Virtual Team Effectiveness And Sequence Of Conditions

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ABSTRACT

This study examines the sequence of Group Task Pressure (GTP) and communication medium conditions on group effectiveness. It contributes to the task-technology fit research by considering the sequence of these conditions on task-technology fit related to group effectiveness. The study has value for professionals pursuing the construction and management of virtual teams. A pilot experiment was conducted using 22 subjects in eight groups with a mixed 2x2 design. Given the sample size, the study is more descriptive than inferential. The study manipulated GTP by combinations of time scarcity, reward and task complexity. The media conditions used in the study were face-to-face and synchronous computer-mediated chats. Group effectiveness was measured by the length of time groups took to complete assigned tasks. The four study conditions were: a simple task completed face-to-face, a simple task completed in a computer-mediated condition, a complex task completed in a face-to-face condition and a complex task in a computer-mediated condition. Each group was rotated through all the conditions. The sequence of communication medium conditions were significant, but not the sequence of GTP conditions. Groups starting in the face-to-face condition took less time to complete their rotation of tasks than groups starting in the computer-mediated condition. Groups starting in both the low and high GTP conditions took the same amount of time to complete the full rotation of task and conditions. Recommendations for subsequent research on group task pressure are presented.

Keywords: Virtual Work; Virtual Teams; Team Performance; Group Work; Computer Mediated Communication; Collaboration; Group Effectiveness; Time Pressure

INTRODUCTION

A great number of studies have emphasized the importance of communication environment for effective team performance. This research has been influenced by Media Richness Theory (Daft and Lengel 1984;Daft and Lengel 1986) . While Media Richness Theory (MRT) has high face validity, empirical studies have not always supported MRT (Kiesler et al. 1984;Kiesler and Sproull 1992;Olson et al. 1997;Sproull and Kiesler 1986). MRT has been critiqued by adaption theorists (McGrath et al. 1993;Poole and DeSanctis 1990) who emphasize that both task-fit and group adapation have a role in group effectiveness. Groups react to a mismatch of task and communication fit by adjusting task and communication. The sequences of conditions can be a factor that group adjustment process.

This paper builds on the literature by asking questions related to the sequence of both communication medium and task pressure conditions on group performance. Social presence theory, media richness, and task pressure literature are reviewed to provide context for the question of GTP and media sequence on group performance. The hypotheses are then presented followed by a review of the methods used in the study and a discussion with recommendations for additional study as a conclusion.

LITERATURE REVIEW

Social Presence Theory

Seminal work on the relationship of technology and task was completed by Short, Williams and Christie (1976) in their work on teleconferencing. Their resulting Social Presence Theory (SPT) described communication mediums in terms of the degree to which the medium conveyed the physical presence of the participants. Physical presence was constituted of both verbal cues like timing, pauses, voice inflection, and nonverbal cues like facial expression, gaze, posture and physical presence. Social presence was a function determined by both the "warmth" and "personalness" of the medium or by how appropriate it was for a specific task (Fish et al. 1992;Johansen 1977;Reid 1977). The loss of nonverbal cues resulted in a significant decrease of social presence. As Short et al (Short, Williams, & Christie 1976) explained, audio and text media do not convey several visual cues present in face-to-face interaction and thus facilitate less social presence. Social presence is a human perception, not a quality of a technology.

Social Information Theory

Many researchers have explored online relationships. The initial studies were negative describing online communication as depersonalized. Walther (1992) strove to establish the value of online relationships and proposed the Social Information Processing Theory. SIP observes that online communication compensates for nonverbal communication as individuals develop alternative ways of giving and receiving messages. People are attuned to cues that are substituted for nonverbal communication, such as emoticons. People in face-to-face interaction are motivated to reduce interpersonal uncertainty and increase affinity. Individuals actively use computers, with their limited communication means, to put together perceptions of others. Once established, both online and face-to-face interpersonal relationships carry the same relational dimensions.

Media Richness

SPT can be seen in the work of Daft and Lengel's (1984) Media Richness Theory(1987) as communication richness. A communication mediums richness, or ability to transmit information, is related to the degree to which the communication medium carries social presence. According to Media Richness Theory (MRT), individuals communicating in computer-mediated conditions have less social presence than individuals communicating via telephone. Individuals communicating via telephone have lower social presence than if they were face-to-face.

