Communication Monographs
Vol. 71, No. 3, September 2004, pp. 352–372

Routledge
Taylor & Francis Group

Group Performance and Collaborative Technology: A Longitudinal and Multilevel Analysis of Information Quality, Contribution Equity, and Members' Satisfaction in Computer-Mediated Groups

Andrew J. Flanagin, Hee Sun Park & David R. Seibold

This study examined changes in members' satisfaction with group processes as they worked together over time to complete a series of seven group tasks. Members of 10 groups ($N = 58$) communicated with each other using a computer-based collaborative technology over a 10-week period. Satisfaction with group processes was partitioned into individual and group levels with Hierarchical Linear Modeling, and information quality and contribution equity were introduced as predictors of satisfaction. Findings indicated that (1) individuals' satisfaction increased over time; (2) the quality of information acquired from group members and the equity of contributions among members positively affected satisfaction after completion of the first group task; (3) information quality did not significantly affect the rate of changes in satisfaction, whereas contribution equity did; and (4) when individuals' contributions and others' average contributions were used as separate predictors of satisfaction, individuals' contributions were negatively related to satisfaction, but others' contributions were positively related to an individual's satisfaction.

Keywords: Computer-mediated communication; Computer-mediated groups; CMC; Collaborative technology; Group satisfaction

---

Andrew Flanagin (Ph.D., Annenberg School for Communication, University of Southern California, 1996) is associate professor, and David Seibold (Ph.D., Michigan State University, 1975) is professor in the Department of Communication at the University of California, Santa Barbara. Hee Sun Park (Ph.D., University of California, Santa Barbara, 2003) is assistant professor in the Department of Communication at Michigan State University. The authors thank René Dailey for her contributions, Ashley Duggan and Thomas Wiggins for their suggestions during the preliminary stages of this research, and the editor for his helpful comments. Please address all correspondence to Professor A. Flanagin, Department of Communication, 4840 Ellison, University of California, Santa Barbara, Santa Barbara, CA 93106-4020, USA. Email: flanagin@comm.ucsb.edu.

ISSN 0363-7751 (print)/ISSN 1479-5787 (online)
DOI: 10.1080/0363452042000299902

Although research using single observations (Frey, 1994a), often of zero-history groups (Frey, 1994b), has generated significant findings on group behaviors and outcomes (see Hare, Blumberg, Davies, & Kent, 1994), it is difficult to make inferences regarding developmental aspects of group processes from these findings (McGrath, Arrow, Gruenfeld, Hollingshead, & O'Connor, 1993). Absent multilevel analyses, the effects of individual versus group differences also are difficult to discern (Poole, Keyton, & Frey, 1999). Furthermore, in view of a contemporary media environment that enables collaboration among group members who are often not colocated, the nature of communication and information sharing is undergoing fundamental shifts (Scott, 1999). This study seeks to address each of these important issues in research on group communication by invoking multilevel analyses of longitudinal groups working together through computer-mediated channels. The goal of this investigation is to examine a crucial outcome variable—members' satisfaction with group processes—as influenced by contribution equity and information quality, and as it unfolds over time within groups supported by collaborative technologies. Each of these issues is examined in turn.

Collaborative Technology and Satisfaction with Group Processes

Research on face-to-face (FtF) groups indicates that member satisfaction is vital to groups. For example, the satisfaction of group members is critical to group performance (Keyton, 1991; Shaw, 1981); performance suffers when members are dissatisfied and unable to remedy their problems (Maier, 1950; Shaw & Blum, 1965). In addition, Gouran (1973) has shown that member satisfaction is significantly affected by people's perception of their own and others' contribution to group problem-solving efforts, and that satisfaction in FtF groups also varies directly with network centrality and with cohesiveness.

Computer-based technologies have been developed to aid group meetings in the hope of facilitating group performance, especially decision quality, process efficiency, and members' satisfaction (Scott, 1999). New technologies provide greater speed and flexibility in communication among group members (Bickson, 1994; Morton, 1996) and have been shown to result in increased member satisfaction in both laboratory studies and organizational settings (e.g., Alavi, 1994; Lou & Scammell, 1996; Nunamaker, Briggs, & Mittleman, 1995; Palmer, 1998). Negative effects of collaborative technologies on satisfaction also have been reported, however (e.g., Carey & Kacmar, 1997; Straus & McGrath, 1994; Straus, 1997; Warkentin, Sayeed, & Hightower, 1997), in part because such technologies take time for users to learn (Orlikowski, 1993), are sometimes inadequate in handling information flow (Ciborra, 1996), and may not protect privacy (Ciborra & Patriotta, 1996). Thus, the effects of group communication technologies on group members' satisfaction with group processes are somewhat equivocal (for a review, see Scott, 1999).

To some extent inconsistent findings on the relationship between group communication technologies and satisfaction with group processes may be explained by examination of moderating variables such as group size (Benbasat & Lim, 1993) and

members' experience with technologies (Hollingshead, McGrath, & O'Connor, 1993). Increases in either group size or familiarity with the use of the technologies generally lead to greater satisfaction. On the other hand, group members who do not adapt well to the use of collaborative technologies may become *less* satisfied over time. Thus, as members succeed or fail in familiarizing themselves with these technologies and getting along well with other group members, groups using collaborative technologies may be more or less satisfied with group processes in completing group tasks.

Notwithstanding these potential moderating factors, members' satisfaction with group processes—including in computer-mediated groups (CMG; Scott & Easton, 1996)—may hinge on perceptions of whether one belongs to a group whose members contribute equally (Gouran, 1973), or on perceptions of contribution equity among members. Satisfaction with group processes also may depend on how well group members interact with one another during group work (Shaw, 1981), especially in the form of the quality of information exchanged, a particularly relevant issue in computer-mediated groups (Olaniran, 1996). Finally, member satisfaction may vary over time as a result of these and other factors, such as performance and satisfaction at prior times (Poole et al., 1999). These potential determinants of member satisfaction in CMGs are examined in the following three sections, and three research questions are posed that undergird this investigation.

Contribution Equity in Group Work

Members' satisfaction with group processes may depend to some degree on contribution equity across group members. In general, the perception of equity in contribution is positively associated with greater satisfaction (Dittrich & Carrell, 1979; Kalleberg & Griffin, 1978; Wall & Nolan, 1987), although much less is known about this relation in computer-mediated groups working over time. According to equity theory, people assess their investments in relation to those of relevant others, and perceptions of equity or inequity motivate emotions and behaviors (Adams, 1965). More specifically, when people perceive that their contribution is unbalanced, relative to others' contributions, they experience inequity, which leads to a negative affective state.

