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Computer Mediated Teamwork and the Efficiency Framework:
Exploring the Influence of Synchrony and Cues on Media Satisfaction, and
Outcome Success

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Abstract

The Efficiency Framework holds that despite users' reported preferences for media requiring less effort and time, the expenditure of effort predicts outcome success. It maintains that there is an important distinction between media satisfaction and the perceived and actual success of interactions. This project tests these predictions, and extends the model by comparing synchronous to asynchronous media. One hundred and forty-two participants in groups of 3 or 4 engaged in collaboration over a 5 week period. Groups were assigned to either interact face-to-face, or to one of four media conditions. The results support the need to distinguish media perception from outcome success. There were no significant main effects on success, but there was greater perceived group effectiveness for synchronous text and face-to-face interactions. Exploratory structural equation analysis showed that media characteristics predict copresence, which increase perceptions of group effectiveness, which in turn predict success. Results are discussed with respect to their pertinence for some theoretical and measurement biases in computer-mediated communication research.

Computer networked collaboration systems have facilitated people's ability to work together remotely. However, there has been much debate about how to determine and measure satisfaction and what satisfaction levels portend for media's ability to facilitate successful interactions. Instrumentally speaking, people are able to adapt their communication behaviors to successfully utilize almost any medium regardless of media features or capabilities (Walther, 1996). However, being able to make something work does not mean it is the most efficient way to do it. Therefore, the *Efficiency Framework* (Nowak, Watt & Walther, 2005; Walther, in press; Watt, Walther, & Nowak, 2002) argues that even though people can use any medium to fulfill their interaction goals, some media facilitate communication more efficiently, with less effort, than others. Further, it recognizes that a lack of efficiency may lead to a reduction in satisfaction with a medium, but that neither satisfaction nor efficiency predict outcome quality or success.

In other words, satisfaction with a medium may neither be necessary nor sufficient for an instrumentally successful interaction and behavior adaptation may require more effort and reduce efficiency and satisfaction. In this sense, the Efficiency Framework resembles media richness theory which, in its original form (Daft & Lengel, 1984), argued that very lean media could be employed to address equivocal tasks. However, the Efficiency Framework argues that using less efficient, or more effortful media use is not necessarily a bad thing. In fact, it argues that the application of greater effort, as in behavior adaptation, yields greater investment and outcomes from the interaction.

In several studies and theoretical positions including Social Presence and Media Richness, media success and efficiency have been judged in terms of people's self-reported satisfaction with the medium, or the interaction. Media comparisons following media richness or

social presence models have typically focused on the influence of the number and type of cues, a medium provides for the interaction (Daft & Lengel, 1986; Rice, 1993; Short, Williams & Christie, 1976). Cues in this context refer to the nonverbal signals that are present in face to face interactions including those coming from voice (tone, inflection, etc) as well as visual information (eye gaze, facial expression, and even physical appearance). These cues generally communicate social status, dominance, attention, and even identity. When comparing media on this metric, researchers discuss the number of the communication cue systems a medium can convey as compared to the number of cues available in face to face interactions, or comparing media to each other. For example researchers may compare text based systems to video systems, or to unmediated face to face interactions. The general assumption is that media with fewer cues provide less satisfactory interactions and participants are generally asked how appropriate they thought the medium was, or how satisfied they were with the medium they used (see Walther & Parks, 2002 for a discussion).

The Efficiency Framework maintains that efficiency, satisfaction, and success are separate constructs and should be treated as such. This project explicitly tests the predictions of the Efficiency Framework by comparing group projects done using unmediated face-to-face settings, high cue (audio video) synchronous, high cue asynchronous, low cue (text based) synchronous, and low cue asynchronous media and revealing how the different computer media used while preparing a final work product influenced objective final outcome success, people's perceived effectiveness, sense of copresence, and media satisfaction.

Considering Computer Media and Cue Deficit Disorder Theories

A variety of theoretical perspectives and fields of study have tried to explain how different features of media (audio, video, text only) influence people's success, satisfaction with,

or perceptions of, computer media. Several theories--most notably social context cues hypothesis (Sproull & Kiesler, 1986) and media richness theory (Daft & Lengel, 1986)--have suggested that interactions using 'lean media,' or computer media with fewer cues (e.g., text based) lead to a deficit in the quality of communication, are less efficient, and less satisfying than either face-to-face interactions, or interactions using "rich media," or computer media with more cues (e.g. video conferencing systems) (Rice, 1993).

Media Richness Theory, as an efficiency theory, provide some useful insights into how people adapt their behaviors to make use of various media systems. However, as Walther and Parks (2002) argued, "the fundamental claim is that *if* users select richer media for equivocal messages, then their efficiency will be greater" (p. 534), and this fundamental claim has yet to be directly tested. In tests of Media Richness, efficiency has largely been operationalized by asking people to report how appropriate a particular medium is for a given task (Rice, 1993) or as the extent to which a medium is like face to face or seems sociable (Short et al., 1976). While both sociability and appropriateness are important, neither measure either satisfaction or success. Finally, much of this research has examined user satisfaction with media, inferring that the satisfaction and success are identical constructs; though they have important distinctions (see Melone, 1990). Indeed, the Efficiency Framework argues that self-reported preferences and differences on satisfaction ratings across media do not necessarily influence success, efficiency, or outcome quality.

Interestingly, few researchers have compared synchronous to asynchronous media in terms of either efficiency or even media richness; though synchrony has been shown to influence the person perception processes (Nowak, Watt, & Walther, 2005). While synchronous media provide real time interactions that could enhance involvement compared to asynchronous

systems, they carry many of the disadvantages of face to face meetings, including the need to set up a time when everyone can focus on the task at hand (Johansen & O'Hara-Devereaux, 1994 Walther, 1996). The need for coordination of meeting times across time zones may reduce both satisfaction and the level of efficiency compared to system that allows people to engage with the task whenever they are so inclined. But again, this does not mean this will reduce outcome success.

Research on this topic has widely concluded that this difference between perceptions of media appropriateness, or even the ability of media to provide social presence is related to the level of bandwidth of a system, or the number of cues as explained above. Essentially, the fewer cues a medium has, the less like face to face it is believed to be. It is true that a face to face interaction is, and always will be, different from a mediated interaction. This does not necessarily make it better or worse.

However, researchers have assumed that face to face interactions are more efficient and satisfactory and further that media that are less like face to face provide a less satisfactory, less successful interaction than either face to face interactions, or than media resembling face to face (Hollan & Stornetta, 1992). Kayany, Wotring, and Forrest (1996) observed that, "The most familiar interactive mode of communication, face-to-face, was the benchmark against which all other media were compared" (p. 401). Based on this assumption, the success of computer media has frequently been judged and operationalized in terms of its ability to mimic, or to be "like" face-to-face and not by actually measuring people's liking of, satisfaction with, or success with the medium.