Daft and Lengel (1987) proposed that media richness was a function of: 1) a medium's ability to provide immediate feedback; 2) the number of cues and channels accessible; 3) the variety of language possible; and 4) the degree of attention personally focused on the receiver or the sender. Their media classification was formal unaddressed written communication, addressed written communication, computer-mediated communication, telephone, video, and face-to-face. Face-to-face communication is the richest given its ability to facilitate multiple simultaneous observations of many cues: facial expression, body language, tone, and more. Further, face-to-face communication facilitates immediate feedback to check and confirm exchanged communication.

MRT suggested that for brainstorming tasks which involve routine tasks that are well understood and do not require emotional connotations, lean communication mediums, such as e-mail, provide sufficient information. The presence of additional emotive connotations can actually reduce group performance as more information is presented than is required. Media rich communication mediums are best linked to equivocal tasks, such as negotiation or decision making, which feature multiple interpretations of the available information and may involve conflict. The more a task requires multiple streams of communication, the richer the required communication medium. Accomplishing a complex task via a lean communication medium is not effective (Daft and Lengel 1987). Accomplishing a simple task via a rich communication medium is also inefficient (van der Kleij R. et al. 2009) .

Dennis and Valacich (1999) suggested a revised MRT, media synchronicity theory. MST incorporates the characteristics of modern communication technologies, particularly those technologies that feature simultaneous conversation. Face-to-face meetings only allow one person to speak at a time and those who are most verbal dominate, regardless of how much knowledge they have. Convincing group members to adopt a good idea are diminished if the person is less present. Group effectiveness can be increased when there is simultaneous communication. This technological development changes the Daft and Lengel (1984) media richness ranking (1987).

MRT has strong face validity, but has met with critique (van der Kleij 2007). One critical stream comes from adaptation theorist who emphasize that while task-fit is an important element of group effectiveness, group adaptation to mismatched task-fit also plays a role in group effectiveness. Groups react to a mismatch of task and communication fit by adjusting task and communication. Further, it is assumed that groups can be successful without a perfect task and communication fit. These adaptation theories do support the MRT alignment of work task and communication medium in that they suggest that fit is a factor. However, groups can adjust to the misfit (van der Kleij R., Lijkwan, Rasker, & De Dreu 2009).

Adaptive Structuration Theory

Sociotechnical Systems Theory was developed by the Tavistoc Institue of Human Relations shortly after World War II in the United Kingdom. The most well known Tavistock research was the longwall method of coal-getting by Trist and Barnforth (1951). They pointed out that organizations consist of both social and technical systems. You cannot change one without changing the other. A change in technology will lead to a change in the organization's social system.

DeSanctis and Poole (1994) also recognized the existence of technical and social systems. DeSanctis and Poole (1994) forwarded the Adaptive Structuration Theory, based on the work of Gidden (1984), as a means of organizational change. ADT understands change as a function the interaction of people and technology. New technology results in organizational change as the users adapt structures to utilize that technology. Organizational change involves the social dynamic of technology and people.

Individuals in organizations using technology for group work have perceptions about that technology regarding its limitations. These perceptions vary by group. These perceptions then influence how technology is utilized and impacts group performance. Systems are developed as individuals create structures, that is, as they determine what can and cannot be done with a technology. This interaction is the structuration process (DeSanctis and Poole 1994). It brings structure and change to organizations.

Attentional Focus Model

The Karau and Kelly (1992) Attentional Focus Model has been a useful framework in understanding the effect of time pressure on groups. The AFM attempts to integrate previous research on time pressure and performance with contemporary research on group interaction and performance. The AFM recognizes that time pressure does not function independently. Other factors are utilized by groups to determine the salient task cues; roles, hierarchies, norms, individual status and difference, are a few of the many factors often operating in conjunction with time pressure (Kelly and Loving 2004).

The basic idea of the AFM is that task time limits may affect what a group interacts with in its task environment. Time pressure increases group awareness of environmental factors that appear to be central in meeting the time line. Group members focus on a narrower range of task-relevant cues. Task completion becomes the primary filter and interaction objective. The focus becomes reaching consensus or making a decision in a timely manner (Kelly & Loving 2004). The group is less concerned with the quality of that decision or generating alternatives. At times this can result in less creative, more inadequate, and less carefully considered decisions (Kelly and Karau 1999).

