggested by social presence theory. A strength of the assessment measure used in this study is that the items were grounded in prior social presence literature and research. The factor structure supported the construct validity of the Networked Minds Social Presence measure.

Each factor or subscale appeared to internally consistent as confirmed by Cronbach Alpha scores consistently greater than .80 across all factors. Continued validity tests will be necessary to further confirm this structure of the construct.

The current study supported two criterion-related validity tests of the measure. Consistent with predictions from theory, the social presence measure was able to distinguish between social presence experience of face-to-face interaction and mediated interaction. This pattern was found for four of the factors or subscales of the measure. Two of the factor subscales, perceived message understanding and perceived emotional interdependence yield null results, although the differences between conditions were in the direction predicted. In general this result was supportive of the measures ability to distinguish between levels of mediated and face-to-face levels of social presence.

On the other hand, the measure failed in the criterion-related validity test involving the ability of the measure to distinguish between two levels of mediated interaction involving different levels of social cues. Here the overall test of the measure indicated no differences between experiences in these two media. An analysis of the two subscales or factors, perceived message understanding and perceived emotional understanding, indicated that the low affordance textual medium provided greater social presence than the high affordance medium. This result is contrary to what would be predicted from theory and, furthermore, is the reverse result. This suggests that the measure may not be sensitive enough to detect differences in social presence across different media, and/or that differences predicted by theory either do not exist or are in a different direction than predicted.

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Interpretations of the findings were inconsistent with theoretical predictions for the criterion tests. Interpretation of the differences between face-to-face and mediated interactions need further testing.

Several limitations were evident in the current study. In particular, the confound resulting from the difference in media type and sensory stimuli is of concern. Next, a clear limitation exists in the lack of relational comparison between interactants and variation of objective. Task compared to social interaction may dramatically influence the affective dimensions as well as behavioral interdependence.

7. Future directions

Research has recently completed comparing the relationships of interactants and media type. The focus of this research is how interaction, at a perceptual level, is influenced by various mediated channels and the interpersonal relationship between interactants. The design was a 2 X 4 independent groups experimental design where relationship (friend/stranger) is crossed with interaction conditions. Participants were randomly assigned to one of four media conditions: (1) face-to-face, (2) audio/video (3) audio-only and (4) text. Results are forthcoming.

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Table 1

Face to face Versus Mediated Interactions

Construct and media		Mean	SD	t	Sig
Co-Presence					
	FtF	5.11	.66	5.68	.01
	Mediated	4.51	.84		
Attentional Allocation					
	FtF	4.93	.88	3.95	.01
	Mediated	4.44	1.02		
Perc. Message Understanding					
	FtF	4.41	.86	.114	ns
	Mediated	4.27	.94		
Perc. Emotional Understanding					
	FtF	5.08	.72	3.78	.01
	Mediated	4.62	.94		
Perc. Behavioral Interdependence					
	FtF	4.25	.93	5.34	.01
	Mediated	3.46	1.15		
Perc. Emotional Interdependence					
	FtF	3.79	1.01	1.72	ns
	Mediated	3.54	1.08		

Table 2

Text Versus Audio/Video Mediated Interactions

Construct	Condition	Mean	SD	t	Sig
Co-Presence					
	Text	4.50	.88	-.20	ns
	Video	4.53	.80		
Attentional Allocation					
	Text	4.41	.97	1.29	ns
	Video	4.39	1.08		
Perc. Message Understanding					
	Text	4.46	.84	2.61	.01
	Video	4.08	.99		
Perc. Emotional Understanding					
	Text	4.82	.88	2.74	.01
	Video	4.42	.97		
Perc. Behavioral Interdependence					
	Text	3.45	1.18	-.14	ns
	Video	3.47	1.12		
Perc. Emotional Interdependence					
	Text	3.50	1.05	-.52	ns
	Video	3.59	1.11		

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Table 3

Retained Items of the Networked Minds Social Presence Measure

Factor Items		**Factor Loading**
Co-presence (M=4.72, SD=0.83) α = .84		
1.	I noticed (my partner).	.76
2.	(My partner) noticed me.	.75
3.	(My partner's) presence was obvious to me.	.65
4.	My presence was obvious to (my partner).	.64
5.	(My partner) caught my attention.	.62
6.	I caught (my partner's) attention.	.64
Attentional Allocation (M=4.58, SD=1.00) α = .81		
7.	I was easily distracted from (my partner) when other things were going on.	.71
8.	(My partner) was easily distracted from me when other things were going on.	.61
9.	I remained focused on (my partner) throughout our interaction.	.67
10.	(My partner) remained focused on me throughout our interaction.	.63
11.	(My partner) did not receive my full attention.	.58
12.	I did not receive (my partner's) full attention.	.69
Perceived Message Understanding (M=4.78, SD=0.90) α = .87		
13.	My thoughts were clear to (my partner).	.52
14.	(My partner's) thoughts were clear to me.	.77
15.	It was easy to understand (my partner).	.81
16.	(My partner) found it easy to understand me.	.80
17.	Understanding (my partner) was difficult.	.71
18.	(My partner) had difficulty understanding me.	.73
Perceived Affective Understanding (M=3.72, SD=1.14) α = .86		
19.	I could tell how (my partner) felt.	.79
20.	(My partner) could tell how I felt.	.70
21.	(My partner's) emotions were not clear to me.	.72
22.	My emotions were not clear to (my partner).	.69
23.	I could describe (my partner's) feelings accurately.	.72
24.	(My partner) could describe my feelings accurately.	.68
Perceived Emotional Interdependence (M=3.62, SD=1.06) α = .85		
25.	I was sometimes influenced by (my partner's) moods.	.81
26.	(My partner) was sometimes influenced by my moods.	.69
27.	(My partner's) feelings influenced the mood of our interaction.	.73
28.	My feelings influenced the mood of our interaction.	.64
29.	(My partner's) attitudes influenced how I felt.	.78
30.	My attitudes influenced how (my partner) felt.	.53
Perceived Behavioral Interdependence (M=4.32, SD=0.91) α =. 82		
31.	My behavior was often in direct response to (my partner's) behavior.	.58
32.	The behavior of (my partner) was often in direct response to my behavior.	.74
33.	I reciprocated (my partner's) actions.	.71
34.	(My partner) reciprocated my actions.	.55
35.	(My partner's) behavior was closely tied to my behavior.	.70
36.	My behavior was closely tied to (my partner's) behavior.	.65