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When Does the Medium Matter? Knowledge-Building Experiences and Opportunities in Decision Teams.

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When does the medium matter? Knowledge-building experiences and opportunities in decision-making teams

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Abstract

The purpose of this investigation was to examine whether temporal scope—the extent to which teams have a past or expect to have a future together—affects face-to-face and computer-mediated teams' ability to communicate effectively and make high quality decisions. Results indicated that media differences existed for teams lacking a history, with face-to-face teams exhibiting higher openness/trust and information sharing than computer-mediated teams. However, computer-mediated teams with a history were able to eliminate these differences. These findings did not extend to team-member exchange (TMX). Although face-to-face teams exhibited higher TMX compared to computer-mediated teams, the interaction of temporal scope and communication media was not significant. In addition, openness/trust and TMX were positively associated with decision-making effectiveness when task interdependence was high, but were unrelated to decision-making effectiveness when task interdependence was low.

Keywords: Computer-mediated groups; Virtual teams; Human–technology interaction; Communication effectiveness; Decision-making; Remote management

1. Introduction

Advances in technology have greatly expanded how teams interact and perform their activities. While traditional face-to-face team interaction is still prevalent, virtual teams that meet through electronic media (e.g., e-mail or computer conference) are becoming increasingly popular (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2001; Bell & Kozlowski, 2002; Cascio, 2000; Fulk & Collins-Jarvis, 2000; Kiesler & Sproull, 1992; McGrath & Hollingshead, 1994; Townsend, DeMarie, & Hendrickson, 1998). Moreover, scholars have called for team research to include contextual factors such as media and task type in order to understand both boundary conditions and new frontiers for theories of group interaction (e.g., Hackman, 1999; Marks, Zaccaro, & Mathieu, 2000). The purpose of this study is to look at one critical contextual factor that is likely to impact team processes: *temporal scope*, or the extent to which teams "have pasts together and expect to have futures" (McGrath, 1991, p. 149).

Temporal scope is a key defining feature of teams. Some teams, *future teams*, have little experience as intact teams but anticipate an extended future with fellow team members (e.g., a newly formed project team). Other teams, *past teams*, have numerous past experiences with fellow team members, yet anticipate little future interaction with those members (e.g., project teams nearing the completion of a project). *Standing teams* have both a history of experience with members and anticipate continued ongoing future interaction. Finally, some teams are temporary in nature, wherein members share no prior experience and expect no future interaction (e.g., temporary *ad hoc teams*).

Unfortunately, our understanding of media use in teams is limited by the fact that, with few exceptions (e.g., Hollingshead, McGrath, & O'Connor, 1993; Zack, 1994), research has been conducted in context stripped

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environments—for example, using ad hoc teams brought together for a one hour experiment (see McGrath, 1984, 1991 for a critique). Temporal factors may be important in understanding virtual and face-to-face team processes and outcomes (Walther, 1992). Although there are pockets of research that examine temporal issues in teams (see Kelly & Karau, 1999; Marks, Mathieu, & Zaccaro, 2001; McGrath, 1988; McGrath & Kelly, 1986; McGrath & O'Connor, 1996), few studies, have explicitly compared past teams or future teams to the ad hoc teams typically studied in small group research. Further, few studies have examined the manifestation of these temporal differences in face-to-face and virtual teams. This study examines how various levels of temporal scope and communication media (virtual vs. face-to-face) interact to influence communication effectiveness in teams. We also examine whether the relationship between communication effectiveness and team decision-making outcomes depends on the degree of interdependence inherent in the task.

2. Temporality in virtual teams

Developments in the virtual teams literature (Bell & Kozlowski, 2002; Hesse, Werner, & Altman, 1988), and research on temporal scope specifically (Carlson & Zmud, 1999; Walther, 1992, 1994), highlight how temporal qualities can affect the relationship of various communication media with team processes and outcomes. For example, virtual teams might vary according to the extent that their communication is synchronous versus asynchronous (McGrath & Hollingshead, 1994) or collocated in time (Bell & Kozlowski, 2002). Research on virtual teams shows that social/contextual factors affect how team members perceive and use communication media (e.g., DeSanctis & Poole, 1994; Fulk, Schmitz, & Steinfield, 1990; Markus, 1994; Ngwenyama & Lee, 1997; Walther, 1992), and temporal scope is an important contextual factor. Teams may have discrete or continuous lifecycles (Bell & Kozlowski, 2002) that affect the history or experience members can accrue and the future interaction team members can expect.

The amount and type of experience that team members share is an important characteristic of temporal scope (Carlson & Zmud, 1999; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000; Walther, 1992). Experience can enable virtual teams to overcome the limitations of electronic media, such as nonverbal cues available in face-to-face teams (Walther, 1992). Carlson and Zmud's (1999) channel expansion theory suggests that communication media will provide opportunities for more meaningful communication as communication partners gain *knowledge-building experience* with the media, the task, the context and each other. These knowledge-building experiences narrow the differences between face-to-face and computer-mediated communication by enriching the "lean" electronic media. Limited tests of these arguments have yielded mixed results suggesting the need for additional research.