In high time pressure conditions, groups focus on task completion activities. Kaplan and Miller (1987) reported that time pressure reduced systematic processing of task information resulting in faster decisions. Kelly and Loving (Kelly & Loving 2004) reported that when time is not a pressure for a group task, group members may be less task focused. Decreased group time pressure can result in group members seeing, and considering, a wider range of options. Additional cues are noticed and processed more systematically resulting in better decisions.

Kelly et al. (1997) found that time pressure performance effects were dependent upon the type of task. Time pressure groups performed better on judgmental tasks. Groups without task pressure performed better on intellective tasks. The effect of time pressure is contingent upon the group task.

Study Value

This study intends to add to the task-technology literature by exploring the sequence of both communication medium and GTP conditions. Social presence, media richness, and communication processes are all key elements of understanding the relationship between an effective match of task and technology. A better understanding of condition sequence will provide a fuller picture of how to link technology and tasks. The affect of sequence of study condition on group effectiveness is linked to Adpative Structuration Theory and the Attentional Focus Model.

Hypotheses

The study explored these hypotheses:

1. Groups starting with rich media conditions (low technical structure) will reduce the amount of time groups need to complete their tasks. See Figure 1.
2. Groups starting with low GTP conditions will reduce the amount of time groups need to complete their tasks. See Figure 2.

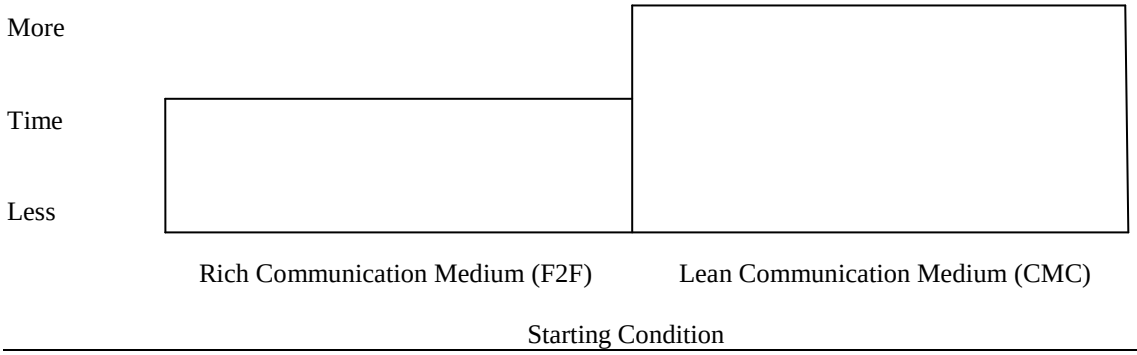

Figure 1: Hypothesis One – Affect of Media Starting Position on Time for Task Completion.

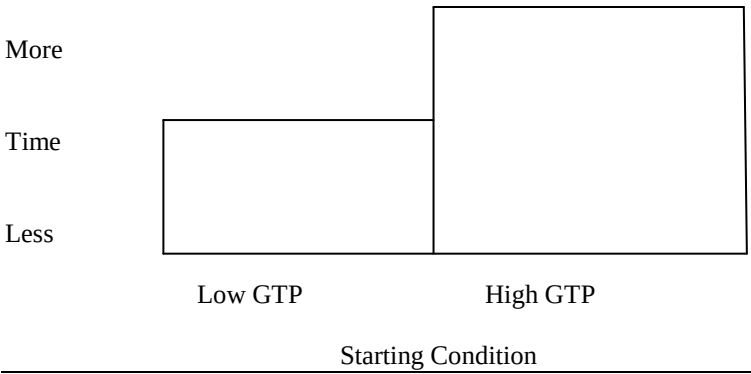

Figure 2: Hypothesis Two – Affect of GTP Starting Position on Time for Task Completion.

Research Method

The study is a pilot to guide subsequent research examining the relationship of group effectiveness to sequence of conditions. The study is descriptive; however, uses inferential statistical language as a means of describing the data and findings. A one way ANOVA was utilized to review the significance of group starting condition on group effectiveness.

The study conditions were GTP and communication medium. Group task pressure was manipulated by combinations of task complexity, reward, and time pressure. Complexity was addressed using a gradation of math puzzles, the reward was extra points based on group performance and time pressure was introduced through the timekeeper's instructions and stopwatch. The study media conditions were face-to-face and computer-mediated chats. The four study conditions were: a simple task completed face-to-face, a simple task completed in a computer-mediated condition, a complex task completed in a face-to-face condition and a complex task in a computer-mediated condition. Each group was rotated through all the conditions. See Figure 3.

