



## Transformational leadership in context: Face-to-face and virtual teams

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### ABSTRACT

This experimental study examined transformational leadership in the context of traditional teams using face-to-face communication and virtual teams using computer-mediated communication. Thirty-nine leaders led both face-to-face and virtual teams. Repeated-measures analyses revealed similar mean levels of transformational leadership in both team types; however, leader rank order varied across team type. Post hoc analyses revealed that the most effective leaders were those who increased their transformational leadership in virtual teams. Furthermore, analyses at the team level revealed that the effect of transformational leadership on team performance was stronger in virtual than in face-to-face teams. Team-member ratings of transformational leadership were equally linked to project satisfaction in face-to-face and virtual teams. Considered as a whole, our results suggest that transformational leadership has a stronger effect in teams that use only computer-mediated communication, and that leaders who increase their transformational leadership behaviors in such teams achieve higher levels of team performance.

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### 1. Introduction

The advancement of new communication technologies in the workplace has given rise to a rapidly spreading business practice – the virtual project team (Bell & Kozlowski, 2002; Driskell, Radtke, & Salas, 2003; Dundis & Benson, 2003). The typical virtual project team is characterized by temporary lifespan and membership (Avolio, Kahai, & Dodge, 2001; Bell & Kozlowski, 2002), spatial dispersion (Zaccaro & Bader, 2003; Zigurs, 2003), and the use of predominantly computer-mediated communication (Driskell et al., 2003). Leaders of such teams face a unique set of challenges, such as successfully influencing team members while relying on computer-mediated communication. Yet, little is known about “which technological developments [...] have the potential to change radically what we know [about leadership]” (Zigurs, 2003, p. 339). For this reason, it is becoming increasingly important to study leadership in context (Antonakis, Avolio, & Sivasubramaniam, 2003; House & Aditya, 1997; Shamir & Howell, 1999), particularly in the electronic communication context of virtual teams.

Important theoretical and empirical research on virtual leadership has begun to appear in the literature. A prime example is Avolio and colleagues' theoretical work (Avolio et al., 2001; Avolio & Kahai, 2002, 2003), which coined the term “e-leadership” and employed adaptive structuration theory (DeSanctis & Poole, 1994) to explain how communication technologies may interact with team leaders and members to produce new team structures and cultures. Several lab studies examine the effects of transformational, transactional, participative, and directive leadership on various team outcomes, such as creativity, satisfaction with task and leader, communication, and team performance, in virtual teams (e.g., Kahai, Sosik, & Avolio, 2003; Sosik, 1997; Sosik, Avolio, & Kahai, 1998; Sosik, Kahai, & Avolio, 1999; Weisband, 2002). Qualitative studies provide information about the experiences of virtual leaders and team members with respect to issues such as effective and ineffective leadership behaviors, challenges

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virtual teams face, and practice-proven ideas for helping virtual teams function successfully (e.g., Hambley, O'Neill, & Kline, 2007; Hart & McLeod, 2003; Wiesenfeld, Raghuram, & Garud, 1999). Generally, the findings of this literature speak to the importance of effective leadership behaviors, such as those specified by transformational leadership theory (Bass & Avolio, 1994), in virtual communication contexts. Specifically, this literature suggests that transformational and participative leadership behaviors are of greater importance in teams where communication is constrained by technology.

Although the e-leadership literature makes an important contribution to our knowledge of virtual leadership, there have been few direct comparisons of leadership in virtual and face-to-face project teams. Thus, the primary purpose of our study is to provide such a comparison, with a focus on transformational leadership. In an experimental study, we address two questions related to whether and how leadership may differ in virtual and face-to-face teams. First, we use a within-person design to examine the extent to which leaders are consistent in their behaviors across settings. Do leaders alter their behavior to use more (or less) transformational leadership behaviors in virtual project teams, as compared to face-to-face project teams? Second, we compare the outcomes of transformational leadership in face-to-face and virtual teams. We test predictions from leadership and communication theories (e.g., Avolio et al.'s (2001) adaptive structuration theory and Reicher, Spears, & Postmes' (1995) social identity model of deindividuation effects), which suggest that transformational leadership behaviors may be associated more strongly with team effectiveness in virtual than in face-to-face project teams.

