IDEA GROUP PUBLISHING

701 E. Chocolate Avenue, Suite 200, Hershey PA 17033, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com

ITP4805

Unraveling the E-Collaboration Paradox: Evidence of Compensatory Adaptation to Low Media Naturalness

John D'Arcy
PhD Student
MIS Department
Temple University
207B Speakman Hall
Philadelphia, PA 19122
Phone: 215 204-3052
Fax: 215 204-3101
jdarcy@temple.edu

Ned Kock
Associate Professor & Director
E-Collaboration Research Center
Lehigh University
621 Taylor Street, Rm 372
Bethlehem, PA 18015
Phone: 610 758-3415
Fax: 610 758-6429
nfk2@lehigh.edu

ABSTRACT

There is substantial empirical evidence from the literature on electronic collaboration suggesting two apparently contradictory conclusions, which characterize a phenomenon that has been referred to as the "e-collaboration paradox": (a) the suppression of face-to-face communication elements in electronic communication media (e.g., the suppression of the ability to convey nonverbal cues in e-mail) poses obstacles to communication; and (b) groups performing collaboration tasks through electronic communication media often present levels of performance equivalent to or greater than similar groups interacting face-to-face. This paper summarizes a theoretical framework developed to explain these apparently contradictory conclusions, as well as two studies that provide support for the framework. The paper concludes with suggestions for future avenues of research aimed at testing and refining the theoretical framework.

INTRODUCTION

The advent of the Internet, e-business, and the proliferation of low-cost computer networks and electronic communication tools have led to an increased interest in research in how electronic media affect collaborative work in organizations (Kock and Murphy, 2002). This area of inquiry has taken different forms and different names over the years, such as computer-supported cooperative work, computer-mediated communication, groupware, group support systems, and collaboration technologies. In this paper, we use the term electronic collaboration (e-collaboration) as an "umbrella" term that comprises these closely related fields. E-collaboration is broadly defined as collaboration among individuals engaged in a common task using electronic technologies (Kock and D'Arcy, 2002). Examples of e-collaboration technologies are Web-based chat tools, Web-based synchronous conferencing tools, e-mail, Internet-based listservs, collaborative writing tools, group decision support systems, teleconferencing tools, and virtual reality environments.

There has been a substantial amount of empirical research on e-collaboration in the past twenty-five years and the body of research in this area continues to grow. While impressive in terms of volume, this body of research has failed to provide an explanation of e-collaborative behavior in its full complexity. This paper reviews past research on e-collaboration and discusses what is referred to as the "e-collaboration paradox" (Kock and D'Arcy, 2002). The e-collaboration paradox is summarized and explained through two hypotheses: media naturalness and compensatory adaptation. The media naturalness hypothesis builds on the notion that, since human beings have used face-to-face communication throughout most of their evolutionary history, modern humans must be conditioned or "hardwired" for face-to-face communication. Therefore, modern humans prefer communication mediums that are more natural (with face-to-face being the most natural) when communicating with each other. The compensatory adaptation hypothesis builds on the notion that human beings, when faced with communication obstacles, try to compensate for them by changing their behavior in relatively predictable ways. Therefore, human beings faced with the communication obstacles posed by less natural communication media (such as those created by e-collaboration tools) tend to adjust their behavior to compensate for such obstacles. This view is complementary to the media naturalness view because compensatory adaptation cannot occur without the existence of obstacles in the first place. Next, we present two research studies that provide evidence of the competing influences of media naturalness and compensatory adaptation. Finally, we discuss the results of the studies and outline areas for future research.

THE E-COLLABORATION PARADOX

The body of research on e-collaboration that has accumulated over the past twenty-five years has led to many empirical findings. Two general and competing findings which have been associated with this research are: (a) people seem to consistently perceive face-to-face communication (as well as communication that incorporates key elements of the face-to-face medium, such as facial expressions and nonverbal cues) to pose fewer obstacles to effective communication than other, particularly electronic, media, and; (b) when groups conduct collaborative tasks using e-collaboration technologies, they often present the same level of performance as groups accomplishing the same tasks face-to-face (Kock, 1998; 1999; 2001; 2001b; 2001c). The notion that groups using e-collaboration technologies often times perform just as well as groups communicating face-to-face, given the perceived obstacles to communication posed by e-collaboration technologies, is referred to here as the "e-collaboration paradox" (Kock and D'Arcy, 2002).