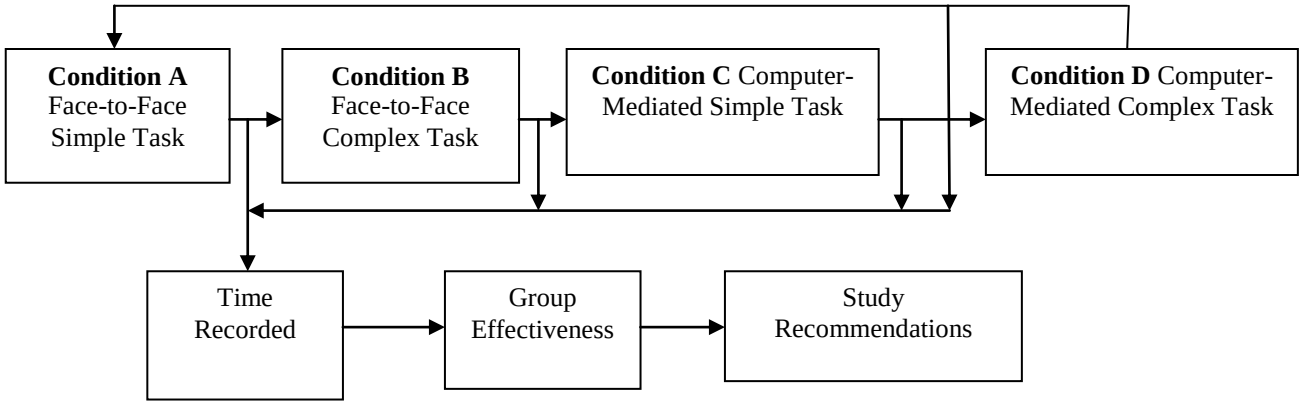

Figure 3: Research Model

Time Pressure Manipulation

Researchers have used a variety of means to introduce time pressure to group. Time constraints should not be determined arbitrarily (Benson and Beach 1996). Time restraints should be tested prior to the study to determine the correct amount of time required to create the desired time pressure. One approach has been to give subjects are given an unlimited amount of time to complete the task and then determine the mean. Svenson and Maule (1993) suggested deducting 25% of the mean time to induce time pressure. Van de Kliej et al (2009) used a similar method, but deducted 75% of the mean to induce high degrees of time pressure. Time pressure has also been inducing by rewarding the highest performing group (2000).

Baltes et al (2002) observed that the communication medium must be a factor in creating time pressure. Simple time limits may not sufficiently address communication efficiency differences between communication mediums. Care needs to be taken in developing time pressure conditions that reflect these differences. Others have suggested that time pressure cannot be created unless group members understand that there is a deadline with real reward or punishment to be avoided. This results in pressure being applied by group members instead of the time limitation (Caballer et al. 2005).

Kelly and Karau (1999) used the impression of time pressure as a stressor. The same amount of time was given to both the high pressure and low pressure condition. The pressure was introduced with the researcher's suggestions and artifacts. The groups in a high pressure condition were told that they had limited time and were given a stopwatch. Groups in a low pressure condition were not told that their time was limited and were not given a stopwatch. Kelly et al. (1997) manipulated time pressure in a similar manner. Time pressure was induced with the instructions. Low time pressure groups were told that their accuracy would be assessed, not time. High task pressure groups were given the same task, but told that they would be assessed on time and accuracy.

Pepinsky et al.(1960) also manipulated time pressure with timekeeper instructions. Low time pressure conditions had a signal given at the end of each 10 minute period. Medium conditions had a signal given every 3 minutes up to 18 minutes with signals following at two minute increments. High conditions had signals given at one minute intervals, increasing to 15 second intervals. The signals consisted simply in the timekeeper's saying, "___minutes to go," or toward the end of the session "____minutes " or "_____seconds."

Task complexity has also been used as a means of introducing time pressure. Kelly and McGrath (1985) used 20, 40, or 50 five letter anagrams in set time intervals of 5, 10 and 20 minutes to induce time pressure in their study on team performance. Team performance was determined on the basis of anagrams-per-person-per- minutes for different conditions of time sequence, time intervals, and task complexity.

