

Virtual team leadership: The effects of leadership style and communication medium on team interaction styles and outcomes

Laura A. Hambley^{a,*}, Thomas A. O'Neill^b, Theresa J.B. Kline^c

^a *University of Calgary, 182 Royal Birkdale Cres, NW, Calgary, Alta., Canada T3G 5R8*

^b *University of Western Ontario, Canada*

^c *University of Calgary, Canada*

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Abstract

This study investigated the effects of transformational and transactional leadership styles and communication media on team interaction styles and outcomes. Teams communicated through one of the following three ways: (a) face-to-face, (b) desktop videoconference, or (c) text-based chat. Results indicated that transformational and transactional leadership styles did not affect team interaction styles or outcomes; that the mean constructive interaction score was higher in FTF than videoconference and chat teams, but not significantly higher in videoconference than chat teams; and that teams working in richer communication media did not achieve higher task performance than those communicating through less rich media. Finally, mean team cohesion scores were higher in FTF and videoconference than chat teams, but not significantly higher in FTF than videoconference teams. These results provide further evidence that communication media do have important effects on team interaction styles and cohesion.

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Rapid technological advancements have led to a new paradigm of work—it can now be conducted anytime, anywhere, in real space or through technology (Cascio & Shurygailo, 2003). The virtual environment and its various communication technologies have created a new context for leadership and teamwork (Avolio, Kahai, Dumdum, & Sivasubramaniam, 2001a). Leadership within this new context has been referred to as “e-leadership” or “virtual leadership,” defined as “a social influence process mediated by advanced information technologies to produce changes in attitudes, feelings, thinking, behaviour, and/or performance of individuals, groups, and/or organizations” (Avolio, Kahai, & Dodge, 2001b, p. 617). For the purposes of

this paper, the term virtual leadership will refer to formal leadership by one individual, as opposed to being shared amongst team members.

In addition to leadership, teamwork has been affected by the virtual environment. Virtual teams are becoming a more common type of work unit and are expected to play an increasingly key role in organizations (Hertel, Konradt, & Orlikowski, 2004; Lipnack & Stamps, 2000). For purposes of this paper, virtual teams are defined as interdependent groups of individuals that work across time, space, and organizational boundaries with communication links that are heavily dependent upon advanced information technologies (Driskell, Radtke, & Salas, 2003; Thompson & Covert, 2003).

Virtual team leadership is considered highly important to virtual team performance (Hambley, O'Neill, &

* Corresponding author. Fax: +1 403 282 8249.

E-mail address: laura.hambley@shaw.ca (L.A. Hambley).

Kline, in press; Hertel, Geister, & Konradt, 2005); a claim that has been substantiated in a recent field study on virtual teams (Webster & Wong, 2003). The authors reported that employees perceived leadership as a critical factor of geographically distributed team success. Despite the widespread increase in virtual teamwork, researchers do not clearly understand the implications of advanced information technology for leadership practices (Zaccaro & Bader, 2002). Furthermore, there exists little evidence in support of or against using more advanced technologies to improve leadership performance (Avolio et al., 2001b). More research is therefore needed to better understand leadership of virtual teams.

Although some research on virtual leadership styles is emerging, there is still a need for research assessing how certain leadership styles interact with communication technologies to affect team processes and outcomes. While there are many different approaches to the study of leadership, transformational and transactional leadership styles will be investigated in the present study. This theoretical basis was chosen for several reasons: first, it has received extensive research support since its inception (Bass, 1985; Bass & Avolio, 1993). Second, the transformational/transactional paradigm can translate clearly into practical recommendations and suggestions for leadership training (Barling, Weber, & Kelloway, 1996; Kelloway & Barling, 2000). Third, these two leadership styles have been shown to impact virtual teams in meaningfully different ways (e.g., Sosik, Avolio, Kahai, & Jung, 1998). Finally, psychometrically sound measures exist that accurately assess these leadership styles (e.g., Multifactor Leadership Questionnaire; Bass & Avolio, 1990).

Several studies have assessed leadership in computer-mediated team contexts (e.g., Hoyt & Blascovich, 2003; Kahai, Sosik, & Avolio, 2003), but few studies have manipulated leadership or used more than one communication medium to determine how technology facilitates or negates the effects of leadership in virtual contexts. Kerr and Jermier (1978) noted that situational variables (e.g., technology) may impact the effectiveness of leader behaviours, but *how* technologies moderate the effects of leadership styles on virtual teamwork has not been specifically addressed. Nonetheless, team leaders are being asked to lead geographically dispersed teams, and research is needed to determine the best ways to do so.

To better understand the effects of leadership styles and communication technology on team processes and outcomes, we conducted a laboratory study to carefully control for and manipulate leadership style and communication medium. Specifically, we compared the effects of transformational and transactional leadership within teams communicating face-to-face (FTF), through videoconference, or text-based chat (chat). Our study contributes to the extant literature by examining the

effects of leadership styles on outcomes across virtual and FTF teams. Furthermore, the inclusion of desktop videoconference provided a means to compare leadership in a medium that has not been considered in previous leadership research. Finally, this study enables a comparison of the effects of communicating through videoconference to FTF and chat on team interaction styles and outcomes.

Leadership

Research has demonstrated that leaders can make a critical difference to team performance and effectiveness (e.g., Morgeson, 2005; Zaccaro & Klimoski, 2002). Indeed, Salas, Sims, and Burke's (2005) recent review and model of teamwork included team leadership as one of the "Big Five" contributors to team effectiveness. Elsewhere, it has been argued that leaders play important roles in modeling effective teamwork, and in setting ground rules for team members to engage in successful team processes (Cascio & Shurygailo, 2003). In short, leadership appears to be an integral part of effective teamwork.

There are several theoretical approaches to the study of leadership, but one well-known and contemporary framework is transformational/transactional leadership. Referred to as the new leadership paradigm (Bryman, 1992), charismatic leadership (House, 1996), transformational leadership (Bass, 1985), or the full range leadership theory (Sivasubramaniam, Murray, Avolio, & Jung, 2002), the distinction between transformational and transactional leadership has received a great deal of research attention (Dvir, Eden, Avolio, & Shamir, 2002). Specific to the purposes of the present study, transformational and transactional leadership styles have been the focus of many existing studies on teams communicating through technologies (Sivasubramaniam et al., 2002).

Transactional leaders view the leader-follower relationship as a process of exchange (Bass & Avolio, 1993). They tend to gain follower compliance by either offering rewards or threatening punishment. Two main leadership factors are characteristic of this leadership style: (1) contingent reward, and (2) management by exception. In contrast, transformational leadership focuses on motivating and inspiring followers to perform beyond expectations and comprises four main factors: (1) idealized influence (or "charisma"), (2) inspirational motivation, (3) intellectual stimulation, and (4) individualized consideration (Bass & Avolio, 1993). Transformational leaders are skilled at increasing and broadening follower interests, gaining commitment to the goals and mission of the group/organization, and motivating people to go beyond their self-interests for the good of the group (Den Hartog & Koopman, 2001).

Some research has found that transformational leadership is more effective than transactional leadership (Bass, 1997). Bass suggested that highly effective leadership needs to go beyond the reward-punishment exchange that typifies transactional leadership. Also, Jung (2001) found that FTF teams led by a transformational leader outperformed their counterparts that were led by a transactional leader on a brainstorming task. In another FTF study, transformational leadership predicted empowerment, group cohesion, and perceived group effectiveness (Jung & Sosik, 2002). Finally, Lim and Ployhart (2004) conducted a study using combat teams, and reported that transformational leadership was strongly related to team performance in both typical and maximum FTF contexts.

In addition to individual studies, meta-analyses have also been conducted on transformational and transactional leadership. One meta-analysis found that, although both styles related positively to performance, the relationship with transformational leadership was significantly stronger (Lowe, Kroeck, & Sivasubramaniam, 1996). A more recent meta-analysis (Judge & Piccolo, 2004), however, found that transformational leadership was indeed an effective style, but the contingent reward aspect of transactional leadership was also highly effective. Additionally, these two leadership styles tended to be highly correlated.

In sum, both transactional and transformational leadership styles have been linked to effective performance in face-to-face teams, with transformational leadership tending to be more effective overall. Despite the overall advantage of transformational leadership, however, there are certain conditions when the contingent reward aspect of transactional leadership may be more strongly associated with positive work outcomes (e.g., job performance; Judge & Piccolo, 2004). To further complicate matters, research focusing on the effectiveness of transactional and transformational leadership within the context of virtual teams is relatively scarce (for exceptions, see Hoyt & Blascovich, 2003; Sosik et al., 1998), though leadership style and technology are likely to interact in complex ways. Thus, the present study investigated how leadership styles affected virtual team outcomes *depending* on the type of communication medium used. The following section discusses communication media in the context of virtual teams to give the reader an understanding of the types of media typically studied and the observed effects.

Communication technologies and virtual teams

In the case of virtual teams that never or rarely meet FTF, communication technologies are vital for collaboration (Hollingshead, 2004). The use of such technolo-

gies continues to grow as they become more accessible and their cost declines (Baker, 2002; Spreitzer, 2003). Two commonly used theoretical frameworks for comparing the effects of different communication technologies are media synchronicity (Dennis & Valacich, 1999) and media richness (Daft & Lengel, 1986), each of which is described below.

According to media synchronicity theory, two types of communication encompass virtual team interaction: synchronous and asynchronous. Synchronous interaction occurs when team members communicate at the same time (in real time), such as through teleconferencing, videoconferencing, or chat sessions (Avolio et al., 2001a). “Synchronous” communication media allow individuals to work on the same task, with the same information, at the same time (Baker, 2002; Dennis & Valacich, 1999). “Asynchronous” interaction involves team members communicating at different times, such as in the case of e-mail or threaded discussions.

The degree to which a communication medium allows for synchronous communication affects the flow of conversation (Sellen, 1995). Communication technologies that more closely approximate FTF interactions, such as videoconference, would be closer in conversational style to an in-person meeting (O’Connell, Whittaker, & Wilbur, 1993). As tasks become more complex and require interdependence, reciprocal communication, and feedback among team members, synchronous media are found to be more effective than asynchronous media (Bell & Kozlowski, 2002; Maruping & Agarwal, 2004).