Temporal scope matters only if it alters the way that teams utilize media and that utilization affects team processes and performance. The present study focuses on how temporal scope affects team communication and decision-making. In discussing their model of virtual teams, Bell and Kozlowski (2002) call for more research on the combination of temporal qualities, communication media, and task type effects on team processes and outcomes. Moreover, they note that most prior research has focused on asynchronous forms of computer-mediated communication, and that future research would benefit by employing synchronous technologies. Such "information rich" technologies, they argue, may enable virtual teams to perform as effectively on complex tasks as face-to-face teams. The framework depicted in Fig. 1 begins to answer that call. As illustrated in this model, we anticipate that a team's temporal scope, and communication media will affect communication effectiveness. The causal relationship between communication effectiveness and decision-making effectiveness, in turn, is moderated by task interdependence. Further justification for these relationships is provided below.

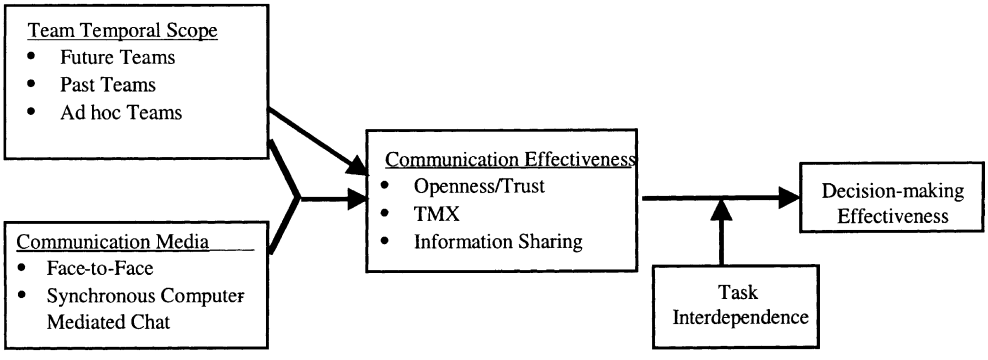

Fig. 1. Model of the effects of temporal scope and communication media on communication effectiveness and decision-making effectiveness.

We selected three variables to assess communication effectiveness—openness/trust, team-member exchange, and information sharing. *Openness/trust* is the degree to which members are willing to trust each other, are receptive to each other's ideas, and are motivated to exchange information and ideas. It reflects a composite of conceptually similar constructs—communication openness and receptivity/trust (Burgoon & Hale, 1987; O'Reilly & Roberts, 1976). Communication effectiveness is also reflected in the quality of team member interaction, *or team-member exchange* (TMX). While initially identified as an individual level construct (Seers, 1989), we treat TMX as an aggregate measure of the quality of team interaction including cohesiveness and teamwork (Watson, Michaelsen, & Sharp, 1991). Finally, effective communication often requires information exchange, particularly in situations where members hold unique information important to solving a problem (Stasser & Titus, 1987). As such, we also examine *information sharing* as a key component of communication effectiveness.

3. Temporal scope: knowledge-building experiences and opportunities

3.1. Past teams: shared knowledge-building experiences

Past teams ought to be able to communicate more effectively than ad hoc teams who have no prior history and do not perceive opportunities for future interaction. Experience expands a team's *capacity* for effective communication by ensuring that members have similar understanding of technology, task execution, team interaction, and member knowledge, skills and abilities (Mathieu et al., 2000). Knowledge about members' personalities, abilities, and behavioral tendencies enable teams to efficiently allocate resources, assign roles, and anticipate the actions of team members (Holmes & Rempel, 1989; Kelley & Thibaut, 1978; Wegner, 1995). Marks et al. (2000) suggested that these "team mental models" lead to higher quality communication, particularly in situations where teams must come together to make sense of complex or equivocal cues (e.g., Klimoski & Mohammed, 1994; Mathieu et al., 2000; Moreland, 1999; Moreland, Argote, & Krishnan, 1996). Experienced teams are more likely to have a shared vision of objectives and plans, exhibit greater coordination and teamwork, and make more accurate decisions (Dyer, 1984; Hollenbeck, Ilgen, LePine, Colquitt, & Hedlund, 1998; Mathieu et al., 2000).

This discussion highlights the benefits of shared team experience, which if valid, ought to be reflected in enhanced openness/trust and TMX. However, explicit information sharing (e.g., number of ideas shared) may be reduced in past teams. Mennecke and Valacich (1998) found that on-going groups with a history shared less information than ad hoc groups. However, experienced groups may share less explicit information without compromising understanding (Bernstein, 1964; Eisenberg & Witten, 1987). In sum, we anticipate that across communication media, past teams will exhibit higher openness/trust and TMX while sharing less information than ad hoc teams.