We argue that the paradox can be explained based on two hypotheses, which are consistent with the competing findings summarized above. The first hypothesis, media naturalness, argues that human beings have been engineered to communicate face-to-face since they have used this medium to communicate throughout most of their evolutionary history. Given that our biological communication apparatus has been designed for face-to-face communication, tools that suppress elements of face-to-face communication (such as e-collaboration tools) pose cognitive obstacles for communication (Kock, 2001). The second hypothesis, compensatory adaptation, argues that human beings invariably adapt

their behavior in order to overcome obstacles created by e-collaboration technologies, often leading to an interesting result – they perform just as well or "better" than they would face-to-face, even though the their perceptions of the e-collaboration tools used still match predictions based on the media naturalness hypothesis (Kock, 2001; 2001b).

THE MEDIA NATURALNESS HYPOTHESIS

The core theoretical argument underlying the media naturalness hypothesis is that our biological communication apparatus has been optimized by Darwinian evolution for face-to-face communication incorporating five main elements – co-location, synchronicity, and the ability to convey body language, facial expressions, and speech.

Evidence about the evolution of our biological communication apparatus suggests that during over 99 percent of our evolutionary cycle our ancestors relied on co-located and synchronous forms of communication through facial expressions, body language, and sounds to exchange information and knowledge among themselves (Boaz and Almquist, 1997; Cartwright, 2000). Additional evidence is found through the obvious face-to-face communication adaptations in our biological communication apparatus. For instance, evolution endowed human beings with a complex web of facial muscles that allow them to generate over 6,000 communicative expressions. Very few of these muscles are used for purposes other than communication, such as chewing (Bates and Cleese, 2001; McNeill, 1998). Overall, the evolutionary history of our biological communication apparatus suggests that human beings have been engineered for co-located and synchronous communication employing facial expressions, body language, and speech.

The above discussion of our evolutionary history provides a scientific explanation for the apparent bias toward face-to-face communication found in the e-collaboration literature and is reflected in the media naturalness hypothesis: *Group members who choose to use e-collaboration tools experience increased cognitive effort and communication ambiguity proportionally to the degree to which the tools suppress elements that are present in face-to-face communication (e.g. synchronicity, co-location, ability to convey/perceive nonverbal communication cues).*

The media naturalness hypothesis links the use of e-collaboration tools with high cognitive effort and communication ambiguity, but not necessarily with specific media choices or tool-related outcomes. It is also task independent, that is, the media naturalness hypothesis applies to all collaborative tools, even though it acknowledges that the link is less noticeable in tools that do not involve intense communication (Kock, 2001; 2001b).

THE COMPENSATORY ADAPTATION HYPOTHESIS

While it may be intuitive to think that obstacles to high group effectiveness lead to lower quality of group outcomes, there is evidence from fields such as biological anthropology (Dolzhansky, 1971) and analytical psychology (Jung, 1968) suggesting that human beings voluntarily or involuntarily compensate for obstacles posed to them and in many cases achieve outcomes even better than if the obstacles were not present (Kock and Murphy, 2002).

The compensatory adaptation hypothesis argues that users of e-collaboration tools present two common patterns of reactions toward those tools. First, based on the media naturalness hypothesis, users generally perceive e-collaboration tools as creating cognitive obstacles to communication when compared to the face-to-face medium (Kock, 2001; 2001b). That is, e-collaboration tools increase the cognitive effort required to communicate information and knowledge even though they may reduce or eliminate physical barriers to communication, such as geographical dispersion. The second common pattern is that users compensate for the obstacles posed by the media (Kock, 1998; 1999; 2001c). This pattern of compensation is embodied in the compensatory adaptation hypothesis: *Group members who choose to use e-collaboration tools tend to compensate for the cognitive obstacles they perceive as associated with the lack of naturalness of the tools, which leads them to generate group outcomes of the same or better quality than those generated through the face-to-face medium.*

In summary, the compensatory adaptation hypothesis argues that groups who use e-collaboration tools will experience cognitive obstacles to effective communication due to the decreased naturalness of the medium. However, groups will (often involuntarily) attempt to compensate for these obstacles, resulting in group outcomes that are of equal or better quality that if they had interacted solely face-to-face.

EVIDENCE OF COMPENSATORY ADAPTATION FROM TWO STUDIES

Given that the two hypotheses presented in this paper are quite new, some skepticism toward them can be expected. Not many studies directly address both hypotheses in the same context, so this section tries to accomplish this by presenting two studies that provide support for both the media naturalness and compensatory adaptation hypotheses.

The first study tested the two hypotheses through a field experiment employing a repeated measures design where the communication medium used varied according to two conditions: face-to-face and electronic (Kock and Murphy, 2002). The research study recruited subjects from management and engineering ranks of a large defense contractor and their task was to analyze and redesign a business process (i.e. process improvement). The subjects were familiar with each other and with the electronic communication medium (Web-based online discussion boards) used prior to their participation in the experiment, however, they had no prior experience using the electronic communication medium for the collaborative completion of tasks of the same type and complexity used in the experiment (Kock and Murphy, 2002).

