

## Exploring the Concept of Para Social Presence in Virtual Project Teams

Eric T.K. Lim  
 Segal Graduate School of Business  
 Simon Fraser University  
[etl4@sfu.ca](mailto:etl4@sfu.ca)

Yu-Ting Caisy Hung  
 Department of Information Systems  
 School of Computing  
 National University of Singapore  
[dishyt@nus.edu.sg](mailto:dishyt@nus.edu.sg)

### Abstract

*Though contemporary research has testified to the importance of social presence in influencing the format and structure of group processes, its unidimensional nature and inability to accommodate asynchronous communication has eroded its relevance in the face of more sophisticated IT-based collaborative networks such as virtual project teams. Kumar and Benbasat [25, 26] thus advanced the notion of Para Social Presence (PSP) as a broader, encompassing concept that overcomes the aforementioned weaknesses inherent in the existing social presence construct. Yet to-date, there has not been a theoretical and empirical validation of the pertinence of the PSP construct when applied to more dynamic group configurations as claimed. To this end, this study reviews extant literature to first establish whether the PSP construct is meaningful conceptually and then empirically validates its measurement properties over time through a temporal field experimentation setting.*

### 1. Introduction

Virtual project teams are groups of geographically and/or temporally dispersed individuals who are connected *via* collaborative technologies to create IT-based “just-in-time knowledge sharing” networks [28, p. 238]. By exploiting spatial and temporal independencies brought about by the utilization of collaborative technologies, virtual project teams allow “individual contributions [to be] melded together without the expense and trouble of relocating members” [35, p.365]. Through the deployment of virtual project teams, firms are better equipped to leverage localized expertise and proficiencies without being constrained by the traditional handicap of collocation. This in turn endows an organization with greater strategic flexibility, expanded informational capacities and enhanced responsiveness to counter sporadic market conditions [28].

Yet, the formation of virtual project teams within firms is plagued by a host of social hurdles arising from the lack of direct physical contact [5]. The absence of face-to-face interaction in virtual project teams significantly diminishes communication synchronicity and communal citizenship, thereby rendering it substantially difficult for

members to foster and sustain positive collaborative attitudes [36]. It is for this reason that team performance has often been linked to the quality of computer-mediated communication (CMC) among members [28, 43].

A review of contemporary literature by Walter and Parks [45] yielded six predominant CMC theories that endeavor to explain the dynamics of human-computer interactions (refer to Appendix A). Amidst these theories, the Media Richness Theory (MRT) [8, 9], the Media Synchronicity Theory (MST) [10, 11] and the Social Presence Theory (SPT) [42] can be categorized under ‘Trait Theories of Media Selection’ for the similarity of their strategies to media selection [see 4]. While MRT and MST subscribes to a more task-oriented approach to media selection, SPT undertakes a more relational perspective towards comprehending users’ choice of CMC technologies [25, 26, 40]. Consequently, SPT has often been employed to assess the degree to which a specific communication medium allows a user to initiate personal connections with others [19, 42, 43]. According to SPT, media characteristics can change the saliency of the presence of communicators to one another [42]. This saliency of social presence in turn, has an impact on the orientation of discussion in group processes. For examples, communication media with low bandwidth (e.g., text-based systems) tend to lead to perceptions of low social presence. Low social presence may in turn promote task-centric functions at the expense of reduced group consensus [19, 43].

Unfortunately, SPT suffers from two conceptual limitations when applied to the inquiry of virtual project teams. First, the traditional emphasis of SPT has revolved around synchronous communication, which might not be entirely applicable to virtual project teams that encompass both synchronous and asynchronous communication. Second, the original social presence concept was conceived as a unidimensional construct that may not adequately explain the dynamism of virtual project teams. Kumar and Benbasat [25, 26] hence proposed the notion of *Para Social Presence* (PSP) as a broader, overarching multi-dimensional construct that can be extended to the examination of a much wider variety of virtual phenomena with both synchronous and asynchronous communication properties such as virtual project teams.

To-date however, there has yet been a systematic evaluation of the PSP construct as a viable concept from which to understand virtual project teams. This study thus endeavors to contribute to extant literature by theoretically and empirically validating the PSP construct within the domain of virtual project teams.

## 2. Theoretical Foundation

The relationship between social presence and team performance is well acknowledged [17, 19, 44]. Sia *et al* [43] observed that group polarization (i.e., taking more extreme actions) is more pronounced when visual and verbal cues are removed in communications. This is because the absence of such social cues leads to low social presence and in turn encourages one-upmanship behavior (i.e., the tendency of individuals to try and outperform one another in the socially valued directions) but discourages pluralistic balance (i.e., the desire of individuals to achieve a compromise between their preferred positions and the positions thought to be favored by others). Indeed, existing empirical evidence suggests that the pertinence of social presence in CMC is dependent on (1) the contextual backdrop of the interaction, (2) the characteristics of the online communication format, and (3) whether there is a need for social cohesion [17, 44].

Since virtual project teams are spontaneous arrangements that endeavor to overcome spatial and temporal restrictions in bringing together distant experts to create just-in-time knowledge sharing coalitions, their members' ability to easily relate to one another despite anonymity and time constraints is of utmost importance. We believe that social presence plays a salient role in influencing the degrees of task-oriented discussions and social- or relational-oriented communication in virtual project team collaboration [43]. Hence, the PSP construct is relevant for studies in the domain of virtual project teams.