Media richness theory is a commonly used theory for explaining how different communication media affect task performance (Daft & Lengel, 1986). A rich medium allows for: (1) transmitting multiple verbal and nonverbal cues, (2) using natural language, (3) providing immediate feedback, and (4) conveying personal feelings and emotions (Daft & Lengel). The richest medium is FTF communication, followed by telephone, chat, e-mail, and print communications. Newer technologies, such as videoconference, are thought to rank above the telephone, but below FTF communication in terms of media richness (Webster & Hackley, 1997). Technologies that allow the recipient(s) to see physical gestures and facial expressions are thought to increase the richness of the information conveyed (Fletcher & Major, 2003), thereby contributing to the greater richness of videoconference as compared to telephone or text-based media.

Most studies to date have typically compared FTF with only one type of communication medium (Staples & Webster, 2003). Although researchers acknowledge videoconference as another alternative to text-based media, they are usually not able to include it in their studies (e.g., Jarvenpaa & Leidner, 1999), and therefore cannot determine if increments in media richness will result in incremental effects on team outcomes.

However, comparing several communication media with each other will help increase our understanding of the technologies that allow virtual teams to collaborate most effectively (Baker, 2002; Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002). For example, the present study provided the opportunity to assess whether or not there was a linear relationship between media richness and team outcomes because we employed more than one medium on a continuum of richness.

Text-based communication

The majority of studies that have examined computer-mediated communication have used text-based systems (Baltes et al., 2002). Although the most common form of text-based communication is e-mail (Pulley, Sessa, & Malloy, 2002), most research has instead focused on synchronous communication technology, such as “chat” (Baltes et al., 2002). The logistics of studying asynchronous media such as e-mail are more difficult, especially in single session laboratory studies. Because chat is a synchronous form of communication, it is superior to asynchronous e-mail for intensive tasks that require considerable information sharing and collaboration (Balthazard, Waldman, Howell, & Atwater, 2002; Bell & Kozlowski, 2002).

A suggested benefit of chat communication is that this type of text-based interaction may allow for more reflection and the ability to choose one’s words more carefully than in FTF or telephone communication (Wolfe, 2002). Chat can also allow team members to more efficiently share ideas in brainstorming tasks because everyone can “speak” at once, thereby minimizing process losses (Griffith & Neale, 2001). Additionally, chat may neutralize the tendency for increased relational conflict often observed in demographically dissimilar groups, because these differences are less salient (Mannix, Griffith, & Neale, 2002). Conversation in this medium, however, has also been criticized for lacking focus because multiple group members may be speaking at the same time (Wakertin, Sayeed, & Hightower, 1997). Also, different rates of typing and reading can lead to more or less delayed responses by individuals within the group discussion, and could result in low contributions by some members who could otherwise improve the team’s performance.

Videoconferencing

Videoconference is a relatively rich communication medium, allowing for the transmission of both verbal and nonverbal cues (Martins, Gilson, & Maynard, 2004). In their meta-analysis of computer-mediated communication and group decision-making, Baltes et al. (2002) found a paucity of studies that examined videoconference, so they were unable to include it as a

variable. Likewise, a more recent meta-analysis examining the effects of task complexity in virtual teams still did not find enough studies of videoconference to include this medium (Wiggins & Horn, 2005). Videoconference is, however, becoming an increasingly common method of team communication for geographically dispersed teams, and requires more research to examine its effectiveness (Bell & Kozlowski, 2002; Spreitzer, 2003).

The benefits of videoconference over less rich communication media, such as chat, are becoming apparent in the literature. In addition, desktop videoconference (conducted between two or more people directly from each of their desktop computers) is becoming an affordable communication option for a wide variety of users and organizations (Townsend, Demarie, & Henderickson, 2001). Beyond being a cost effective substitute for FTF communication, it is critical to understand how videoconference affects productivity and virtual team collaboration. Indeed, virtual team researchers are calling for more studies that employ today’s advanced synchronous technologies, such as videoconference, in team decision-making (Bell & Kozlowski, 2002; Baltes et al., 2002).

Virtual team leadership

Several field and laboratory studies provide insight into how leadership styles may affect virtual team interaction and performance (e.g., Kahai & Avolio, 2006; Kahai, Sosik, & Avolio, 1997, 2003, 2004; Sosik, Avolio, & Kahai, 1997; Sosik et al., 1998). For example, Sosik et al. (1997) found that transformational leadership was associated with higher levels of group potency (the group’s belief that it can be effective) than transactional leadership, and that group potency was related to group effectiveness. However, transformational leadership exerted a stronger impact on group performance in only one of two sessions. In the other session, teams led by transactional leaders outperformed the transformational groups.

Building on their earlier work, Sosik et al. (1998) assessed the effects of transactional goal-setting and facets of transformational leadership on group creativity. The results suggested that goal-setting and inspirational leadership positively predicted group creativity. Conversely, intellectual stimulation and individualized consideration were negatively related to creativity, likely because they were interpreted negatively by the zero-history teams. For example, transformational leaders that encourage followers to “go above and beyond” may have been considered intrusive and critical in the short-term groups. Nevertheless, the Sosik et al. (1998) study demonstrated that aspects of transformational and transactional leadership can positively influence group outcomes.

A third study examining transformational versus transactional leadership in a virtual team setting found that groups working with a transactional leader had higher levels of group efficacy and task satisfaction than groups working with a transformational leader when individual inputs were identified (Kahai et al., 2003). This advantage disappeared in the anonymous condition, which highlights the role of anonymity in enhancing the effects of transformational leadership (this was also observed by Sosik et al., 1997).

Collectively, there are at least three learnings based on this literature review. First, the transactional/transformational paradigm predicts team processes and outcomes in both FTF and virtual teams. Second, neither of these leadership styles consistently outperforms the other, possibly because aspects of both leadership styles are important depending on contextual details (Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002).

Third, transactional leadership can be more effective than transformational leadership in identified conditions, but often the leadership styles are equalized or transformational leadership becomes more effective in situations involving anonymity (Sosik et al., 1997, 1998; Kahai et al., 2003). Put another way, the data suggest that as a communication medium becomes more anonymous, transformational leadership may be the more effective leadership style relative to transactional leadership. To further elaborate on these three lessons, the present study sought to determine the extent to which leadership styles impact team outcomes differentially in three communication media within a laboratory-based environment.

Team and virtual team processes

Leadership is thought to directly impact team processes (Zaccaro, Ardison, & Orvis, 2004), which are the ways in which team members transform inputs (e.g., team member contributions and skills) into outputs (e.g., solutions; Cooke & Szumal, 1994). For leaders to impact team performance, therefore, they must successfully influence the team's processes. In other words, successful team performance depends jointly on team and leadership processes (Zaccaro & Klimoski, 2002). The processes of interest in this study are team interactions, or "team interaction styles" (Cooke & Szumal, 1994).

Team interaction styles

As team members work together to complete tasks, their roles become highly interdependent, requiring effective interactions (Balthazard et al., 2002). A team's interaction style is best understood in terms of the communication patterns used to deal with task conflicts and maintenance of team member relationships (Balthazard et al.).

Cooke and Szumal (1994) suggested that team interactions can be analyzed in terms of two general styles: "constructive" and "defensive." A constructive interaction style is characterized by a balanced concern for personal and group outcomes, cooperation, creativity, free information exchange, and respect for others' perspectives. Comparatively, defensive styles include passive and/or aggressive behaviours. *Passive behaviours* include limited information sharing, lack of questioning, lack of impartiality, lack of creative thinking, greater emphasis solely on fulfillment of affiliation goals, and maintaining harmony. *Aggressive behaviours* place greater emphasis on personal agendas and ambitions above concern for the group outcome. Examples of aggressive behaviours are competition, criticism, interruptions, and impatience for others' perspectives.

Whether a team's dominant interaction style is constructive or defensive can result in different levels and patterns of effectiveness (Cooke & Szumal, 1994). Effectiveness has been measured as both the quality and acceptance of the solution by team members. In terms of quality, constructive groups have been found to most consistently produce the highest quality solutions, followed by aggressive then passive groups. As for levels of solution acceptance, constructive groups usually produce the highest levels, followed by an equal level of acceptance between aggressive and passive groups. Defensive styles tend to result in marginal-quality solutions that are not accepted by all team members, as well as low levels of member satisfaction (Cooke & Szumal; Smith, Peterson, Johnson, & Johnson, 1986; Watson & Michaelsen, 1988).

Virtual team interaction styles

There are very few studies on virtual team interaction styles, but results from these studies are interesting. Research has shown that communicating virtually does not substantially affect how interaction styles impact team outcomes. Specifically, the effects of FTF and virtual interaction on decision performance and processes have been found to be directionally consistent (Potter & Balthazard, 2002). Also, the effects of virtual team interaction styles on solution quality and acceptance are similar in magnitude to FTF teams (Potter, Balthazard, & Cooke, 2000).

The strengths of relationships between certain interaction styles and team performance, however, have been found to differ between FTF and virtual teams. For example, a constructive interaction style is the most conducive to high team performance in either FTF or virtual teams. A passive interaction style, however, tends to result in lower performance for virtual than FTF teams, likely because it is easier to ignore other team members in a virtual setting, and more difficult to reverse or moderate passivity (Potter et al., 2000). Another interesting difference is that aggressive interaction styles have been

found to do less damage (e.g., limiting team member input) in a virtual team, possibly because technology-mediated communication makes it easier for all members to contribute rather than being significantly hampered by a dominating team member (Potter et al.).

Team outcomes

Several studies have found that leadership can affect team performance, which may take a variety of forms depending on the team's tasks and purposes (e.g., Wag-eman, 2001). Both objective and subjective performance indicators are important in assessing team outcomes (Sundstrom, De Meuse, & Futrell, 1990). A team may perform well objectively, but due to internal conflict, be very unwilling to work together again. Thus, it is important to include a construct which subjectively captures team member satisfaction and willingness to work together in the future, in addition to task performance, when measuring overall team effectiveness (Kline, 1999; Sundstrom et al.). The two types of team outcomes of interest in this research are task performance and team cohesion. Task performance is the objectively measured outcomes of a team task or project. Team cohesion, in contrast, is a dynamic process that is reflected in the tendency for a group to stick together and remain united in the pursuits of its instrumental objectives and/or for the satisfaction of member affective needs (Carron, Brawley, & Widmeyer, 1998). Meta-analyses have demonstrated that team cohesion and team performance are related (Gully, Devine, & Whitney, 1995; Mullen & Copper, 1994), although the direction of the cause/effect relationship is unclear (Chansler, Swamidass, & Cammann, 2003).