As group members' perceptions of their own effort relative to other group members become more evenly distributed, group members may report greater and easier interaction among group members (Wittenbaum & Stasser, 1998). Although computer-mediated communication technologies and time affect participation in small groups, participation equalization findings might be limited to initial, or early, group meetings (Bonito & Hollingshead, 1997). As group members accumulate more experience working as a group, participation patterns may change (Contractor & Seibold, 1993) and contribution equity may shift as well, in several ways. Groups in which members contribute equally their effort and time for group work may see more benefits from using collaborative technologies and be more satisfied than groups in which there are widely varying degrees of contribution. On the other hand,

it is possible that members of equitable groups become increasingly dissatisfied over time with their group processes, whereas members of inequitable groups become more satisfied. In order to determine the role of contribution equity and its relation to initial versus long-term satisfaction with group processes over time, group processes in technologically supported groups must be examined longitudinally (Scott, 1999).

Quality of Information and Group Performance

Research shows that the use of technology to support group processes can improve the quality of information and group decisions (Sharda, Barr, & McDonnell, 1988; Steeb & Johnson, 1981; Valacich, Paranka, George, & Nunamaker, 1993). More generally, the quality of information that group members are able to acquire from one another is important to the satisfaction of group members (Gouran, 1973) and is essential for successful group outcomes (Gouran, Brown, & Henry, 1978). And, when group members perceive that they receive information of high quality from their fellow team members, they may feel more strongly that their group is being productive and thus become more satisfied with group processes overall.

Perceptions of the quality of information acquired using collaborative tools, however, may affect levels of satisfaction with group processes in complex ways (Brashers, Adkins, & Meyers, 1994). When long-term groups complete their first task together, it is likely that the quality of information acquired influences their initial satisfaction with group processes. On one hand, the perception of the quality of information acquired can have a monotonic relationship with satisfaction over time (i.e., the relationship between the perception of information quality and satisfaction may stay the same). On the other hand, the quality of information acquired may be related to changes in the varying rate of satisfaction: group members may be satisfied or dissatisfied with group processes more or less rapidly, depending on the quality of information they acquire, which could influence long-term satisfaction.

Longitudinal Analysis of Group Communication and Satisfaction

These issues suggest two methodological problems that have beset group communication research: a heavy reliance on one-time observation of groups and the tension between individual-level versus group-level analyses (Poole et al., 1999). These issues have combined to limit researchers' ability to uncover important group processes as they unfold over time and simultaneously at the individual and group levels.

Over-Time Analysis

Although calls for longitudinal studies of group interaction processes have been numerous, over-time group research has been scarce (Scott, 1999). Furthermore, reliance on single observations of group communication has troubled group communication researchers, and the importance of conducting studies over time has

been stressed repeatedly (e.g., Bales & Strodtbeck, 1951; Bormann, 1970; Cragan & Wright, 1990; Frey, 1994a, 1994b; Poole, 1983a; Poole et al., 1999). Over-time analysis is especially necessary in studies examining transitions in task groups (Gersick, 1988, 1989), models of group decision development (e.g., Fisher, 1970; Poole, 1983b; Poole & Roth, 1989), and general perspectives on group development related to time (McGrath, 1993; McGrath et al., 1993; Mennecke, Hoffer, & Wynne, 1992). Accordingly, researchers have begun to examine over-time influences in roles and relationships (Contractor, Seibold, & Heller, 1996), patterns of decision making (Corfman, Steckel, & Lehmann, 1990), and technology use (McGrath, 1993; Poole & DeSanctis, 1990). Further application of over-time analysis, as well as development of dynamic or process theories, provide the potential to expand inference beyond simple correlational techniques and to examine the effects of time lags on causal influences among variables (Monge, 1990).

Satisfaction with group processes can change over time (Olaniran, 1996). Some groups become satisfied with their group processes faster than other groups, and differences exist in the nature of this satisfaction, particularly as it unfolds over time. Therefore, conducting multiple observations in a sufficiently long period is necessary if researchers are to pinpoint the reasons for such change and capture the development (or deterioration) in group processes.

Multilevel Analysis

Despite the strengths of individual- and group-level analyses, group-level analysis overlooks how individual characteristics interact to affect group-level constructs, whereas individual-level analysis violates the statistical assumption of independence when individuals are nested in their respective groups (Poole et al., 1999). Discussions of unit of analysis problems (e.g., Glick & Roberts, 1984; Glisson, 1987; Hopkins, 1982; Hox & Kreft, 1994; Hoyle & Crawford, 1994; Morran, Robison, & Hulse-Killacky, 1990; Sirotnik, 1980; Tetlock, 1986) have noted that the group as a whole, or the individuals within groups, or both, can be the proper unit of analysis, depending on the theoretical constructs invoked. Problems occur when variables from the group level are disaggregated at the individual level, when variables from the individual level are aggregated at the group level, or especially when the findings from such analyses are not carefully interpreted (Hox & Kreft, 1994). Furthermore, focusing on only one level at a time is problematic because variables from different levels can interact with each other to explain specific outcome variables. For most statistical analyses it is misleading to assume that individuals nested in a group behave independently of each other.

One way to deal with the unit of analysis problem is to use multilevel analyses, which enable researchers to discern variations at both group and individual levels. Hierarchical Linear Modeling (HLM; Nezlek & Zyzniewski, 1998; Pollack, 1998) enables researchers to simultaneously examine individual-level and group-level variables, as well as the relationship between them, in hierarchical data structures in which individuals are nested in groups. For a two-level model the lower level can

focus on individual-level variables (e.g., gender, individual communication style) and the higher level can focus on group-level variables (e.g., mixed-sex versus same-sex groups, group norms). Especially with over-time analysis, a three-level model also can be developed, treating repeated observations of individuals as the first level because the multiple observations of an individual are nested within the person. Individuals and groups comprise the second and third levels. The major advantages of HLM are that cross-level effects can be modeled and that the variance-covariance among a set of individual-level variables can be decomposed into within- and between-group components (Bryk & Raudenbush, 1992).