We focus on transformational leadership because of its documented effectiveness in the research literature (see Judge & Piccolo, 2004), and because theory highlights the importance of transformational leadership in virtual teams (Avolio et al., 2001; Bell & Kozlowski, 2002). Transformational leadership is comprised of idealized influence (also referred to as charisma), inspirational motivation, intellectual stimulation, and individualized consideration behaviors. Leaders are charismatic when they inspire devotion and loyalty, display a strong commitment to ideals, and emphasize the importance of a collective mission. Leaders are inspirational when they appeal to employees' feelings and emotions, transmit an enthusiastic vision of the future, and express confidence about successful completion of goals. Leaders are intellectually stimulating when they question assumptions, challenge their employees intellectually, and encourage re-thinking of ideas. Leaders are individually considerate when they recognize the unique needs and abilities of their employees, treat employees as individuals, and coach and develop their employees.

Substantial evidence has accrued that the four dimensions of transformational leadership are highly intercorrelated, and that their relations with outcome variables are similar (see Lowe, Kroeck, & Sivasubramaniam, 1996). However, there may be theoretical and practical value to studying the four transformational leadership dimensions separately in some settings (Antonakis et al., 2003), especially when these settings have not received much research attention. Because the empirical literature on leadership in virtual communication settings is still young, in this study we examine the broad transformational composite (e.g., Bono & Judge, 2003; Kark, Shamir, & Chen, 2003), as well as the transformational dimensions (e.g., Sosik et al., 1998). Further, leadership is a complex construct that could be described and measured in multiple ways. For example, transformational leadership theory (Bass, 1985) represents a clearly behavioral approach to leadership which specifies exactly what transformational leaders do. In contrast, attributional theories (e.g., Conger & Kanungo, 1987; Shamir, 1992) and categorization theories (e.g., Lord, 1985; Lord & Maher, 1991; Yukl, 1998) suggest that followers are likely to view leaders as charismatic if they fit a profile, and hence — that leadership is in the eye of the beholder. Rather than pitting these two philosophical approaches against each other, we take the position that both perspectives have merits as they assess different, yet equally valid, aspects of leadership. Hence, in this study, we examine both leadership behaviors (i.e., what leaders actually say and do as reported by independent observers) and leadership perceptions (i.e., what followers perceive leaders say and do).

### 1.1. Team type and leadership

Whereas Avolio & Kahai (2003, p. 327) expressed confidence that “leadership mediated by technology can exhibit exactly the same content and style as traditional face-to-face leadership,” they agreed with Ziguers (2003) that we do not know how technology affects leadership or management. To better understand the impact of electronic communication technologies on leadership (both leadership behaviors and leadership perceptions), we draw from several communication theories, collectively known as technology-deterministic or cues-filtered-out approaches (e.g., Shannon & Weaver, 1949; Short, Williams, & Christie, 1976; Daft & Lengel, 1984; Sproull & Kiesler, 1986). These theories assert that face-to-face communication is superior to computer-mediated communication for the following reasons: 1) Face-to-face communication is richer in nonverbal (i.e., visual) and paraverbal (i.e., auditory) cues; 2) Face-to-face communication minimizes information loss due to the simultaneous usage of multiple communication channels; 3) Face-to-face communication maximizes feelings of social presence and conversational involvement; 4) Face-to-face communication transmits information about social standing and social context; and 5) Face-to-face communication is less physically and cognitively taxing than other communication media.