Lombard and Ditton [27] taxonomized presence into six different categories as tabulated in Table 1. Of the six categories, the categories of "social actor within medium" and "medium as a social actor" seem to be the most salience ones in the context of virtual project teams. As aptly surmised by Kumar and Benbasat [26]:

"when two social actors communicate in a mediated environment, these actors get used to this mediated environment over time and ascribe characteristics to media that might increase or decrease the richness of the medium [such that] it is more elegant and parsimonious to concentrate purely on psychological rather than psychophysical dimensions." [p.12]

Kumar and Benbasat [25, 26] thus postulated that it is imperative and viable to integrate these two categories of presence to generate the improved construct of PSP, which encapsulates both social attributions of

communication media within a wider range of contexts and the growing movement towards the dual inclusion of synchronous and asynchronous communication contexts among Management Information Systems (MIS) scholars [e.g., 3, 23]. Differences between PSP and the traditional construct of social presence are summarized in Appendix B. As can be inferred from Appendix B, the PSP construct is definitely the better of the two if we are hoping to decipher a phenomenon as diverse and as dynamic as virtual project teams.

Table 1: A Taxonomy of Presence [adapted from 27]

Presence as...	Characteristics
Social Richness	Presumably the most prevalent form of conceptualization among researchers in media selection, presence is defined as the extent to which communicators can convey verbal and non-verbal cues [3, 4]
Realism	Defined as the degree to which a medium can produce realistic representations of the entities one is interested in, this conceptualization of presence has been widely employed in the field of graphics and animation (e.g., perceptual vs. social realism)
Transportation	Analogous with sensations of 'you-are-there', 'it-is-here' and 'we-are-together', this conceptualization of presence is primarily concerned with whether users share a feeling of being transported to the artificial reality [30]
Immersion	To evaluate the extent to which a virtual environment immerses users perceptually and/or psychologically, this conceptualization of presence distinguishes between psychophysical responses (i.e., perceptual immersion) and deeper involvement (i.e., psychological immersion) [2, 18].
Social Actor within Medium	Addresses social responses of users to entities within particular media, this conceptualization of presence seeks to discern users' reactions to interpersonal distant cues from across the medium and/or virtual actors
Medium as a Social Actor	Captures social responses of users to cues provided by particular media, this conceptualization of presence is interested in users' reactions to social cues exhibited by the medium as though it were a social actor [32].

As a multi-dimensional concept, Kumar and Benbasat [25, 26] delineated PSP into five constituent dimensions, namely, *immediacy/intimacy*, *sense of understanding*, *positivity*, *involvement*, and *dominance*. Amongst these five dimensions, dominance was dropped in this study as Kumar and Benbasat's [25, 26] conceptualization of dominance is related to the capacity of a medium to subjugate the user, which may be applicable in the context of e-commerce but to a much lesser extent in virtual project teams where domination is exercised by the members using the medium rather than the medium

itself. Further, we employ the term *connectivity* in place of immediacy/intimacy as it is a more accurate reflection of the medium's capability to bring together people with common goals or interests.

**Connectivity**, as conceived by Kumar and Benbasat [25, 26], refers to *the extent to which a specific communication medium creates a sense of community (establishment of shared goals and objectives) among correspondents*. Media with high connectivity are therefore those that offer functionalities allowing correspondents to arrive at consensus fast (e.g., e-calendars, shared folders). As Grudin [16] noted, while collaborative technologies never offer the precise same benefits to each and every team member, individuals can still stand to benefit from collective usage. Ehrlich [12] reinforced the above statement with an empirical study of electronic calendar systems. An interesting discovery made by Ehrlich [12] is that while the direct beneficiaries of electronic calendars were conference conveners (e.g., managers or secretaries), every member of the group was motivated to maintain a personal calendar. Grudin [16] offers another example in the form of a distributed project management system that covers the scheduling and chronicling of activities, the creation of and evaluation of plans and schedules, the management of product versions and changes, and the monitoring of resources and responsibilities. Grudin [16] maintained that while the primary beneficiaries for such an application are typically the project managers, other members of the team also stand to gain from being kept updated about the progress of others as well as that of the collective body [see also 29]. In much the same way, connectivity is vital to virtual project team in blurring individual boundaries to attain general consensus on team goals and agenda items that are pertinent to the collective body.

**Sense of understanding**, as defined in this research, is *the extent to which a specific communication medium conveys accurately and completely the correspondents' thoughts and ideas to facilitate mutual understanding*. As remarked by Reeves and Nass [39], "in all computer-mediated communication, including teleconferencing and other technologies that enable two or more people to sense each other using technology as an intermediary... the perceptions of other people and objects may change because stimulus information about them is filtered through the representational capabilities of a machine" [p.66]. They hence postulated that the larger the number of representational facilities accessible from the medium, the higher is the probability that the complete range of social cues can be conveyed from the sender and interpreted correctly by the recipient [39]. For instance, video-conferencing technology possesses an edge over its teleconferencing counterpart because with the addition of video images, it opens up a whole new spectrum of visual cues such as facial expressions and body languages that

empowers correspondents with greater expressiveness. In the words of Reeves and Nass [39], video-conferencing will thus boast of better *perceptual bandwidth* than teleconferencing by increasing the number of human senses that can be employed by individuals to infer communicated messages. Bickmore [1] echoed similar sentiments in stating that "body language and familiar silent signals are as much a part of social experience as the conversation [such that] building systems to recognize and respond to such moves will propel interface technology to the next horizon" (p.38).