Research Questions

In order to address these theoretical and methodological issues this study uses HLM (Bryk & Raudenbush, 1992) to analyze longitudinal observations of individuals' satisfaction with group processes. More specifically, this study investigates groups using collaborative technologies for an extended period of time, by examining the impact that contribution equity and information quality have on satisfaction with group processes. First, changes over time in individuals' satisfaction with group processes are analyzed. Second, the extent to which these changes can be explained by constructs at the individual-level and the group-level are examined. In particular, how changes in group members' satisfaction are influenced by equity in contribution to group work and by the quality of information that individuals acquire with the use of collaborative technologies are assessed. Toward these ends the following three research questions are posed:

RQ1: In computer-mediated groups how much variance in members' satisfaction is explained separately by individual-level and group-level analyses?

RQ2: In computer-mediated groups does group members' satisfaction change over time?

RQ3: In computer-mediated groups what effects do (a) contribution equity and (b) information quality have on satisfaction with group process over time?

Method

Collaborative Technology and Participants

Participants were advanced college students (juniors and seniors) enrolled in an undergraduate course focusing on collaborative technologies in contemporary organizations ($N = 58$). Participants in this research used a custom-designed, computer-based software application that was delivered via the Internet. This technology was modeled after group support systems used in contemporary organizations and was designed to support members working together in online groups. The system provided a range of options to support group teamwork. Users were able to access self-generated reference material and to work together by way of asynchronous,

text-based communication and information-sharing features. More specifically, users could assemble information to complete tasks and then share it with members of their group either by sending electronic messages to any combination of members or by placing information in a common database. In addition to these communication and information-sharing functions the technology enabled group members to work on jointly authored documents to fulfill group work requirements. Tasks completed by group members required wide-scale participation over extended periods of time and were the sole basis for evaluation in the course. Thus, tasks were interdependent, purposeful, the basis for meaningful rewards, and substantially resembled organizational work tasks. Prior to using the system for group work, all users attended mandatory training and were allotted time to experiment with the technology.

Procedure

Participants were randomly assigned to groups of between five and seven members with whom they worked for 10 weeks using the collaborative technology already described. Forty-one females (71%) and seventeen males (29%) formed 10 groups, all of which were mixed-sex (although the majority membership of each group was female). Group membership remained the same for the duration of their time together, except for the early attrition of a few members (which occurred prior to data collection). Upon completion of each of seven group tasks, participants completed a comprehensive online survey that asked them to assess their experiences and perceptions of the previous task. They were required to complete this survey before beginning the next task.

Group members were identified to one another only by non sex-specific pseudonyms, which were selected after pretests of the sex neutrality of these names. Participants thus did not know the actual identity of the other members of their own group, nor did they know the user identification names of members from groups other than their own. In this manner participants worked with a stable group of people whose identity and attendant cues (sex, appearance, etc.) were anonymous for the duration of their working relationship. Thus, participants experienced "partial anonymity" or that condition in which "either a source cannot be individually specified or when there is not a high level of knowledge about a source" (Anonymous, 1998, p. 391).

Measures

Due to its inverse of contribution equity as a theoretical construct, and because measures of equity are based on discrepancy scores, *contribution inequity* is used to describe the operationalization of equity. Moreover, inequity can be conceptualized as a group-level as well as an individual-level variable. Therefore, both group-level contribution inequity and individual-level contribution inequity were derived.

Group-level contribution inequity

Inequity in groups was calculated by comparing group members' ratings of every member of their group on the extent of their contribution in the completion of the task. In this fashion each group member's assessment of an individual's contribution was used to obtain a single contribution score for each person. If group members' contributions equaled the average contribution of others, their score was equal to one. If group members contributed less than other group members, their score was less than one. If group members contributed more than other group members, their score was more than one. Thus, if every member in a group contributed almost equally, there would be very small variance across individual contribution assessments. On the other hand, large discrepancies in group members' contributions would result in large variance across individual contribution assessments. The average variance across the tasks represents group-level contribution inequity (named GROUP_INEQUITY in the following analyses), where higher values indicate less contribution equity (i.e., higher contribution inequity) within a group.

Individual-level contribution inequity

After completing each group assignment, all group members estimated their own contribution, as well as the contributions of every other group member, by allocating a percentage of perceived contribution to each person (total allocations summed to 100%). Ratings for all members were then averaged across the tasks. Individual-level contribution inequity (named IND_INEQUITY in the following analyses) was operationalized as a difference between individuals' ratings of their own contribution and the average of their ratings of others' contributions. Thus, the greater the discrepancy, the less equity (i.e., the higher the contribution inequity, in terms of one's contribution exceeding others' contributions). Approximately 80% of the discrepancy scores for the seven tasks were positive, indicating that the majority of the participants perceived that their contributions were greater than those of their fellow group members.

Quality of information acquired

Quality of information acquired (named QUALITY in the following analyses) was measured by a series of items asking about the accuracy, currency, availability, and relevance of information that people in their group provided using the collaborative technology. Averaged over tasks 1 to 7 the reliability (Cronbach's alpha) of the four measures of information acquired was .84.

Satisfaction with group process

Satisfaction with group process was measured by four items assessing decision fairness, decision coordination, satisfactory work, and choice confusion (reverse coded), which were based in part on items from Green and Taber (1980). The satisfaction measures were judged on a five-point Likert-type scale bounded by "very dissatisfied" and "very satisfied" such that high values on satisfaction assessment

measures indicate high satisfaction. Averaged over tasks 1 to 7 the reliability (Cronbach's alpha) of the four measures of satisfaction with group processes was .83.

Hierarchical Linear Modeling

Because this study focused on estimating how individuals' satisfaction with group processes is influenced by the group to which they belong, a method was used that is designed for such situations—Hierarchical Linear Modeling (HLM; Bryk & Raudenbush, 1992). The HLM model presented here has a three-level nested structure: multiple individual reports over time nested in those individuals, who are, in turn, nested in groups.

To examine individual as well as group change over time, level 1 measures individual change over time. This level, known as the within-individual level, allows satisfaction to vary for each individual across the seven time periods. Level 2 of the model measures differences between individuals within groups. Here, each individual's initial status and change are predicted as a function of individual-level variables. Level 3 of the model measures differences between groups. At this level differences among groups in average change rates and means of satisfaction, contribution inequity, and information quality are examined.

Results

At the first stage of the analysis a *three-level model* is developed in order to examine individual-level and group-level variances in individuals' satisfaction with group process and to find if individual-level and group-level predictors account for the variances. QUALITY and GROUP_INEQUITY are specified as predictors in this stage. The second stage of the analysis involves the development of a *two-level model* with QUALITY and IND_INEQUITY, as well as two additional predictors, an individual's own contribution (MY_CON) and others' contributions (OTHER_CON).