The differences between face-to-face and virtual communication highlighted by technology-deterministic theories suggest that one might find less transformational leadership in virtual teams. Because electronic communication tends to be lacking in visual and auditory cues — the main carriers of emotional communication — transformational behaviors that are emotional in nature may occur less frequently in virtual teams. Both charisma (idealized influence) and inspirational motivation employ nonverbal and paraverbal cues (Kirkpatrick & Locke, 1996); hence, it may be hard to display and perceive these transformational behaviors in electronically-mediated communication settings. Virtual communication is also more confusing (Thompson & Coovert, 2003), more laborious and more cognitively taxing than face-to-face communication. For example, it takes at least four times longer to type than to speak (Hancock, 2004; Walther, 1993). Hence, leaders may engage in less intellectual stimulation, because challenging

employees to re-think their assumptions and engaging employees in the decision-making process may prove too difficult and time-consuming in virtual environments. In fact, in interview studies, members of virtual teams report that their leaders often employ one-way, top-down communication and that leaders micro-manage a lot (Hambley et al., 2007), suggesting that virtual followers do not find their leaders to be very intellectually stimulating. Research also reveals that task-orientated, to-the-point communication is the norm in virtual teams, at the expense of social-relational communication (Bordia, 1997; Cornelius & Boos, 2003; Hollingshead, 1996; Straus, 1997; Thompson & Coovert, 2003). Furthermore, it has been suggested that managers think of electronic communication as a tool to achieve tasks, not as a relational tool (Chidambaram, 1996). If social-relational communication is displaced by task-oriented communication, relational leadership behaviors may also suffer. Specifically, leaders may engage in fewer individualized consideration behaviors, such as taking the time to establish close relationships with individual team members and to develop team members. In interview studies, both virtual leaders and virtual followers report that leaders are challenged to establish relationships with followers (Hambley et al., 2007).

In sum, technology-deterministic communication theories predict, and preliminary data from qualitative studies reveals, that each of the transformational leadership behaviors will be harder to display in virtual than in face-to-face teams. In other words, technology-mediated communication can be expected to have an overall negative effect on leadership behaviors, as well as on followers' perceptions of leadership behaviors.

**Hypothesis 1.** Transformational leadership, including the four components of idealized influence, inspirational motivation, intellectual stimulation and individualized consideration, occurs less frequently in virtual than in face-to-face project teams.

It is possible, however, that the contextual effects predicted in Hypothesis 1 may not be the same for all leaders. It is plausible that some leaders who are successful at using transformational leadership behaviors in face-to-face teams might use less of this type of leadership in virtual teams, or when forced to rely on electronic communication. Other leaders may believe that transformational leadership behaviors are more important in contexts where communication richness is limited, and, as a result, they may increase their transformational behaviors in virtual communication settings. Thus, an important issue examined in this study is the cross-situational consistency of leadership behaviors; do some leaders alter their behavior to match the team communication context? This question is practically significant as in a typical business setting, leaders may be responsible for both face-to-face and virtual teams (Malhotra, Majchrzak, & Rosen, 2007). Answering this question requires a within-person analysis, comparing the behavior of each leader across contexts.

From a trait perspective, there is little reason to expect behavior to vary across situations. In fact, meta-analytic studies link personality and intelligence to leadership (Judge, Bono, Ilies, & Gerhardt, 2002; Judge, Colbert, & Ilies, 2004). If leadership behavior is a function of certain traits and characteristics, then leaders might be expected to demonstrate similar behaviors across situations. Studies testing this consistency-specificity hypothesis have produced mixed results, however. Some researchers reported that leadership behaviors are consistent across situations (e.g., Albright & Forziati, 1995; Barnlund, 1962; Bell & French, 1950; Borgatta, 1954; Carter & Nixon, 1949; Geier, 1967; Gibb, 1950; Gordon & Medland, 1965; Schultz, 1974; Zaccaro, Foti, & Kenny, 1991), but others found evidence that leadership behaviors vary by context (Barrow, 1976; Herold, 1977; Hill, 1973; Hill & Hughes, 1974; James & White, 1983).