The subjects were randomly assigned to dyads and to communication conditions. Each dyad completed two similar process redesign-related tasks using different communication media for each task. Half of the dyads (i.e., 10 dyads) completed one of the tasks face-to-face while the other half completed the same task electronically. After this, all dyads moved on to the next task, using different media than they had used in the first task.

Five dependent variables were analyzed in the study: cognitive effort, communication ambiguity, message preparation, task outcome quality, and fluency. All of the measures were tested based on comparison of means methods, through MANOVA and Mann-Whitley U tests (Rosenthal and Rosnow, 1991). The differences between the means were found to be statistically significant for all variables except task outcome quality. The results suggest that the use of the e-collaboration tool, when compared with the face-to-face medium, increased cognitive effort by about 41%, communication ambiguity by about 80%, and message preparation by about 47%, while at the same time reducing fluency by approximately 77%. The study also suggests that the e-collaboration tool had no significant effect on the quality of the outcomes generated by the dyads.

The significantly higher levels of cognitive effort and communication ambiguity in the electronic media condition suggest that this condition created obstacles to effective group communication, thus supporting the media naturalness hypothesis. The significant differences in message preparation and fluency strongly suggest that group members thought harder about what they were saying and used more carefully prepared messages, when using the e-collaboration tool than when communicating face-to-face. It is reasonable to expect that this increased thoughtfulness and preparation were an attempt to compensate for the obstacles posed by the e-collaboration tool. Thus, the compensatory adaptation hypothesis was supported. Finally, the fact that differences in task outcome quality were insignificant suggests that the compensatory adaptation behavior displayed by the subjects in the electronic condition was successful as they performed just as well as the subjects in the face-to-face condition.

The second study contributed evidence in connection with the two hypotheses through an action research investigation of twelve process improvement groups interacting through an electronic communication medium (electronic list servs). Six of the groups came from Waikato University, a large university in New Zealand, and six came from MQM, a branch of the Ministry of Agriculture and Fisheries in New Zealand.

The criteria for selecting client organizations for the research included a commitment to process improvement (demonstrated by the existence of at least one formal organization-wide process improvement program) and initial absence of electronic communication support for process improvement activities. The selection criteria ensured that process improvement group participants had previously participated in a face-to-face process improvement group, creating a basis for comparison from which to form their perceptions regarding e-collaboration tools in process improvement efforts (Kock, 2001c).

The researcher in this study, consistent with the action research methodology, attempted to directly improve the participant organizations by providing technical support for the process improvement groups. The study made use of structured and unstructured interviews, participant observation, and compilations of electronic postings collected from the e-collaboration tool to study the twelve process improvement groups through their stages of development. Structured interviews employed an "in-depth interviewing" method addressing the perceptions of group members to the electronic process improvement groups versus their previous experience in face-to-face process improvement groups. Additional unstructured interviews were also conducted with each of the participants to avoid bias from the structured questions. The data from the unstructured interviews were triangulated with structured interview results, as well as the electronic postings.

The success or failure of each process improvement group was determined based on the results of the process redesign efforts. Process redesign attempts were considered successful if the recommended process changes were implemented fully or partially and led to positive observable results.

The results suggest that the use of the e-collaboration tool had a positive impact on group success as four out of the six process improvement groups conducted at MQM were successful as well as four out of the six process improvement groups at Waikato. That is, eight out of the twelve groups, or 67%, were successful while using the e-collaboration tool in their process improvement efforts. While the number of groups studied was relatively low, the identical success rates in the two organizations suggest a certain generality to this result (Kock, 2001c). Moreover, the success rate of the groups studied was significantly higher than the average suggested by the literature, in spite of the use of an e-collaboration tool for communication (Kock, 2001c).

Analysis of the interview data provides further insights as group members provided their explanations for the successful process redesign outcomes associated with the use of the e-collaboration tool.

Group member from Waikato University:

"When I write, my thinking process from formulating the ideas in my head to getting them down becomes more elaborate. I have to take much more time over that than I would if I was speaking. I think that, because one is forced to do that by writing the answer down, then the written answer you get is much more focused. So I think that is an advantage. It requires more time, from the participants, because they have to focus their writing, but, as a result, you get [better individual contributions]."