Copresence and Social Presence: Feeling Connected for Successful Interactions

a reasonable, but still naïve, hypothesis, would thus be: we can predict the effects upon interaction of varying medium of communication by listing the cues that are not transmitted via the different media, by discovering the functions of these cues by reference to research on face-to-face communication, and then deducing the way in which the outcome or processes of the conversation would be altered by the absence of these cues. (Short, Williams, & Christie, 1976, p. 63)

To determine the extent to which a mediated interaction is successful, it is important to consider more than just the characteristics of the medium. It is important to also consider the sense of connection, satisfaction, efficiency, involvement, and salience, of and with the task and the communicators as well as success and outcome quality. Both successful and satisfying interactions will generally require some level of a connection to, or with, another person or entity (e.g. a bot) as well as the ability to focus on and complete the goal of the interaction, but they are different constructs. There are a variety of ways researchers have used to evaluate successful interactions, as considered in this section, including social presence, copresence, and partner involvement.

The theoretical construct of *social presence* is not defined in terms of media, or number of cues or senses connected for the interaction. Instead, social presence was originally defined in terms of the degree of mental salience of the interaction partner during the interaction as well as the salience and importance of the interpersonal relationship (Short, Williams, & Christie, 1976, p. 65). Short, et al., were very clear that the relevance and focus of social presence extended beyond the features of the medium, and the individual interaction. This focus on the salience of the person and the relationship is a key, but frequently over looked, part of this theory.

While Short et al. argued that the medium would certainly influence outcomes and the level of efficiency in an interaction, they were careful to note that the number of cues would not be the only predictor and certainly more cues would not always be better. However, most researchers have interpreted it in that way. In fact, Culnan and Marcus (1987) argued that Social Presence was the earliest of the “cues filtered out” theories of CMC (Culnan & Markus, 1987). Short et al.’s conclusions that social presence was a quality of the medium and the cues provided in a medium, certainly contributed to this interpretation.

Further, the measures of social presence, including those that rate the medium on criteria including “a lot like face-to-face” or “sociable/unsociable” relate more to the user’s perception of, or satisfaction with, a medium, and not perceived, or interactionally-experienced partner salience (see also Nowak & Biocca, 2003). This perception of a medium may be related to, or even drive espoused satisfaction with the medium, but is not a measure of interpersonal salience, efficiency, or capability of a medium or success of the resulting interaction. A successful interaction should be determined by outcomes, perhaps by shared attention to the project, focus on the task, salience of the partner, or even interest or involvement with the task or the project, but not by perception of, or satisfaction with, the medium.

Another concept that is related to the sense of salience of a partner is copresence. Goffman (1963, p. 22) explained that when copresence is achieved, communicators are, “uniquely accessible, available, and subject to one another.” Ciolec (1982) argued that copresence includes a feeling of attention, or responsiveness, to others. Copresence as considered here refers exclusively to a psychological connection to, or with, another person that is possible in face to face interactions and when connected by computer media. It is related to, but distinct from, the concept of *presence* or *telepresence* in that presence generally refers to a sense of

immersion in a medium whereas copresence refers to a sense of involvement with a person or intelligent other (see Lee, 2004; Nowak & Biocca, 2003).

While both copresence and social presence are similar conceptually, there are some important distinctions. First is the reciprocal nature of copresence, which contains an important element: it is not enough that a person reports being involved, though copresence is related to involvement, because we also must consider their perception of the availability and involvement of their partner for the interaction. Further, the focus on a person's involvement with the partner, and their perception of their partner's involvement as opposed to their perception of or satisfaction with the medium, makes it meaningfully different from the way social presence has been operationalized as discussed above (see also Nowak, 2001; Nowak & Biocca, 2003).

Considering the Efficiency Framework: Number of Cues and Synchrony

Historically, researchers have compared people's satisfaction with mediated interactions to their satisfaction with face-to-face interactions, and using these measures, mediated interactions have almost always been seen as lacking in some way (see Caldwell, Uang, & Taha, 1995; Schmitz & Fulk, 1991). Mediated interactions are different from face-to-face, and some mediated interactions are different from others. However, this does not mean that one is inherently better than the other.

Despite occasional satisfaction deficits, "lean" media can facilitate successful interactions under certain conditions, as evidenced by the fact that people frequently choose media, particularly text based systems such as email, for incredible extents of their interactions (as seen in the Pew Internet and American Life Project; Madden, 2004). Text based media may not provide the most efficient connection, but it must work or people would not choose it so

frequently. It may be that the speed, relative cost, and convenience of email make up for any lack of efficiency in other areas (Walther & Parks, 2002).

Media can provide all necessary functions and capabilities for successful interactions and can even augment people's ability to communicate with affordances such as time- and space-independence. However, people still report a preference for multiple-channel and face-to-face communication (e.g. Gale, 1991; Rice, 1993; Tang & Isaacs, 1993). This may be because lean media require more effort to achieve the same "relative effectiveness" that face to face or richer media could provide (Walther & Park, 2002). The Efficiency Framework argues that when effort is relatively onerous, the more difficult medium may be initially less satisfying, but still useful (Nowak et al., 2005). It is quite possible that the increased effort requires more focus on, and attention to, the interaction which might increase the sense of connection, or copresence, with the interaction partner. This increased involvement may improve outcome quality and perceived group effectiveness.

Consistent with the efficiency predictions, some studies have revealed that successful interactions using cue lean media takes more time than using cue rich, or face to face interactions (Walther, 1992). This is consistent with the claim that using these systems may be less efficient and may require increased effort. Human evolution has yielded a capability to transmit and receive substantive and affective information simultaneously through multiple channels (i.e., numerous verbal, vocal, and visual physical behaviors that are simultaneously perceived via visual and aural sensory systems, and decoded at the same time). For example, people are able to process information simultaneously in the channels of verbal and nonverbal communication with little conscious effort. This would not be advantageous if nonverbal and verbal information was redundant.

However, the relationship of nonverbal to verbal behavior is often complementary, with nonverbal behavior potentially adding qualification or even contradiction to verbal messages (Ekman & Friesen, 1969). Moreover, multichannel communication facilitates the seamless transmission of multiple messages, such as content and relational messages simultaneously (Watzlawick, Beavin, & Jackson, 1967). Processing both substantive and affective messages is possible in even cue lean systems including text-based communication.

The transmission of complementary levels of information requires greater effort and more time in cue lean media as compared to the processing of multichannel communication in cue rich media, or in unmediated face to face interactions (Walther, 1992). Therefore, achieving common understanding and developing perceptions of partners in cue lean (e.g. text only) communication may demand significant extra effort, compared to face-to-face communicators (see for review Walther & Parks, 2002). Thus, it may be that for some interaction goals, successful mediated interactions require more effort, attention, and involvement than successful face-to-face interactions. However, this premise has not yet been tested.

The Efficiency Framework is relatively unique in its proposal that single-cue systems require more effort for complex information processing compared to multiple channel systems, the latter of which may result in greater efficiency (Daft & Lengel, 1984; Korzenny, 1978). The expenditure of less effort frees partners' cognitive resources for information processing, and thus could promote greater satisfaction (see Olaniran, 1996). From this perspective, claims that multi-cue communication devices such as video-based systems provide functionality that non-visual communication cannot, are deconstructed. For instance, Whittaker (1995; Whittaker & O'Connell, 1997) argued that visual information in communication is more than just information

about communication partners; video provides a shared workspace, allowing communicators to sense environmental cues that contextualize and add meaning to the references being discussed.