Three-Level Model

Three steps of a three-level model development are presented in this section. Each step of the model development addresses each of the three research questions. First, a fully unconditional model (i.e., no predictors at any level) is used to examine how much variance in the outcome variable (satisfaction with group processes) is explained by each level. Second, an unconditional model (i.e., TIME POINT as a predictor in level 1 and no predictors at levels 2 and 3) finds how much temporal variation exists in level 1 (7-point time observations) and how much variation in intercept (initial satisfaction after the first task completion) and slope (the rate of change in satisfaction over time) can be explained by levels 2 and 3. Finally, a conditional model introduces QUALITY and GROUP_INEQUITY as level 2 and level 3 predictors, respectively.

Table 1 Three-Level Analysis (Fully Unconditional Model)

Fixed effect	Coefficient	*SE*	*t*-ratio	*df*	*p*-value
Average group mean	3.77	0.07	56.98	9	$<.001$
Random effect	**Variance component**	**Variance decomposition (percentage by level)**	***df***	χ^2	***p*-value**
The observed status (level 1)	.366	77.38			
Individual (level 2)	.088	18.60	48	129.73	$<.001$
Groups (level 3)	.019	4.02	9	17.89	.04

The one-way ANOVA (fully unconditional model)

The first research question asked how much variance in satisfaction is explained separately by individual-level and group-level analyses. The one-way ANOVA with random effects provides useful preliminary information about how much of the variation in the outcome lies at the first level (within an individual), at the second level (between individuals), and at the third level (between groups), and about the reliability of individuals' and groups' sample mean as an estimate of its true population mean.

For the level 1 (within-individual) model the observed status for each time is modeled as a function of an individual's mean status across all times plus a random error equal to the deviation of the observed status from the individual mean. For the level 2 (between-individual) model each individual mean is viewed as an outcome of mean group satisfaction plus the deviation of the individual mean from the group mean. Within each of the groups the variability among individuals is assumed to be the same. The level 3 (group-level) model presents the variability among groups. The group means vary randomly around a grand mean and a random group effect, that is, the deviation of a group's mean from the grand mean. In all cases, the random effects are assumed to be normally distributed with a mean of 0. Table 1 reports the results. In a fully unconditional model there is only one fixed effect, which in this case is the average group mean. Reliabilities of the level 1 coefficient and the level 2 coefficient were .63 and .44, respectively.[1]

In estimating the proportion of variation that is within individual, between individuals in groups, and among groups, the variation of each level was divided by the total variation ($.366 + .088 + .019 = .473$). In response to RQ1, the largest percentage (77.38%) lies within individuals (i.e., at level 1), a small, but substantial, percentage (18.60%) lies between individuals within groups (i.e., at level 2), and only a trivial portion (4.02%) lies between groups (i.e., at level 3). Both of these smaller variations between individuals and between groups are statistically significant, however, as indicated in the second panel of Table 1.

Table 2 Three-Level Analysis (Unconditional model at Levels 2 and 3)

Fixed effect	Coefficient	*SE*	*t*-ratio	*df*	*p*-value
Average initial status	3.43	0.11	32.23	9	$<.001$
Average change rate	0.11	0.02	5.22	9	$<.001$
Random effect	**Variance component**		*df*	χ^2	*p*-value
Level 1					
Temporal variation	.260				
Level 2 (individuals within groups)					
Individual initial status	.203		48	118.58	$<.001$
Individual initial change rate	.009		48	104.58	$<.001$
Level 3 (between groups)					
Group mean status	.057		9	19.75	.02
Group mean change	.002		9	15.27	.08
level-1 coefficient			Percentage of variance between groups		
Initial status			21.92		
Change rate			18.18		

Unconditional model

The second research question asked if group members' satisfaction levels with group processes change over time. With this unconditional model temporal variations in group members' satisfaction are examined. Individual change trajectories, which are predicted by temporal variation in satisfaction from the first task to the last, comprise level 1 of the model, the variation in change parameters among individuals is captured in level 2 of the model, and the variation among groups is represented in level 3 of the model. The results presented in Table 2 indicate a positive overall change rate averaged across all individuals and groups. Reliabilities for intercept and slope at level 2 were .627 and .484, respectively. Reliabilities for intercept and slope at level 3 were .503 and .339, respectively.

Of more substantive interest was the decomposition of the variance in individuals' satisfaction and change rates into their within- and between-groups components. The estimates for the variance components appear in the second panel of Table 2. The χ^2 statistics accompanying these variance components indicate significant variation among individuals within groups for initial status and change rates and significant variation between groups for mean status. The change rate between groups was not statistically significant, however.

With TIME POINT as a variable to account for variance among multiple reports of satisfaction with group processes, it is possible to estimate how much variance individual-level and group-level analyses explain in the initial status of satisfaction (the intercept) and the change rate of satisfaction over time (the slope). By comparing the level 1 variance components in Tables 1 and 2, it was determined that

the introduction of temporal variation in the model accounted for an additional 28.96% of the variance in level 1 ([.366–.260]/.366; recall also that level 1 accounted for 77.38% of the variance in the outcome variable). Based on these variance components estimates, as reported in the second panel of Table 2, one can also compute the percentage of variation that lies between groups for both initial status and change rate. As indicated in the third panel of Table 2, approximately 22% of the variance in initial status lies between groups, and therefore approximately 78% of the variance in initial status is between individuals. For change rate, approximately 18% of the variation is between groups, and approximately 82% of the variance is between individuals.[2] It seems that individual differences in satisfaction with group processes are greater than group differences.

Conditional model (intercept- and slope-as-outcomes model)

Having examined variance decomposition at each of the three levels, an exploratory model was considered that allows estimation of the separate effects of the quality of information acquired (QUALITY) and inequity in contribution (GROUP_INEQUITY) in order to answer Research Questions 3a and 3b. Building on the previous model, QUALITY and GROUP_INEQUITY were introduced as separate predictors at the second and third levels, respectively. At level 2 expected individual status (or rate of change) was modeled as a function of mean initial group status (or change rate), the deviation of the individual mean from the group mean, and QUALITY. At level 3 the group means are viewed as a function of the overall mean initial status (the grand mean), the deviation of the group mean from the grand mean, and GROUP_INEQUITY. Results show that GROUP_INEQUITY as a group-level variable did not significantly account for the variation in initial status and rate of change in satisfaction with group processes, whereas QUALITY as an individual-level variable did.