More recently, a model has been postulated that provides a theoretical rationale for the effects of transformational leadership on team cohesion (Dionne, Yammarino, Atwater, & Spangler, 2004). Specifically, these researchers posited that transformational leadership will increase shared vision and team commitment, which will in turn be related to increased team cohesion. Additionally, they suggested that team cohesion leads to increased team task performance, implying that leaders can have effects on team cohesion that ultimately lead to changes in team performance. In the present study, however, we examined how leadership influenced team cohesion as an outcome in its own right.

Hypotheses

Interaction effects of leadership styles and communication media on team interaction styles

Past research in FTF contexts has supported the more positive effects of transformational, as compared

with transactional leadership, on team processes and outcomes (Bass, 1997; Lowe et al., 1996). Although both styles have been found to be effective and correlated (Judge & Piccolo, 2004), the literature seems to suggest that transformational leadership is more effective overall. For instance, transformational leadership in problem-solving teams leads to increased enthusiasm and confidence of team members, promoting understanding and appreciation of differing views, and intellectually stimulating members to re-examine critical assumptions and to view problems in new ways (Bass & Avolio, 1994). These characteristics are thought to foster constructive, as opposed to defensive, team interaction.

Indeed, research has found support for a positive relationship between shared transformational leadership and constructive team interactions, and a negative relationship with defensive team interactions (Balthazard et al., 2002). Similar findings would be expected in a situation with a single transformational leader, whose behaviours would more likely foster constructive team interaction than would those of a transactional leader. These effects may, however, differ depending on communication medium.

Although some research has found that communication media interact significantly with leadership style to affect group processes (e.g., Davis et al., 2003), more research is needed. In particular, little is known about the effects of videoconference on team interaction styles. Based on media richness theory, richer media allow for more verbal and nonverbal cues, and therefore more natural team communications and decision-making (Baltes et al., 2002). Further, richer media should enable a leadership style to have greater effects on team interaction, as more verbal and nonverbal cues allow the leader's behaviours to be more salient. For example, in the case of transformational leadership, richer media should facilitate positive leadership effects on constructive team interaction. In addition, less rich media may result in a leader's style having less influence because of a reduction in number of messages exchanged (Avolio et al., 2001a), which may lessen the effects of each leadership style.

It should be noted, however, that the present discussion is somewhat speculative. It assumes that transformational leadership is more effective than transactional leadership in rich media, but that these differences will tend to disappear as the media becomes leaner (because there is less opportunity for the leader to influence the team). The difficulty with this assumption is that transformational leadership is *not consistently* more effective than transactional leadership in the teamwork and virtual teamwork literature. Consider for example, a study by Sosik et al. (1997) that found support for the superiority of transformational leadership in the first team session, but also found that transactional leadership was most effective in the second session. Elsewhere, combat team performance and ratings of cohesion have

correlated equally as strongly with platoon leaders' transformational and transactional leadership styles (Bass, Avolio, Jung, & Berson, 2003). Thus, transformational leadership may not be a better predictor of team performance than transactional leadership in conventional FTF or virtual settings.

To better understand the effects of leadership in FTF and virtual settings, Kahai et al. (2003) studied leadership under identified (FTF) and chat conditions. Those authors found that transformational leadership was less effective than transactional, but that this difference disappeared in the anonymous condition. The authors explained their findings by suggesting that certain facets of transformational leadership may be better suited for situations where team members are not readily identified. For example, intellectual stimulation encourages individuals to arrive at better solutions. However, asking team members to work towards a better solution may be viewed as critical and intrusive in an identified (and short-term) context. Conversely, if an individual feels more anonymous, he/she may accept these comments as being more constructive and less personal, resulting in an increased focus on the task at hand. This rationale suggests that transformational leadership will be the most effective leadership style under leaner (and more anonymous) conditions, but as media richness increases, transactional leadership will become the better style. Accordingly, we postulated the following hypothesis:

Hypothesis 1. Transactional leadership will more strongly predict a constructive interaction style than will transformational leadership in richer media (i.e., FTF), but this effect will decrease as the medium becomes leaner (i.e., in videoconference and chat).

As noted, there is evidence that transformational leadership tends to be more effective than other leadership styles (Dvir et al., 2002). For example, Howell and Frost (1989) found that subjects working under a transformational leader had higher task performance and reported greater levels of task adjustment compared to individuals that were led by a structuring or considerate leader. Furthermore, a field study by Howell and Avolio (1993) found that facets of transformational leadership were positively associated with business-unit performance, but that contingent reward and active management by exception facets of transactional leadership were negatively related to performance. The authors concluded that "the more positive contribution to unit performance came from the behaviours associated with transformational leadership" (Howell & Avolio, 1993, p. 899).

In another investigation of transformational and transactional leadership, 68 managers of global virtual teams from countries throughout the world were compared on key team outcomes (Davis et al., 2003). The

authors found that only transformational leadership predicted commitment to the team. Finally, Jung (2001) compared transformational and transactional leadership styles on a brainstorming task and found that transformational leadership was the stronger predictor of performance. Taken together, there exists non-trivial support for the advantage of transformational over transactional leadership.

Despite the aforementioned research, it is not known how leadership styles may interact with communication media to affect team outcomes (i.e., performance, cohesion). Media richness theory argues that richer media allow for more verbal and nonverbal cue transmission, which may allow the leader to have greater effects on teamwork. Comparatively, less rich media may result in a leader's style having less influence, and may also reduce the amount of positive interaction (Avolio et al., 2001a), both of which may lessen the effects of leadership styles on team outcomes. This rationale suggests that transformational leadership may be more effective than transactional leadership in FTF settings, but that the differences will diminish as the medium becomes leaner (e.g., chat).

Similar to the discussion for Hypothesis 1, the present argument implies that as media becomes richer, the effectiveness of transformational leadership relative to transactional leadership will increase as well. However, this assertion may not be warranted. Judge and Piccolo's (2004) meta-analytic findings suggested that the most effective leadership style depends on the outcome. For example, transformational leadership was a better predictor of follower satisfaction with the leader, while transactional leadership was a stronger predictor of leader job performance. Thus, both transformational and transactional leadership styles are effective predictors of certain criteria.

Laboratory research using paradigms similar to that of the present study have also found that transformational leadership may not always predict team outcomes more strongly than transactional (e.g., Sosik et al., 1997, 1998). Despite the clear advantage of transformational leadership in one session of a two-part study, Sosik et al. (1997) found that transactional was more effective in the second session of the same experiment. Furthermore, in a follow-up study specific facets of transformational leadership (i.e., inspirational leadership behaviours) were related positively to team effectiveness (Sosik et al., 1998). However, other aspects (i.e., intellectual stimulation and individualized consideration) were negatively associated with team outcomes.

Kahai et al. (2003) provided an explanation for these results based on their own study. Recall that those authors found that transactional leadership was more effective in an identified, (as opposed to anonymous) condition. In leaner and more anonymous media,

differences between the two leadership styles were not found. The authors argued that certain aspects of transformational leadership (e.g., intellectual stimulation) may be interpreted as criticisms in identified (e.g., FTF) conditions. Under greater anonymity (e.g., chat), transformational behaviours may challenge group members (instead of threaten them) to exert effort in a more positive way. Given the similarity of the present research design with that of Sosik et al. (1997, 1998) and Kahai et al. (2003), we suspect that comparable results will be found. Thus, we propose the following:

Hypothesis 2a. Transactional leadership will predict team performance more strongly than will transformational leadership in richer media (i.e., FTF), but this effect will decrease as the medium becomes leaner (i.e., in videoconference and chat).

Hypothesis 2b. Transactional leadership will predict team cohesion more strongly than will transformational leadership in richer media (i.e., FTF), but this effect will decrease as the medium becomes leaner (i.e., in videoconference and chat).

Effects of communication media on team interaction styles and outcomes

The medium through which teams communicate has been found to significantly affect their interaction styles (Balthazard et al., 2002). Both media synchronicity and media richness theories suggest that FTF communication is the most effective medium for team interaction, but other media can also be effective depending on task complexity (McGrath, Hollingshead, & O'Connor, 1993). Although other communication media, such as videoconference and chat are also synchronous, they are less rich than FTF communication, with videoconference being richer than chat. Based on the expectation that richer media will allow for communicating greater verbal and non-verbal cues, and will lead to more effective team interactions, the following hypotheses are offered:

Hypothesis 3. Richer communication media will result in a higher constructive team interaction style than less rich media, such that the mean constructive interaction style will be: (a) higher in FTF than videoconference teams, (b) higher in FTF than chat teams, and (c) higher in videoconference than chat teams.

Hypothesis 4. Richer communication media will result in a lower defensive team interaction style than less rich media, such that the mean defensive interaction style will be: (a) lower in FTF than videoconference teams, (b) lower in FTF than chat teams, and (c) lower in videoconference than chat teams.

Past research has demonstrated direct effects of communication media on team cohesion. Specifically, Straus and McGrath (1994) and Wakertin et al. (1997) found that FTF teams are more cohesive than virtual teams communicating through synchronous and asynchronous text-based media, respectively. Moreover, a meta-analysis by Baltes et al. (2002) found that computer-mediated (text-based) teams performing interdependent tasks were usually less satisfied than their FTF counterparts. The lower satisfaction may have been due, in part, to frustration with the fact that typing takes much longer than verbal communication (Wiggins & Horn, 2005). However, one cannot assume FTF teamwork leads to more cohesive teams than virtual teamwork. Instead, it may depend on the specific type of communication media used by the virtual team, with richer media leading to greater cohesion. Extending past research findings to include videoconference, the following hypothesis is offered:

Hypothesis 5. Teams interacting through richer communication media will report higher levels of team cohesion than teams interacting through less rich communication media, such that the mean team cohesion score will be: (a) higher in FTF than videoconference teams, (b) higher in FTF than chat teams, and (c) higher in videoconference than chat teams.

Similar findings are expected in regards to the effects of communication media on task performance, although past research has been somewhat mixed. Most studies have either found no differences in task performance between virtual and FTF teams or that virtual teams tend to perform more poorly than FTF teams on interdependent team tasks (Baltes et al., 2002; Wiggins & Horn, 2005). Interdependent team tasks require a high degree of accurate message transmission and reciprocal exchanges among team members. Participants using less rich media may not transfer messages as efficiently as their FTF counterparts because of media limitations (Thompson & Covert, 2006). Because the present study used a highly interdependent team task, it was expected that task performance would increase using richer media. This expectation is due to the greater ease of communicating and collaborating in richer, synchronous media. Thus, the following hypothesis is offered:

Hypothesis 6. Teams interacting through richer communication media will display greater task performance than teams interacting through less rich communication media, such that the mean task performance score will be: (a) better in FTF than videoconference teams, (b) better in FTF than chat teams, and (c) better in videoconference than chat teams.