Conversely, communication media can be deployed in ways (whether knowingly or unknowingly) that do not reflect reality, thereby misleading correspondents in the interpretation of communicated messages. For instance, the choice of the appearance, the tone, the texture, and the digital voices 3D avatars is found to impose salient effects on individuals' perceptions even though these avatars may not reflect the actual personality of the user – a deeper voice with a formal appearance may express more authority than one whose speech is sharper and dresses casually [37, 38].

**Involvement** is *the extent to which a specific communication medium sustains correspondents' attention and interests in interacting with one another*. Inherently, communication via communication technologies does not depart from the social environment in which interaction takes place. While technological designs may be neutral, their reception is confounded by distinctions that already prevail in the immediate social system [16]. Grudin [16] testified to the tendency of system users to attach socially constructed meanings in the utilization of collaborative technologies. Quoting the example of emails, Grudin [16] noted that while developers view the utilization of emails as a distinction between sender and receiver, its actual usage in the workplace normally emphasizes the distinction between supervisor and subordinate [see also 34]. Media promoting high involvement would thus entail functionalities that project feelings of being engaged in actual face-to-face conversation among correspondents. As professed by Fish *et al* [13], "insofar as audio and video communication mimics the features of face-to-face communication in being expressive, interactive, and focusing attention on personal attributes, it should function as face-to-face communication" [p. 50]. In the same vein, involvement is a crucial component of successful virtual project team by closing the virtual distance among members such that interactions resemble almost face-to-face communication.

**Positivity** is *the extent to which a specific communication medium induces a sense of comfort and relaxation among correspondents when interacting with one another*. As postulated by Jaspersen *et al* [22], communication is intrinsically a political process whereby

“sensemaking is not only the product of mutually shared assumptions and interpretative procedures, but also a political dialog through which actors influence the perceptions, decisions and behaviour of others” [p.412]. That is, whoever dominates the social dialog and regulates its flow will dictate the formation of subjective meanings, ultimately determining the outcomes. To control meanings within dialogues, individuals or collectives turn to the use of language and symbols to reconstruct social reality regarding what appropriate decisions, structures, and goals are [22]. Such practices are especially prominent in situations where the absence of formalized structure presents opportunities for individuals or collectives to install personalized language and symbols promoting their influence over others [33]. This phenomenon is observed in Kling and Iacono’s [24] study of IT developers in which they, lacking formal authority, create a social construction of the methodology that empowers IT professionals who implement the methodology. The same can be said of virtual project teams where the absence of rigid controls may easily breed political dialogues within the group such that members are always under pressure during discussions. Communication media with high positivity might therefore be able to break down the political overtone of group discourses (e.g., emoticons). However, it should also be emphasized that the utilization of these functionalities may in itself be part of a political manoeuvre to induce false perceptions of comfort and relaxation among correspondents.

### 3. Methodology

To validate the measurement properties of the four PSP sub-dimensions, a temporal field experimental design was chosen. Experimental studies involve an intervention by the researcher that goes beyond what is required for measurement [7] and field experimentation techniques in particular, facilitate the collection of data in natural, and hence more generalizable, settings [46]. Furthermore, the research design offers a limited degree of experimental control, which might be useful for theory testing [46]. For the PSP measures to be deemed as stable indicators, it is imperative for them to withstand the test of time, hence the temporal setting.

The field experiment was conducted in conjunction with a class project for an undergraduate module in an Asian university. The module accentuates strategic applications of information and communication technologies (ICT) and is a compulsory course offered to undergraduates pursuing a degree in MIS. As part of the course credit, enrolled students are expected to complete a group assignment (a case analysis) that necessitates the application of the concepts and theories introduced in the module to solve various business problems. The

assignment was carried out in an anonymous virtual project team environment over a two-week period.

Scale items for the PSP sub-dimensions were adapted from Kumar and Benbasat [25, 26] (see Appendix C). To establish construct validity and evaluate the extent to which elicited measurement items adequately tap on their corresponding latent variables, a round of labelled card sorting was conducted with a panel of judges comprising 5 postgraduate students who are either familiar with the topic of virtual project teams or, at the very least, have done research in the realm of MIS [31]. Each judge was presented with the 4 primary constructs and their definitions together with a randomly sorted list of reflective items. The judges were then instructed to assign each item to one of the constructs or to an ‘ambiguous’ category if they were unsure of its placement. Hit ratios averaged 83.3% and can be interpreted as a good indication of construct validity [31].

Non-anonymity could be a potential confound to our empirical investigation as prior familiarity among team members may compromise the accuracy of our instrument as a pure measurement of the PSP endowed by the communication media. To emulate an anonymous collaborative environment of virtual project teams, a series of measures were undertaken. First, dummy email accounts were created and assigned to each subject. These email accounts were intended specifically for correspondences among virtual project team members with regards to project-related matters. Furthermore, to ensure that team members will not come to recognize one another via transmissions of audio and/or visual cues, functionalities facilitating synchronous voice conversations and video conferences were striped from the collaborative technologies in use for the experiment.

Data was collected on two separate occasions on a weekly basis via an online questionnaire. A total of 76 students participated in the experiment [Sample N = 76]. Participants were randomly assigned to virtual project teams consisting of 4 to 5 members. All 76 participants completed the experiment and responded to both questionnaires. For both online questionnaires, repeated and homogeneous responses were removed. This yields eventual samples of 76 and 71 data points for week 1 and week 2, respectively (see Appendix C).