Two-Level Model

Although the variation of satisfaction with group processes was statistically significant in the group level (level 3), that level accounted for only about 4% of the variance in satisfaction with group processes. Additionally, for initial status and change rate in level 2, group level accounted for only about one-fifth of the total variation (versus four-fifths of the variation explained by individual level). Furthermore, GROUP_INEQUITY did not have any statistically significant variance in the group level's one-fifth of the total variation. Thus, a two-level model was developed that focused on level 1 and level 2 only, without regard to group differences. Two predictors (QUALITY and IND_INEQUITY) will be introduced at level 2 to explain initial status (i.e., intercept) and change rate (i.e., slope) at level 1. Table 3 presents the descriptive statistics for each variable. First, the unconditional model is developed.

Table 3 Descriptive Statistics of Variables

Variable name	*N*	Mean	*SD*	Minimum	Maximum
Level 1 descriptive statistics					
Time point	406	3.00	2.00	0.00	6.00
Satisfaction	406	3.77	0.69	1.00	5.00
Level 2 descriptive statistics					
QUALITY	58	4.08	0.44	3.29	5.00
IND_INEQUITY	58	1.13	1.89	− 1.67	8.11

Unconditional model

Level 1 of the model is comprised of individual change trajectories predicted by temporal variation in satisfaction from the first task to the last, as before. At level 2 expected status and change rate are modeled as functions of mean initial status plus the deviation of individuals' satisfaction scores.

As reported in Table 4 the estimated mean intercept and mean change rate for satisfaction with group processes were 3.44 and 0.11, respectively. These data indicate that the average satisfaction score after the first task completion was 3.44 and that individuals were increasing their satisfaction by an average of 0.11 for each task completed during the seven time periods. Both the mean intercept and change rate have large *t*-test values indicating that both parameters are necessary for describing the mean change rate.

The estimates for the variance of individual change rate parameters were 0.268 and 0.011, respectively. As shown in Table 4 the variations were statistically significant, indicating that there are significant variations among individuals' initial satisfaction levels and change rates. Modeling each parameter as a function of individual-level variables is thus warranted. Reliabilities for the intercept and slope were .689 and .535, respectively.

Table 4 Linear Model of Change in Satisfaction with Group Processes (Unconditional Model)

Fixed effect	Coefficient	*SE*	*t*-ratio	*df*	*p*-value
Mean initial status	3.44	0.08	42.38	57	$<.001$
Mean change rate	0.11	0.02	6.06	57	$<.001$
Random effect	Variance component	*df*	χ^2		*p*-value
Initial status	0.268	57	183.56		$<.001$
Change rate	0.011	57	122.57		$<.001$
Level 1 error	0.260				

Table 5 Linear Model of Change in Satisfaction with Group Processes (Effects of Acquired Information Quality and Differences Between My Contribution and Others' Contribution)

Fixed effect	Coefficient	*SE*	*t*-ratio	*df*	*p*-value
Model for initial status					
Base	1.76	0.68	2.59	55	.01
QUALITY	0.44	0.15	2.76	55	$<.01$
IND_INEQUITY	-0.09	0.03	-3.42	55	$<.01$
Model for change rate					
Base	-0.11	0.18	-0.59	55	.56
QUALITY	0.04	0.04	1.11	55	.27
IND_INEQUITY	0.02	0.01	2.36	55	.02

Conditional model (intercept- and slopes-as-outcomes model)

Two predictors are now introduced into the level 2 model: information quality (QUALITY) and contribution inequity (IND_INEQUITY). Level 1 is unchanged from the previous unconditional model. At level 2, information quality and contribution inequity are introduced as predictors for intercept and slope, respectively.

Table 5 shows the estimated fixed-effects results for this analysis. The results indicate that QUALITY and IND_INEQUITY significantly predict initial satisfaction with group processes. IND_INEQUITY also influences the rate of change in satisfaction, whereas QUALITY does not significantly affect that rate of change. In other words, for initial status the higher the quality of information that individuals acquire, the higher the satisfaction after the completion of the first task. However, there is no change over time in the relationship between QUALITY and satisfaction. On the other hand, for IND_INEQUITY, the more an individual's own contribution exceeds others' contributions, the less satisfied that individual is after completion of the first task. Additionally, IND_INEQUITY has a statistically significant effect on the rate of change in satisfaction. Interestingly, however, the higher individuals' contributions are relative to others' average contributions, the higher the rate of change in their satisfaction over time. The more individuals perceive themselves to contribute, the more rapidly their satisfaction grows.

Table 6 Variance Explained in Initial Status and Growth Rate as a Result of Information Quality and Inequity in Group Participation

Model	Initial status variance	Growth rate variance
Unconditional	0.268	0.011
Conditional on QUALITY and IND_INEQUITY	0.162	0.010
Proportion of variance explained (percentage)	39.55	9.09

Table 7 Linear Model of Change in Satisfaction with Group Processes (Effects of Acquired Information Quality, My Contribution, and Others' Contribution)

Fixed effect	Coefficient	*SE*	*t*-ratio	*df*	*p*-value
Model for initial status					
Base	1.37	0.99	1.38	54	.17
QUALITY	0.45	0.16	2.82	54	$<.01$
OTHER_CON	0.11	0.04	2.71	54	$<.01$
MY_CON	−0.09	0.03	−3.06	54	$<.01$
Model for change rate					
Base	−0.25	0.27	−0.92	54	.36
QUALITY	0.05	0.04	1.21	54	.23
OTHER_CON	−0.02	0.01	−1.41	54	.16
MY_CON	0.02	0.01	2.48	54	.02

Table 6 displays the estimated variances for the random effects in this model and compares these results with those from the unconditional model. The proportion of variance explained is the difference between the total parameter variance (estimated from the unconditional model) and the residual parameter variance (based on this conditional model), relative to the total parameter variance. Introducing QUALITY and IND_INEQUITY as predictors accounts for 39.55% of the parameter variance in the initial status and 9.09% of the parameter variance in the rate of change in satisfaction with group processes.

Interestingly, for the rate of change the estimated parameter indicates that the greater one's own contribution compared to others' contributions, the more rapidly that individual's satisfaction changes. In order to find out more about this relationship, one's own contribution (MY_CON) and others' average contributions (OTHER_CON) were entered as separate predictors at the second-level of a subsequent model, in the place of differences in contribution (IND_INEQUITY).

As shown in Table 7 others' contributions and one's own contribution account for significant variations in the satisfaction level after the first task completion (i.e., initial status), but in the opposite direction. That is, the higher others' contributions, the greater satisfaction, whereas the higher one's own contribution, the less satisfaction. For the rate of change in satisfaction over time, only one's own contribution accounts for significant variation. This time, however, the sign is positive, indicating that the higher one's own contribution, the more dramatically that rate of satisfaction increases over time.