Methods

Research design

This study used a 2 (transactional/transformational leadership) \times 3 (chat/videoconference/FTF communication media) factorial design. Sixty experimental teams, with three to four participants in each team, were randomly assigned across these six conditions. Each team was led by a confederate leader displaying one of the two leadership styles.

Participants

Participants in this study were 228 undergraduate students from a mid-sized Canadian University. Fifty-one percent of participants were psychology majors, with the rest majoring in a variety of other disciplines (e.g., biological sciences, nursing, business). On average, participants had completed 2.8 years of their degree. The mean age for the sample was 23.8 years (range: 17–51 years), and the sample was 87% female.

All participants were recruited through the psychology bonus credit system (i.e., they were enrolled in at least one psychology course at the time of this study), thereby receiving partial course credit in exchange for their participation. Prior to signing up for the study, participants were told not to sign up with friends, as this study attempted to have all zero-history teams. It was confirmed that teams were zero-history based on negative responses to the demographic item “were any of the other group members your friends?” Although this was a university student sample, most participants had considerable work experience. Eighty-two percent of the sample was currently employed at the time of the study, working an average of 16 hours per week in a variety of industries. Participants reported working an average of five different jobs over the course of their lives, each of which they held for at least one month.

Upon signing up for the study, participants were scheduled to be on a team comprised of between three and four participants and a team leader (what team they were assigned to depended on the time slot for which they signed up, which varied between FTF, videoconference, and chat).

Task

A structured problem solving exercise, the Meeting Effectiveness Situation™ (MES) was used to measure task performance in this study (Human Synergistics, 2002). This exercise has been used for team development in corporate settings, and appears to be higher in complexity when compared to frequently-used group “survival” tasks. The MES has 20 items (survival tasks typically have 10) that are relatively detailed, particularly

six items that require an additional choice of two possible options for each. Furthermore, this task tends to generate engaging discussions because the topic (i.e., attending workplace and/or university meetings) was relevant to the participants in the sample. In contrast, most participants have not had experience with the content of group survival-type tasks such as being stranded on the moon or in the desert (e.g., Desert Survival Situation; Balthazard, 1999b). In terms of complexity, according to the typology of Van de Ven, Delbecq, and Koenig (1976), the MES would be considered *intensive*. Specifically, it is intensive because it involves an interdependent arrangement in which team members diagnose, problem solve, and/or collaborate simultaneously as a team to accomplish the task.

The MES requires participants to identify the optimal sequence for carrying out 20 activities involved in conducting a successful meeting (e.g., “decide who should attend the meeting and why”; “set approximate time limits for discussion of specific agenda items”). Solutions to the MES are first developed on an individual basis, and then as a team. Individual and team solutions are then compared to the experts’ solution, provided by Human Synergistics International (Human Synergistics, 2002). This provides an objective solution with which to compare individual and team solutions and addresses a weakness of past research; that of subjective measurement of team solution quality (Huang, Wei, Watson, & Tan, 2002). Comparisons between individuals’ and their team’s scores indicates whether the team was able to use their collective knowledge and skills to solve the problem better than they could individually.

Technology

The technology-mediated conditions (videoconference and chat) of this study took place in a computer laboratory with six-foot dividers simulating an office environment (i.e., cubicles). The hardware and software used for this study was carefully researched and chosen based on the following criteria: (a) currently used or similar to technology used by organizations (externally valid), (b) user-friendly (intuitive to use with minimal training and support), (c) of high quality, and (d) reliable.

Videoconferencing

The hardware and software used to conduct the videoconference sessions was Polycom® ViaVideo™, which is a state-of-the art desktop videoconference system allowing for clear picture and voice transmission. High quality, noise cancelling headphones were provided to each participant for audio transmission, and to block out noise distraction (further simulating a virtual environment). Rather than only seeing the other team members through voice activation (e.g., when a participant

speaks the person's image is projected), ViaVideo allowed each participant to continually see the head and shoulders of the speaker as well as the two or three other team members (but the option to see oneself was turned off). A screen shot capturing what a participant's screen looked like can be found in Fig. 1.

Chat

The software used for the chat teams was the chat component of BlackBoard®. This is a basic chat program, which associates each participant's name with his/her statements (which is very similar to chat technology used by organizations). All participants could see the comments of all the other participants, each being associated with the individual's first name. Participants in the chat condition wore the same noise-blocking headsets as used for videoconferencing, so as to block out distraction and simulate a virtual team work environment.

Team leaders

Two male, senior-level undergraduate students were hired and trained to carry out the leadership manipulation. They were blind to the study's hypotheses. Leaders of the same gender (males in this case) were used to control for potential gender effects. The leaders were randomly assigned to each group, and displayed either a transactional or transformational leadership style, based on a pre-determined script, which was a tailored and expanded version of that created by Kahai and Avolio (2006). The script was modified through extensive practice and pilot testing so as to sound realistic in all three

media conditions. A description of how each style was carried out is provided as follows:

Transactional

Leaders displaying a transactional style set goals for the task and highlighted and linked extrinsic rewards to successful task accomplishment. The transactional leader typed (in the text-based condition) or articulated (in the videoconference or FTF condition) comments based on the pre-determined script. These comments: (1) emphasized expectations (what team members needed to do), (2) emphasized the team's goals for the exercise (arriving at the best possible solution), (3) emphasized the potential reward (in exchange for achieving an effective ordering of the 20 items), (4) displayed satisfaction as the team progressed through and completed the MES, and (5) were professional, but not overly enthusiastic or upbeat. Example comments made by the transactional leader are: "Remember, we could be one of the top teams and win the reward by coming up with the best ordering of these activities" and "I think we are well on our way to creating a great team answer, so let's keep working towards our goal of coming up with the best possible ranking" (both reflect the contingent reward factor).

Transformational

Leaders displaying a transformational style repeatedly emphasized the importance of working together, and linking team synergy (i.e., the team decision is greater than the sum of individual decisions) to successful collective outcomes. The transformational leader augmented the positive goal-setting effects of the transactional leader by projecting confidence in team members, emphasizing



Fig. 1. Screen capture of a team desktop videoconference as used in this study.

task interdependence, the importance of collective action, and the opportunity to learn from the other team members (Sosik et al., 1997).

Specifically, the transformational leader typed or articulated comments based on the pre-determined script. These comments: (1) emphasized the importance of the collective task and its relevance to their university and work meetings, (2) expressed confidence that the team would complete the exercise with the best possible solution, (3) highlighted the importance of working together to determine a team solution better than any one person could do alone, (4) encouraged an understanding and appreciation of different ideas within the team, (5) indicated what team members could learn from the task, (6) stressed the importance of questioning each other's assumptions, ideas and viewpoints, (7) made each participant feel that they were an important part of the team and that their opinion mattered, and (8) was upbeat and enthusiastic. Examples of comments made by the transformational leader are: "Let's continue being as open as we can in questioning each other's ideas and assumptions about these activities" (reflects the intellectual stimulation factor); and "You have come up with a lot of good ideas so far by working together as a team (reflects the inspirational motivation factor).

Pilot study

A pilot study was conducted with 30 undergraduate/graduate students from the Department of Psychology acting as participants in the six different experimental conditions. The main purposes of the pilot study were to: (1) test all experimental procedures, (2) ensure that the two trained leaders were able to successfully facilitate a team through these technologies, and (3) test the required timing to complete the task individually and as a team in each condition. Procedures were modified as necessary based on results of the pilot study.

Procedure

Videoconferencing and chat conditions. Teams in these two conditions were considered virtual teams given that their interactions were conducted solely through communication technology, and they were not introduced FTF prior to interacting virtually. Every effort was made to ensure that participants did not interact with each other FTF at anytime throughout the study.

Upon arriving at the computer laboratory, participants were greeted by the researcher or a research assistant (RA)¹, and immediately directed to one of the four

computer terminals, each separated by six-foot dividers so they could not see or be seen by the leader or other team members in the lab. After being seated, they were given a brief overview of the study and provided with two copies of the informed consent form to read and sign. They were also told that each member of the teams performing in the top 10% in each condition (6 teams in total) would receive a \$20 bookstore gift certificate. These were awarded once all sessions were completed. When all participants had signed the informed consent forms, each was given the MES booklet, along with verbal directions and timing instructions (20 min to complete the individual exercise).

Once participants finished the individual exercise, the researcher or RA assisted them with logging on to their team session. They were told that they would be working on the same task they just completed, but with a team of two or three other students as well as an assigned, trained leader. Further, they were told that the team session would involve discussing the exercise and achieving the best possible consensus ranking of the items (a ranking with which all team members could agree). They were also instructed about the time limit for the team task (35 min for videoconference teams; 50 min for chat teams), plus a 10-min introduction session (note that based on pilot testing chat teams were given 15 more minutes than FTF and videoconference teams to allow for the greater time demands of typing).

The leader began by facilitating approximately 10 min of introductions prior to facilitating the MES. The primary purpose of this non-task related communication was to allow time for team members to adapt to the communication medium. This time to familiarize oneself with the communication technology is important, and studies not doing so have been criticized (Wakertin et al., 1997). Researchers have found that typically 10 min is enough time to become familiar with the operation of a desktop videoconference system (Townsend et al., 2001).

Following the introductions, the leader facilitated completion of the MES. Their leadership script began with an introductory message that was either transactional or transformational. As the group worked at achieving consensus, the leader interjected comments based on the script. The recommended timing of these comments was included in the script, but the leader used his training, experience, and discretion to provide each comment at an appropriate time in the conversation to maintain realism. The leader checked each comment as he made it, ensuring that all comments were made in each team session. In addition, the leader was unaware of the experts' solution, and did not provide his opinion on the ordering of the 20 items; instead, he played a team facilitation role.

Prior to completing the team session, the leader informed the team members that the final component

¹ Due to the requirements to keep participants separated, three RAs were required for each laboratory session (one of which sometimes included the researcher). Each RA was responsible for one or two of the participants, so as to ensure equal timing of exercises and efficient completion of the session within the 2-h time limit.

of the study involved completing on-line questionnaires. These took 15–20 min to finish, and were completed prior to participants being debriefed.

Face-to-face condition. The procedure for the FTF experimental condition was consistent with the procedures and timing used in the two virtual team conditions (except for chat, which was 15 min longer). Participants signed up for the study according to a set of prearranged time slots. Each of the twenty teams in the FTF condition was composed of a team leader and 3–4 participants. The teams met in a standard meeting room on the university campus, and were seated around a table upon entering the room. They were instructed not to speak to one another until the leader began the team session. Once the team session began, the leader followed the same procedure and script as used in the virtual conditions, with some flexibility to ensure appropriate timing and realism of comments. Once the team MES was completed, team members were brought to separate computer terminals to complete the on-line surveys, then debriefed.