Video, optimally, may allow for the observation of specific artifacts, rather than users themselves (Geisler, 1999). This may allow users to adapt their language to even more efficient by facilitating the ability to use referential, rather than descriptive, speech (Gergle, Kraut, & Fussell, 2004). Videoconferencing thus provides particular communicative advantages to geographically and/or temporally dispersed groups that text-based communication cannot, at least when visible objects are involved. Although such claims as these may be true by stark comparison and as seen in normative use, the Efficiency Framework suggests that video offers greater potential to achieve these effects more rapidly and naturally than non-visual mediated alternatives, but that it is not infinitely more capable of doing so than other media used with experience or extraordinary effort.

Rather, if communicators use media that does not convey their personal physical appearance or their immediate physical surroundings and the objects in it, they can, and indeed must, accommodate for the absence of these features. To do so they may use more deictic language, i.e. tell one another explicitly what object or feature they may be discussing (“now let’s discuss the tip of the widget from its back” or “the third paragraph on the second page from the end” rather than “this one”; Gergle et al., 2004). Or if it is their emotional and affective reactions, partners may shift from video to text by using any number of verbal strategies to convey affect which people readily substitute for nonverbal expressions when nonverbals are occluded by media (e.g., “I really like that” or other overt statements of emotion, rather than a smile; Walther, Loh, & Granka, 2005). It is possible that this more effortful expression will result in fewer misunderstandings, which could also be an indicator of successful interactions.

Thus, the Efficiency Framework (Nowak et al., 2005; Walther, in press; Watt et al., 2002) recognizes that multiple-channel communication can facilitate interactions with less cognitive and behavioral effort, in less time, than systems with fewer channels. Users themselves may not be consciously aware of these issues, and may attribute media differences to factors other than the differential effort that alternative media require.

Research indicates that this preference for face-to-face or multichannel communication is not based on its ability to provide better, or more successful, interactions. Mühlfelder, Klein, Simon, and Luczak (1999) found no differences in interpersonal trust between videoconferencing and face-to-face communication. Hinds (1999) found that real-time videoconferencing overloaded the cognitive processing of coworkers performing a complex task, and biased their perceptions of one another, compared to those using a text-based conferencing system. Matarazzo and Sellen (2000) similarly found participants using a lower quality videoconferencing system preferred it and completed their tasks more quickly than via a higher quality system. Less dense information about the other participants was apparently less distracting from the task, compared to a high-resolution, more captivating but less useful focus on each other's faces.

It is likely that some media are easier to use and more efficient than others. While much attention has been paid to the number of cues, very little attention has been paid to the difference between synchronous and asynchronous media. One way in which asynchronous computer media may be able to increase communicative efficiency is by removing temporal constraints. The influence of synchrony on efficiency is difficult to predict because while synchronous systems may provide a real time connection, asynchronous media are convenient and make collaboration across time zones less onerous. Email, group conferencing, and other

asynchronous systems allow users to write and respond independent of time zones or other impediments to mutual availability (Johansen & O'Hara-Devereaux, 1994), which overcomes many of the problems associated with competing demands for attention and time that make synchronous and, face-to-face meetings difficult (Hesse, Werner, & Altman, 1988; Walther, 1996).

Concurrently, asynchronous media have been afforded with capabilities designed to increase efficiency that are not possible in synchronous or face-to-face interactions. For example, the communicator can revise messages before sending them. Users can take all the time they need, without "costs" associated with the delayed response that would be present in a synchronous interaction (Clark & Brennan, 1991). Asynchrony allows sorting and archiving the content of the interaction so both current members and those who join a group late can review past interactions (see Turoff, 1991). These features turn temporal independence into a utility that allows users to prevent the interaction from becoming disorganized and indecipherable.

There is no doubt that mediated interactions are different from face-to-face interactions in systematic and specifiable ways. Among these ways are both the number of cues provided by the medium and the mode of synchrony the medium sustains (whether synchronous or asynchronous). People may report a preference for face-to-face, or multi-channel media, not because they are qualitatively better, but because they are more natural, familiar, relatively effortless, and perhaps more efficient in ideal conditions, or maybe just because it seems like the right thing to say.

Understanding this framework has important implications for people's use and evaluation of media. Further, examining the success of interactions mediated by different systems will lead to different conclusions about when and how to use media than examining satisfaction with

media. The fact that the difference in satisfaction appears to be the case even when outcome quality is no different across media (e.g., Gale, 1991; Rice, 1993; Tang & Isaacs, 1993) supports the Efficiency Framework's separation of satisfaction from success.

The Influence of Cues and Synchrony: Differentiating Satisfaction and Success

First, the Efficiency Framework points out the importance of separating success (outcome quality) and satisfaction with the medium or interaction. Further, it recognizes that asking people about their perception of the medium's similarity to face to face, or about their notions of socially appropriate media usage are not valid measures of either satisfaction or success. According to the Efficiency Framework, both the efficiency of, and level of satisfaction with, a medium will be influenced by varying the characteristics of a medium on some level. However, objective success would not be determined by the features of the medium as long as participants were familiar with the medium and had sufficient time to complete the project to overcome any potential reduction in efficiency.

Although one must be wary of making conclusions based on the absence of significant differences, the Efficiency Framework predicts that media characteristics will not effect the outcome success, or quality of the group project, as we have operationally defined success. It posits that people adapt their communication to the features of any interface and therefore will be instrumentally successful regardless of efficiency or perceived group effectiveness. Therefore, we predict:

H1: There will be no effects of cues or synchrony on outcome success.

The Efficiency Framework argues that the medium may influence people's perceptions of their level of efficiency. Further, media characteristics will likely influence perceived group effectiveness and there is an important distinction between perceived group effectiveness and

final outcome quality, though they will be correlated. Both perceived group effectiveness and outcome quality are different from, but will likely influence their satisfaction with, the medium, which is what we argue is measured by social presence items. This is also likely to influence their perception of the success of their project. It could be that people will report less media satisfaction (social presence) with the group project in some conditions because they have had to work harder to adapt their communication behavior, or because they felt it different than face-to-face.

However, we predict that people will need to increase involvement, and copresence, in the interaction to adapt to the media and overcome the potential reduction of efficiency in some media. This increase in effort and copresence required to complete the project in some media will make people perceive higher levels of group effectiveness. Therefore, it is not the lack of efficiency that will drive the perceived group effectiveness, but instead, the level of copresence, or involvement, with the interaction. In other words, perceived group effectiveness (group satisfaction) will be influenced by efficiency of the medium, but more so by the level of copresence. Therefore, media with fewer cues and those that are asynchronous will be perceived to be less efficient. Further, media that are perceived to be less efficient will require more attention to, and involvement with, the interaction.

The fact that people have to work harder in some interactions than others, and that some media have been shown to be less efficient may reduce satisfaction both with the medium and with the group overall, but not necessarily perceived or actual success. We argue that this increased effort required to overcome the reduction of efficiency implicit in some media (particularly cue lean media) is likely to require people to be more involved in the interaction to actively monitor their communication behaviors as they adapt them to meet the features of the

medium. This monitoring and adaptation is likely to most effective in media that are familiar and most intuitive given that users will have to expend less attention to figuring out the capabilities of the medium and experience will have shown them how to successfully use it.