3.2. Future teams: anticipated knowledge-building opportunities

Future teams are likely to exhibit more effective communication than teams without a future (particularly ad hoc teams) because future teams will likely be *motivated* to engage in good faith initial interactions with team members as they look forward to future *knowledge-building opportunities*. In initial encounters, individuals are motivated to seek information about others in order to reduce their uncertainty and experience comfort in the interaction. Studies indicate that people in initial interactions more actively engage in information-seeking strategies, including self-disclosure and information sharing, than do others interacting with familiar partners (Berger, 1979, 1987). Communication partners who expect ongoing interaction are more cooperative when negotiating than those nearing termination (Heide & Miner, 1992). Moreover, team members are more likely to be friendlier and respond more favorably to one another when they anticipate a future together (Darley & Berscheid, 1967; Hesse et al., 1988; Marlowe, Gergen, & Doob, 1966; Walther, 1994, 1996). Consequently, we anticipate that future teams will exhibit higher openness/trust and TMX compared to ad hoc teams, and share more information than both ad hoc and past teams.

3.3. Temporal scope and media differences

Experimental studies indicate that ad hoc virtual teams are typically more task focused, impersonal, uninhibited, and antisocial (Connolly, Jessup, & Valacich, 1990; Hiltz, Johnson, & Turoff, 1986; Hiltz, Turoff, & Johnson, 1989), whereas face-to-face teams tend to exhibit more positive socio-emotional reactions—a finding attributed to the greater social presence and cues available in face-to-face teams (Dubrovsky, Kiesler, & Sethna, 1991; Kiesler, Zubrow, Moses, & Geller, 1985). Consequently, we expect that across all teams modest media differences are likely to be maintained—driven primarily by media's strong effects under ad hoc conditions.

For past teams, however, we expect media differences to diminish. Knowledge-building experiences will enable past teams to overcome limitations inherent in the media, leading teams communicating through electronic

media to approach the levels of effectiveness found in face-to-face teams. Experience brings opportunities to convey information that, in temporary ad hoc teams, may not be achieved. Researchers have suggested that shared team knowledge is more important than media differences in explaining communication processes. Indeed, as Zack's (1994) study of editorial teams highlights, face-to-face interaction is more facilitative of building shared knowledge, but once a shared interpretive context has been built, objectively leaner media such as electronic mail can be used to communicate effectively.

Less clear is whether media differences will diminish for future teams. Although the prospect of knowledge-building opportunities should heighten team motivation to communicate effectively, absent knowledge-building experience, we do not expect that future teams will nullify communication media differences. In sum, we expect that future and ad hoc teams will exhibit a greater degree of openness/trust, TMX, and information sharing when interacting face-to-face rather than in a virtual computer-mediated medium, but that these media differences will diminish for past teams.

4. Communication and team decision-making effectiveness

Theories of media selection and use often stop short of empirically validating the link between communication and team decision-making effectiveness, including potential moderators of this relationship. Research suggests that the impact of teams' interaction processes on effectiveness may depend on task interdependence—the extent to which team members are dependent upon each other to get tasks accomplished (Gibson, 1999; Wageman, 1995). When interdependence is high, teams must coordinate to be successful; communication media can affect a team's ability to coordinate. Media richness theories assume that decision-making effectiveness depends on the match between the coordination needs of the task and the degree to which a particular medium supports that coordination (Daft & Lengel, 1984). Although there is some evidence to the contrary (Klimoski & Karol, 1976), too much communication, or a surplus of social context cues, can lead to production blocking on low coordination tasks (McGrath & Hollingshead, 1994). Brainstorming studies provide some support for the media-task fit hypothesis in that computer-mediated teams tend to generate more ideas than face-to-face teams. Unfortunately, the limited findings comparing the effects of media on decision-making effectiveness for other types of tasks are largely equivocal (cf. Dennis & Kinney, 1998; Dennis, Kinney, & Hung, 1999; Straus & McGrath, 1994).

Although the media-task fit hypothesis has received mixed support, one of its underlying assumptions appears to be valid: communication effectiveness may positively relate to decision-making effectiveness on high coordination tasks, but be unrelated to decision-making effectiveness on low coordination tasks. McGrath and Hollingshead (1994, p. 109) summarize this view: "Tasks requiring groups to generate ideas may require only the transmission of specific ideas; evaluative and emotional connotations about messages and source are not required and are often considered a hindrance." They add, "Tasks requiring groups to negotiate and resolve conflicts may require the transmission of maximally rich information, including not only facts, but also values, attitudes, affective messages, expectations, commitments, and so on."

