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ABSTRACT

In the group decision-making literature, the effects of diversity on group interaction and performance have also been well investigated. However, with the increasing reliance of organizations on collaborative technology, it is not clear whether cognitive diversity affects the decision-making processes and group performance across cultural and geographic boundaries in a similar fashion as it does in traditional face-to-face teams. Our goal of this study, thus, is to compare the effects of cognitive diversity on group interaction and decision outcomes in traditional teams and computer-mediated teams. Considering the two dimensions of cognitive diversity, we suggest that in traditional teams, surface-level cognitive diversity reduces team members' satisfaction with group interaction; while deep-level cognitive diversity improves team members' satisfaction with group decisions. In comparison, the negative effect of surface-level cognitive diversity will be mitigated in virtual teams, whereas the positive effect of deep-level cognitive diversity will be strengthened. The study is empirically tested using an intellective decision-making task. Results provide partial support for our hypotheses, and shed light on both research and practice involving technology-mediated teams.

Keywords

Cognitive diversity, Decision-Making, Computer-Mediated Communication.

INTRODUCTION

Many studies suggest that cognitive diversity brings a positive element to group performance and it leads to team creativity and improved quality of decision-making (e.g., Bantel and Jackson, 1989). Although not directly focusing on cognitive diversity, other group researchers have also investigated the effects of diversity on decision-making. Group interaction and decision quality are usually the dependent variables in examination of diversity. Research findings suggest that diverse teams have a lot of potential in terms of creativity. However, diverse teams may not outperform homogenous ones on overall solution quality because heterogeneity can hurt group interaction (Distefano and Maznevski, 2000). People with similar attributes are likely to categorize themselves into the same category, and tend to get along with each other. Getting along is a beneficial factor to group process, and group homogeneity contributes to group interaction by building higher levels of cohesion (O'Reilly, Caldwell and Barnett, 1989) and reducing intense arguments associated with less conflict (Eisenhardt, Kahwajy and Bourgeois, 1997). Therefore, even though diverse teams have the creativity advantage given their abilities of bringing together different ideas, knowledge, and approaches to work, workforce diversity also brings the risks of group clashes and paralysis because of the detrimental impact of diversity on group interaction.

Given the increasing reliance of organizations on information technologies, it becomes a common phenomenon that group members work across cultural and geographic boundaries to discuss business issues and make decisions via computer-mediated communication (CMC). Although research about diversity in traditional teams is mature and well developed, much less is known about the effects of cognitive diversity on group decision-making in CMC settings. Our goal in this paper is thus to compare the impacts of cognitive diversity on group interaction and group outcome in traditional face-to-face (FTF) groups and CMC groups. Specifically, we focus on two levels of cognitive diversity, i.e. surface-level cognitive diversity and deep-level cognitive diversity. We propose that in traditional teams, surface-level cognitive diversity reduces team members' satisfaction with group interaction, while deep-level cognitive diversity improves team members' satisfaction with

group decisions. Drawing upon the CMC literature, we further suggest that in technology-supported teams, the negative effect of surface-level cognitive diversity will be attenuated in virtual teams, whereas the positive effect of deep-level cognitive diversity will be amplified.

In the following sections, we first present our research model based on the theoretical work about cognitive diversity in decision-making. Empirical results obtained from a decision-making experiment are presented and explained, followed by discussions of limitations and implications of this study for practice and research.

THEORETICAL BACKGROUND AND RESEARCH MODEL

Our research model is presented in Figure 1. We focus on decision-making tasks and explore the effects of cognitive diversity on group interaction as indicated by process satisfaction, and on the quality of decision-making as implied by solution satisfaction. Below we discuss the details of our research model and present our hypotheses.