Discussion

Given the well-established importance of the determinants and effects of group members' satisfaction in face-to-face contexts (Gouran, 1973; Maier, 1950; Shaw, 1981), it is remarkable how little is known about *changes* in members' satisfaction as

groups perform their work over time—not only in face-to-face groups, but especially in environments supported by collaborative technologies in which members are not co-present. This study investigated computer-mediated group members' satisfaction with group processes as they completed seven tasks over 10 weeks. Fifty-eight members of 10 computer-mediated groups reported satisfaction with group processes at seven points in time. With regard to the research questions posed, four results are noteworthy.

First, findings revealed that individuals' levels of satisfaction changed over time. As is evident from the level 2 and level 3 models in the HLM analyses, the overwhelming portion of the variation is between individuals, not between groups. This relative lack of group variation is not entirely surprising, since no experimental induction was invoked to vary satisfaction across groups. Nonetheless, these changes in individual members' satisfaction have important implications. There has been a plethora of investigations involving satisfaction (Keyton, 1991) and reporting relationships between members' satisfaction and its many correlates and effects. Given the relative dearth of longitudinal investigations of group members' states and behaviors by communication researchers (Poole et al., 1999), however, and findings from this study that satisfaction levels change over time, these results may be need to be reinterpreted in terms of *when* the relationship was observed in those groups' development. Because the majority of investigations has examined satisfaction-related dynamics in groups with no history of interacting prior to the investigation, findings may well be attenuated or amplified by processes associated with performance on subsequent tasks. On the other hand, when satisfaction was assessed at single points *later* in groups' development, those findings may be artifactually affected by group history.

Second, the effects of an important communication variable—the quality of information acquired from other group members—on individuals' satisfaction in computer-mediated groups was examined. Results indicated that the higher the quality of information that members reported receiving from others through the collaborative technology, the higher their satisfaction following completion of the first task. This finding remained relatively constant, with information quality not affecting subsequent rates of change of members' satisfaction. Indeed, although information quality accounted for more than 30% of the parameter variance in initial satisfaction (following completion of the first task), it was associated with less than 10% of the parameter variance in rate of change in members' satisfaction with group processes in the computer-mediated groups. In part this outcome is due to the relative stability in the relationship between perceived information quality and satisfaction over time. Consistent with previous research demonstrating that interacting via collaborative technologies enhances the quality of information in computer-mediated groups (Sharda et al., 1988; Steeb & Johnson, 1981; Valacich et al., 1993), perceived information quality and satisfaction increased quite constantly over time.

Third, perceptions of one's own and others' information contributions had significant and intriguing effects on members' satisfaction. Interestingly, the higher

others' contributions the higher one's own satisfaction, but the higher one's own contribution the less satisfied one was. The portion of this finding underscoring the relative importance of others' contributions is consistent with Gouran's (1973) study of face-to-face (FtF) groups solving a problem at one point in time. Gouran found that one's perception of others' contributions consistently and most strongly predicted members' satisfaction. Another aspect of findings from this study is inconsistent with Gouran's results, however, which indicated that perceptions of the quality of one's own contributions were not strongly related to satisfaction in FtF groups. Although Gouran's results suggest that members place more responsibility on others for group outcomes (in ways that mediate their own satisfaction), results of the present investigation indicate that members' satisfaction is negatively related to the absolute amount of their own contributions. Whether this finding is a consequence of contribution dynamics over time (which Gouran did not study), or whether it is due to norms of equitable participation that may exist in computer-mediated groups but not in FtF groups (which we did not study), remains unclear and warrants further study.

Finally, especially pronounced were the effects of another aspect of group participation—members' perceived contribution inequity (one's own contributions relative to the average of others' perceived contributions). Contribution inequity was significantly related to satisfaction with group processes in these 10 computer-mediated groups beginning with completion of the initial task. The more that a member's own reported contribution exceeded the average of other members' perceived contributions, the less that individual's satisfaction across the seven tasks. Furthermore, although information quality did not significantly affect the rate of changes in computer-mediated group members' satisfaction (as discussed above), contribution inequity was significantly associated with the rate of change of members' satisfaction. In other words, satisfaction changes over time and perceived contribution inequity appears to influence the speed of this change. In addition, one's own absolute (not relative) contribution affects the change rate, whereas others' average contribution does not. This finding indicates that although the relationship between contribution inequity and satisfaction is negative when examined for a single point in time, CMG members with greater contribution inequity show faster changes in their satisfaction over time. That is, CMG members with greater contribution inequity are less satisfied with group processes initially, but the rate at which they become more satisfied over time is greater than the rate for those with more contribution equity.

In spite of the fact that data from this study were collected over time, based on interdependent, purposeful tasks that served as the basis for meaningful rewards, there are potentially relevant limitations as a result of these data as well. Findings from this study are derived from a small number of groups, of relatively fixed size, that was comprised of students who were not working within a realistic organizational environment. As such findings may lack robustness, and potentially deviate from organizational groups composed of a wider range of membership sizes, with existing group histories and hierarchies. Future research is required to determine the consequence of these differences, and to determine if results of this study are

replicable across groups working with technologies with both richer and leaner communication and information sharing capabilities.

Ultimately, this study provides insight into the dynamics of computer-supported groups by examining members' satisfaction with group processes, as influenced by the quality and equity of members' contributions toward the collective effort. Importantly, findings from this study are based on longitudinal observations of groups performing meaningful tasks, couched at both the individual and group levels. Consequently, this research sheds light on important features of virtual groups (Ahuja & Galvin, 2003) operating within the present-day media environment at a time when such understanding is crucial for those interested in contemporary group processes (Fulk & Collins-Jarvis, 2001; Jackson, Poole, & Kuhn, 2003; Kline & McGrath, 1999).

Notes

[1] Although these reliabilities may seem low, they are quite typical, especially with a small sample size (Pollack, 1998). Reliability in HLM measures "the ratio of the true score or parameter variance, relative to the observed score or total variance of the sample mean" and determines weights given to different means (i.e., individual mean, group mean, and grand mean) in composing a Bayes estimator (Raudenbush & Bryk, 2002, p. 46). For further discussion, see Raudenbush and Bryk (2002).

[2] Percentage of variance between groups for initial status = $[.057/(.057 + .203)] \times 100$. Percentage of variance between groups for change rate = $[.002/(.002 + .009)] \times 100$.