We therefore expect that the relationship between communication effectiveness and decision-making effectiveness will be moderated by task interdependence. Specifically, openness/trust, TMX, and information sharing will be positively associated with decision-making effectiveness when task interdependence is high, and will be unrelated to decision-making effectiveness when task interdependence is low.

5. Method

5.1. Sample

A total of 198 undergraduate students from two sections of an upper-level organizational behavior class at a large Midwestern university participated in a lab study as a course requirement. Students were randomly assigned to teams of three within their section of the course, forming 66 teams.

5.2. Manipulations

Temporal scope. Teams were assigned to one of three levels of temporal scope: future, ad hoc, or past. Ad hoc teams were drawn from one section of the course, and were formed for the sole purpose of completing the experimental tasks. These teams did not meet prior to the experimental session and were explicitly told that they would not interact as a team again.

Individuals from the other class section were randomly assigned to either the future or past team conditions. These teams were told that they would be an intact team for the duration of the 10-week course, that they would perform a number of team-based tasks throughout the course requiring them to interact with one another formally, and that one of their required team assignments involved working in a team decision making lab (the experiment). However, because of "scheduling constraints", approximately half of the teams would complete the assignment in week two (future teams), and half would complete it in week ten (past teams).

Future teams met their fellow team members upon arriving at the lab, and had no prior team member experience. Past teams, upon arriving at the lab, had worked together frequently throughout the quarter on both in-class (e.g., winter survival exercise) and out-of-class (e.g., team paper) team assignments, but knew that the lab exercise represented the final time the group would formally interact. Thus, for future teams, the prospect of knowledge-building opportunities with teammates was high, but their knowledge-building experience was low. Conversely, past teams had extensive knowledge-building experience with team members, but low prospect of future knowledge-building opportunities.

Communication media. Half of the teams completed the decision-making lab face-to-face and half of the teams completed it using synchronous computer-mediated chat software with members dispersed in different rooms.

5.3. Procedures

Teams were given a brief overview of the decision-making tasks, and were told that researchers were studying the process by which teams make decisions. To provide sufficient opportunities for team communication and to assess the importance of task interdependence, all teams performed two tasks. The order of the tasks was random and there were no order effects. For the low interdependence task, teams were given 12 min to generate as many ideas as they could to improve security in the campus area—a low coordination task according to McGrath's (1984) task circumplex. This topic has been used in prior brainstorming research (e.g., Gallupe et al., 1992) and was highly relevant to students as several well-publicized crimes had recently occurred near campus.

The high interdependence task required team members to play the roles of different division managers in a company that manufactured cakes. Created for this study, this task is characteristic of hidden profile tasks whereby members must pool unshared knowledge in order to reach the highest quality decision (Stasser & Titus, 1987). Teams were told that their company was facing an egg shortage—a critical ingredient in cakes. As division managers, they had to negotiate amongst themselves the allocation of a limited supply of raw materials (eggs). Teams were instructed to seek a solution that produced the greatest number of cakes for the company. Participants' briefing information told them only the specific number of raw materials (whites, yolks, and shells) they needed to meet their division's production quotas. They did not receive information about the needs of other divisions. Thus, each member held critical unique information necessary to solving the problem, and successful problem solving required members to coordinate and share their unique information. If members withheld information or failed to see the potential for sharing eggs, a sub-optimal solution would result. Teams were instructed to notify the experimenter once they had reached a unanimous decision on the allocation of resources.

Following the two tasks, team members completed a questionnaire assessing openness/trust, TMX, and the manipulation checks. For the computer-mediated condition, transcripts of all team discussions were maintained electronically. Face-to-face team communication was recorded with videotape and audiotape and then transcribed. These records were the basis for the final measure of communication effectiveness (information sharing).

5.4. Measures

All items, unless otherwise specified, were based on a 7-point Likert scale with values ranging from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*).

Manipulation checks. Three items tapped the extent team members were familiar with each other and had worked together in the past. Two items assessed the extent to which teams perceived that they would continue to interact in the future. One item was included to assess perceived differences in social presence (immediacy or salience of others) across media.

Openness/trust. Two items from O'Reilly and Roberts's (1976) communication openness scale and five items from Burgoon and Hale's (1987) receptivity/trust scale were combined to form a measure of openness/trust ($\alpha = .90$). A sample item is, "It's easy to talk openly with members of this group."

Team-member exchange. An 8-item scale developed by Watson et al. (1991) was used to measure TMX. Responses were based on a 7-point scale ranging from 1 (*A Very Little Extent*) to 7 (*A Very Great Extent*) ($\alpha = .88$). A sample item is, "To what extent do members of your group encourage each other to work as a team?"

Information sharing. Based on review of transcripts, two graduate students, blind to our conditions, counted each piece of unique (not commonly held) task information shared on the high interdependence task. The total number of unique pieces of information shared served as our measure of explicit information sharing.