Measures

The following section describes each of the measures used in this study. Some of the measures (the team interaction styles and team cohesion) were assessed at the individual level and then aggregated and analyzed at the team level. Thus, a description of the interrater agreement calculations used to determine the appropriateness of collapsing individual to team level data is first described.

Interrater agreement. The interrater agreement levels (r_{wg}) for each scale were assessed using the calculations proposed by James, Demaree, and Wolf (1984, 1993). This procedure is conducted to ensure that averaging ratings across team members into a single aggregate score is appropriate. Stated simply, this procedure assessed whether or not team cohesion and team interaction styles are appropriately analyzed at the team level.

The mean levels of r_{wg} for the scales were quite high using the James et al. formula (all above .90). One team had a mean r_{wg} value, calculated across all five scales, lower than .70. Given that particular team's low overall interrater agreement, the analyses were re-run without their data. None of the results were affected, however, and the analyses reported are based on those including all of the teams.

Questionnaires. The on-line questionnaires consisted of: (a) demographic questions, (b) the Group Styles Inventory[®] (GSI; Cooke & Szumal, 1994), (c) a measure of team cohesion, and (d) manipulation check items. Each of these measures is described in the following section.

Demographic questions. Thirteen questions asked about participant characteristics, such as gender, age, year of studies, and work experience.

Team interaction styles. A web-based version of the Group Styles Inventory[®] (GSI; Balthazard, 1999a; Cooke & Szumal, 1994) was used to measure each team's dominant interaction style. The GSI is a self-report survey consisting of 72 statements assessing constructive and defensive team interaction styles. Items focused on the ways in which team members interacted with each other and approached the task during the problem-solving session. Example items include: "was communication supportive and constructive?" (assesses constructive interaction), "did tactfulness inhibit direct communication and the questioning of ideas?" (assesses passive interaction), and "were you interrupted by others trying to sell their ideas?" (assesses aggressive interaction). Participants indicated the extent to which each item described the interaction style of their team using a five-point Likert scale ranging from 0 (*not at all*) to 4 (*to a very great extent*). Internal consistency for these scales ranged from .88 to .94, indicating that participants answered the items in a consistent manner (see Table 2). After checking for acceptable agreement levels between participants on each team, responses to the GSI were averaged. Then, an average constructive, defensive, passive and aggressive interaction score was calculated for each team.

Team cohesion. Team cohesion was measured by participants' ratings on nine items that assessed group atmosphere and the extent to which team members stuck together (Balthazard et al., 2002; Cook, 1981; O'Reilly, Caldwell, & Barnett, 1989). Example items include: "members appeared to feel that they were really part of the group" and "members of the group really stuck together." Responses were rated on a five-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). After checking for an acceptable agreement level between team members, the items were summed and averaged for each team. The Cronbach's α coefficient for these nine items was .82, calculated at the individual level.

Task performance. Objective task performance on the MES was assessed by calculating the difference between the team consensus and the average of the team member's individual performance scores on the MES, commonly referred to as the "conventional scoring algorithm," which is the most commonly used in group research (Balthazard et al., 2002). Thus, performance in this study is determined *relative* to each team's individual capability, rather than ignoring individual scores and solely considering the team's final performance score.

Manipulation checks

Leadership style. To determine whether participants correctly perceived the intended leadership style, a post-experimental manipulation check was conducted. Participants were given nine questions adapted from

the Multifacet Leadership Questionnaire (MLQ; Kahai & Avolio, 2006), about the leadership style exhibited by their leader to determine if their perceptions of it differed across the transactional and transformational conditions. The first five questions assessed transformational leadership behaviours (e.g., “the leader emphasized the importance of working together as a team”), while the last four assessed transactional leadership behaviours (e.g., “the leader indicated that we could potentially win a reward (gift certificate) for generating a winning team solution”). The internal consistency of the five transformational items was .85, and for the four transactional items was .70.

Media richness. Eight questions were administered to assess participants’ perceptions of the richness of the communication medium (Suh, 1999). Example items include “the environment in which we communicated helped us to better understand each other” and “I could easily explain things in this environment.” These items were measured on a seven-point Likert scale format, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The Cronbach’s α was .93 for these items.

Results

Manipulation checks

Leadership style

To determine whether participants correctly perceived the intended leadership style, responses to the nine leadership manipulation check items were analyzed using independent t-tests. These revealed that the score on the five transformational manipulation check items was higher ($n = 114$, $\bar{X} = 4.34$) for participants led by a transformational leader than those led by a transactional leader ($n = 114$, $\bar{X} = 3.94$), $t(226) = 4.20$, $p < .001$. Similarly, the score on the four transactional manipulation check items was higher ($n = 114$, $\bar{X} = 4.48$) for participants led by a transactional leader than those led by a transformational leader ($n = 114$, $\bar{X} = 3.61$), $t(226) = -9.25$, $p < .001$. Thus, the leadership manipulation appeared to be experienced by participants.

Media richness

To determine whether participants perceived differences in the richness between the three communication media (FTF, videoconference, and chat), scores on these eight questions were compared using a one-way ANOVA. Results indicated that there was a significant effect of communication medium on perceived media richness $F(2, 225) = 98.98$, $p < .001$. As expected, the follow-up tests of mean differences showed that chat was perceived to be lower in media richness than videoconference ($\bar{X} = 3.48$, $\bar{X} = 3.96$,

respectively), $p = .025$; and videoconference was perceived to be lower in richness than FTF ($\bar{X} = 5.92$), $p < .001$. These results suggest that participants did perceive differences in the richness of these three communication media.

Data analyses and results

Means and standard deviations at the team level for the team interaction styles (constructive, defensive, passive, aggressive), team cohesion and performance are shown in Table 1. Correlations among these variables are depicted in Table 2.

To assess Hypothesis 1, which predicted that transactional leadership would more strongly predict a constructive interaction style than would transformational leadership in richer media, but that this effect would decrease as the medium became leaner, a 2×3 factorial ANOVA was conducted. A significant interaction was not found between communication medium and leadership style on constructive team interaction, $F(2, 54) = .098$, *ns*.

Hypothesis 2a postulated that transactional leadership would more strongly predict team performance than would transformational leadership in richer media (i.e., FTF), but this effect would decrease as the medium became leaner. This hypothesis was tested using a 2×3 factorial ANOVA, however, the interaction term was

Table 1
Means and standard deviations of team scores

Scale	Mean	Standard deviation
Constructive	3.38	.29
Defensive	2.26	.22
Passive	2.34	.21
Aggressive	1.65	.25
Cohesion	3.92	.39
Performance	40.59%	20.98%

Note: the range for the GSI scales (constructive, defensive, passive, and aggressive) and cohesion is 1–5.

“Performance” is the average percent change scores across all 60 teams (it represents the difference between the average individual score and the team score).

Table 2
Scale correlations and reliability coefficients

Scale	1	2	3	4	5	6	7
Teams ($n = 60$)							
Constructive	$\alpha = .93$						
Defensive	-.472**	$\alpha = .94$					
Passive	-.425**	.929**	$\alpha = .88$				
Aggressive	-.460**	.949**	.764**	$\alpha = .91$			
Cohesion	.813**	-.650**	-.599**	-.620**	$\alpha = .82$		
Performance	.184	-.026	-.103	.043	.143	—	

* $p < .05$.

** $p < .01$.

not significant, $F(2, 54) = .33$, *ns*. Similarly, Hypothesis 2b argued that transactional leadership would more strongly predict team cohesion compared to transformational leadership in rich media, but this effect would decrease as the medium became leaner. Once again, the 2×3 factorial ANOVA was not significant, $F(2, 54) = .37$, *ns*.

To assess Hypothesis 3, which was that richer communication media would result in higher constructive team interaction scores than less rich communication media, a one-way ANOVA was conducted. A statistically significant effect was found for communication medium, $F(2, 57) = 11.22$, $p < .001$, $\eta^2 = .28$ (see Table 3). Follow-up tests of mean differences, conducted at a family-wise Bonferroni corrected α level of .017, indicated that the mean constructive interaction score was higher in FTF ($\bar{X} = 15.41$) than videoconference ($\bar{X} = 14.20$) teams, $p = .041$. Also, the mean constructive interaction score was higher in FTF ($\bar{X} = 15.41$) than chat ($\bar{X} = 13.15$) teams, $p < .001$. Mean constructive interaction scores were not significantly higher in videoconference ($\bar{X} = 14.20$) compared to chat ($\bar{X} = 13.15$) teams. Thus, Hypotheses 3a and 3b were supported, but not Hypothesis 3c.

To assess Hypothesis 4, which was that richer communication media would result in lower defensive team interaction scores than would less rich media, a one-way ANOVA was conducted. A significant effect was not found, thereby not supporting Hypotheses 4a–c ($F(2, 57) = 2.27$, *ns*).

Additional ANOVAs were conducted on the effects of communication media on the specific components of defensive team interaction: passive and aggressive. No significant effect of communication media was found on passive team interaction ($F(2, 57) = 1.54$, *ns*). The effect of communication media on aggressive team interaction also failed to achieve significance $F(2, 57) = 2.84$, $p = .067$, $\eta^2 = .09$ (see Table 3).

Hypothesis 5, which predicted that teams interacting through richer communication media would score higher on team cohesion than teams interacting through less rich communication media, was tested using a

one-way ANOVA. Results revealed that richer communication media resulted in higher scores on team cohesion than did less rich media, $F(2, 57) = 11.74$, $p < .001$, $\eta^2 = .29$ (see Table 3). Follow-up tests conducted at a family-wise Bonferroni corrected α level of .017 indicated that the mean team cohesion score was higher in FTF ($\bar{X} = 4.15$) than text-based ($\bar{X} = 3.64$) teams, $p < .001$. Also, the mean team cohesion score was higher in videoconference ($\bar{X} = 3.97$) than text-based ($\bar{X} = 3.64$) teams, $p = .009$. The mean team cohesion score was not significantly higher in FTF ($\bar{X} = 4.15$) compared to videoconference ($\bar{X} = 3.97$) teams.

Hypothesis 6, which predicted that teams interacting through richer communication media would display greater task performance than teams interacting through less rich communication media, was also tested using a one-way ANOVA. Richer communication media did not result in higher scores on task performance than did less rich media ($F(2, 57) = 2.56$, *ns*).