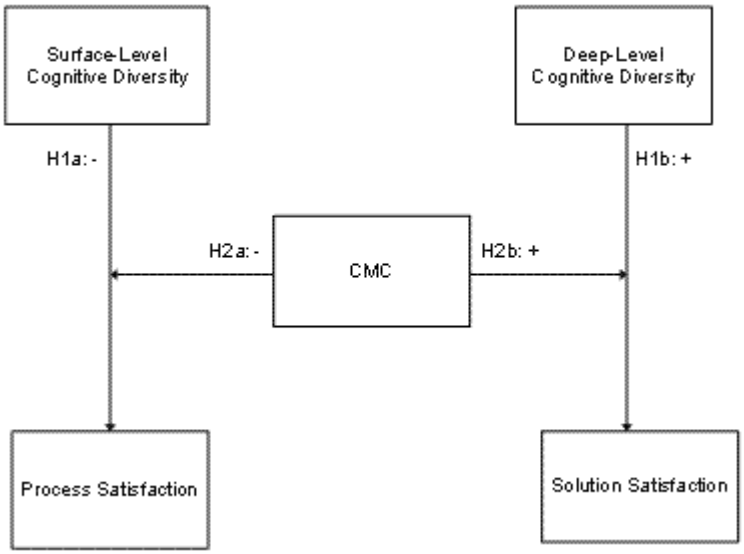

Figure 1: Research Model

Research Model

During the last half-century, researchers in many domains have explored the effects of diversity on group processes and performance. Research in this domain is primarily built upon social categorization, social identity, and similarity/attraction theories. Results suggest that diversity impacts these two variables in different ways. First, when people perceive others to be similar and in the same social category, they are more likely to get along and interact well with each other. Group homogeneity thus is associated with more open communication that helps build higher levels of cohesion (O'Reilly et al, 1989). Also, similarities among team members tend to result in less disagreement and fewer arguments; therefore homogenous groups are associated with less conflict (Eisenhardt et al, 1997).

Second, some studies suggest that heterogeneity has positive effects on group performance because group members with diverse attributes contribute to group interaction with different ideas and perspectives, which ultimately improves the quality of outcomes (Schweiger, Sandberg and Ragan, 1986). Also, heterogeneity produces tension and conflict, which reduces group think and contributes to a more complete analysis of the problems and consequently better decisions and performance (Watson, Kumar and Michaelsen, 1993).

In a group decision-making task, both the social environment of group interaction (i.e. group process) and the quality of a group's decision (i.e. group performance) play an important role in affecting member satisfaction (Gouran, 1973). Subsequent studies have suggested that group processes and performance are related to different dimensions of satisfaction. One dimension correlates to group processes and reflects satisfaction with interaction quality and is defined as process satisfaction. Process satisfaction includes relational and procedural aspects of the activity, member contribution, and participation (Witteman, 1991). It is positively correlated with variables that represent group interaction such as cohesion, wherein the more cohesive a group is, the more its members are likely to be satisfied with the group's interaction processes (Summers, Coffelt and Horton, 1988). The other dimension of satisfaction correlates to group performance and is defined as solution satisfaction, which is associated with the quality of decisions made by the group. This dimension captures task-oriented behavior and generates a sense that the products created are worth more than the costs of producing them (Gouran,

Brown and Henry, 1978). Based on these arguments, we use process satisfaction as a reflection of the quality of a group's interaction, and solution satisfaction as an indication of decision-making performance.

Main Effects of Cognitive Diversity

Cognitive diversity refers to the differences among team members' overtly unobservable traits such as attitudes, values, and beliefs (Kilduff, Angelmar and Mehra, 2000). Individuals have their own cognitive schemas that explain the world around them and help make sense of their interpersonal behaviors. Cognitive schemas may be understood through a duality of deep-level and surface-level structures. On the one hand, cognitive schemas represent deep structures that are not so easily identifiable, such as personal beliefs or culture, which is the world-view of a particular group of people that constructs meanings and subjectivities (Geertz, 1973). In order to be communicative, cognitive schemas are articulated and revealed through text and actions, which reflect their surface structures. Deep-level cognition forms subjectivity, and the inner life of acting subjects, and surface-level cognition is embedded in the social world.

When working in a group, individual-level interpretations converge into an interpretation that could be ascribed to the group due to commonality of schemas (Daft and Weick, 1984). With the presence of dissimilarities in personal interpretations, group members share and discuss the differences until a single, group-level interpretation is reached. However, not all cognitive schemas always lead to convergence of individual interpretations, while there are conditions under which the convergence process will not yield a single group interpretation. Specifically, cognitive complexity (information equivocality) and politicality (contentious biases) impede any shared schema's ability to forge consensus (Moussavi and Evans, 1993).