This study introduced time pressure with a timekeeper and stopwatch. In every condition the timekeeper stated that the group would be timed and rewards given for groups with the highest performance. After ten minutes hints would be given to the group at 45 second intervals until the puzzles were completed. Groups were penalized for each hint given by an addition of 30 seconds to their final time. The timekeeper was present and silent during the study, providing hints and confirming answers as asked. When the puzzles had been completed, the timekeeper gave the group its final time.

Treatments and Procedure

Subjects in the computer-mediated condition were dispersed in a large library, out of line of site. Their only means of communication was text chat. Subjects in the face-to-face condition were located in a private room with a white board, chairs and a table. No conversation about the experiment was allowed between group members during the study. Each condition had a timekeeper to distribute the puzzles, give instructions and verify solutions. Each group member was given their own packet of puzzles for that condition. Only the timekeeper had the solutions.

Task Manipulation

Task complexity was manipulated through the use of computer based math puzzles. A puzzle with four numbers involving a three step solution were used for the high task complexity condition and a puzzle with three numbers involving a two step solution for the low task complexity condition. The puzzles required participants to use combinations of division, multiplication, subtraction, and addition. The math puzzles utilized were from the "Brain Builder" puzzle program (Sheppard 2002). Each puzzle had more than one solution. See Figures 4 and 5. When the group had agreed upon a solution (electronically for the computer-mediated condition and voice consensus for the face-to-face condition), one group member brought the solution to the timekeeper for verification. Groups could not proceed to the next puzzle until they solved the current puzzle. The same puzzles were used for each condition

Reward

The study also used reward to induce task pressure. Students were given course extra credit points based on their group performance. A range of points given was 5% to 3% of the course total. Groups were ranked by their overall time efficiency with points assigned on the basis of rank.

Communication Medium

The media conditions in the study were synchronous computer-mediated conferences and face-to-face meetings. Each group's starting condition was determined randomly. The condition sequence was the same for each group contingent upon starting condition: face-to-face low GTP to face-to-face high GTP to computer-mediated low GTP to computer-mediated high GTP. Groups were started in each condition.

Subjects

Prior to the study, subjects were given sample puzzles and solutions. All the subjects had experience with the computer-mediated asynchronous Blackboard platform and synchronous chat. The subjects had seen each other in class, but were not well acquainted. Group membership was determined randomly. There were 22 subjects in the study from two university graduate courses and one undergraduate course. Seven of the subjects were international students. The study consisted of six teams of three subjects and two teams of two subjects.