Division Manager at Waikato University:

"You think more when you're writing something, so you produce a better quality contribution. Take for example what [a members' name removed] wrote, she wrote a lot and it seemed that she thought a lot about if before she emailed it to the group. She wasn't just babbling off the top of her head, she tended to think out what she was writing. I know I did it a lot, specially my first message. I really thought a lot to put it together."

The comments above, which are representative of the responses obtained through interviews, suggest that the process improvement group members had to think harder and spend more time on message preparation before communicating with other group members when using the e-collaboration tool as compared to their prior experience in face-to-face process improvement groups. It is reasonable to expect that the increased focus and extra preparation were an attempt to compensate for the obstacles posed by the e-collaboration tool, providing support for the compensatory adaptation hypothesis. Further, while this study did not directly measure variables such as cognitive effort and ambiguity, the compensatory behavior suggested through both the participant interviews and the positive process improvement outcomes also suggests the presence of cognitive obstacles, consistent with the media naturalness hypothesis. This is plausible given the fact that cognitive obstacles must exist in the first place in order for compensatory adaptation to occur. The success rate of the process improvement groups suggests that their compensatory adaptation behavior was extremely successful, as they achieved a rate of success that was significantly higher than the average suggested by the literature and over twice that of process improvement attempts based on business processing re-engineering principles (Kock, 2001c).

DISCUSSION

The findings on e-collaboration behavior presented in this paper are significant since they contradict much of the previous research that suggests that e-collaboration tools have a negative impact on group outcomes. The first study suggests that the obstacles posed by e-collaboration tools do not significantly affect the quality of group outcomes while the second study suggests that the use of e-collaboration tools may actually increase the quality of group outcomes. While the competing influences of the media naturalness and compensatory adaptation hypotheses provide a general explanation of these results, further clarification is necessary to understand why the groups in the second study outperformed face-to-face collaborative groups while the groups in the first study presented performance outcomes that were at the same level as face-to-face groups.

One possible explanation lies in the methodological differences between the two studies. The first study, a repeated measures field experiment, involved an experimental task in which the participants were required to work in groups and redesign a process for procuring complex software development services. While this experimental task was developed based on a "real" project (Kock and Murphy, 2002), it placed participants in a controlled setting with an experiment facilitator and time restrictions. The experiments involved hypothetical choices made under conditions where there were no consequences to the participants regarding their process redesign efforts. Hence, the conditions were artificial.

The second study, an action research investigation of the use of an e-collaboration tool in twelve process improvement groups, studied the groups in their natural working environment while they worked on "real" process improvement projects. Unlike the task used in the first study, the tasks in the second study did not involve hypothetical choices and the outcome of each process improvement effort had a direct impact on the participants. Thus, the groups faced real consequences and had incentives to make high quality process improvement decisions.

Incentives have the effect of motivating individuals to work harder and to achieve a higher level of performance by increasing an individual's involvement with the task (Todd and Benbasat, 1999). Involvement is defined as the perceived personal relevance and hence commitment an individual has to completing a task (Celsi and Olson, 1988; Barki and Hartwick, 1989). Given the motivating effect of incentives, it seems reasonable that subjects in the second study worked harder, and thus, overcompensated for the obstacles posed by the e-collaboration tool. This would explain the high quality of outcomes of their process improvement efforts while using the e-collaboration tool. Following this logic, it also seems reasonable that subjects in the first study had less motivation to perform well in their task, compared to the subjects in the second study, due to the experimental nature of the task. The subjects in the first study still exhibited compensatory adaptation (perhaps involuntary) to the obstacles posed by the e-collaboration tool, but their level of compensatory adaptation was not as high as the subjects in the second study. Hence, the performance of the subjects in the electronic condition was equal to, but not better, than those of the face-to-face groups in the first study.

While these explanations for the e-collaboration behavior exhibited in both studies are speculative, they suggest the need for further refinement of the media naturalness and compensatory adaptation hypotheses. The compensatory adaptation hypothesis argues that all users of e-collaboration tools will compensate for the obstacles posed by the electronic medium. However, the degree of compensatory adaptation behavior may be dependent on other factors. Future research should address the moderating influence of variables such as motivation and self-efficacy on compensatory adaptation.

CONCLUSION

This paper argues, in an apparently paradoxical way, that obstacles posed by e-collaboration tools do not significantly affect the quality of group outcomes, as groups often attempt to compensate, or even overcompensate for them. This counterintuitive argument is supported by evidence from two studies that examined the competing influences of media naturalness and compensatory adaptation. The results presented help explain many of the contradictory findings of research on e-collaboration technologies conducted so far and open the way for future theoretical integration.