Decision-making effectiveness. For the brainstorming task, effectiveness was measured as the total number of unique ideas generated by each team. For the negotiation task, effectiveness was based on the total number of cakes that could be made as determined by each team's allocation decisions. Both scores were standardized.

6. Results

6.1. Preliminary analysis

For the manipulations checks, a one-way ANOVA revealed significant differences between the three temporal scope conditions for perceived history of interaction, $F(2,195) = 175.24$, $p < .001$, and anticipated future interaction, $F(2,195) = 195.61$, $p < .001$. Bonferroni post hoc tests ($\alpha = .05$) revealed that, as expected, past teams were significantly more likely to say they had worked together in the past ($M = 4.62$, $sd = 1.20$) than members of both ad hoc ($M = 1.39$, $sd = .94$) and future ($M = 1.74$, $sd = 1.14$) teams ($p < .001$). Future teams also indicated that they anticipated working together in the future ($M = 6.67$, $sd = .67$) significantly more than ad hoc ($M = 1.91$, $sd = 1.47$) and past ($M = 3.60$, $sd = 1.74$) teams ($p < .001$). Also, face-to-face teams reported significantly higher social presence ($M = 5.94$, $sd = 1.54$) than computer-mediated teams ($M = 5.22$, $sd = 1.87$), $t(196) = 2.95$, $p < .01$. Based on these analyses, the manipulations were effective.

Two of our measured variables—openness/trust and TMX—were assessed at the individual level. To ensure the appropriateness of aggregating these variables to the team level, two independent tests were performed. First, each scale was assessed using the $r_{wg(J)}$ test suggested by James, Demaree, and Wolf (1984). The average $r_{wg(J)}$ test result was .93 for TMX and .96 for openness/trust, indicating relatively high interrater agreement and confirming the appropriateness of aggregation (Yammarino & Markham, 1992). Second, confirmatory "within-and-between analysis" (WABA) tests run using ANOVA further confirmed the appropriateness of aggregation (Yammarino & Markham, 1992). Both test results were significant, indicating that between-group variance was higher than within-group variance (Openness/trust: $F(65,193) = 2.04$, $p < .001$; TMX: $F(65,197) = 1.83$, $p < .05$). Subsequent analyses were performed using each team's average score for these two variables.

Means, standard deviations, and correlations for each measured variable are shown in Table 1. Cell means and standard deviations for openness/trust, TMX, and information sharing can be found in Table 2. Given the power limitations inherent in team research, we adopt an alpha level of .10 for all subsequent analyses.

6.2. Temporal scope and communication effectiveness

In comparing past teams to ad hoc teams, planned contrasts indicated that past teams did not exhibit higher openness/trust, $t(63) = 1.08$, $p = .28$, or share less information, $t(63) = .12$, $p = .91$, than ad hoc teams, contrary to expectations. As predicted, however, past teams exhibited higher TMX than ad hoc teams, $t(63) = 2.16$, $p < .05$. Thus, it appears that past teams

Table 1
Descriptive statistics and zero-order correlations ($N = 66$ teams)

Variable	Mean	*sd*	1	2	3	4
1 Openness/trust	5.74	.71	—			
2 Team-member exchange	4.98	.83	.69**	—		
3 Information shared	9.12	2.93	.30*	.33**	—	
4 Brainstorming outcome	19.03	7.74	−.11	−.15	−.14	—
5 Negotiation outcome	137.62	51.80	.26*	.22*	.09	−.10

* $p < .05$.
** $p < .10$.

Table 2
Summary of communication effectiveness cell means and standard deviations

Communication effectiveness	Temporal scope				
	Communication media	Future	Ad hoc	Past	Row
Openness/trust	FTF	5.93 (.60)	6.06 (.39)	5.83 (.75)	5.93 (.60)
	CM	5.29 (.72)	5.28 (.77)	5.97 (.59)	5.53 (.75)
	Column	5.61 (.73)	5.67 (.72)	5.90 (.67)	5.73 (.70)
Team-member exchange	FTF	5.48 (.76)	4.75 (.44)	5.14 (.94)	5.14 (.79)
	CM	5.04 (.66)	4.36 (.97)	5.00 (.78)	4.82 (.84)
	Column	5.26 (.73)	4.56 (.76)	5.07 (.85)	4.98 (.82)
Information sharing	FTF	12.23 (4.43)	10.35 (1.76)	8.88 (1.32)	10.44 (3.10)
	CM	9.09 (2.13)	6.25 (1.23)	7.92 (1.78)	7.80 (2.07)
	Column	10.66 (3.76)	8.30 (2.57)	8.40 (1.61)	9.12 (2.93)

Note. FTF = face-to-face communication media, CM = computer-mediated communication media.