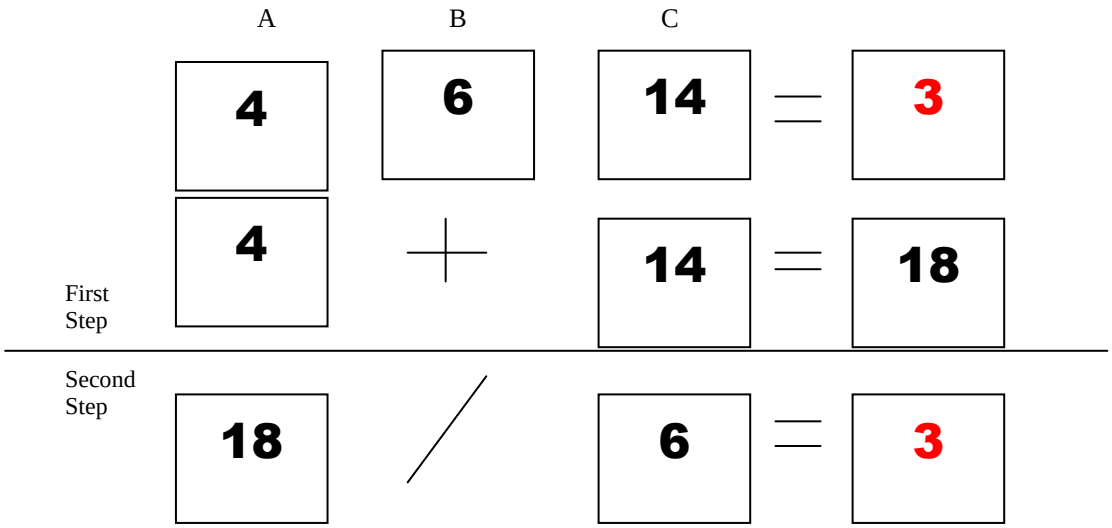

Figure 4: Three Number Puzzle

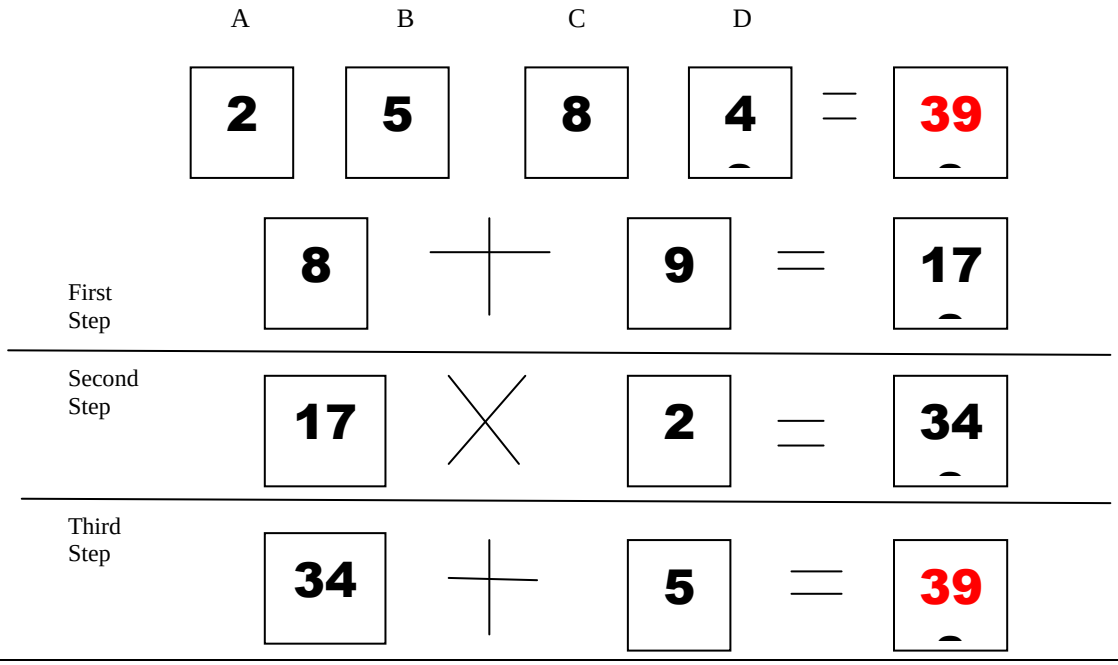

Figure 5: Four Number Puzzle

RESULTS AND DISCUSSION

Hypothesis One: Groups starting with rich media conditions (low technical structure) will reduce the amount of time groups need to complete their tasks. See Figure 1.

Hypothesis One and the Adaptive Structuration Theory were supported by the study. See Figure 6. There was a significant relationship between group starting position related to communication condition and group effectiveness. AST has been suggested as a means of understanding how groups work (DeSanctis & Poole 1994).

AST introduces the variables of time and expectation. People have initial perspectives regarding a technology's assets and liabilities. These perspectives frame how technology is utilized and impacts group performance. Over time these expectations can be changed through accumulative experience. These adaptations then restructure how the group works together. Individual expectations influence how a technology is used which impacts group performance. AST would suggest that over time groups learn how to work within their given technology parameters. Over time, groups should complete their tasks with increasing effectiveness and become more adept with complex tasks.

Given a positive gradation of technology with face-to-face being low and the computer-mediated condition being high, groups starting in the lower technical position of face-to-face should be more effective than those groups starting in a higher technical condition. Groups starting in the face-to-face condition will have less initial technical structure to which they need to adapt. This should position them to adapt to the computer-mediated condition with its increased technical structure more effectively.

Hypothesis Two: Groups starting with low GTP conditions will reduce the amount of time groups need to complete their tasks.

Hypothesis Two was not supported by the study. There was no significant relationship between group starting position related to GTP condition and group effectiveness.

Research on sequence of GTP conditions and group effectiveness has been mixed. Karau and Kelly (1992) proposed the AFM as a means of understanding group behavior in high time pressure conditions. Time pressure interacts with several group factors and should be understood in context of the whole system. When under high time pressure, groups tend to focus on completing their task assignment. Group members focus on a narrower range of alternatives and processes making completing the task a higher priority that the quality of the task.