### 4. Data Analysis

To establish the convergent and discriminant validity of the constructs, a confirmatory four-factor model was analyzed. In accordance with standard LISREL methodology [14, 15] and Churchill’s [6] scale development technique, the measurement model was revised by dropping items with high reported standardized residuals, i.e. measures exhibiting a significant degree of shared non-specified variance. Each dropped item was also carefully read to ensure that its residual variance

makes sense theoretically. After dropping items, the measurement models for both weeks exhibited satisfactory fit with their respective dataset as the majority of their fit indices fall well within recommended thresholds<sup>1</sup> (see Appendix D).

To determine the final set of indicators that exhibit good psychometric properties over time for measuring PSP within the context of virtual project teams, items that consistently display a significant degree of shared non-specified variance were dropped. In other words, as deducible from Appendix D, one indicator was dropped from *connectivity* and one from *involvement*. The remaining indicators were then analyzed for discriminant validity using a combined sample comprising data points from both weeks.

Discriminant validity was verified by comparing the fit indices of the original four-factor measurement model against other confirmatory factor models with only three latent variables, thereby performing discriminant validity checks on every possible pairwise combination of two constructs [41]. The fit indices of the original four-factor measurement model were significantly better than the probable union of any other two constructs in the model (see Appendix E), thus supporting Kumar and Benbasat’s [25, 26] claim of discriminant validity for the four PSP sub-dimensions. Table 2 depicts the internal consistency of the four PSP constructs for the combined sample whereas table 3 illustrates their inter-construct correlations.

Table 2. Internal Consistency of PSP Constructs

	AVE [> .50]	Cronbach’s $\alpha$ [> .70]	Fornell [> .70]
Connectivity (CO)	0.95	0.95	0.97
Involvement (IN)	0.88	0.93	0.96
Positivity (PO)	0.84	0.94	0.96
Sense of Understanding (UN)	0.85	0.94	0.96

Table 3. Standardized Inter-Construct Correlation Matrix

	CO	UN	IN	PO
Connectivity (CO)	<b>0.97</b>			
Involvement (IN)	0.66	<b>0.94</b>		
Positivity (PO)	0.61	0.73	<b>0.92</b>	
Sense of Understanding (UN)	0.75	0.76	0.69	<b>0.92</b>

## 5. Discussion

<sup>1</sup> According to most references in contemporary literature on Confirmatory Factor Analysis (CFA) using LISREL,  $\chi^2$  to degrees of freedom ratio should be less than 1:3, GFI, CFI and NFI should be above 0.90, AGFI should be above 0.80, RMR should be below 0.05 whereas RMSEA should cutoff around either 0.06 or 0.08 [14, 20, 21].

Kumar and Benbasat [25, 26] advanced the concept of PSP as a substitute for the conventional notion of social presence that is constrained by its unidimensional nature and its inability to cater to asynchronous communication contexts. Yet, they fall short of providing an empirical analysis of its properties. Subscribing to the perspective that the PSP construct can be readily applied to virtual project teams, this study explores the theoretical relevance of each of the PSP sub-dimensions to virtual project teams and validates their measurement properties when employed in an actual empirical investigation. Evidence suggests that with the exception of a couple of indicator variables, the majority of measurement items, as advocated by Kumar and Benbasat [25, 26], exhibits good psychometric properties and remains relatively stable over time.

Theoretically, our study reinforces Kumar and Benbasat’s [25, 26] contention that social presence exists as a multi-dimensional construct in its manifestation with each of the four sub-dimensions representing a specific aspect of human-computer interaction. Consequently, studies that collapsed the multi-faceted characteristic of social presence into a singular notion run the risk of limiting insights, which can be gleaned from its application.

Further, by validating the PSP concept and its sub-dimensions in an anonymous virtual project team environment, we are convinced that the generic, temporal setup of our field experiment ensures that our findings (i.e., construct validity of the PSP sub-dimensions) should be amenable across most virtual team settings. This study hence offers an anchor point from which scholars can proceed to employ the PSP sub-dimensions in future research.

## 6. References

- [1] T.W. Bickmore, “Unspoken Rules of Spoken Interaction”, *Communication of the ACM* (47:4), 2004, pp. 38-44.
- [2] F. Biocca, and B. Delaney, “Immersive Virtual Reality Technology”, in *Communication in the Age of Virtual Reality*, F. Biocca and M. Levy (eds.), Lawrence Erlbaum Associates, Hillsdale, NJ, 1993, pp. 57-124.
- [3] K. Burke, and L. Chidambaram, L. “How Much Bandwidth is Enough? A Longitudinal Examination of Media Characteristics and Group Outcomes”, *MIS Quarterly* (23:4), 1999, pp. 557-580.
- [4] P.J. Carlson, and G.B. Davis, “An Investigation of Media Selection Among Directors and Managers: From ‘Self’ to ‘Other’ Orientation”, *MIS Quarterly* (22:3), 1998, pp. 335-362.
- [5] J. Chaar, S. Paul, and R. Chillarege, “Virtual Project Management for Software”, in *Proceedings of the National Science Foundation Workshop on Workflow & Process Automation*, Athens, GA, May 8-10, 1996.
- [6] G.A. Churchill, “A Paradigm for Developing Better Measures of Marketing Constructs”, *Journal of Marketing*

*Research* (16:1), 1979, pp. 64-73.