Discussion

Hypothesis 1 sought to determine whether type of communication medium would interact with leadership style to affect constructive team interaction. A significant interaction was not found, suggesting that leadership style did not affect constructive team interactions differently depending on the communication medium. Furthermore, a post-hoc analysis investigating the main effects of leadership style on constructive team interaction was not significant. Despite the greater number of verbal and nonverbal cues available through richer media such as FTF, the effects of the leaders' styles on constructive team interactions were not any different than through less rich media (e.g., chat). This finding may be the result of the short-term nature of this task, which regardless of media type, may not have allowed sufficient time for leadership style to influence team interaction. In addition, the scripted nature of the leadership styles would have enabled both transformational and transactional leaders to clearly exert their influence in all three media (because an equal number of messages were transmitted irrespective of media type). In actual virtual teams, however, leaders may not be able to communicate as many messages through less rich media in order to influence team members. Future field research is needed that examines the extent to which leaders influence teams to a different degree based on the communication medium's richness.

Hypothesis 2a sought to determine whether leadership style would interact with communication medium to affect team performance. A significant interaction was not found. Furthermore, a post-hoc analysis investigating the main effects of leadership style on team performance was not significant. Similar findings were

Table 3
Analysis of variance for communication media and constructive interactions, aggressive interactions, and cohesion

Source	SS	df	F	η^2	p
Between subjects					
Constructive	51.077	2	11.22**	.28	.000
Within group error	129.761	57	(2.28)		
Aggressive	7.35	2	2.84	.09	.067
Within group error	92.133	57	(1.66)		
Cohesion (C)	2.675	2	11.74**	.29	.000
Within group error	6.491	57	(0.114)		

Note: values enclosed in parentheses represent mean square errors.

** $p < .001$.

revealed for Research Question 2b. That is, the interaction between leadership style and communication media on team cohesion was not significant, nor was an ad-hoc analysis on the main effects of leadership style on team cohesion. Taken together, these findings indicate that leadership style did not predict team outcomes in this study, even when the communication medium was considered. Although previous research has found that leadership styles predict team outcomes (Bass et al., 2003; Hoyt & Blascovich, 2003; Sosik et al., 1997), both styles have been found to relate more positively than the other under various conditions (Howell & Avolio, 1993; Howell & Frost, 1989; Kahai et al., 2003; Sosik et al., 1997), and may have been equally effective in the present study.

Had we included a condition without a designated leader, or a condition with a leader trained to display laissez-faire behaviours, we could have confirmed whether or not the two leadership styles had an effect on team outcomes. As it stands, we cannot be sure if the leadership manipulation affected team outcomes compared to a “no leadership” condition, though we do know that transactional and transformational leadership styles did not have differential effects on the dependent variables. Comparing these leadership styles to laissez-faire leadership is a potential avenue for future research.

The results of Hypothesis 3 partially support the prediction that richer communication media result in higher constructive team interaction scores than less rich communication media. Specifically, the mean constructive team interaction score was higher in FTF compared to chat teams. This supports the work of Balthazard et al. (2002), who found that FTF teams demonstrated higher levels of constructive interaction than those communicating through chat. Results of the current study also found that the mean constructive team interaction score was higher in FTF than videoconference teams. Contrary to the postulates of media richness theory (Daft & Lengel, 1986), however, the mean constructive team interaction score was not higher in videoconference than in chat teams. These findings suggest that in order to maximize teams’ constructive interactions, FTF communication is the most effective alternative. Given the realities of today’s organizations, however, FTF teamwork is not always financially or logistically feasible. For example, the costs of flying people to meet FTF may be prohibitive for many organizations, making virtual teamwork a necessity (Baltes et al., 2002). Also, in order to acquire the required talent, hiring workers from various locations who are unable or unwilling to relocate may be necessary (Bell & Kozlowski, 2002).

The lack of difference found between constructive team interaction scores of videoconference and chat teams suggests that desktop videoconference may not

be an improvement over chat in helping team members interact more constructively, at least for this type of short-term, problem solving task. Perhaps the additional costs of videoconference may not be necessary for this type of virtual teamwork. The greater efficiency of completing problem solving tasks through videoconference as compared to chat, however, may be another consideration. Teams using chat in this study took approximately 13 more minutes, on average, to complete this task than teams communicating through videoconference. The costs of desktop videoconference, therefore, could possibly be justified based on its greater efficiency.

It is important to note that participants had much more skill and experience with chat than videoconference. Only 15% of the participants had previously participated in a videoconference, whereas 62% indicated having used chat (e.g., chat rooms). Perhaps more exposure to videoconference might increase their ability to utilize this medium more effectively, thereby enabling more constructive interaction than through chat.

Hypothesis 4, which stated that richer communication media would result in lower defensive team interaction scores than less rich media, was not supported. Although counter to expectations, this non-significant result corroborates the finding of Balthazard et al. (2002) who found that FTF teams were not less likely to demonstrate defensive interaction styles than virtual teams. The present study’s finding suggests that teams do not interact more defensively through less rich media and also that either videoconference or chat may be viable alternatives to FTF team communication. As with Hypothesis 3, this finding does not support videoconference as being more effective than chat.

Hypothesis 5, which predicted that teams interacting through richer communication media would score higher on team cohesion than teams interacting through less rich communication media, was partially supported. Specifically, the mean team cohesion score was higher in both FTF and videoconference than chat teams, but not significantly different between FTF and videoconference teams. This finding suggests that desktop videoconference can lead to teams that are equally cohesive as those communicating FTF. As a result, desktop videoconference could be a viable alternative to producing cohesive teams when FTF meetings are not feasible.

This result also supports the earlier findings of Straus and McGrath (1994) and Wakertin et al. (1997) in that FTF teams are more cohesive than virtual teams communicating through synchronous and asynchronous text-based media, respectively. Moreover, it corroborates Baltes et al. (2002) meta-analysis that found that computer-mediated (text-based) teams performing interdependent tasks were usually less satisfied than their FTF counterparts. This lower satisfaction may be due, in part, to frustration with the fact that typing takes much longer than verbal communication (Wiggins &

Horn, 2005). Thus, one cannot assume FTF teamwork leads to more cohesive teams than virtual teamwork. Instead, it may depend on the specific type of communication media used by the virtual team.

Hypothesis 6, predicting that teams interacting through richer communication media would display greater task performance than teams interacting through less rich communication media, was not supported. Specifically, richer communication media did not result in higher scores on task performance than did less rich media. This result supports virtual teamwork as being a viable alternative to FTF teamwork, at least for these types of short-term, problem solving tasks. The question remains, however, as to whether actual, longer-term virtual teams can also develop equal levels of task performance through communicating virtually versus FTF.

Theoretical and practical implications

This study built upon existing theory on virtual team leadership, which compared to FTF leadership theory, is still in its infancy (Zaccaro et al., 2004). The hypothesized relationships tested in the laboratory study built upon the work of both virtual team researchers (e.g., Avolio et al., 2001b; Balthazard et al., 2002) and media richness theorists (Daft & Lengel, 1986; Dennis & Valacich, 1999). The major contribution of this study is its examination of leadership and teamwork in three different media, including desktop videoconference, which has not, to the researchers' knowledge, been studied in this context. Specifically, leadership and teamwork have not been studied together in a study comparing desktop videoconference to the more commonly studied chat and FTF media. This study responds to calls from other researchers for more empirical research about the effects of videoconference on leadership and teamwork (e.g., Bell & Kozlowski, 2002; Townsend et al., 2001). Such research will contribute to the knowledge base about leading through a broader range of communication media.

Another theoretical implication of this study is that it builds upon other researchers' work in applying the transformational/transactional leadership paradigm to the study of virtual teams (Avolio et al., 2001b; Kahai & Avolio, 2006; Kahai et al., 2003). Although much more empirical research is needed to understand how these leadership styles play out in a variety of virtual teams, this study makes an important contribution by examining these styles in a controlled, laboratory setting.

In addition to building upon virtual leadership theory, this study provides some practical implications for organizations currently using or considering implementing virtual teams. Organizations will need to make decisions about the leadership of these teams, the most

appropriate communication media, and how these choices will ultimately affect the performance and satisfaction of team members. The findings from the current laboratory study offer some insights into these types of important decisions.

Although this study did not find different effects between transformational and transactional leadership styles, the importance of team leadership cannot be overlooked. Other studies have demonstrated significant effects of virtual team leadership (e.g., Davis et al., 2003; Kahai & Avolio, 2006; Kahai et al., 2003; Sosik et al., 1997). Further research, especially field research, is needed to continue exploring these virtual leadership styles and the moderators and mediators that increase or decrease their effects.

This study provided some insights into the effects of three different communication media. FTF teams demonstrated more constructive interaction than did videoconference or chat teams, yet the defensive interaction between teams in all three media did not differ. Further, FTF and videoconference teams demonstrated higher cohesion than did chat teams. Teams in all three media seemed to demonstrate equal task performance. These findings are mixed, but point to the fact that not all of these media are equally effective. In some regards, virtual teams face greater challenges than FTF teams (Thompson & Covert, 2006). As argued by Balthazard et al. (2002), compared to FTF teams, virtual teams face cohesion and interaction challenges, especially in the early stages of team development. Thus, it is important from the inception of a virtual team to ensure it develops effective leadership, interaction styles, cohesion, and ultimately performance.

Limitations

One limitation of this study is that it was conducted using zero-history teams completing a contrived, short duration task in a laboratory setting. Also, unlike many real virtual teams, participants in this study did not work for the same organization, and would not be working together in the future. Many real-world virtual teams, however, are ad hoc teams that interact on short-term projects (Balthazard et al., 2002), indicating that these laboratory results may generalize to some extent to real virtual teams. In particular, they may be generalizable to virtual teams that form, function, and disband fairly quickly.

It is also necessary to emphasize that leadership styles were simulated, so they may not have appeared as believable or realistic as would be the case in a real team or virtual team. Further, the differences in the two leadership styles may not have been clearly experienced by participants. Even though participants heard the comments, as evidenced by the significant leadership manipulation check results, they may not have taken them

seriously or applied them to the task. Although the leaders were given some flexibility in the timing of their comments, and the ability to interject additional generic comments, they still may not always have been viewed as realistic. They also did not have power over their teams such as is often the case in real organizations (e.g., leader conducting followers' performance reviews).