The reason for these disparate findings may lie in how leadership has been operationalized. Whereas all of the studies reporting cross-situational consistency examined leadership emergence or leadership potential in small leaderless groups, all of the studies reporting cross-situational specificity examined the leadership behaviors or effectiveness of actual or assigned leaders. Leadership emergence is likely to be more stable than leadership behavior because emergence is more strongly correlated with personality ( $R = .53$  compared to  $R = .39$ ; Judge et al., 2002) and intelligence ( $\rho = .25$  compared to  $\rho = .17$ ; Judge et al., 2004) than is leadership effectiveness. Because we examine transformational leadership behaviors, we expect that our results will be consistent with previous investigations that find evidence for cross-situational specificity of leadership behaviors, such that leaders will vary in the extent and in the manner in which they alter their behavior to adapt to the situation. However, because some leaders may increase transformational behaviors in virtual settings, whereas others may reduce such behavior, we do not offer a directional hypothesis.

**Hypothesis 2.** Transformational leadership behaviors vary, within leader, based on team context (virtual vs. face-to-face).

### 1.2. Team type and leadership effectiveness

Due to the impoverished communication environment, virtual teams operate under conditions of challenge, confusion and uncertainty. Several different theories, all referencing the concept of weak situations, suggest that such contexts create the best opportunities for leadership to affect team outcomes. For example, Shamir & Howell (1999) argue that weak situations do not provide people with clear social or structural cues to guide their behavior, and that such contexts create opportunities for influence of charismatic and transformational leadership. Waldman and Yammarino (1999) take essentially the same position, as they argue that volatile situations, or situations of high uncertainty, increase the potential for charismatic and transformational leadership effects. Leaders who operate under weak, uncertain situations have a greater chance to appeal to and engage followers' self-concepts, values, and identities (Shamir & Howell, 1999), as well as to set inspiring goals, allay followers' concerns, generate confidence, and motivate performance (Waldman & Yammarino, 1999). The theoretical predictions of these leadership scholars are in perfect alignment with predictions derived from a new cluster of communication theories, referred to as social-deterministic theories (e.g., Reicher et al., 1995; Spears, Postmes, Lea, & Watt, 2001; Walther, 1996; Walther & Burgoon, 1992). Specifically,

social-deterministic theories argue that the uncertainty characteristic of virtual communication leads virtual interactants to experience a greater need for structure and socio-relational context than face-to-face interactants.

Recently, Avolio and colleagues (e.g., Avolio et al., 2001; Avolio & Kahai, 2002, 2003) proposed a new theory of e-leadership, which describes how leadership interacts with communication technology in the modern workplace. The central point made by this theory is that virtual teams need not necessarily suffer the effects of leaner communication media. Rather, virtual teams can adapt the technology to suit their needs by creating a new culture of technology use. Virtual team *leaders* are expected to play an essential role in this adaptation process. Avolio et al. (2001) stated: “we take the position that the successful appropriation of advanced information technology is tied to the type of leadership system in which it is placed” (p. 623). In particular, Avolio and colleagues predicted that virtual teams with participative leaders should outperform virtual teams with directive leaders. Hence, this new theory of e-leadership also recognizes the crucial role of leadership in virtual contexts.

The idea that leadership is crucial in virtual teams has already received some support in case studies of virtual teams. For example, Armstrong & Cole (2002) reported that good leadership differentiated successful from unsuccessful virtual teams. Specifically, leaders who generated discussion among team members, strove to reach agreement, modeled group norms, coached team members, acknowledged difficulties posed by distance and virtual communication, created concrete expectations and goals, and rewarded performance led more successful virtual teams. Malhotra et al. (2007) studied 54 virtual teams from 14 industries, and observed six specific behaviors of successful virtual leaders — establishing trust, ensuring that team members feel understood and appreciated, managing virtual meetings, monitoring team progress, enhancing the external visibility of team members, and ensuring that individuals benefit from their participation in virtual teams. In a 4-week study of student virtual teams, Weisband (2002) found that leaders who created awareness about other team members' progress on their individual tasks, schedules, and personal lives and interests, as well as clarified the project task requirements, led more successful virtual teams. Many of the leadership behaviors described in these studies clearly fall into the domain of transformational leadership.