Researchers have reviewed the affect of task complexity on group decision making (Ben Zur and Breznitz 1981;Christensen-Szalanski 1980;Gilliland and Schmitt 1993;Payne et al. 1988;Smith et al. 1982;Svenson et al. 1990;Wright 1974;Zakay 1985). Time pressure can lead to a restricted information search (Durham et al. 2000) and can make decisions without looking at all the alternatives (Janis 1983). Gilliland and Schmitt (1993) observed the impact of time constraints on both the amount of information processed and the time invested in examining each piece of information. Other researchers have observed that time pressure closed people's mind (Kruglanski and Freund 1983). Groups may accelerate information processing in an attempt to make the decision process more efficient (Ben Zur & Breznitz 1981;Payne, Bettman, & Johnson 1988) and the pace of decisions (Bryan and Locke 1967). These findings would suggest that engaged in a linear process of simple to complex would be more efficient than groups encountering high GTP as their initial condition. The low GTP condition will allow groups to gain initial experience with decision making that can be built on as GTP conditions increase.

Additional researchers (Kaplan and Miller 1987;Kelly & Loving 2004) have demonstrated the effect of time pressure on group decision making processes. However, the sequence of conditions related to increased time pressure and task complexity did not appear to affect the amount of time the groups needed to complete their tasks. The sequential effect starting in a low time pressure and task complex condition, with its open decision making process, then moving to a high time pressure low task complex condition, resulting in a possible snowball effect with the initial success of a more open decision making process preparing the group for a more restricted decision making process, was not reported.

This study lined up with the work of Kaplan and Miller (1987) and Kelly and Loving (2004). There was no significant relationship between GTP sequence and group effectiveness. These results may also have been the result of the research design. More time may be required for the research conditions to take effect. The lack of concurrence with previous studies may be attributed to insufficient exposure to the decision making process in each condition. Subjects did not fully experience the changes in decision making processes within each condition and thus did not report any difference.

Limitations

There were some limitations that prevent the study from being generalized. It lacked sufficient power to use inferential statistics. While statistical language was used in the study and was the mode of analysis, the study is more descriptive and based on means. Further, the research design did provide the conditions required to examine process and condition sequence. The study lacked the longitudinal component to better understand the relationship between condition sequence and group effectiveness. There was insufficient time for groups to experience the effects of structuration. More would have been learned about AST related to group effectiveness if the groups had been given more time for these processes to more fully develop. Moreover, the introduction of time pressure could have been improved. A pretest to determine time means would have better informed time pressure application. Using instruction and artifacts to induce time pressure has value and could have been better applied with a clearer idea of the actual time involved in groups completing the tasks in each condition. Reward was added to the design in order to further amplify time pressure. Reward can be effective if the group members perceive the reward as beneficial. The likelihood of additional extra credit points leading to a grade change was minimal. As a result, the reward was not motivational. Lastly, more care needed to have been taken to assess the GTP and communication medium interaction effect. The study was not able to address the significance of that interaction.

Recommendations

The rise of homeland security concerns and continued disaster response has led to increased utilization, and reliance, on short-term abbreviated virtual teams. Emergency teams will last only as long as the crisis. Their time to process and adapt to their task and technology will be abbreviated. What will matter are their initial responses, which mirror the focus of this study. More needs to be done to better understand, and support, the success and development of virtual emergency teams.

Subsequent research on group effectiveness and sequence of conditions need to include risk. Risk changes the landscape for group participants. They can behave one way in low risk conditions and very different way in high risk conditions. The degree of "skin in the game" can affect research findings related to group effectiveness and condition sequence. The value of a study will be related to the value the subjects place on research design outcomes.

Much has been written on task-technology fit related to the optimal alignment of task and technology. Work has also been done on the impact of time pressure on group decision making (Ben Zur & Breznitz 1981;Christensen-Szalanski 1980;Gilliland & Schmitt 1993;Payne, Bettman, & Johnson 1988;Smith, Mitchell, & Beach 1982;Svenson, Edland, & Slovic 1990;Wrightsman 1974;Zakay 1985) and task complexity (Campbell 1988). However, is room to learn more about the affect of time pressure related specifically to group effectiveness.

Another area meriting further research would be the affect of condition sequence on group effectiveness. Such research would have value for work flow design and organization prescribing sequences for maximum group efficiency. AST addresses process, but is more descriptive than prescriptive. It provides a framework for describing the interaction of groups, tasks, and technology related to organizational change. This foundation for understanding this process and would have added value if it could be used in a prescriptive way to address group effectiveness.

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