Three theoretical bases are most common for explaining the effects of diversity on group process (e.g. conflict, cohesion, communication) and ultimately group performance: social categorization and social identification, similarity/attraction, and information diversity and decision-making (Williams and O'Reilly, 1998). The tenets of social categorization and social identification theories are individuals desire to maintain self-esteem, which is done through a process of social comparison with others. Before making the comparisons, individuals define themselves in terms of social identity and categorize themselves and others into social categories using easily discernable features (Turner, 1982). Once the categorization has occurred, members tend to generate more favorable feelings toward those in their groups and reject the out-group members (Brewer, 1979).

Through communication and interaction, group members coming from different backgrounds are subject to the discovery of their surface-level cognitive diversity, which is reflected by the differences in their ideas. Once evoked, these distinctions among individuals will potentially lead to stereotypes, biases, and prejudices. Since group members form subgroups with those who think alike, groups with diverse cognitive structures on the surface-level (i.e. the communicative level) are often associated with lower levels of cohesion, reduced within-group communication, higher levels of conflict, and ultimately group dysfunction and decreased group satisfaction (Triandis, Kurowski and Gelfand, 1994). Drawing upon social categorization theory, we propose that surface-level cognitive diversity will have negative effects on group processes in traditional face-to-face teams.

> *H1a: In traditional teams, there will be a negative relationship between surface-level cognitive diversity and members' satisfaction with group process.*

The similarity/attraction paradigm suggests that members perceive themselves to be similar to or different from others in the group based on the attributes ranging from demographic variables to attitudes and values. Similarity among group members increases their interpersonal attraction and liking (Byrne, 1971). Similarity/attraction paradigm tends to focus on deep-level cognitive diversity to the extent that individuals will interact first before forming opinions (Carte and Chidambaram, 2004). Given that communicative cognitions are shaped by deep-level cognitive attributes, individuals who share similar cultures and values will find it easier and more desirable to interact with each other (Pfeffer, 1985). Individuals with different deep cognitive structures may find it difficult to penetrate an interaction network built off of similarities. Moreover, dissimilarity often results in intra-group process losses (Riordan and Shore, 1997).

People may change their surface-level ideas easily if they are challenged by alternative explanations. However, deep-level cognition is not easily transformed as it is deeply rooted in social meanings and is the belief held by a person. Groups comprised of members with high levels of cognitive diversity allow members to access to a greater range of information, which enhances group performance (Ancona and Caldwell, 1992). Individuals with cognitive diversity have a broader range of knowledge and experience, which promote creativity in groups. To this end, cognitive diversity adds new information and contributes to improved team performance in problem solving tasks that require multiple perspectives and diverse knowledge.

In addition, cognitive diversity brings different individual interpretations that challenge group consensus and reduce the possibility of groupthink. Groupthink occurs when a majority of people in a group impose their common position on a minority of dissenters during decision making (Janis, 1989). In cases where the majority position is "wrong", people with

minority positions are confronted with fear of reprisal from or negative evaluation by the majority. By the same token, to avoid criticizing and rejecting viewpoints, group members with good ideas not supported by the majority will withhold their opinions. To this end, groupthink is detrimental as it hinders the contribution of fresh perspectives or creative solutions to problems that do not align with the majority position (Diehl and Stroebe, 1987). So we suggest that with the help of both information completeness and challenges of in-group thinking, deep-level cognitive diversity will enhance group performance in traditional face-to-face teams.

H1b: In traditional teams, there will be a positive relationship between deep-level cognitive diversity and members' satisfaction with group solution.

Moderating Effects of CMC

Communication technologies offer a range of capabilities, including anonymity, simultaneity, and the lack of information richness and instant feedback. Some of these capabilities limit certain aspects of traditional FTF communication while others enhance them (Carte and Chidambaram, 2004). The capabilities that curb normal communication and speech patterns (i.e. reductive capabilities) include visual anonymity, equality of participation, and asynchronous communication; whereas the capabilities that enhance normal communication exchanges (i.e. additive capabilities) include coordination support, electronic trail, and enhanced capabilities that support decision making and rich messaging.