Another limitation related to the leadership manipulation is that the two types of leadership, transformational and transactional, may not represent a true dichotomy. Indeed, some researchers have found that these styles are highly correlated and that they are both associated with positive performance (Judge & Piccolo, 2004). Although other studies have used this dichotomy, it may not adequately reflect real-world leaders who may simultaneously display aspects of both styles.

The findings from this study are also limited because the sample was comprised of undergraduate university students instead of actual employees in organizations. As noted previously, however, 82% of this sample was currently employed at the time of the study, working an average of 16 h per week in a variety of industries. These students, therefore, had considerable workplace experience and provide a reasonable sample for study.

The composition of this sample represents another potential limitation of this study. With the majority of participants being female (87%), many of the teams were composed mostly or all of females, while both leaders were male. Thus, the generalizability of these findings to teams comprised mostly or all of males, or teams led by females, is questionable. Statistical gender comparisons indicated, however, that there were no significant differences between genders on any of the outcome variables. Further research examining the effects of gender composition in virtual teams is needed to better understand potential differences.

The power of this study represents an additional limitation, as it was low to moderate. Despite this, some effects were found, which are likely to be even stronger in the population. Future research should strive to obtain a higher power level so that relationships can more readily be detected. This may mean comparing fewer conditions than was the case in this study.

Future research

Future research is needed to determine whether the findings from this study apply to field settings through examining virtual teams working on actual problem solving tasks and projects. Such studies would help capture the "motivational element" (Balthazard et al., 2002) that may not have been as strong in the current study. Furthermore, by measuring the styles of real leaders, a determination could be made about what styles and

behaviours are most effective in actual teams. Also, future research could examine whether these relationships and effect sizes are similar when team members have more familiarity and expertise with the task at hand.

More fully examining applications of the transformational/transactional leadership paradigm to virtual teams is another area for future research. For example, the laissez-faire style of leadership, a style that is essentially representative of a lack of leadership, was not examined as a condition in this study. This style can be contrasted with shared leadership, which other studies (e.g., Balthazard et al., 2002) have examined. Shared leadership, unlike laissez-faire, does not involve having a leader, but rather leadership is shared or rotated amongst team members. As we noted earlier, if we had investigated laissez-faire or shared leadership we would have been able to confirm if transformational and transactional did indeed affect team outcomes similarly. With the current design, we cannot confirm whether transformational and transactional leadership styles had either a similar effect on team outcomes or no effect. Thus, how these different leadership styles, including laissez-faire and shared leadership, effect virtual team outcomes will be an important contribution of future research.

More research is also needed to determine which types of interventions (e.g., selecting, training, coaching, team building) are needed to enhance the leadership, constructive team interaction, team cohesion, and performance of virtual teams. Although practical recommendations abound in the popular literature, more empirical laboratory and field research is needed which incorporates new technologies, such as videoconference, that may be increasingly used by virtual teams.

Conclusion

This study suggests that both transformational and transactional leadership styles are equally effective across communication media in teams completing short-term, problem solving tasks. Furthermore, this research provides additional confirmation that the communication media through which teams communicate influence certain aspects of their interactions and cohesiveness. Together these findings point to the importance of virtual leaders establishing media through which virtual teams can most effectively communicate and collaborate, thereby increasing their constructive interactions and cohesion, which in turn may ultimately impact their performance. There are still more questions than answers about virtual team leadership, but given the continued growth of virtual teams across industries, this exciting area of research is ripe for future research endeavours.

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References

- Avolio, B. J., Kahai, S., & Dodge, G. E. (2001b). E-leadership: implications for theory, research, and practice. *Leadership Quarterly*, *11*(4), 615–668.
- Avolio, B. J., Kahai, S., Dumdum, R., & Sivasubramaniam, N. (2001a). Virtual teams: implications for e-leadership and team development. In M. London (Ed.), *How People Evaluate Others in Organizations* (pp. 337–358). Mahwah, NJ: Lawrence Erlbaum.
- Baker, G. (2002). The effects of synchronous collaborative technologies on decision making: a study of virtual teams. *Information Resources Management Journal*, *15*(4), 79–93.
- Baltes, B. B., Dickson, M. W., Sherman, M. P., Bauer, C. C., & LaGanke, J. S. (2002). Computer-mediated communication and group decision making: a meta-analysis. *Organizational Behavior and Human Decision Processes*, *87*(1), 156–179.
- Balthazard, P. A. (1999a). *Group styles inventory—internet edition*. Arlington Heights, IL: Human Synergistics/Center for Applied Research.
- Balthazard, P. A. (1999b). In J. C. Lafferty & A. W. Pond (Eds.), *Virtual version of the desert survival situation*. Arlington Heights, IL: Human Synergistics/Center for Applied Research.
- Balthazard, P., Waldman, D. A., Howell, J., & Atwater, L. E. (2002). *Modeling performance in teams: the effects of media type, shared leadership, interaction style, and cohesion*. Paper presented at the meeting of the Academy of Management, Denver, Colorado.
- Barling, J., Weber, T., & Kelloway, K. E. (1996). Effects of transformational leadership training on attitudinal and financial outcomes: a field experiment. *Journal of Applied Psychology*, *81*(6), 827–832.
- Bass, B. M. (1985). *Leadership and performance beyond expectations*. New York: Free Press.
- Bass, B. M. (1997). Does the transactional—transformational leadership paradigm transcend organizational and national boundaries? *American Psychologist*, *52*, 130–139.
- Bass, B. M., & Avolio, B. A. (1990). *The multifactor leadership questionnaire*. Palo Alto, CA: Consulting Psychologists Press.
- Bass, B. M., & Avolio, B. J. (1993). Transformational leadership: a response to critiques. In *Leadership Theory and Research: Perspectives and Directions* (pp. 49–79). Academic Press, Inc.
- Bass, B. M., & Avolio, B. J. (1994). *Improving organizational effectiveness through transformational leadership*. Thousand Oaks, CA: Sage.
- Bass, B. M., Avolio, B. J., Jung, D. I., & Berson, Y. (2003). Predicting unit performance by assessing transformational and transactional leadership. *Journal of Applied Psychology*, *88*(2), 207–218.
- Bell, B. S., & Kozlowski, S. W. J. (2002). A typology of virtual teams: implications for effective leadership. *Group and Organization Management*, *27*(1), 14–49.
- Bryman, A. (1992). *Charisma and leadership in organizations*. London: Sage.
- Carron, A. V., Brawley, L. R., & Widmeyer, W. N. (1998). The measurement of cohesiveness in sport groups. In J. L. Duda (Ed.), *Advances in Sport and Exercise Psychology Measurement* (pp. 213–226). Morgantown, WV: Fitness Information Technology.
- Cascio, W. F., & Shurygailo, S. (2003). E-leadership and virtual teams. *Organizational Dynamics*, *31*(4), 362–376.
- Chansler, P. A., Swamidass, P. M., & Cammann, C. (2003). Self-managing work teams: an empirical study of group cohesiveness in “natural work groups” at a Harley-Davidson motor company plant. *Small Group Research*, *34*, 101–120.
- Cook, J. D. (1981). *The experience of work: A compendium and review of 249 measures and their use*. New York: Academic Press.
- Cooke, R. A., & Szumal, J. L. (1994). The impact of group interactional styles on problem-solving effectiveness. *Journal of Applied Behavioral Science*, *30*(4), 415–437.
- Daft, R. L., & Lengel, R. H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, *32*(5), 554–571.
- Davis, D. D., Mihalescz, M., Bryant, J. L., Tedrow, L., Liu, Y., & Say, R. (2003). *Leadership in global virtual teams*. Paper presented at the meeting of the Society for Industrial and Organizational Psychology, Orlando, Florida.
- Den Hartog, D. N., & Koopman, P. L. (2001). Leadership in organizations. In N. Anderson, D. S. Ones, H. K. Sinangil, & C. Viswesvaran (Eds.), *Handbook of Industrial, Work and Organizational Psychology* (Vol. 2, pp. 166–187). London, England: Sage.
- Dennis, A. R., & Valacich, J. S. (1999). Rethinking media richness: Towards a theory of media synchronicity. In *Proceedings of the 32nd Hawaii International Conference on System Sciences*, *1*, pp. 1–10.
- Dionne, S. D., Yammarino, F. J., Atwater, L. E., & Spangler, W. D. (2004). Transformational leadership and team performance. *Journal of Organizational Change Management*, *17*, 177–193.
- Driskell, J. E., Radtke, P. H., & Salas, E. (2003). Virtual teams: effects of technology mediation on team performance. *Group Dynamics: Theory, Research, and Practice*, *4*, 297–323.
- Dvir, T., Eden, D., Avolio, B. J., & Shamir, B. (2002). Impact of transformational leadership on follower development and performance: a field experiment. *Academy of Management Journal*, *45*(4), 735–744.
- Fletcher, T. D., & Major, D. A. (2003). *The effects of communication modality on teamwork processes*. Paper presented at the meeting of the Society for Industrial and Organizational Psychology, Orlando, Florida.
- Griffith, T. L., & Neale, M. A. (2001). Information processing in traditional, hybrid and virtual teams: from nascent knowledge to transactive memory. In B. M. Staw & R. I. Sutton (Eds.), *Research in organizational behaviour* (Vol. 23). New York: Elsevier.
- Gully, S. M., Devine, D. J., & Whitney, D. J. (1995). A meta-analysis of cohesion and performance. *Small Group Research*, *26*, 497–525.
- Hambley, L. A., O'Neill, T. A., & Kline, T. J. B. (in press). Virtual team leadership: perspectives from the field. *International Journal of e-Collaboration*.
- Hertel, G., Geister, S., & Konradt, U. (2005). Managing virtual teams: a review of current empirical research. *Human Resource Management Review*, *15*, 69–95.
- Hertel, G., Konradt, U., & Orlikowski, B. (2004). Managing distance by interdependence: goal setting, task interdependence, and team-based rewards in virtual teams. *European Journal of Work and Organizational Psychology*, *13*, 1–28.
- Hollingshead, A. B. (2004). Communication technologies, the internet, and group research. In M. B. Brewer & M. Hewstone (Eds.), *Applied Social Psychology* (pp. 301–317). Blackwell Publishing: Malden, MA.
- House, R. J. (1996). Path-goal theory of leadership: lessons, legacy and a reformulated theory. *Leadership Quarterly*, *7*(3), 323–352.
- Howell, J. M., & Avolio, B. J. (1993). Transformational leadership, transactional leadership, locus of control and support for innovation: key predictors of consolidated-business-unit performance. *Journal of Applied Psychology*, *78*, 891–902.