The question is whether the features of, or people's satisfaction with, the medium influences levels of copresence in the interaction. This study examines how, or if, different characteristics of media such as synchrony and varying number of cues influence outcome success, perceived group effectiveness, media satisfaction, and copresence in the interaction..

It is possible, as previous theories have predicted, that the media that are most like face to face (e.g. those with more cues) will be easiest to navigate. This would explain why they provide the highest satisfaction, but media that are new or unfamiliar require more attention to the medium as people work to understand what it does and how it works. Research has shown that people have the most experience with face to face interactions, but that the most common use of computers involves text based systems. Also, audio video systems have not widely diffused for a variety of reasons (see, e.g., Noll, 1992).

Therefore, we predict that copresence will not be affected by number of cues, but by the use of the simple and familiar interfaces. Specifically, face to face and text based systems are likely to be the most familiar and this might make them easiest to navigate. It is also likely that synchronous media require less effort, where feedback is instantaneous. If true, this could increase both dimensions of copresence in the interaction. Therefore, we predict:

H2: There is an interaction of the number of cues and synchrony on perceived group effectiveness.

H3: There is an interaction of the number of cue systems and synchrony on perceived copresence.

Unlike traditional theories of media use and effects which predict that more cues elicit greater copresence, the Efficiency Framework offers a McLuhanesque “cool media” approach. It draws on the effects of greater adaptive efforts to achieve copresence when the user must make up for the presence-providing deficits of the medium (see also Walther, 1996 with regard to similar interpersonal effects). Thus it offers the directional prediction,

H4: Communication media with fewer cue systems lead to greater copresence than those presenting more cue systems.

The measurement of users’ affective reactions to media and each other is complicated by artifacts in the scales that are often used to make such comparisons. As argued above, the measures of social presence developed by Short et al. (1976) ask not about the salience of the interaction partner (as the construct *social presence* is defined), but instead measure of the perception of a medium’s similarity to face to face interactions, or media satisfaction.

Given these measures, media that are closer to face-to-face (e.g. more cues or synchronous) should be rated higher on media satisfaction (social presence) due to structural features regardless of their functional dynamics, and those in face-to-face interactions will render greater satisfaction than anyone in mediated conditions almost regardless of what happens.

In other words, if measures of social presence are actually measuring media satisfaction, they do not assess the sense of a connection to partners. Instead, we predict they measure the extent to which a mediated experience differs from face-to-face. If this is correct, then social presence will be related to and predicted by the features of the medium (cues, synchrony) rather than perceived or actual project quality. Therefore, we predict:

H5: Groups using media with more cues or synchrony will report greater media satisfaction than groups using media with fewer cues or asynchronicity.

H6: Groups interacting face-to-face will report greater media satisfaction than mediated groups.

To test these predictions, we examine the independent and combined effects of synchrony and cues, across the spectrum of social presence, the sense of copresence, and perceived group effectiveness, and the outcome success (the collaboration task outcome). In order to address these issues, as well as in order to evaluate the practical utility of a new development in communication technology, research was conducted employing groups using technology that varied in synchrony, cues, and mediation.

Method

Participants

Participants were 142 students enrolled in a communication course at a large public university in the eastern United States. These students were randomly assigned to 39 groups of 3 or 4 members each. These groups, in turn, were assigned to collaborate either face-to-face, or using one type of computer medium to complete a class project.

The Media

To disentangle the impact of cues and synchrony on outcome quality, five different group collaboration conditions were used. This included face-to-face groups and four mediated groups that were factorial combinations of time mode and cue multiplicity, including synchronous high cue (synchronous CUSeeMe video conference), synchronous low cue (synchronous WebBoard Chat), asynchronous high cue (audio-visual system known as the Time Independent Collaboration system--TIC-- development of which is detailed in Watt et al., 2002), and Asynchronous low cue (WebBoard text-based conference).

The Task.

Students were asked to work in their group to prepare a 12-15 minute oral report that was worth 20% of their overall grade in a course. They were to prepare a mock presentation to Congress to argue for a new policy of how to balance privacy and national security. The final oral report required each group member to present a portion of the arguments, thus preventing “social loafing.” In addition, the group that gave the best presentation received a \$100 prize.

Procedure

All participants came to a computer lab for an hour at the same time and day each week for five weeks to complete the task. Only face to face groups were in the same room at the same time. With synchronous mediated groups, all group members were participating at the same time in different locations. No two members of the same asynchronous group participated either at the same, or adjacent, times. Asynchronous participants would download and review their teammates' messages and respond as desired. No time limits were given to participants in any condition, although the amount of time they used each medium was similar in all conditions, including face to face.

Following the completion of the project report participants completed a paper and pencil self-report questionnaire assessing the social presence, perceived group effectiveness, and copresence.

Measurement Instruments.

Items were selected from previously published scales and adapted to the task. Item analysis based on Chronbachs *alpha* was used to construct the final scales, with the exception of the outcome success measure. The dimensionality of each scale was determined as follows. First, confirmatory factor analysis tests of internal consistency and parallelism were applied to

the initial set of items for each instrument. Any item that did not meet all tests was removed from the scale, until the final scale achieved at least a .70 Chronbach's *alpha*, indicating that the items represented a unidimensional additive scale. See Appendix A for items.

Synchronicity. This manipulated independent variable had two levels in the factorial experimental design, low (asynchronous text and asynchronous audio/visual conditions) and high (synchronous text and synchronous audio/visual).

Cues. This manipulated independent variable had two levels in the factorial experimental design, low (both text conditions) and high (both audio/visual conditions).

Outcome success. Three Ph.D. students in Communication and Rhetoric evaluated the final 10-12 minute oral presentations. Presentations were evaluated for outcome success with a fixed checklist that required evaluation of argument structure, articulation of main points, conclusions, content, and delivery/style on a series of scales that yielded an overall evaluation of the quality of the group's presentation on a 0 to 36-point scale. The mean of the most reliable pair of scores provided by the evaluators of each group was used that group's measure of Group Success. Inter-rater reliability achieved a Pearson product-moment correlation of .66 on the group evaluations, indicating a reasonably high level of agreement between coders on the overall Group Success variable.

Media Satisfaction measures were based on Short et al.'s (1976) social presence scale. These items ask participants to consider the medium's similarity to face to face interactions, or media satisfaction. See Appendix A for items included. Reliability analysis yielded an inter-item Cronbach's *alpha* of .91.

Copresence. Copresence was operationalized as two separate scales of involvement as detailed fully by Nowak and Biocca (2003). See Appendix A for items included. One is self

reported involvement and the other is partner involvement. *Self reported Copresence* was measured using 3 Likert type items on a 7 point scale. These items achieved a unidimensional inter-item *alpha* reliability of .71. *Partner Copresence* was measured with 10 7-point Likert-type items from indicators of involvement (Burgoon & Hale, 1987). Inter-item reliability was *alpha* = .91.

Perceived Group Effectiveness. This was measured using 9 Likert type items from Canary and Spitzberg's (1987) conversational effectiveness scale. Items were revised so that the meeting replaced the word conversation in the initial scale to make items relevant to this project. See Appendix A for items included. Inter-item reliability was *alpha* = .83.