[7] Cooper, D.R., and P.S. Schindler, P.S. *Business Research Methods* (6th edition), McGraw-Hill, Irwin, CA, 1998.

[8] R.L. Daft, and R.H. Lengel, "Organizational Information Requirements", *Management Science* (32:5), 1986, pp. 554-571.

[9] R.L. Daft, and R.H. Lengel, "Information Richness: A New Approach to Manager Information Processing and Organization Design", in *Research in Organizational Behavior* (Vol. 6), B. Staw, and L.L. Cummings, (eds JAI Press, Homewood, IL, 1984, pp. 191-233.

[10] A.R. Dennis, and J.S. Valacich, "Rethinking Media Richness: Towards a Theory of Media Synchronicity", in *Proceedings of the 32<sup>nd</sup> Hawaii International Conference on System Sciences*, IEEE Computer Society Press, 1999.

[11] A.R. Dennis, J.S. Valacich, C. Speier, and M.G. Morris, "Beyond Media Richness: An Empirical test of Media Synchronicity Theory", in *Proceedings of the 31<sup>st</sup> Hawaii International Conference on System Sciences*, IEEE Computer Society Press, 1998.

[12] S.F. Ehrlich, "Strategies for Encouraging Successful Adoption of Office Communication Systems", *ACM Transactions on Office Information Systems* (5:4), 1987, pp. 340-357.

[13] R.S. Fish, R.E Kraut, R.W. Root, and R.E. Rice, "Video as a Technology for Informal Communication," *Communication of the ACM* (36:1), 1993, pp. 48-61.

[14] D. Gefen, D. Straub, and M. Boudreau, "Structural Equation Modeling and Regression: Guidelines for Research Practice", *Communications of AIS*, (4:7), 2000, PP. 1-78.

[15] D.W. Gerbing, and J.C. Anderson, "An Updated Paradigm for Scale Development Incorporating Unidimensionality and Its Assessment", *Journal of Marketing Research* (25:2), 1988, pp. 186-92.

[16] J. Grudin, "Groupware and Social Dynamics: Eight Challenges for Developers", *Communication of the ACM* (37:1), 1994, pp. 92-105.

[17] C.N. Gunawardena, "Social Presence Theory and Implications for Interaction and Collaborative Learning in Computer Conferences", *International Journal of Educational Telecommunications* (1:2/3), 1995, pp. 147-166.

[18] C. Heeter, C. "Communication Research on Consumer Virtual Reality", in *Communication in the Age of Virtual Reality*, F. Biocca and M. Levy (eds.), Lawrence Erlbaum Associates, Hillsdale, NJ, 1995, pp. 191-218.

[19] S.R. Hiltz, K. Johnson, and M. Turoff, "Experiments in Group Decision Making: Communication Process and Outcome in Face-to-Face Versus Computerized Conferences", *Human Communication Research* (13:2). 1986, pp. 225-252.

[20] L-T., Hu, and P.M. Bentler, "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria versus New Alternatives", *Structural Equation Modeling* (6:1), 1999, pp.1-55.

[21] S.L. Jarvenpaa, N. Tractinsky, and M. Vitale, "Consumer Trust in an Internet Store", *Information Technology and*

*Management* (1:1), 2000, pp. 45-71.

[22] J. Jasperson, T.A. Carte, C.S. Saunders, B.S. Butler, H.J.P. Croes, and W. Zheng, "Review: Power and Information Technology Research: A Metatriangulation Review", *MIS Quarterly* (26:4), 2002, pp. 397-459.

[23] E. Karahanna, and D.W. Straub, "The Psychological Origins of perceived Usefulness and Ease-of-use", *Information & Management* (35), 1999, pp. 237-250.

[24] R. Kling, and S. Iacono, "The Control of Information Systems Development After Implementation", *Communications of the ACM* (27:12), 1984, pp. 1218-1226.

[25] N. Kumar, and I. Benbasat, "Para-Social Presence and Communication Capabilities of a Web Site", *e-Service Journal* (1:3), 2002a, pp. 5-24.

[26] N. Kumar, and I. Benbasat, "Para-Social Presence: A Re-conceptualization of 'Social Presence' to Capture the Relationship Between a Web Site and Her Visitors", in *Proceedings of the 35th Hawaii International Conference on System Sciences* (HICSS 2002), 2002b.

[27] M. Lombard, and T.B. Ditton, "At the Heart of It All: The Concept of Presence", *Journal of Computer Mediated Communication* (3:2), 1997.

[28] A. Malhotra, A. Majchrzak, R. Carmen, and V. Lott, "Radical Innovation without Collocation: A Case Study at Boeing-Rocketdyne", *MIS Quarterly* (25:2), 2001, pp. 229-249.

[29] D.L. McCracken, and R.M. Akscyn, "Experience with ZOG Human Computer Interface System", *International Journal of Man-Machine Studies* (21:3), 1984, pp. 293-310.

[30] Millerson, G. *The Technique of Television Production*, Hastings House, New York, 1969.

[31] G.C. Moore, and I. Benbasat, "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation", *Information Systems Research* (2:3), 1991, pp. 192-222.

[32] C. Nass, and J. Steur, "Voices, Boxes and Sources of Messages: Computers and Social Actors", *Human Communication Research* (19:4), 1994, pp. 504-527.

[33] M. Newman, and F. Noble, "User Involvement as an Interaction Process: A Case Study", *Information Systems Research* (1:1), 1990, pp. 89-113.