Out of this discussion, we can now outline an agenda for further work on the media naturalness and compensatory adaptation hypotheses. First, research is needed to understand the temporal aspects of the compensatory adaptation phenomenon. Compensatory adaptation involves a "cost" as users exert cognitive effort to overcome the limitations of e-collaboration tools. We need to understand if and when this cost becomes too much of a burden for users of e-collaboration tools, causing them to discontinue their use.

Second, future research needs to address the likely reduction in cognitive effort associated with e-collaboration tools as users become more adept at using those tools. At least one recent study supports the notion that the need for compensatory adaptation will decrease as the familiarity with an e-collaboration tool increases (Carlson and Zmud, 1999).

Finally, future research should address compensatory adaptation in several contexts. A limitation of the studies presented in this paper is that they both involved similar tasks where the users were required to evaluate a business process and come up with an optimal redesign solution. These tasks could be considered "idea generation." Prior research on e-collaboration behavior found that groups using e-collaboration tools performed just as well as face-to-face groups on idea generation and decision-making tasks, but found that face-to-face groups outperformed groups using e-collaboration tools on intellective and negotiation tasks (Hollingshead et al., 1993). While both the media naturalness and compensatory adaptation hypotheses are task independent, perhaps the degree of compensatory behavior is influenced by the nature of the task performed.

REFERENCES

Barki, H. and Hartwick, J. (1989), Rethinking the Concept of User Involvement, *MIS Quarterly*, V.13, pp.53-63.

Bates, B. and Cleese, J. (2001), *The Human Face*, DK Publishing, New York, NY.

Boaz, N.T. and Almquist, A.J. (1997), *Biological Anthropology: A Synthetic Approach to Human Evolution*, Prentice Hall, Upper Saddle River, NJ.

Carlson, J.R. and Zmud, R.W. (1999), Channel Expansion Theory and the Experiential Nature of Media Richness Perceptions, *Academy of Management Journal*, V.42, No.2, pp. 153-170.

Cartwright, J. (2000), *Evolution and Human Behavior: Darwinian Perspectives on Human Nature*, The MIT Press, Cambridge, MA.

Celsi, R. and Olson, J. (1988), The Role of Involvement in Attention and Comprehension Processes, *Journal of Consumer Research*, V.15, pp.210-224.

Dobzhansky, T. (1971), *Mankind Evolving: The Evolution of the Human Species*, Yale University Press, New Haven, CN.

Hollingshead, A.B., McGrath, J.E., and O'Conner, K.M. (1993), Group Task Performance and Communication Technology: A Longitudinal Study of Computer-Mediated Versus Face-to-Face Work Groups, *Small Group Research*, V.24, No.3, pp. 307-333.

Jung, C.G. (1968), *Analytical Psychology: Its Theory and Practice*, Vintage Books, New York, NY.

Kock, N. (1998), Can Communication Medium Limitations Foster Better Group Outcomes? An Action Research Study, *Information & Management*, V.34, No.5, pp. 295-305.

Kock, N. (1999), *Process Improvement and Organizational Learning: The Role of Collaboration Technologies*, Idea Group Publishing, Hershey, PA.

Kock, N. (2001), The Ape that Used Email: Understanding E-communication Behavior through Evolution Theory, *Communications of the AIS*, V.5, Article 3, 29 pp. http://cais.isworld.org/.

Kock, N. (2001b), Behavior Toward E-Communication Tools: A New Theoretical Model Based on Evolution Theory, *Proceedings of the 2001 Informing Science Conference*, Cohen, E. and Zaliwski, A.J. (Eds), Cracow University of Economics, Crakow, Poland, pp. 310-317.

Kock, N. (2001c), Compensatory Adaptation to a Lean Medium: An Action Research Investigation of Electronic Communication in Process Improvement Groups, *IEEE Transactions on Professional Communication*, V.44, No.4, pp. 267-285.

Kock, N. and Murphy, F. (2002), *Redesigning Acquisition Processes through E-Collaboration*, E-Collaboration Research Center, Temple University, Philadelphia, PA.

Kock, N. and D'Arcy, J. (2002), Resolving the E-collaboration Paradox: The Competing Influences of Media Naturalness and Compensatory Adaptation, *Information Management and Consulting*, (Forthcoming).

McNeill, D. (1998), *The Face: A Natural History*, Little, Brown and Company, Boston, MA.

Rosenthal, R. and Rosnow, R.L. (1991), *Essentials of Behavioral Research: Methods and Data Analysis*, McGraw Hill, Boston, MA.

Todd, P. and Benbasat, I. (1999), Evaluating the Impact of DSS, Cognitive Effort, and Incentives on Strategy Selection, *Information Systems Research*, V.10, N.4, pp.356-374.