References

Adams, J. S. (1965). Inequity in social exchange. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (*Vol. 2*, pp. 267–299). New York: Academic Press.

Ahuja, M. K., & Galvin, J. E. (2003). Socialization in virtual groups. *Journal of Management*, *29*, 161–185.

Alavi, M. (1994). Computer-mediated collaborative learning: An empirical evaluation. *MIS Quarterly*, *18*, 159–174.

Anonymous. (1998). To reveal or not to reveal: A theoretical model of anonymous communication. *Communication Theory*, *8*, 381–407.

Bales, R. F., & Strodtbeck, F. L. (1951). Phases in group problem-solving. *Journal of Abnormal and Social Psychology*, *46*, 485–495.

Benbasat, I., & Lim, L. (1993). The effects of group, task, context and technology variables on the usefulness of group support systems: A meta-analysis of experimental studies. *Small Group Research*, *24*, 430–462.

Bickson, T. K. (1994). Organizational trends and electronic media: Work in progress. *American Archivist*, *57*, 48–67.

Bonito, J. A., & Hollingshead, A. H. (1997). Participation in small groups. In B. R. Burleson (Ed.), *Communication yearbook* (*Vol. 20*, pp. 227–261). Thousand Oaks, CA: Sage.

Bormann, E. G. (1970). The paradox and promise of small group research. *Communication Monographs*, *37*, 211–217.

Brashers, D. E, Adkins, M., & Meyers, R. (1994). Argumentation and computer-mediated group decision making. In L. R. Frey (Ed.), *Group communication in context: Studies of natural groups* (pp. 263–282). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models*. Newbury Park, CA: Sage.

Carey, J. M., & Kacmar, C. J. (1997). The impact of communication mode and task complexity on small group performance and member satisfaction. *Computers in Human Behavior*, *13*, 23–49.

Ciborra, C. U. (1996). Mission critical: Challenges for groupware in a pharmaceutical company. In C. U. Ciborra (Ed.), *Groupware and teamwork: Invisible aid or technical hindrance?* (pp. 90–120). Chichester, UK: John Wiley & Sons.

Ciborra, C. U., & Patriotta, G. (1996). Groupware and teamwork in new product development: The case of a consumer goods multinational. In C. U. Ciborra (Ed.), *Groupware and teamwork: Invisible aid or technical hindrance?* (pp. 121–142). Chichester, UK: John Wiley & Sons.

Contractor, N. S., & Seibold, D. R. (1993). Theoretical frameworks for the study of structuring processes in group decision support systems. *Human Communication Research*, *19*, 528–563.

Contractor, N. S., Seibold, D. R., & Heller, M. A. (1996). Interactional influence in the structuring of media use in groups: Influence in members' perceptions of group decision support system use. *Human Communication Research*, *22*, 451–481.

Corfman, K. P., Steckel, J. H., & Lehmann, D. R. (1990). Longitudinal patterns of group decisions: An exploratory analysis. *Multivariate Behavioral Research*, *25*, 249–273.

Cragan, J. F., & Wright, D. W. (1990). Small group communication research of the 1980's: A synthesis and critique. *Communication Studies*, *41*, 212–236.

Dittrich, J. E., & Carrell, M. R. (1979). Organizational equity perception, employee job satisfaction, and departmental absence and turnover rates. *Organizational Behavior and Human Performance*, *24*, 29–40.

Fisher, B. A. (1970). Decision emergence: Phases in group decision-making. *Speech Monographs*, *37*, 53–66.

Frey, L. R. (1994a). The call of the field: Studying communication in natural groups. In L. R. Frey (Ed.), *Group communication in context: Studies of natural groups* (pp. ix–xiv). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Frey, L. R. (1994b). The naturalistic paradigm: Studying small group in the postmodern era. *Small Group Research*, *25*, 551–577.

Fulk, J., & Collins-Jarvis, L. (2001). Wired meetings: Technological mediation of wired gatherings. In F. M. Jablin & L. L. Putnam (Eds.), *The new handbook of organizational communication: Advances in theory, research, and methods* (pp. 624–663). Thousand Oaks, CA: Sage.

Gersick, C. J. G. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal*, *31*, 9–41.

Gersick, C. J. G. (1989). Marking time: Predictable transitions in task groups. *Academy of Management Journal*, *32*, 274–309.

Glick, W. H., & Roberts, K. H. (1984). Hypothesized interdependence, assumed independence. *Academy of Management Review*, *9*, 722–735.

Glisson, C. (1987). The group versus the individual as the unit of analysis in small group research. *Social Work With Groups*, *9*, 12–30.

Gouran, D. S. (1973). Correlates of member satisfaction in group decision-making discussions. *Central States Speech Journal*, *24*, 91–96.

Gouran, D. S., Brown, C., & Henry, D. R. (1978). Behavioral correlates of perceptions of quality in decision-making discussions. *Communication Monographs*, *45*, 51–63.

Green, S. G., & Taber, T. D. (1980). The effects of three social decision schemes on decision group process. *Organizational Behavior and Human Performance*, *25*, 97–106.

Hare, A. P., Blumberg, H. H., Davies, M. F., & Kent, M. V. (1994). *Small group research: A handbook*. Norwood, NJ: Ablex.

Hollingshead, A. B., McGrath, J. E., & O'Connor, K. M. (1993). Group task performance and communication technology: A longitudinal study of computer-mediated versus face-to-face work groups. *Small Group Research*, *24*, 307–333.

Hopkins, K. D. (1982). The unit of analysis: Group means versus individual observations. *American Educational Research Journal*, *24*, 623–641.

Hox, J. J., & Kreft, I. G. G. (1994). Multilevel analysis methods. *Sociological Methods and Research*, *22*, 283–299.

Hoyle, R. H., & Crawford, A. M. (1994). Use of individual-level data to investigate group phenomena: Issues and strategies. *Small Group Research*, *25*, 464–485.

Jackson, M. H., Poole, M. S., & Kuhn, T. (2003). The social construction of technology in studies of the workplace. In L. Lievroux & S. Linvingstone (Eds.), *The handbook of new media* (pp. 236–253). London: Sage.

Kalleberg, A. L., & Griffin, L. J. (1978). Positional sources of inequality in job satisfaction. *Sociology of Work and Occupations*, *5*, 371–401.

Keyton, J. (1991). Evaluating individual group member satisfaction as a situational variable. *Small Group Research*, *22*, 200–219.