In sum, virtual communication creates a sense of uncertainty and ambiguity in virtual followers, and opens the door for transformational leaders to influence followers. Transformational leaders are in a position to provide a sense of social context, to structure the work, and to create a sense of predictability and certainty. Therefore, we expect that when transformational leadership behaviors are used in virtual project teams, they may have greater impact than when used in face-to-face project teams.

**Hypothesis 3.** Team type will moderate the effects of transformational leadership on team performance, such that there will be a stronger association between transformational leadership and team performance in virtual teams than in face-to-face teams.

**Hypothesis 4.** Team type will moderate the effects of transformational leadership on project satisfaction, such that there will be a stronger association between transformational leadership and project satisfaction in virtual teams than in face-to-face teams.

## 2. Methods

### 2.1. Participants and procedures

Undergraduate students ( $n=301$ ) enrolled in introductory psychology classes at a public university participated in this laboratory experiment for course credit. During recruitment, students chose to sign up for the role of a leader or a follower. Forty six students signed up to be team leaders (67% female). The remaining 255 students were randomly assigned to either a face-to-face ( $n=129$ ) or a virtual ( $n=126$ ) team. The leaders and team members had no prior interaction and were assigned to a team based on scheduling availability. Each of the 46 leaders was assigned to lead two teams — one virtual and one face-to-face. Due to scheduling constraints, there were some instances where we were not able to match a leader with two teams. Thus, our final sample consisted of 39 leaders, 115 face-to-face team members, and 118 virtual team members. The average number of team members in a group was 3 in both conditions.

Leaders were asked to come to the lab for a 2.5 h time block and were scheduled to meet sequentially with two teams — one face-to-face and one virtual — in counterbalanced order. Each team meeting was 1 h in length. Neither leaders nor team members were aware of the nature of the experiment or our research question in advance. However, one or two days prior to the leaders' scheduled appointment, leaders received an email explaining that they would be leading a team in preparing a proposal for Creative Ideas, a fictitious company in the mailing and shipping business. According to the scenario, Creative Ideas was launching a new project that involved building self-service mailing booths. The leader email included an attachment with a description of the project and a template for a proposal that the team would complete during their meeting. The text of the email instructed leaders that they were to familiarize themselves with the team task (completing a proposal for self-service mailing booths), and come up with ideas and strategies for how to approach the task with their teams. The email also stated that leaders had absolute discretion as to how to lead their teams. In contrast, team members received an email that contained only a reminder of their scheduled meeting time.

Upon leaders' arrival, they were randomly assigned to either a face-to-face or a virtual team for their first session. A research assistant introduced the leader to the team members and encouraged the team members to introduce themselves and spend about 5 min in an informal, get-to-know each other discussion. Teams were then given verbal instructions about how to use the project proposal template, which was preloaded on computers. Participants were also informed that a small monetary prize (\$20 for leader, \$10 for each team member) would be awarded to the five best project proposals at the end of the semester.



In the face-to-face condition, the leader and team members were seated at a table with a computer. One chair was designated as the leader's chair and a video camera was aimed toward that chair. After giving instructions, the research assistant turned on the camera and left the room. In the virtual team condition, the leader and each team member were directed to individual rooms, each of which was equipped with a computer. A specially created email account (in Hotmail) was already open on each computer, and an instant messaging session (hereafter referred to as chat) was also running. Participants received brief instructions about how to use the email and the chat tools. With the exception of two participants, all indicated they had used both Hotmail and chat before. The leader's Hotmail account contained an attachment of the project proposal template. The leaders' computer was set to capture all of his or her communications.