The reductive capabilities of computer-mediated technologies will be our focus in this paper because they are most widely used in almost every computer-mediated communication. Although such capabilities are associated with impaired relational development especially during the early stages of a diverse group's life (Chidambaram, 1996), they could be helpful in mitigating the negative effects of cognitive diversity on group interaction. Especially for zero-history teams, members may exchange less comments or ideas in a CMC setting (Hollingshead, 1996). The limited communication constraints that team members encounter prevent them from recognizing the surface-level cognitive differences, thus group interaction will be associated with less conflict and more cohesiveness (Triandis et al, 1994; Miranda and Bostrom, 1993). Consequently, group members will be more satisfied with group processes. To sum up, we expect that the negative impact of surface-level cognitive diversity on group interaction will be mitigated by CMC.

H2a: In CMC groups, the negative effects of surface-level cognitive diversity on process satisfaction will be weakened.

Information completeness is one of the advantages of teams with deep-level cognitive diversity. CMC encourages group members to convey information that is not otherwise conveyed through face-to-face communication by lowering evaluation apprehension and increasing participation (Sproull and Kiesley, 1986; Dennis, George, Jessup, Nunamaker and Vogel, 1988). Thus, CMC is associated with even more complete information by providing an open environment for group communication of deep-level cognitions. As we mentioned earlier, the ability of any shared schema is impeded by information equivocality and contentious biases (Moussavi and Evans, 1993). The reduced cues in CMC groups, in a sense, strengthen information equivocality, which could be a negative factor in some cases, but is beneficial in sustaining the deep-level cognitive diversity of individual members.

From the perspective of groupthink, CMC breaks down the communication barriers raised by majority influence by reducing inhibitions associated with evaluation apprehension (Dennis et al, 1988). Thus, CMC has the potential to alleviate majority influence (Tan, Wei, Watson, Clapper and McLean, 1998). Specifically, CMC reduces the verbal and visual cues that are effective means of exerting conformance pressure, which makes it longer for the minority to yield to majority influence. Also, CMC enhances the ability of the minority to challenge groupthink because the minority is less constrained by verbal and visual cues in their behaviors and is less concerned about how they will be evaluated by the majority. In other words, members with deep-level cognitive diversity will become more active in group interactions because those with minority opinions will be more courageous in expressing their perspectives and challenging others' positions. Thus, we propose that CMC will reduce groupthink and weaken the influence of majorities and thereby raise the quality of group decisions.

H2b: In CMC groups, the positive effect of deep-level cognitive diversity on solution satisfaction will be amplified.

RESEARCH DESIGN

This study involved an intellective decision-making task that was accomplished by 21 groups, 11 of which were face-to-face teams while the remaining 10 were computer-mediated groups. A total of 73 subjects participated in the study.

Information about country of origin and major were collected from all subjects. We use country of origin as a surrogate for deep-level cognition, and major as a proxy for surface-level cognition. To evaluate group interaction processes and group outcome, we relied on Gouran's (1978) satisfaction scale, with five items measuring process satisfaction and

another five items measuring solution satisfaction. The process satisfaction scale generated a reliability of .90; and the solution satisfaction exhibited a reliability of .85.

The unit of analysis in this study is the group. Given that the two independent variables were categorical, we followed Blau's method and calculated a diversity index for each variable (country of origin and major) using the formula $1-\Sigma pi^2$, where pi = the percentage of individuals in the ith category. The results provided an index of diversity, with a larger number indicating higher team diversity for variable. Table 1 presents the descriptive statistics for the continuous variables.

	CMC Groups		FTF Groups	
	Mean	Std. Deviation	Mean	Std. Deviation
SATISFACTION				
Process	3.50	.54	4.13	.45
Solution	3.41	.36	3.98	.44

Table 1: Descriptive Statistics

We also tested the correlations among the continuous variables using both groups, as presented in Table 2. The results revealed that for the subjects in both settings, the two measures of satisfaction were significantly related ($p<.01$), confirming that they are inter-related.

	Process Satisfaction	**Solution Satisfaction**
Process Satisfaction	1	
Solution Satisfaction	.617**	1

** Correlation is significant at the .01 level (2-tailed)

Table 2: Correlations

RESULTS

We first ran the one-way ANOVA for all the data (21 groups) to examine whether the FTF and CMC settings were statistically different regarding the two dependent variables (i.e. process and solution satisfaction). The results were significant ($p<.01$) as indicated in Table 3, and suggested that FTF and CMC teams expressed different levels of satisfaction with their interaction and decision solution.