- Howell, J. M., & Frost, P. (1989). A laboratory study of charismatic leadership. *Organizational Behaviour and Human Decision Processes*, 43, 243–269.
- Hoyt, C. L., & Blascovich, J. (2003). Transformational and transactional leadership in virtual and physical environments. *Small Group Research*, 34(6), 678–715.
- Huang, W. W., Wei, K. K., Watson, R. T., & Tan, B. C. Y. (2002). Supporting virtual team-building with a GSS: an empirical investigation. *Decision Support Systems*, 34, 359–367.
- Human synergistics (2002). *Meeting Effectiveness Situation™*. Plymouth, MI: Human Synergistics International.
- James, L. R., Demaree, R. G., & Wolf, G. (1984). Estimating within-group interrater reliability with and without response bias. *Journal of Applied Psychology*, 69, 85–98.
- James, L. R., Demaree, R. G., & Wolf, G. (1993). rwg: An assessment of within-group interrater agreement. *Journal of Applied Psychology*, 78, 306–309.
- Jarvenpaa, S. L., & Leidner, D. E. (1999). Communication and trust in global virtual teams. *Organizational Science*, 10(6), 791–815.
- Judge, T. A., & Piccolo, R. F. (2004). Transformational and transactional leadership: a meta-analytic test of their relative validity. *Journal of Applied Psychology*, 89, 755–768.
- Jung, D. I. (2001). Transformational and transactional leadership and their effects on creativity in groups. *Creativity Research Journal*, 13(2), 185–195.
- Jung, D. I., & Sosik, J. J. (2002). Transformational leadership in work groups: the role of empowerment, cohesiveness, and collective-efficacy on perceived group performance. *Small Group Research*, 33(3), 313–336.
- Kahai, S., & Avolio, B. (2006). Leadership style, anonymity, and the discussion of an ethical issue in an electronic context. *International Journal of e-Collaboration*, 2(2), 1–26.
- Kahai, S., Sosik, J., & Avolio, B. (1997). Effects of leadership style and problem structure on work group process and outcomes in an electronic meeting system environment. *Personnel Psychology*, 50, 121–146.
- Kahai, S. S., Sosik, J. J., & Avolio, B. J. (2003). Effects of leadership style, anonymity, and rewards on creativity-relevant processes and outcomes in an electronic meeting system context. *Leadership Quarterly*, 14(4-5), 499–524.
- Kahai, S., Sosik, J., & Avolio, B. (2004). Effects of participative and directive leadership in electronic groups. *Groups and Organization Management*, 29(1), 67–105.
- Kelloway, K. E., & Barling, J. (2000). What we have learned about developing transformational leaders. *Leadership and Organizational Development Journal*, 21(7), 355–362.
- Kerr, S., & Jermier, J. M. (1978). Substitutes for leadership: their meaning and measurement. *Organizational Behavior and Human Performance*, 22, 375–403.
- Kirkman, B. L., Rosen, B., Gibson, C. B., Tesluk, P. E., & McPherson, S. O. (2002). Five challenges to virtual team success: lessons from Sabre, Inc. *Academy of Management Executive*, 16(3), 67–79.
- Kline, T. (1999). *Remaking teams: A revolutionary research-based guide that puts theory into practice*. San Francisco: Jossey-Bass/Pfeiffer.
- Lim, B., & Ployhart, R. E. (2004). Transformational leadership: relations to the Five-Factor Model and team performance in typical and maximum contexts. *Journal of Applied Psychology*, 89(4), 610–621.
- Lipnack, J., & Stamps, J. (2000). *Virtual teams: People working across boundaries with technology* (2nd ed.). New York: John Wiley.
- Lowe, K. B., Kroeck, K., & Sivasubramaniam, N. (1996). Effectiveness correlates of transformational and transactional leadership: a meta-analytic review of the MLQ literature. *Leadership Quarterly*, 7(3), 385–425.
- Mannix, E. A., Griffith, T., & Neale, M. A. (2002). The phenomenology of conflict in distributed work teams. In P. Hinds & S. Kiesler (Eds.), *Distributed work* (pp. 213–233). Cambridge, MA: The MIT Press.
- Martins, L. L., Gilson, L. L., & Maynard, M. T. (2004). Virtual teams: what do we know and where do we go from here? *Journal of Management*, 30, 805–835.
- Maruping, L. M., & Agarwal, R. (2004). Managing team interpersonal processes through technology: a task-technology fit perspective. *Journal of Applied Psychology*, 89(6), 975–990.
- McGrath, J. E., Hollingshead, A. B., & 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(3), 307–333.
- Morgeson, F. P. (2005). The external leadership of self-managing teams: intervening in the context of novel and disruptive events. *Journal of Applied Psychology*, 90(3), 497–508.
- Mullen, B., & Copper, C. (1994). The relation between group cohesiveness and performance: an integration. *Psychological Bulletin*, 115, 210–227.
- O'Connell, B., Whittaker, S., & Wilbur, S. (1993). Conversations over videoconferences: an evaluation of the spoken aspects of video-mediated communication. *Human Computer Interaction*, 8, 389–428.
- O'Reilly, C., Caldwell, D., & Barnett, W. (1989). Work group demography, social integration, and turnover. *Administrative Sciences Quarterly*, 34, 21–37.
- Potter, R. E., & Balthazard, P. A. (2002). Virtual team interaction styles: assessment and effects. *International Journal of Human-Computer Studies*, 56, 423–443.
- Potter, R. E., Balthazard, P. A., & Cooke, R. A. (2000). Virtual team interaction: assessment, consequences, and management. *Team Performance Management: An International Journal*, 6(7/8), 131–137.
- Pulley, M. L., Sessa, V., & Malloy, M. (2002). E-leadership: a two-pronged idea. *Training and Development*, 35–47.
- Salas, E., Sims, D. E., & Burke, C. S. (2005). Is there a “Big Five” in teamwork? *Small Group Research*, 36, 555–599.
- Sellen, A. J. (1995). Remote conversations: the effects of mediating talk with technology. *Human Computer Interaction*, 10, 401–444.
- Sivasubramaniam, N., Murray, W. D., Avolio, B. J., & Jung, D. L. (2002). A longitudinal model of the effects of team leadership and group potency on group performance. *Group and Organization Management*, 27, 66–96.
- Smith, K. A., Peterson, R. P., Johnson, D. W., & Johnson, R. T. (1986). The effects of controversy and concurrence seeking on effective decision making. *Journal of Social Psychology*, 126, 237–248.
- Sosik, J. J., Avolio, B. J., & Kahai, S. S. (1997). Effects of leadership style and anonymity on group potency and effectiveness in a group decision support system environment. *Journal of Applied Psychology*, 82(1), 89–103.
- Sosik, J. J., Avolio, B. J., Kahai, S. S., & Jung, D. I. (1998). Computer-supported work group potency and effectiveness: the role of transformational leadership, anonymity, and task interdependence. *Computers in Human Behavior*, 14(3), 491–511.
- Spreitzer, G. M. (2003). Leadership development in the virtual workplace. In S. E. Murphy & R. E. Riggio (Eds.), *The future of leadership development* (pp. 71–86). Mahwah, NJ: Laurence Erlbaum Associates.
- Staples, S., & Webster, J. (2003). *A review and classification of research on virtual teams and an identification of research opportunities*. Paper presented at the meeting of the Society for Industrial and Organizational Psychology, Orlando, Florida.
- Straus, S. G., & McGrath, J. E. (1994). Does medium matter? The interaction of task type and technology on group performance and member reactions. *Journal of Applied Psychology*, 79(1), 87–97.
- Suh, K. S. (1999). Impact of communication medium on task performance and satisfaction: an examination of media-richness theory. *Information and Management*, 35, 295–312.

- Sundstrom, E., De Meuse, K. P., & Futrell, D. (1990). Work teams: applications and effectiveness. *American Psychologist*, *45*(2), 120–133.
- Thompson, L. F., & Coovert, M. D. (2003). Teamwork online: the effects of computer conferencing on perceived confusion, satisfaction, and postdiscussion accuracy. *Group Dynamics: Theory, Research, and Practice*, *7*, 135–151.
- Thompson, L. F., & Coovert, M. D. (2006). Understanding and developing virtual computer-supported cooperative work teams. In C. Bowers, E. Salas, & F. Jentsch (Eds.), *Creating High-Tech Teams* (pp. 213–241). Washington, DC: APA.
- Townsend, A. M., Demarie, S. M., & Henderickson, A. R. (2001). Desktop video conferencing in virtual workgroups: Anticipation, system evaluation and performance. *Information Systems Journal*, *11*, 213–227.
- Van de Ven, A. H., Delbecq, A. L., & Koenig, R. (1976). Determinants of coordination modes within organizations. *American Sociological Review*, *41*, 322–328.
- Wageman, R. (2001). How leaders foster self-managing team effectiveness: design choices versus hands on coaching. *Organizational Science*, *12*, 559–577.
- Wakertin, 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*(4), 975–996.
- Watson, W. E., & Michaelsen, L. K. (1988). Group interaction behaviors that affect group performance on an intellectual task. *Group and Organization Studies*, *13*, 495–516.
- Webster, J., & Hackley, P. (1997). Teaching effectiveness in technology-mediated distance learning. *Academy of Management Journal*, *40*, 1282–1309.
- Webster, J., & Wong, W. K. P. (2003). *Comparing traditional and virtual group forms: Identity, communication and trust in naturally occurring project teams*. Paper presented at the meeting of the Society for Industrial/Organizational Psychology, Orlando, Florida.
- Wiggins, B., & Horn, Z. N. J. (2005). *Explaining effects of task complexity in computer-mediated communication: A meta-analysis*. Paper presented at the meeting of the Society for Industrial and Organizational Psychology, Los Angeles, CA.
- Wolfe, M. (2002). *InSite broadband collaborative research project, final report: Knowledge management*. Calgary, AB: Advanced Networks, Applications, Systems and Technologies (ANAST).
- Zaccaro, S. J., Ardison, S. D., & Orvis, K. L. (2004). Leadership in virtual teams. In D. V. Day, S. J. Zaccaro, & S. M. Halpin (Eds.), *Leader development for transforming organizations: Growing leaders for tomorrow* (pp. 267–292). Mahwah, NJ: Lawrence Erlbaum Associates.
- Zaccaro, S. J., & Bader, P. (2002). E-leadership and the challenges of leading e-teams: minimizing the bad and maximizing the good. *Organizational Dynamics*, *31*, 377–387.
- Zaccaro, S. J., & Klimoski, R. (2002). The interface of leadership and team processes. *Group and Organization Management*, *27*, 4–13.