[34] C. Perin, "Electronic Social Fields in Bureaucracy", *Communications of the ACM* (34:12), 1991, pp. 75-82.

[35] G. Piccoli, and B. Ives, "Trust and the Unintended Effects of Behavior Control in Virtual Teams", *MIS Quarterly* (27:3), 2003, pp. 365-395.

[36] A. Powell, "Antecedents And Outcomes Of Team Commitment In A Global, Virtual Environment", *Unpublished Doctoral Thesis for the Kelley School of Business Indiana University*, 2000.

[37] L. Qiu, and I. Benbasat, "An Investigation in the Effects of Text-to-Speech Voice and 3D Avatars on the Quality of Live Help in Electronic Commerce", *ACM Transactions on Computer Human Interaction*, 2005a. (Forthcoming)

[38] L. Qiu, and I. Benbasat, "The Effects of Text-To-Speech

Voice and 3D Avatars on Consumer Trust in the Design of 'Live Help' Interface of Electronic Commerce”, *International Journal of Human-Computer Interaction* (19:1), 2005b, pp. 75-94.

[39] B. Reeves, and C. Nass, “Perceptual Bandwidth”, *Communication of the ACM* (43:3), 2000, pp. 65-70.

[40] R.E. Rice, “Media Appropriateness: Using Social Presence Theory to Compare Traditional and New Organizational Media”, *Human Communications Research* (19:4), 1993, pp. 451-484.

[41] A.H. Segars, “Assessing the Unidimensionality of Measurement: A Paradigm and Illustration Within the Context of Information Systems Research”, *Omega* (25:1), 1997, pp. 107-121.

[42] Short, J., E. Williams, and B. Christie, *The Social Psychology of Telecommunications*, Wiley, New York, 1976

[43] C.L. Sia, B.C.Y. Tan, and K.K. Wei, “Group Polarization and Computer-Mediated Communication: Effects of Communication Cues, Social Presence, and Anonymity”,

*Information Systems Research* (13:1), 2002, pp. 70-90.

[44] C-H. Tu, and M. McIsaac, “The Presence of Social Presence and Interaction in Online Classes”, *The American Journal of Distance Education* (16:3), 2002, pp. 131-150.

[45] J.B. Walther, and M.R. Parks, “Cues Filtered Out, Cues Filtered In: Computer-Mediated Communication and Relationships”, in *Handbook of Interpersonal Communication* (3<sup>rd</sup> ed.), M.L. Knapp, and J.A. Daly, (eds.), Sage, Thousand Oaks, CA, 2002, pp. 529-563.

[46] R.W. Zmud, M.H. Olson, and R. Hauser, “Field Experimentation in MIS Research”, in *The Information System Research Challenge: Experimental Research Methods*, I. Benbasat (ed.), Harvard Business School, 1990, pp. 97-111.

**Appendix A**

A Comparison of Computer-Mediated Communication (CMC) Theories (adapted from Walter and Parks [45])				
Theory	Key Proposition(s)	Implication(s) for CMC	Finding(s)	Construct(s)
<b>MRT</b>	There is an optimal match between the equivocality (i.e., extent of personal and/or emotional attachment) of the interactional tasks and the communication media among which one may choose, i.e. the more equivocal the interactional task, the richer must be the selected communication medium in order to improve the <i>efficiency</i> of the exchange	<ul style="list-style-type: none"> <li>To explain preferences among communication media for tasks with different equivocality</li> </ul>	<ul style="list-style-type: none"> <li>Leaner communication media do not lend themselves to efficient communication of emotionally complex matters</li> <li>Managers attaining successful match between equivocality and richness of communication media tend to perform better in their organization</li> </ul>	Multiplicity of Cues – Number of communication cue systems conveyed by a communication medium Immediacy of Feedback – Extent to which the communication medium offers full interruptibility Message Personalization – Extent to which communication messages can be tailored to a specific individual Language Variety – Extent to which communication media supports the natural language
<b>MST</b>	Extent to which individuals work together on the same activity at the same time (i.e., shared focus) will influence the choice of communication media in terms of their synchronizing capabilities	<ul style="list-style-type: none"> <li>To explain preferences among communication media for tasks requiring different levels of interactional synchronicity</li> </ul>	<ul style="list-style-type: none"> <li>Communication media with low synchronicity is preferred for conveyance (i.e., the exchange of information followed by deliberation on its meaning) whereas communication media with high synchronicity is preferred for convergence (i.e., development of shared meaning for exchanged information)</li> </ul>	Immediacy of Feedback – Extent to which a medium enables users to give rapid feedback on the communication they receive Symbol Variety – Number of ways by which information may be communicated Parallelism – Number of simultaneous conversations that can co-exist effectively Rehearsability – Extent to which a medium enables the sender to rehearse or fine-tune the message before sending Reprocessability – Extent to which a medium facilitates the reexamination or reprocessing of a message within the context of the communication event