Table 3
Summary of multivariate and univariate effects of temporal scope and communication media on openness/trust, team-member exchange, and information sharing

Variable	F[a]	p	η^2
MANOVA			
Temporal scope	5.97	.000	.24
Communication media	8.05	.000	.29
Temporal scope × communication media	2.10	.059	.10
ANOVA			
Openness/trust			
Temporal scope	1.26	.292	.04
Communication media	7.02	.010	.11
Temporal scope × communication media	3.31	.043	.10
Team-member exchange (TMX)			
Temporal scope	4.49	.015	.13
Communication media	2.87	.096	.05
Temporal scope × communication media	0.26	.774	.01
Information sharing			
Temporal scope	6.94	.002	.19
Communication media	21.75	.000	.27
Temporal scope × communication media	2.57	.085	.08

[a] Multivariate Fs are for Wilk's lambda of each main and interactive effect.

engaged in more positive teamwork as indicated by higher TMX, but did not exhibit higher openness/trust or share less information. Both past and ad hoc teams lacked a future, which may explain why openness/trust and information sharing were similar. In particular, the lack of a future may have led team members to feel less accountable (Lerner & Tetlock, 1999), decreasing their motivation to be open and share information.

Planned contrasts confirmed our predictions that future teams would exhibit higher TMX than ad hoc teams, $t(63) = 2.90,\ p < .01$, and share more information than ad hoc and past teams, $t(63) = 3.20,\ p < 01$. Contrary to expectations, future teams did not exhibit higher openness/trust than ad hoc teams, $t(63) = -.27$, $p = .79$. Teams lacking a future appear less likely to share information. Moreover, the prospect of an ongoing future appears to motivate teams to engage in more positive teamwork than temporary ad hoc teams.

We conducted a MANOVA to determine the main and interaction effects of temporal scope and communication media on the three indicators of communication effectiveness simultaneously. We then conducted separate univariate ANOVAs; the results of which are shown in Table 3. The multivariate effects of communication media, $F(3, 58) = 8.05,\ p < .001$, temporal scope, $F(6, 116) = 5.97,\ p < .001$, and their interaction, $F(6, 116) = 2.02,\ p = .06$, were all significant.

Univariate analyses of the temporal scope by communication media interaction indicated a significant interaction for openness/trust, $F(2, 60) = 3.31,\ p < .05$, and information sharing, $F(2, 60) = 2.57,\ p = .09$. As expected, future teams, $F(1, 60) = 5.30,\ p < .05$, and ad hoc teams, $F(1, 60) = 7.20,\ p < .01$, each reported significantly lower openness/trust in the computer-mediated condition compared to the face-to-face condition. However, for past teams, there were no significant differences in openness/trust across media conditions, $F(1, 60) = .29,\ p = .59$. These results are depicted in Fig. 2.

The interaction term for media and temporal scope on TMX was not significant, $F(2, 60) = .26,\ p > .10$. Overall, face-to-face teams exhibited higher TMX than computer-mediated teams regardless of temporal scope, $F(1, 60) = 2.87,\ p = .10$.

The interaction of temporal scope and communication media on information sharing is shown graphically in Fig. 3. As expected, future teams, $F(1, 60) = 9.61$, $p < .01$ and ad hoc teams, $F(1, 60) = 14.93,\ p < .01$, shared significantly more information in the face-to-face

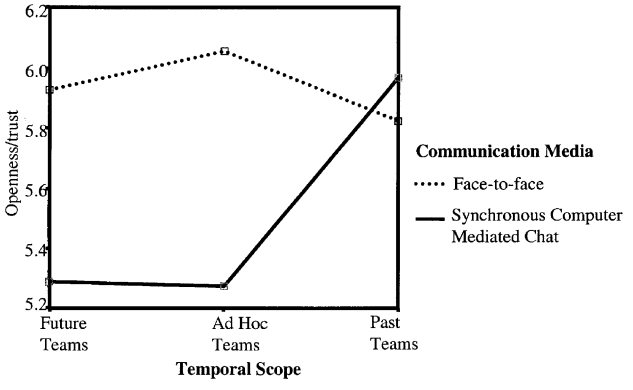

Fig. 2. Graph of the effects of temporal scope and communication media on openness/trust.

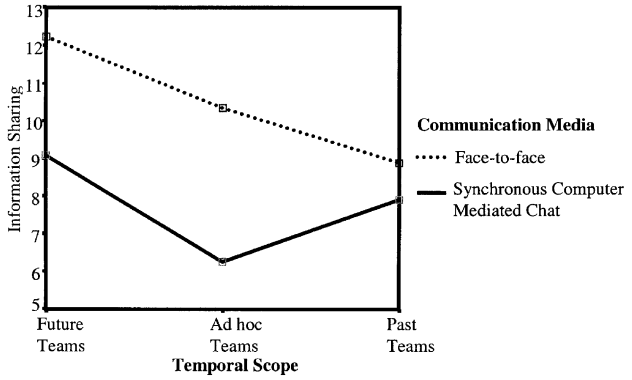

Fig. 3. Graph of the effects of temporal scope and communication media on information sharing.

condition than in the computer-mediated condition. However, for past teams, those using computer-mediated communication shared information at a level similar to face-to-face teams, $F(1, 60) = .98,\ p = .33$. Our findings support the notion that past teams, with a history of knowledge-building experiences, can eliminate media differences with respect to communication effectiveness. Moreover, although future teams were not able to eliminate media differences, they demonstrated the highest levels of information sharing and TMX.