		Sum of Squares	**DF**	**Mean Square**	**F**	**Sig.**
Process Satisfaction	Between Groups	2.054	1	2.054	8.505	.009
	Within Groups	4.588	19	.241		
	Total	6.642	20			
Solution Satisfaction	Between Groups	1.687	1	1.687	10.399	.004
	Within Groups	3.082	19	.162		
	Total	4.769	20			

Table 3: Satisfaction across FTF and CMC Groups

To further examine what factors contributed to these differences, we split up the two groups to investigate the effect of surface-level and deep-level cognitive diversity in both teams. We categorized the groups into low- (index<.5) and high-diversity (index>.5) along diversity indexes of major and country of origin; and conducted one-way ANOVA to assess the influences of surface-level and deep-level cognitive diversity on process and solution satisfaction in both teams. Because of the small sample size (10 for CMC teams and 11 for FTF teams), we consider the significance level to be $p<.1$. Interestingly, for face-to-face teams, surface-level cognitive diversity was significant on solution satisfaction as indicated by Table 4, whereas for CMC groups, deep-level cognitive diversity of was significant on both process satisfaction ($p<.1$) and solution satisfaction ($p<.05$) as presented in Table 5. There were no interaction effects between surface-level cognitive diversity and deep-level cognitive diversity in both teams.

		Sum of Squares	DF	Mean Square	F	Sig.
Process Satisfaction	Between Groups	.008	1	.008	.037	.851
	Within Groups	1.994	9	.222		
	Total	2.003	10			
Solution Satisfaction	Between Groups	.602	1	.602	4.055	.075
	Within Groups	1.337	9	.222		
	Total	2.003	10			

Table 4: The Effect of Surface-Level Cognitive Diversity in FTF Groups

		Sum of Squares	DF	Mean Square	F	Sig.
Process Satisfaction	Between Groups	.986	1	.986	4.929	.057
	Within Groups	1.600	8	.200		
	Total	2.585	9			
Solution Satisfaction	Between Groups	.461	1	.461	5.412	.046
	Within Groups	.682	8	.085		
	Total	1.143	9			

Table 5: The Effect of Deep-Level Cognitive Diversity in CMC Groups

Furthermore, the means plots in Figure 2 and 3 indicate that in FTF teams, higher surface-level cognitive diversity was associated with lower levels of satisfaction with the solution. In CMC teams, higher deep-level cognitive diversity led to higher levels of both process satisfaction and solution satisfaction. The results reveal that, in face-to-face teams, solution satisfaction is negatively impacted by the team's surface-level cognitive diversity. In CMC teams, both process satisfaction and solution satisfaction are positively influenced by the team's deep-level cognitive diversity.

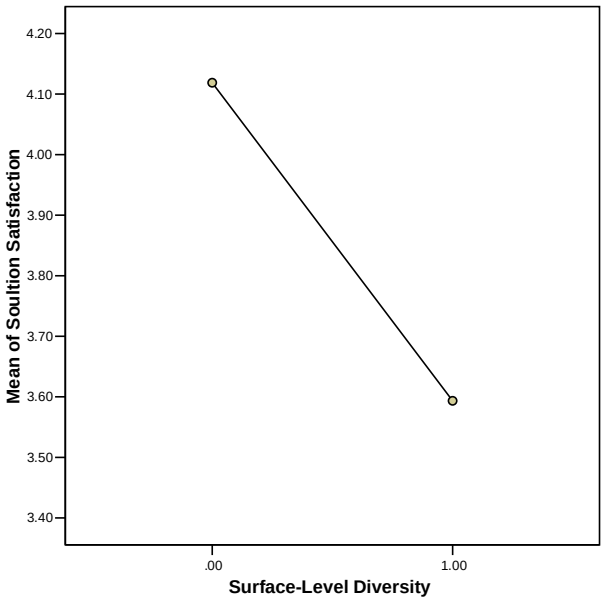

Figure 2: Relationship between Major and Solution Satisfaction in FTF Teams (High Diversity =1)