Correlations among measures indicate a fairly good discriminant validity among the measures (i.e., they are only moderately correlated, and are thus not likely redundant measures of the same underlying construct), as Table 1 shows.

Insert Table 1 here.

Results

The hypotheses were first tested with 2-way (2 x 2) ANOVAs, examining both main effects for the number of cues and for synchrony, and the interaction between cues and synchrony. The analyses were done with only the mediated groups, excluding the face-to-face groups. In a second analysis, post-hoc tests within a five condition one-way ANOVA contrasting each of the mediated group conditions with the face-to-face groups and with each other were subsequently conducted to get a sense of the relative position of each mediated condition to the "standard" of face-to-face communication and to each other. In the case of significant

interactions in the 2-way ANOVAs, the post hoc tests provide a means of understanding the joint contribution of specific levels of cues and synchrony to differences in the means of dependent variables.

H1: There will be no effects of cues or synchrony on outcome success.

This hypothesis was partially supported. The independent effects of synchronicity and number of cues did not reach significance, $F < 1$ for either main effect. There was large and significant interaction effect of these two variables on the quality of final presentation as measured by the Group Success dependent variable, $F(1, 112) = 21.64, p < .001$, partial $\eta^2 = .16$. The asynchronous high-cue group (TIC system) scored highly on quality ($M = 18.77$). Asynchronous high cue was significantly higher (according to post hoc Scheffe tests) than asynchronous low-cue ($M = 11.87, p < .001$) and synchronous high-cue conditions ($M = 13.02, p < .01$). However, the asynchronous high-cue condition did not differ significantly from the synchronous low-cue condition ($M = 16.87$) or the face-to-face condition ($M = 17.20$). The face-to-face groups did not differ significantly in Scheffe tests from any of the mediated experimental groups.

H2: There is an interaction of the number of cues and synchrony on perceived group effectiveness.

There was a significant main effect for number of cues on Perceived Group Effectiveness, $F(1, 107) = 4.21, p < .05$, partial $\eta^2 = .04$, and for synchrony, $F(1, 107) = 11.69, p = .001$, partial $\eta^2 = .10$. These main effects are not directly interpretable due to a significant interaction between cues and synchronicity, $F(1, 107) = 9.58, p < .005$, partial $\eta^2 = .08$ for the interaction. The groups in three conditions, asynchronous low-cue ($M = 43.85$), asynchronous high-cue ($M = 45.38$), and synchronous high-cue ($M = 45.86$) did not differ

significantly from each other in one-way ANOVA post-hoc tests. However, the synchronous low-cue group scored significantly higher on Perceived Group Effectiveness ($M = 53.43$) than did any of the other three experimental conditions. The mean for face-to-face groups ($M = 49.59$) fell between the synchronous low-cue group and the other groups, and the Scheffe test showed no significant difference between the face-to-face condition and any mediated condition on Perceived Group Effectiveness.

H3: There is an interaction of the number of cue systems and synchrony on perceived copresence.

Synchrony showed a significant main effect on the Perceived Partner Copresence dependent variable, $F(1, 112) = 3.91, p = .05$, partial $\eta^2 = .03$. The number of cues also showed a significant main effect, $F(1, 112) = 9.60, p < .01$, partial $\eta^2 = .08$. There was no significant interaction effect ($F < 1$). Those in using low cue media reported higher Perceived Partner Copresence ($M = 55.61$) than did those using high cue media ($M = 51.22$).

The post-hoc analysis showed significant differences only between the group that scored lowest on Perceived Partner Copresence (the asynchronous high cue condition, $M = 50.01$) and the group that scored highest (the synchronous text condition, $M = 57.21$). No other conditions, including the face-to-face, differed significantly from each other.

H4: Communication media with fewer cue systems lead to greater copresence than those presenting more cue systems.

The main effect of synchronicity on Self-Reported Copresence was significant, $F(1, 112) = 14.05, p < .001$, partial $\eta^2 = .11$, while the effect of the number of cues was not, $F < 1$. Those using synchronous media reported higher Self-Reported Copresence ($M = 14.75$) than those using asynchronous media ($M = 12.66$). There was no significant interaction effect.

The post-hoc analysis revealed that face-to-face groups reported higher Self-Reported Copresence ($M = 17.32$) than all but one mediated group. The differences were significant ($p < .01$), with the exception of the low-cue synchronous condition ($M = 15.32$), which did not differ significantly from the face-to-face groups.

H5: Groups using media with more cues or synchrony will report greater media satisfaction than groups using media with fewer cues or asynchronicity.

This hypothesis was not supported. There was no significant main effect for number of cues, $F < 1$ on Social Presence. There was a significant main effect for synchrony, $F(1, 112) = 13.81$, $p < .001$, partial $\eta^2 = .11$, on social presence. However, this main effect must be qualified, and cannot be interpreted directly, as there was a significant interaction between cues and synchronicity, $F(1, 112) = 11.04$, $p = .001$, partial $\eta^2 = .09$, for the interaction.

Post-hoc Sheffe tests in the one-way ANOVA showed the groups in the synchronous low-cue ($M = 39.37$), asynchronous high-cue ($M = 32.60$), and synchronous high-cue ($M = 33.28$) conditions did not differ significantly from each other. However, the low-cue asynchronous group ($M = 27.30$) scored significantly lower than synchronous low cue group ($p < .05$) on social presence. The low mean in this condition accounted for the interaction effect. As the group mean is in the direction opposite of that predicted by the hypothesis, with the higher cue condition producing lower social presence, the hypothesis is not supported.

H6: Groups interacting face-to-face will report greater media satisfaction than mediated groups.

This hypothesis was supported. The face-to-face groups scored significantly higher on Social Presence ($M = 57.68$) than all mediated conditions (means ranged from 27.30 to 39.37) by Scheffe test within the one-way ANOVA ($p < .001$ for all conditions).

Discussion

These results indicate some limitations of prior theory and support for the Efficiency Framework. As predicted by the Efficiency Framework, there was an important difference between media's ability to facilitate outcome success and perceived group effectiveness in, and satisfaction with, mediated interactions. Mediated interactions were perceived as different from face-to-face interactions, but face-to-face interactions were not more successful.

Success is the ability of a medium to fulfill interaction goals and we distinguished between outcome success and perceived group effectiveness. In this case, in direct contrast to what would be predicted by media richness theory, the synchronous low cue group reported more perceived group effectiveness and outcome success, though the asynchronous high cue groups were ranked highest on outcome success. Essentially, this shows that participants are able to accommodate their communication behaviors and utilize the features of any media, even when assigned to them in an experimental context. Further, face-to-face was not significantly different than mediated groups on either perceived group effectiveness or outcome success.

Satisfaction in an interaction is different from the evaluation or perception of media. In this case, we used traditional social presence measures as an indicator of people's perception of the media's ability to provide satisfactory interactions because that is what the items ask. People reported significantly more media satisfaction in face-to-face condition than mediated conditions. This is the only variable where mediation made a significant difference. The tests of direct effects revealed that synchronous low cue media had the highest perceived group effectiveness, though this group received the second highest outcome success rating.