Theory	Key Proposition(s)	Implication(s) for CMC	Finding(s)	Construct(s)
<b>SIP</b>	Instead of viewing the absence of nonverbal cues in CMC as a restriction on communicators' capability to exchange individualized information, communicators are just as motivated to reduce interpersonal uncertainty and develop affinity by adapting their expression of social information to the cues available via the electronic communication medium	<ul style="list-style-type: none"> <li>To explain why relational communication levels in CMC may increase over time and even converge with those of F2F settings</li> </ul>	<ul style="list-style-type: none"> <li>F2F participants are able to form fully developed impressions of one another sooner than their counterparts in CMC, but the impressions of CMC participants continue to develop over time until they achieve similar levels with those in F2F settings</li> <li>CMC tend to generate more interactive information seeking strategies in accomplishing interpersonal functions as compared to F2F settings in that CMC participants employed a greater proportion of self-disclosures and questions with significantly more depth than did F2F partners</li> </ul>	<p>Chronemics – The manner by which one perceive, structure and react to time and nonverbal codes that are embedded in the messages we interpret</p> <p>Chronemic Codes – Nonverbal cues that affect the subjective interpretation of time and messages (e.g., time-stamp and emoticons)</p>
<b>SIT</b>	Lack of nonverbal cues in CMC will tend to place greater emphasis on contextual cues that indicate common social categories, thereby leading to enhanced group identification and self-categorization among members due to their interpretation of message content as signals creating or reinforcing group norms	<ul style="list-style-type: none"> <li>To explain why the richness of the communication media affects the interpretation of messages by causing over-attributions of similarity and group norms</li> </ul>	<ul style="list-style-type: none"> <li>Visually anonymous text-based communication medium users developed greater group-based self-categorization as compared to video-conferencing</li> </ul>	<p>Interpersonal Cues – Individualizing information that personalizes impressions</p> <p>Social Cues – Contextual information that reveals the social structural elements of a group</p>
<b>SPT</b>	Nonverbal cues render the presence of communicators more salient to each other such that it enhances the warmth and friendliness of the interaction	<ul style="list-style-type: none"> <li>To explain the effects of CMC on group discussion and;</li> <li>To predict preferences among communication media alternatives for various tasks</li> </ul>	<ul style="list-style-type: none"> <li>Low bandwidth CMC media (e.g., text-based systems) tend to result in low social presence, which in turn increases task orientation and facilitate group discussion</li> <li>Lack of non-verbal cues (i.e. low bandwidth) and low social presence make it more difficult for leadership to emerge and for groups to reach consensus in socio-emotional terms due to an indifferent and hostile environment</li> </ul>	<p>Bandwidth – Number of communication cue systems conveyed by a communication medium</p> <p>Social Presence – Perceptual proximity among communicators involved in an interaction</p>
<b>TEP</b>	The fewer one's choices of communication media, the more psychological closeness one will experience from employing even a low-bandwidth channel	<ul style="list-style-type: none"> <li>To explain why people frequently make effective use of lean communication media to accomplish high equivocal tasks, i.e. actual media choices often do not match normative expectations (on the basis of optimal efficiency)</li> </ul>	<ul style="list-style-type: none"> <li>No confirmatory evidence on whether electronic propinquity is a consequence of limited media choices or the ability of one-self to accommodate and expand the otherwise limited bandwidth of the medium through greater effort, better application of communication skills and reduction of formality</li> </ul>	<p>Media Richness – Number of communication cue systems conveyed by a communication medium</p> <p>Electronic Propinquity – Psychological proximity one feels towards an electronic communication medium</p>

*Note:* MRT – Media Richness Theory; MST – Media Synchronicity Theory; SIP – Social Information Processing Theory; SIT – Social Identity Theory; SPT – Social Presence Theory; TEP – Theory of Electronic Propinquity



**Appendix B**

Summary of Differences b/w Social Presence and Para-Social Presence (reproduced from Kumar and Benbasat [26])		
Traditional Social Presence		Para-Social Presence
Synchronous Communication	→	Synchronous and Asynchronous Communication
Organization Settings	→	Organization Settings and More
Entities Involved—Two or more people and a medium of interaction		Entities Involved—Should they be humans? (Blurring of Media and Interface)
Virtual Teams		Virtual Teams and Communities
Are the users connected through the medium, for a specific purpose, pre-determined?		Manner in which the web can bring together people with similar goals and interests (connectivity)
Unidimensional	→	Multidimensional

**Appendix D**

Fit Indexes for Confirmatory Factor Models								
CFA Model	$\chi^2_{df}$ [smaller]	$\chi^2/df$ [< 3.0]	GFI [> 0.9]	AGFI [> 0.8]	RMR [< 0.05]	RMSEA [< 0.08]	NFI [> 0.9]	CFI [> 0.9]
4-Factor Model [Week 1] w/o Dropped Items	$\chi^2_{84} = 199.68$	2.38	0.75	0.65	0.160	0.130	0.84	0.90
4-Factor Model [Week 1] w/ Dropped Items	$\chi^2_{38} = 48.11$	1.27	0.91	0.84	0.081	0.038	0.94	0.99
4-Factor Model [Week 2] w/o Dropped Items	$\chi^2_{84} = 137.73$	1.64	0.83	0.75	0.093	0.067	0.91	0.96
4-Factor Model [Week 2] w/ Dropped Items	$\chi^2_{48} = 37.08$	0.77	0.92	0.87	0.059	0.000	0.97	1.00
4-Factor Model [Combined] w/ Dropped Items	$\chi^2_{59} = 101.45$	1.72	0.90	0.85	0.073	0.072	0.95	0.98