Kline, T., & McGrath, J. L. (1999). A review of the groupware literature: Theories, methodologies, and a research agenda. *Canadian Psychology*, *40*, 265–271.

Lou, H., & Scamell, R. W. (1996). Acceptance of groupware: The relationships among use, satisfaction, and outcomes. *Journal of Organizational Computing and Electronic Commerce*, *6*, 173–190.

Maier, N. R. (1950). The quality of group decisions as influenced by the discussion leader. *Human Relations*, *3*, 155–174.

McGrath, J. E. (1993). The JEMCO workshop: Description of a longitudinal study. *Small Group Research*, *24*, 285–306.

McGrath, J. E., Arrow, H., Gruenfeld, D. H., Hollingshead, A. B., & O'Conner, K. M. (1993). Groups, tasks, and technology: The effects of experience and change. *Small Group Research*, *24*, 406–420.

Mennecke, B. E., Hoffer, J. A., & Wynne, B. E. (1992). The implications of group development and history for group support system theory and practice. *Small Group Research*, *23*, 524–572.

Monge, P. R. (1990). Theoretical and analytical issues in studying organizational processes. *Organization Science*, *1*, 406–430.

Morran, D. K., Robison, F. F., & Hulse-Killacky, D. (1990). Group research and the unit of analysis problem: The use of ANOVA designs with nested factors. *Journal for Specialists in Group Work*, *15*, 10–14.

Morton, M. S. (1996). How information technologies can transform organizations. In R. Kling (Ed.), *Computerization and controversy: Value conflicts and social choices* (2nd ed., pp. 148–160). New York: Academic Press.

Nezlek, J. B., & Zyzniewski, L. E. (1998). Using hierarchical linear modeling to analyze grouped data. *Group Dynamics: Theory, Research, and Practice*, *2*, 313–320.

Nunamaker, J. F., Briggs, R. O., & Mittleman, D. D. (1995). Electronic meeting systems: Ten years of lessons learned. In D. Coleman & R. Khanna (Eds.), *Groupware: Technology and applications* (pp. 146–193). Upper Saddle River, NJ: Prentice-Hall.

Olaniran, B. A. (1996). Group process satisfaction and decision quality in computer-mediated interaction: An examination of contingent relations. In R. S. Cathcart, L. A. Samovar, & L. D. Henman (Eds.), *Small group communication* (pp. 134–146). Dubuque, IA: Brown & Benehmail Publishers.

Orlikowski, W. J. (1993). Learning from notes: Organizational issues in groupware implementation. *The Information Society*, *9*, 237–250.

Palmer, J. W. (1998). The use of information technology in virtual organizations. In M. Igbaria & M. Tan (Eds.), *The virtual workplace* (pp. 71–85). Hershey, PA: Idea Group.

Pollack, B. N. (1998). Hierarchical linear modeling and the "unit of analysis" problem: A solution for analyzing responses of intact group members. *Group Dynamics: Theory, Research, and Practice*, *2*, 299–312.

Poole, M. S. (1983a). Decision development in small groups: III. A study of multiple sequences in decision-making development. *Communication Monographs*, *50*, 321–341.

Poole, M. S. (1983b). Structural paradigms and the study of group communication. In M. Mander (Ed.), *Communication in transition: Issues and debates in current research* (pp. 186–205). New York: Praeger.

Poole, M. S., & DeSanctis, G. (1990). Understanding the use of group decision support systems: The theory of adaptive structuration. In J. Fulk & C. W. Steinfield (Eds.), *Organizations and communication technology* (pp. 173–193). Newbury Park, CA: Sage.

Poole, M. S., Keyton, J., & Frey, L. R. (1999). Group communication methodology: Issues and considerations. In L. R. Frey, D. S. Gouran, & M. S., Poole (Eds.), *The handbook of group communication theory and research* (pp. 92–117). Newbury Park, CA: Sage.

Poole, M. S., & Roth, J. (1989). Decision development in small groups: IV. A typology of decision paths. *Human Communication Research*, *15*, 323–356.

Raundenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Scott, C., & Easton, A. C. (1996). Examining equality of influence in group decision support system interaction. *Small Group Research*, *27*, 360–382.

Scott, C. R. (1999). Communication technology and group communication. In L. Frey, D. Gouran, & M. Poole (Eds.), *The handbook of group communication theory and research* (pp. 432–472). Thousand Oaks, CA: Sage.

Sharda, R., Barr, S. H., & McDonnell, J. C. (1988). Decision support system effectiveness: A review and an empirical test. *Management Science*, *34*, 139–159.

Shaw, M. E. (1981). *Group dynamics: The psychology of small group behavior* (3rd ed.). New York: McGraw-Hill.

Shaw, M. E., & Blum, J. M. (1965). Group performance as a function of task difficulty and the group's awareness of member satisfaction. *Journal of Applied Psychology*, *49*, 151–154.

Sirotnik, K. A. (1980). Psychometric implications of the unit-of-analysis problem (with examples from the measurement of organizational climate). *Journal of Educational Measurement*, *17*, 245–282.

Steeb, R., & Johnson, S. C. (1981). A computer-based interactive system for group decision-making. *IEEE Transactions on Systems, Man, and Cybernetics*, *SMC-11*, 544–552.

Straus, S. G., & McGrath, J. E. (1994). Does the medium matter? The interaction of task type and technology on group performance and member reactions. *Journal of Applied Psychology*, *79*, 87–97.

Straus, S. G. (1997). Technology, group process, and group outcomes: Testing the connections in computer-mediated and face-to-face groups. *Human-Computer Interaction*, *12*, 227–266.

Tetlock, P. E. (1986). Is self-categorization theory the solution to the level-of-analysis problem? *British Journal of Social Psychology*, *25*, 255–256.

Valacich, J. S., Paranka, C., George, J. F., & Nunamaker, J. F. (1993). Communication concurrency and the new media: A new dimension for media richness. *Communication Research*, *20*, 249–276.

Wall, V. C., & Nolan, L. L. (1987). Small group conflict: A look at equity, satisfaction, and styles of conflict management. *Small Group Behavior*, *18*, 188–211.

Warkentin, M. E., Sayeed, L., & Hightower, R. (1997). Virtual teams versus face-to-face teams: An exploratory study of a web-based conference system. *Decision Sciences*, *28*, 975–995.

Wittenbaum, G. M., & Stasser,, G. (1998). The reevaluation of information during group discussion. *Group Processes and Intergroup Relations*, *1*, 21–34.

Received September 18, 2003
Accepted August 31, 2004