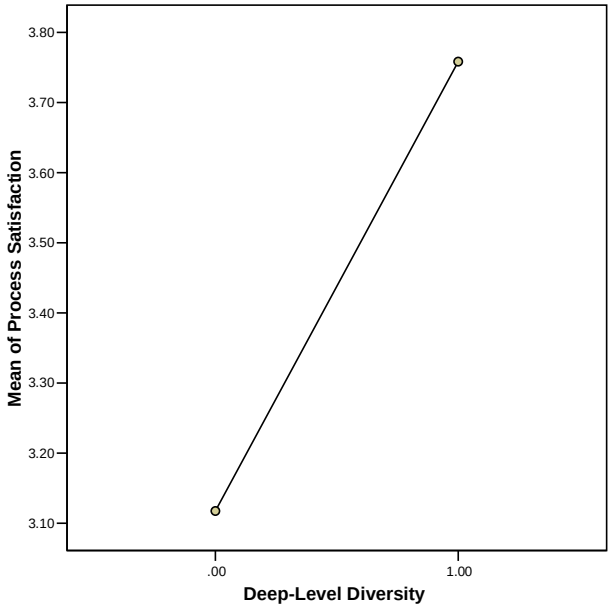

Figure 3a: Relationship between Country of Origin and Process Satisfaction in CMC Teams (High Diversity =1)

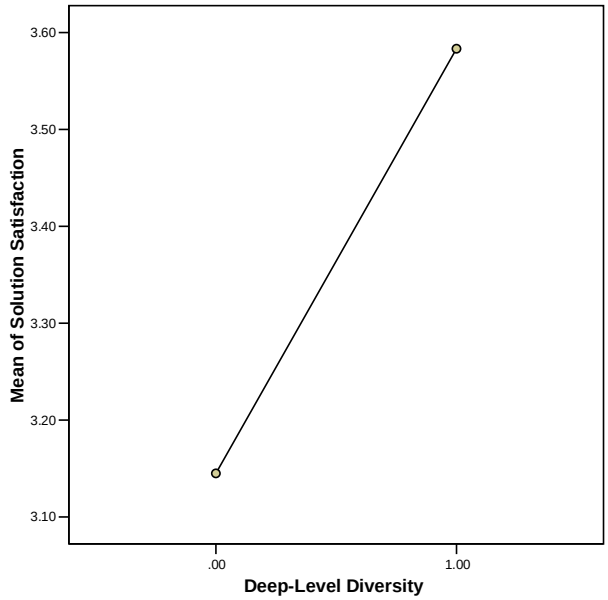

Figure 3b: Relationship between Country of Origin and Solution Satisfaction in CMC Teams (High Diversity =1)

DISCUSSION AND CONCLUSIONS

For FTF teams, contrary to our hypothesis H1a, surface-level cognitive diversity had a negative impact on satisfaction with the solution, but not on process satisfaction. In addition, deep-level cognitive diversity did not have any effects on group solution, contradicting our hypothesis H1b. Based on the existing literature, such results are not counter-intuitive though. In FTF teams, members frequently feel retaliation or worry about being judged by others (i.e. evaluation apprehension) (Connolly, Jessup, and Valacich, 1990). Given this concern, group members in FTF teams may not fully reveal their deep-

structured thoughts or ideas, resulting in an intentional hiding of their deep-level cognitive diversity. Thus, the effects of deep-level cognitive diversity may not be strong enough to have any impacts on group outcome. By holding back different ideas and not daring to integrate them into the final decision, group members also tend to feel less satisfied with the group solution.

For CMC teams, the results support our predictions and reveal that deep-level cognitive diversity demonstrates positive impacts on both satisfaction with group interactions and with the group solution. With the reductive capabilities of CMC, team members have less interaction tension induced by surface-level cognitive diversity, which may actually stimulate group discussion and help team members feel more involved and thus more satisfied with the group interaction. Group members will also feel less evaluation apprehension and will exchange deep-structured ideas more freely. Teams that are cognitively diverse at the deep-level are likely to have higher degrees of creativity, which will stimulate group discussion and improve interaction processes, resulting in better quality of decision-making.

With the increasing popularity of groups supported by advanced communication technology, this study reveals that deep-level cognitive diversity positively impacts group interaction and decision outcomes. Thus, by effectively using computer technologies, decision-making groups will be better off by leveraging their deep-level cognitive diversity to improve group interaction and decision-making performance.

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