The fact that the most successful groups were using either one of the most common synchronous low cue technologies, (text based instant messaging) or the most unique and

unusual (asynchronous audio video) suggests that multiple factors are at play. First, the low cue asynchronous groups (similar to Instant Messaging) were familiar with their medium and found it easy to complete the task utilizing it. In other words, this indicates that people who use a medium frequently become more adept at adopting their communication behaviors to it and to using it effectively and perhaps more efficiently. Alternatively, the high cue asynchronous medium was likely the least familiar and may have required a higher level of effort. It may be that both familiarity with medium and a higher level of effort predict outcome success, in this case both resulted in better rated presentations.

These results are more fully explored by the exploratory structural model presented in the next section.

Structural Analysis of Results

The conventional ANOVA analysis presented above assumes a direct link between the characteristics of the medium (synchrony and cues) and the outcome variables. These tests assume that there is no important covariation between dependent variables that would confound the direct effects of the independent variables, and that there are no variable intervening between the technology differences and the outcomes. However, as Table 1 shows, some of the dependent variables have significant covariance. To test the implicit model assumed in the ANOVA analyses, we conducted a structural path analysis using the AMOS package.

The direct effects tests present synchrony and cue as the independent variables, which directly predict the separate dependent variables (see Figure 1). In testing this model, the overall *chi-square* for this structural model was large and significant ($chi-sq = 106.5$, $d.f. = 10$, $p < .001$), indicating that this structure of independent effects does not fit the data. Therefore, the model was revised.

Previous structural models have suggested that group participant involvement mediates the impact of media characteristics on ultimate effects like partner perception (Nowak, Watt, & Walther, 2005). In this formulation, media characteristics directly affect involvement, which then produces differing outcomes. This basic process was incorporated in the model shown in Figure 2. Analysis of this model improved goodness of fit to the observed data (Root Mean Square Error of Approximation (RMSEA) = .15 as compared to .27 for the ANOVA model in Figure 1), but overall, the implied coefficients in the model still differed significantly from those actually observed ($\chi^2 = 38.1$, d.f. = 9, $p < .001$), indicating this model still is not a good fit to the observed data.

To find a structure that fit the observed data, an inductive and iterative process of model construction was used. First, all non-significant relationships were deleted and the model coefficients recomputed. Then direct paths were introduced between variables where the implied (computed) coefficients were clearly lower than the observed correlation coefficients. This process was repeated iteratively until the model shown in Figure 3 was obtained. This model contains only significant structural coefficients, and has a very good overall RMSEA of .04. The χ^2 test indicates that the implied coefficients in this model do not differ significantly from those observed ($\chi^2 = 12.6$, d.f. = 10, $p > .20$).¹ b

This procedure revealed the presence of covariance between the residuals of two endogenous variable pairs (self-reported copresence and partner copresence; and perceived group effectiveness and media satisfaction). These covariances indicate the presence of a common theoretical construct that overlaps both variables of the pair. In the case of the copresence variables, this is probably due to a common level of overall involvement with the process, which supports the prediction that copresence is a reciprocal construct. Likewise, the covariance

between perceived group effectiveness and media satisfaction is likely due to a common perception of integration with the group that included both perceived group effectiveness and media satisfaction. In this final model, media characteristics produce changes in copresence, which increase the perception of group effectiveness, which in turn predicts outcome success.

Because the final model shown in Figure 3 was inductively constructed, there is a possibility of capitalization on chance variation in inferring structural relationships. To examine this possibility, the data were randomly partitioned into two subsets, which were independently analyzed. The split-half models indicate that the final model structure is stable and correctly represents the observed data (see Figure 3).

The results show that media characteristics (synchrony and number of cues) have an indirect effect on outcome success, mediated by copresence. Copresence directly affects perceived group effectiveness. The only direct link to Outcome Success is through Perceived Group Effectiveness. The characteristics of the medium did not directly produce either of our measures of success (Perceived Group Effectiveness and Outcome Success). The fact that Perceived Group Effectiveness is predicted by Copresence and related to Outcome Success, but not to cues, synchrony or media satisfaction, indicates that Perceived Group Effectiveness is an important indicator of success as we have examined it.

A final issue is related to the question of how best to measure people's connection with one another. The direct relationship between number of cues and social presence measures and the lack of impact of social presence on other variables indicates that these social presence items measure media satisfaction, or the extent to which an interaction is mediated as we predicted.

Limitations

As with any experiment, there are some factors that limit the ability to generalize these results. For example, participants were students doing a class project, which could be different from a workplace setting. However, because this project was a large percentage of the students' grades, students were likely to be highly attentive to the project. As discussed above, another limitation was the fact that all participants had to report to the lab at a particular place and time. This eliminated a potential advantage of asynchronous media that would have come with being able to use the medium at any time or place participants wished.

Other uncontrolled factors in this design may actually increase the external validity of the results. First, in this design, students enrolled in the same courses where they saw each other several times a week, so their interactions were not limited to their assigned media. As with most real world group projects, people rarely limit their project-related interactions to one medium. Participants reported that they discussed the project with teammates via other media and face-to-face.

Another potential problem occurred with the synchronous audio/visual groups. This condition was particularly sensitive to network congestion, which caused delay in some interactions. Data were examined for possibility that this might have produced a more negative relationship between high cues and involvement, but no such effect was found when contrasting groups that experienced more network latency than those whose video conferences were smoother. It is also possible that our measure of outcome success (quality of rhetoric) is not the best measure, although this was a central objective of the task addressed by each group. A final limitation is the reliance on a homogeneous student sample. Future research should replicate this design with differing populations, group tasks, measures and goals.

Conclusion

The results support the predictions outlined by the Efficiency Framework and Korzenny's (1978) theory of electronic propinquity, which suggests, among other things, that users adapt to the medium they have and that there is an important distinction between satisfaction and success. Perhaps users prefer what is familiar, or are responding in what they perceive to be socially appropriate ways when they rate the media as being less satisfactory, even though the medium was sufficient, and in some cases superior for completing the task. Both synchrony and medium familiarity seem to work together to predict copresence, which in turn predict outcome variables. There appear to be three possible reasons for these findings, and while the explanation may be simply that mediated interactions are limited by socially determined rules of appropriateness, or that people are not good at knowing what they need, other explanations are possible as well.

Generally, people felt more copresence and media satisfaction in synchronous media, but there was an interaction effect. Despite the potential convenience of asynchronous media, asynchronous interactions are generally not as involving as synchronous interactions because the people are not there to be engaged in real time. Student participants spend a lot of time interacting face-to-face, and using synchronous text systems (such as Instant Messenger systems) and this familiarity may have added to their sense of copresence in these conditions. Neither synchronous nor asynchronous audio video were as high on copresence as synchronous text. However, synchrony did not significantly increase outcome success.

A second possible explanation is that researchers have been asking the wrong questions in the frequent use of the social presence measures to evaluate media have led to confusing results. Researchers have incorrectly equated social presence with interpersonal salience, but the items measure media satisfaction. While it is true that participants felt the most social presence

in face-to-face, and the lowest in low cue asynchronous media, this was an isolated variable and did not predict either perceived or actual success. In re-examining the measures of social presence, these items may be rational but asking how close a medium is to a face to face interaction, or whether they would choose this medium in the first place seems biased. The affordances of mediated systems are practical and are not needed in ideal situations. If you are in the same time zone and geographic location, then perhaps email would not be the medium of choice. However, practical and realistic considerations make face to face interactions impractical and not ideal. These are not considered in the social presence items.