6.3. Communication effectiveness and decision-making effectiveness

We expected that the relationship between communication effectiveness and decision-making effectiveness would depend on task interdependence. In support of this position, the correlation between openness/trust and decision-making effectiveness was significant and positive for the high interdependence negotiation task, $r = .26,\ p < .05$, but was negative and non-significant for the low interdependence brainstorming task, $r = -.11,\ p > .10$ (see Table 1). However, since each team completed both tasks, we conducted a multivariate repeated-measures analysis with task interdependence as the repeated measure and openness/trust as a covariate. The openness/trust by task interdependence interaction was significant, $F(1, 64) = 4.26,\ p < .05$. Teams higher in openness/trust performed better on the high interdependence negotiation task than those low in openness/trust did. We saw no effect of openness/trust on decision-making effectiveness in the low interdependence brainstorming task.

With respect to TMX, the correlation between TMX and decision quality was significant and positive for the high interdependence task, $r = .22,\ p < .05$, but was negative and non-significant for the low interdependence task, $r = -.15,\ p > .10$ (see Table 1). Again, we conducted a multivariate repeated-measures analysis with task interdependence as the repeated measure and TMX as a covariate. The interaction was significant, $F(1, 64) = 4.15,\ p < .05$. Teams high in TMX performed better on the high interdependence task than teams low in TMX did; we saw no effect of TMX on team decision-making effectiveness in the low interdependence task. Finally, information sharing was not related to decision-making effectiveness on the negotiation task, $r = .09,\ p > .10$, suggesting that information sharing is either not as important as originally thought, or that teams of different temporal scope vary in how they process the information that they share.

7. Discussion

Organizations increasingly utilize communication technologies that enable teams to communicate in virtual, non-traditional ways. Moreover, researchers emphasize the need to incorporate temporal characteristics into studies of teams in general (Marks et al., 2001; McGrath, 1991), and virtual teams specifically (Bell & Kozlowski, 2002). The present research examined the effect of teams' past experiences and anticipated futures together on their ability to communicate in face-to-face and virtual contexts. Results indicate that teams without knowledge-building experience (i.e., future and ad hoc teams) communicating face-to-face reported higher openness/trust and shared more unique information than virtual teams communicating through a synchronous computer-mediated medium. However, these differences did not extend to past teams *with* knowledge-building experiences. Consistent with channel expansion and social information processing theories, experienced virtual teams were able to communicate as effectively as face-to-face teams in terms of openness/trust and information sharing. However, face-to-face teams exhibited higher TMX than virtual teams. Moreover, both future teams and past teams reported higher TMX than ad hoc teams, emphasizing the need for models of teams to incorporate temporal characteristics.

The notion that communication effectiveness needs to match the coordinating needs of the tasks was supported with respect to openness/trust and TMX, but not information sharing. Teams higher in openness/trust and TMX performed better on the high interdependence negotiation tasks; teams higher in information sharing did not. Moreover, on the low interdependence brainstorming task, teams higher in openness/trust and TMX did not generate more ideas than teams low in openness/trust and TMX. Surprisingly, information sharing was not significantly related to decision-making effectiveness. Although future teams shared more information than past and ad hoc teams, information sharing may not be as important as originally thought. Perhaps future team members were more likely to compromise or "cave in" in order to preserve team harmony, despite

superior information. Alternatively, future teams may have lacked the capacity to effectively process the information they shared, whereas past teams, although they shared less explicit information, might have been able to better process the information they did share.

Several limitations and opportunities for future research are noteworthy. First, we chose to exclude standing teams who possess both a history and future. Our focus was on isolating knowledge-building experiences and knowledge-building opportunities, and we felt that future teams and past teams better accomplished this goal. Prior research has focused on standing teams to the exclusion of future and past teams. Mennecke and Valacich (1998), for example, found that standing teams shared less information than ad hoc teams. Complementing this research, we found that past teams did not share less information than ad hoc teams, suggesting that past teams and standing teams may behave differently. Second, our measures of openness/trust and TMX ask subjects to rate their team communication process, post hoc, after the decision-making tasks were completed. We cannot rule out the possibility that team members' perceptions of decision-making effectiveness influenced openness/trust and TMX ratings, rather than vice versa. To minimize this, however, subjects were not given external performance feedback prior to filling out the measures, and evidence suggests that performance cues are less likely to bias ratings of behaviors when the raters experience the behaviors, as in the present study (cf. Lord, Binning, Rush, & Thomas, 1978; Mitchell, Larson, & Green, 1977).