**Appendix E**

Pairwise Discriminant Analysis on Combined Sample									
Model	$\chi^2_{df}$ [smaller]	$\chi^2/df$ [< 3.0]	GFI [> 0.9]	AGFI [> 0.8]	RMR [< 0.05]	RMSEA [< 0.06]	NFI [> 0.9]	CFI [> 0.9]	$\Delta \chi^2$
<b>Original Model</b>	$\chi^2_{59} = 101.45$	1.72	0.90	0.85	0.073	0.072	0.95	0.98	-
Combining CO with UN	$\chi^2_{62} = 223.56$	3.61	0.82	0.73	0.097	0.130	0.90	0.92	122.11***
Combining CO with IN	$\chi^2_{62} = 267.92$	4.32	0.78	0.68	0.130	0.150	0.87	0.90	166.47***
Combining CO with PO	$\chi^2_{62} = 320.41$	5.17	0.75	0.63	0.200	0.170	0.85	0.87	218.96***
Combining UN with IN	$\chi^2_{62} = 256.16$	4.13	0.75	0.63	0.120	0.170	0.88	0.91	154.71***
Combining UN with PO	$\chi^2_{62} = 360.63$	5.82	0.65	0.49	0.130	0.220	0.83	0.85	259.18***
Combining IN with PO	$\chi^2_{62} = 279.49$	4.51	0.72	0.59	0.130	0.190	0.87	0.89	178.04***

Note: All  $\Delta \chi^2$  are statistically significant at the .001 level, thus implying a significant decrease in model fit.

Appendix C

Instrument and Measurement Properties <sup>2</sup>												
Construct	Reflective Measures (All items measured using a 7-point Likert agreement scale and preceded by "In the past week, ...")	Week 1 [Sample N = 76]			Week 2 [Sample N = 71]			Combined [Sample N = 147]				
		Mean (std dev)	Loading [before]	Loading [after]	Mean (std dev)	Loading [before]	Loading [after]	Mean (std dev)	Loading [before]	Loading [after]		
Connectivity (CO)	It was easy to establish shared goals and objectives with my team using the assigned Virtual Team Communication Software.	4.38 (1.57)	0.90	0.94	4.82 (1.44)	0.95	0.94	4.60 (1.52)	0.92	0.94		
	It was easy to determine a common direction on how we should proceed with the project using the assigned Virtual Team Communication Software.	4.58 (1.56)	0.94	0.92	4.70 (1.46)	0.99	1.00	4.65 (1.51)	0.96	0.96		
	I was able to establish a unified vision with my team when using the assigned Virtual Team Communication Medium to work on our project.	4.86 (1.26)	0.93	Dropped	4.85 (1.34)	0.87	Dropped	4.86 (1.30)	0.90	Dropped		
Sense of Understanding (UN)	I was able to make my points properly understood using the Virtual Team Communication Software.	4.70 (1.40)	0.93	0.81	4.70 (1.45)	0.94	0.94	4.71 (1.41)	0.93	0.93		
	I was able to clearly express my thoughts to my team members using the Virtual Team Communication Software.	4.67 (1.41)	0.90	Dropped	4.56 (1.42)	0.95	0.95	4.63 (1.41)	0.92	0.92		
	I was able to express my emotional state to my team members using the Virtual Team Communication Software.	4.21 (1.33)	0.78	0.82	4.24 (1.42)	0.85	0.84	4.23 (1.37)	0.82	0.82		
	I was able to understand my team members' ideas easily using the Virtual Team Communication Software.	4.54 (1.40)	0.88	Dropped	4.62 (1.37)	0.93	0.93	4.58 (1.38)	0.91	0.91		
Involvement (IN)	The use of the Virtual Team Communication Software encouraged me to be more engaged in our team discussion.	4.24 (1.49)	0.93	0.94	4.58 (1.49)	0.91	Dropped	4.40 (1.50)	0.91	0.92		
	I found it interesting to interact with my team members using the Virtual Team Communication Software.	4.17 (1.65)	0.92	0.93	4.44 (1.54)	0.92	0.95	4.29 (1.60)	0.91	0.92		
	I was always keen to interact with my team members using the Virtual Team Communication Software.	4.37 (1.42)	0.83	0.82	4.45 (1.57)	0.92	0.94	4.41 (1.49)	0.88	0.88		
Positivity (PO)	I was able to feel a sense of involvement when interacting with my team members using the Virtual Team Communication Software.	4.78 (1.44)	0.71	Dropped	4.79 (1.29)	0.85	Dropped	4.79 (1.37)	0.78	Dropped		
	The use of the Virtual Team Communication Software did not make me feel any significant pressure from the communication with my team members.	4.67 (1.29)	0.88	0.88	4.66 (1.35)	0.87	0.87	4.66 (1.32)	0.87	0.87		
	I felt positive when communicating with my team members using the Virtual Team Communication Software.	4.75 (1.28)	0.81	0.81	4.69 (1.33)	0.90	0.90	4.72 (1.30)	0.86	0.85		
	I was able to interact with my team members in a relaxed manner using the Virtual Team Communication Software.	4.95 (1.34)	0.90	0.90	4.86 (1.37)	0.94	0.94	4.90 (1.35)	0.92	0.92		
	The use of Virtual Team Communication Software made me feel comfortable in communicating with my team members.	4.72 (1.34)	0.91	0.91	4.73 (1.40)	0.92	0.92	4.73 (1.37)	0.91	0.92		

<sup>2</sup> The term 'Virtual Team Communication Software' was incorporated into each measurement item for the four PSP sub-dimensions in order to contextualize the measures for better interpretation by research participants as advised by Kumar and Benbasat [25, 26]. We believe that subsequent studies can just as easily substitute the terminology for whatever is the collaborative technology of interest without sacrificing the content validity of the measurement items.