Finally, we must recognize that face-to-face is overrated and may never have been a good benchmark in the first place. As media advances, it becomes increasingly clear that mediated interactions will never be the same as face-to-face (Hollan & Stornetta, 1992) and people report a preference for face-to-face interactions. However, this preference is not based on what people need, what is best, or even what will work.

Mediated interactions do not, can not, and will not feel the same as face-to-face interactions. Face-to-face contact is, and always will be, needed at certain times for certain interactions. The goal of media should be to take advantage of things that are only possible in mediated interactions. Researchers should stop the focus on comparing mediated and face-to-face interactions and focus on finding ways that media can augment and enhance the communication process, and help people accomplish their tasks.

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Footnotes

¹ As a check on this causal chain, direct effects from all causally prior variables in the chain to the final outcome variables were introduced in a series of models. None of these new direct paths were significant, indicating that the model shown in Figure 3 with copresence mediation best fits the observed data.

Table 1.

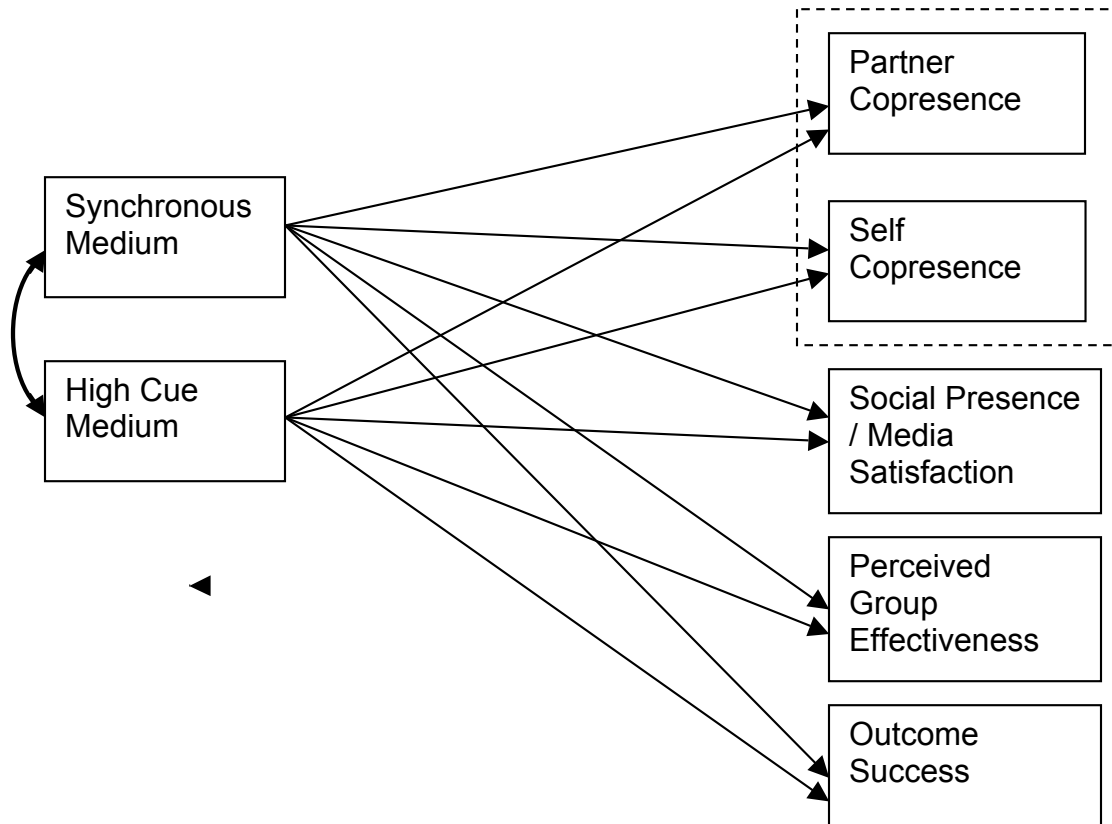
Pearson Correlations Among Variables

	Outcome Success	Partner Copresence	Self Copresence	Social Presence /Media Satisfaction
Partner Copresence	.145			
Self Copresence	.113	.270**		
Social Presence	.155	.041	.510**	
Perceived Group Effectiveness	.174*	.422**	.568**	.419**

* p < .05

** p < .01

Figure 1
Implied Analysis of Variance Model

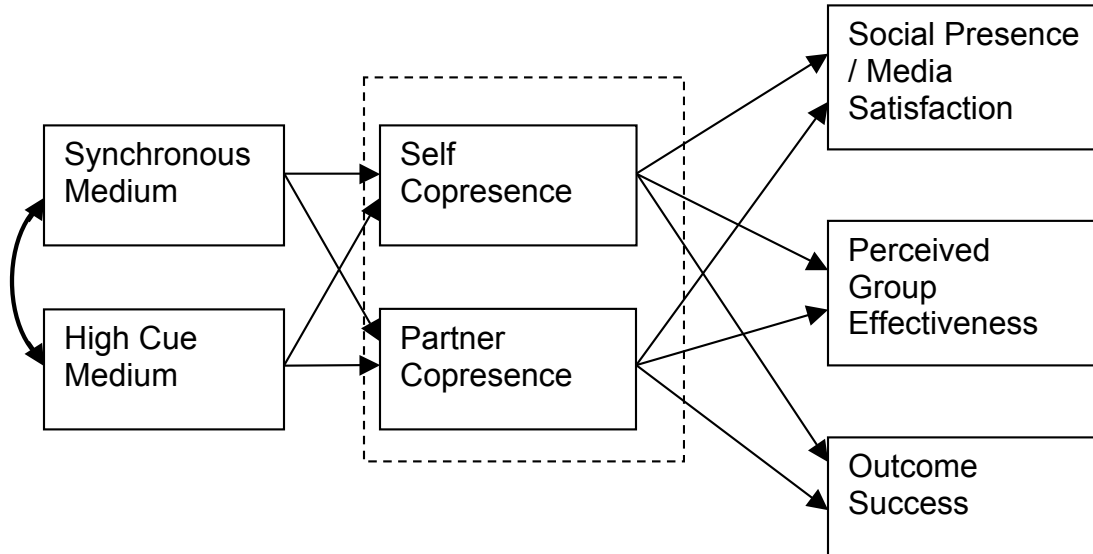


Model $\chi^2 = 106.9$, d.f. = 10, $p < .001$

Root Mean Square Error of Approximation (RMSEA) = .27

Structural coefficients not reported due to poor overall model fit.