A third limitation of our study is the fact that we only focused on experience with team members, omitting other important experiences identified in prior research including experience with technology, task, and organizational context (Carlson & Zmud, 1999; Mathieu et al., 2000). Fourth, our study, consistent with much of the group development literature, assumes that team member familiarity and experience facilitate "development" leading to more positive team outcomes. Yet, teams with a history of positive experiences might perform very differently than teams with a negative history. Even a negative team history, however, can lead to future positive behavior if teams are able to adapt and learn from past mistakes (Kozlowski, Gully, Nason, & Smith, 1999). Although the processes themselves are rarely studied (Moreland, 1999), several studies have demonstrated that groups perform better when members are familiar with each other (Goodman & Leyden, 1991; Gruenfeld, Mannix, Williams, & Neale, 1996; Watson et al., 1991). Future research should attempt to isolate other types of experience and capture the nature or quality of experience shared.

Limitations notwithstanding, the findings from the present study firmly establish the need to incorporate temporal scope into theories of teams. Past teams have a high *capacity* to effectively communicate, even when utilizing electronic media, because of their history of team knowledge and experience. Conversely, future teams may lack the knowledge and experience found in past teams, but are *motivated* to get along with fellow team members. While not examined in this study, standing teams with both a past and a future are likely to be both motivated *and* capable of communicating effectively across communication media. Future research should further explore the relationship between teams of varying temporal scopes including their motivation and capacity to effectively communicate.

Although prior research has identified the need to consider the duration of a team's lifecycle (Bell & Kozlowski, 2002), more detailed studies that focus specifically on the psychological mechanisms, shared cognitions, and team processes at play for future and past teams would advance existing theory. Expectations of future knowledge-building opportunities, for example, might enhance team members' accountability to each other, motivating them to be quality team players (Lerner & Tetlock, 1999). However, accountability towards team members may diminish as teams approach termination. The fact that future teams shared more information than both ad hoc and past teams and reported higher TMX than ad hoc teams is consistent with this view.

The notion of shared experience or common knowledge appears to be an important factor that can shed light on team processes. Shared team experience facilitates at least the following team processes: communication, strategic and coordinated use of resources, and interpersonal relations (Klimoski & Mohammed, 1994; Mathieu et al., 2000). Moreover, in virtual team settings where media might restrict the flow of certain types of information, leading to a loss in understanding, shared team experience might compensate, enabling virtual teams to overcome limitations inherent in the media. It is premature, based on our study alone, to claim that experienced teams only need lean media. We suspect that for ongoing teams where goals include member satisfaction and team viability, or when confronted with complex, novel situations, a hybrid approach involving a balance of face-to-face and virtual interaction would be preferable (Griffith & Neale, 2001). Future research should explore this possibility.

Marks and colleagues refer to team process as the orchestration of taskwork in pursuit of employees' goals (Marks et al., 2001). They identify ten processes, several of which may be particularly relevant in the present study including coordination, conflict management, motivation and confidence building, and affect management. Although our measures of openness/trust and TMX do not provide a precise view of these processes, reflecting more closely what Marks et al. (2001) consider emergent states, they do give us some indications. For

example, openness/trust provides an indication of a team's ability to manage conflict (see Marks et al., p. 368). TMX provides an indication of the levels of coordination, motivation and confidence building occurring. Still, measurement of team processes in future research should focus on techniques designed to synthesize the verbal interaction among team members in order to better understand the processes that occur (Marks et al., 2001).

The present findings also have important implications for practice. Managers should strive to create a level of communication effectiveness commensurate with the coordinating needs of the task—a central, yet largely untested, idea in media richness theories. However, to facilitate communication, managers need to consider a team's temporal scope and communication media. For teams with limited history, communication can be compromised when "leaner" computer-mediated communication is employed. This suggests that managers should avoid assigning highly interdependent tasks to virtual teams with limited history. Indeed, zero-history teams were more open/trusting and shared more information when communicating face-to-face. Conversely, for experienced teams, managers have more flexibility in their choice of communication media and task assignments. For past teams, the medium had no effect on communication effectiveness. Managers can expect experienced virtual teams to communicate in a manner similar to face-to-face teams.

Early research on virtual teams addressed a fundamental question, *does the medium matter* (e.g., Straus & McGrath, 1994)? Our study addresses an important follow-up question, namely, *when does the medium matter*? For past teams, communicating through different media made no difference with respect to communication effectiveness. Past virtual teams were able to communicate as effectively as past face-to-face teams. For future and ad hoc teams, however, communicating through different media did matter as face-to-face teams exhibited higher openness/trust and greater information sharing than virtual teams.

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