Figure 2
Involvement Mediation Model



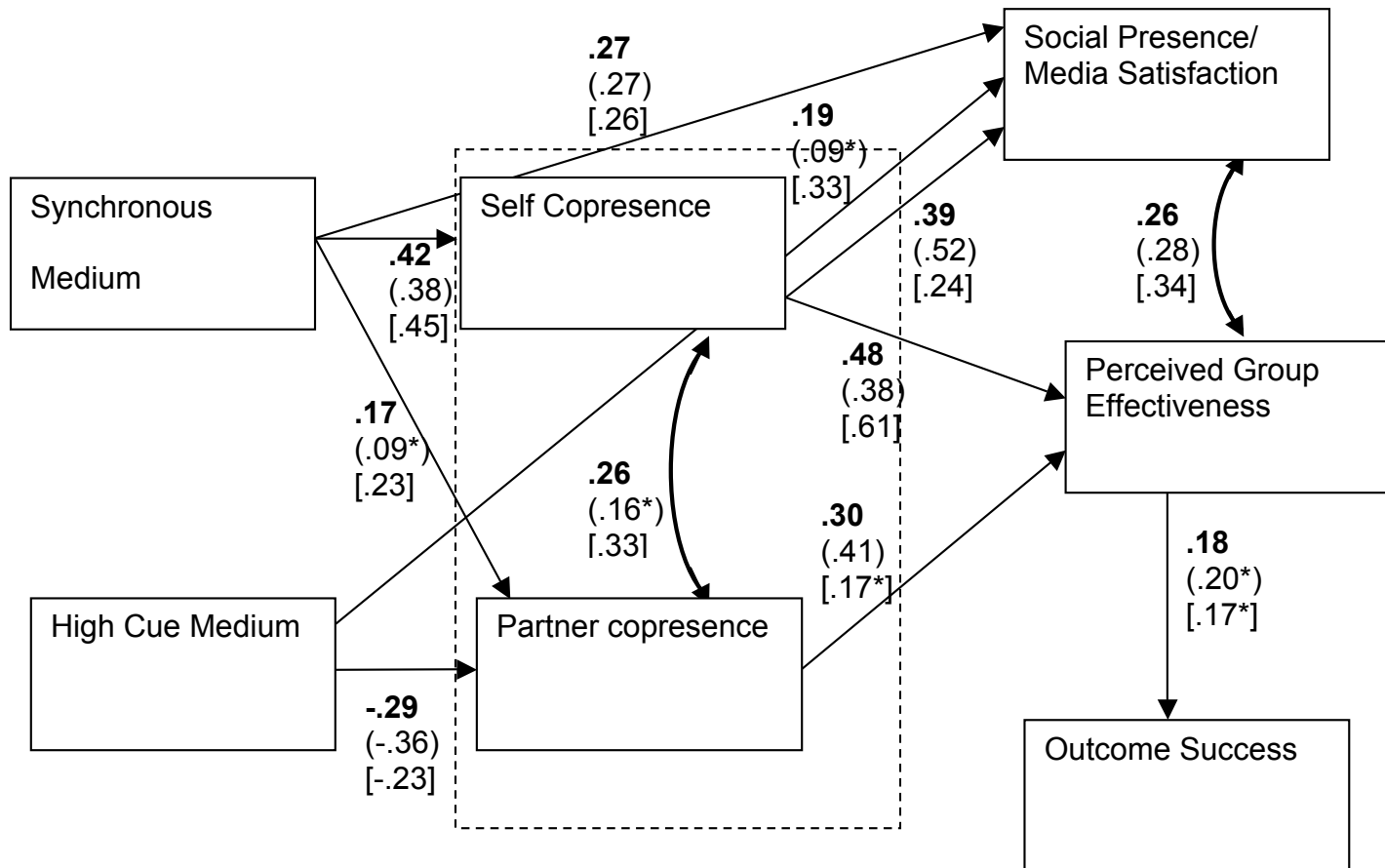
Model $\chi^2 = 38.1$, d.f. = 9, $p < .001$

Root Mean Square Error of Approximation (RMSEA) = .15

Structural coefficients not reported due to poor overall model fit.

Figure 3.

Final Structural Model.



Full Data Model, N=138. Model $\chi^2 = 12.6$, d.f. = 10, $p > .20$. Root Mean Square Error of Approximation (RMSEA) = .04. All structural coefficients significant at $p < .05$

Replication on random split-half subsets of data

Random Split-half Subset 1 (N=69). Model $\chi^2 = 14.5$, d.f. = 10, $p > .15$. Root Mean Square Error of Approximation (RMSEA) = .08. Structural coefficients marked [*] are n.s., all others significant at $p < .05$

Random Split-half Subset 2 [N=69]. Model $\chi^2 = 6.3$, d.f. = 10, $p > .75$. Root Mean Square Error of Approximation (RMSEA) = .00. Structural coefficients marked [*] are n.s., all others significant at $p < .05$.

Appendix A

Measurement Instrument Scale Items

All items within constructed indexes were measured on a 7-point Likert-type scale. The minimum for each index is thus the number of items in the scale and the maximum is 7*number of items in the scale.

Social Presence / Media Satisfaction (Range = 10-70, Alpha = .9146)

- To what extent did you feel you got a good enough idea of how people at the other end were reacting?
- Do you think you got a "feel" for the people at the other end?
- To what extent do you feel you were able to assess your partners' reactions to what you said?
- To what extent was this like a face -to-face meeting?
- To what extent was this like you were in the same room with your group?
- To what extent did you feel the medium facilitated your group's ability to complete the project?
- How likely is it that you would choose to use this system of interaction for a meeting in which you wanted to persuade others of something?
- To what extent did you feel you could get to know someone that you meet only through this system?
- To what extent did your group seem "real"?
- To what extent did you feel the medium detracted from your group's ability to complete the project?

Self-Reported Copresence (Range = 3-21, Alpha = .7134)

- *Reverse:* I was detached during the conversations
- I found the interaction stimulating
- I was intensely involved in our interactions

Partner Copresence (Range = 10-70, Alpha = .9123)

- Partner was willing to listen to me - group mean
- Partner was intensely involved in our interaction - group mean
- *Reverse:* Partner did not want a deeper relationship - group mean
- Partner seemed to find our interaction stimulating - group mean
- *Reverse:* Partner created a sense of distance between us - group mean
- *Reverse:* Partner seemed detached during our interactions - group mean
- Partner created a sense of closeness between us -group mean
- *Reverse:* Partner acted bored by our interactions - group mean
- Partner was interested in our interaction - group mean
- Partner showed enthusiasm for our interactions - group mean

Perceived Group Effectiveness (Range = 9-63, Alpha = .8284)

- Our group meetings were very beneficial
- *Reverse:* The group meetings were useless
- I got what I wanted out of the meetings
- I found the meetings useful and helpful
- *Reverse:* I didn't know what was going on during the meetings or the task
- *Reverse:* Our meetings were generally unsuccessful
- My group did a good job on the task given our constraints
- I achieved everything I hoped in our group project
- My contribution to the group was effective

Outcome success (Range = 0-36, Inter-rater reliability = .66)

Each of the 18 items was scored on a 0-2 scale (0=poor; 1=acceptable; 2=good), and the 18 scales summed to provide the final index of Group Success.

- Gains attention
- States purpose
- Previews topics
- Introduces team
- Main points identified
- Support
- Clear Transitions
- Recaps main points
- Emphasizes central idea
- Definite closing
- Level of Detail
- Appropriate for audience
- Organization of Ideas
- Evidence of preparation
- Enthusiasm/energy
- Vocal quality
- Eye contact
- Smooth hand/offs