Work sessions lasted exactly 1 h; teams were given notices at the 45th and 55th min, and were stopped after 60 min. At that time, the research assistant retrieved the videotape or the chat and email communication, as well as the completed project proposal template. Team members completed a survey and were thanked for their participation. Team leaders were taken to another room and introduced to their second team. If the leaders' first team was virtual, their second team was face-to-face, and vice versa; leaders worked on the same project in both sessions.

Teams worked on what was called the "Self-Serving Mailing Booth Project" (Olson, Olson, & Meader, 1997). Teams played the role of employees of a company called Creative Ideas. The company had recently decided to invest in self-serving mailing booths, which would allow customers to purchase mailing products and to self-mail letters and packages on a 24-hour basis. The teams' goal was to generate a business project proposal that addressed six issues: (1) products, services and mailing options, (2) mail distribution, (3) mail tracking, (4) payment options, (5) physical location and appearance, and (6) target market demographics. The teams were informed that their project proposals were to be judged on four criteria – comprehensiveness, creativity, customer-friendliness, and practicality.

## 2.2. Measures

### 2.2.1. Observer counts of leadership behaviors

A group of 14 undergraduate research assistants were trained to identify transformational behaviors consistent with the dimensions of inspirational motivation, intellectual stimulation and individualized consideration. We did not code idealized influence behaviors as pre-viewing of videotapes and chat records revealed no instances of idealized influence behaviors, possibly due to the relatively short duration of team meetings (i.e., 60 min). In addition, the specific nature of the project task – deciding how to build and market self-service mailing booths – may not have presented enough opportunities for leaders to demonstrate a strong commitment to ideals, beliefs and values.

The training consisted of both lecture and practice components. The research assistants first received a 1-hour lecture on transformational leadership, with a specific emphasis on behavioral exemplars of each dimension. Then, research assistants watched a video segment of a leader and read a chatroom transcript of another leader (not used in subsequent analyses). The trainer (the first author) pointed examples of transformational behaviors in the video and the transcript. Research assistants then received a copy of the entire video episode and the chatroom transcript, and coded these materials on their own. The group came back in a week to compare their counts and discuss agreement and disagreement with each other and the trainer. At the end of the meeting, research assistants proceeded with the coding task. Their agreement was checked periodically by the first author.

The coding task entailed watching all videotaped sessions and reading all chat records with the purpose of counting the number of transformational behaviors displayed by team leaders. Coders used observation sheets on which behavioral examples of individualized consideration, intellectual stimulation and inspirational motivation were listed (see Appendix A for the leadership categories and sample behaviors). As coders observed transformational behaviors, they placed a tick mark in the appropriate category (e.g., inspirational motivation). No direct links were made between counts and specific behaviors during the coding process. However, for training and calibration purposes, coders made notes of exemplar behaviors as they coded. Coders rated videotapes and chat records in random order, rating roughly 2 videos and 3–4 transcripts during each coding session. Each videotape and chat record was viewed and rated by at least 5 coders (average was 9.5 per record). Coders rated leadership behaviors for 29 leaders, as 10 videotapes were not ratable due to poor video or audio quality. Thus, all analyses using counts of leadership behavior are based on 29 leaders (however, all other analyses are based on all 39 leaders). After all counts were completed, we formed a transformational leadership composite by summing the counts for the three dimensions.

### 2.2.2. Follower ratings of leadership behaviors

Team members responded to select items from the Multifactor Leadership Questionnaire (MLQ-5X).<sup>2</sup> The MLQ is a well-established measure of transformational leadership with good reliability and predictive validity (Lowe et al., 1996). Following procedures used by Bono & Judge (2003), we excluded items that were deemed inappropriate in the experimental context. For example, the item "The leader helps others to develop their strengths" was not used because it normally takes a leader more than a 1-hour interaction to develop others' strengths. In total, 12 transformational items (three items each for idealized influence-behavior, inspirational motivation, intellectual stimulation, and individualized consideration) were used. Responses were provided on a 5-point scale, (1 = *Not at all* to 5 = *Frequently, if not always*), and the items were averaged to form a score for each dimension

<sup>2</sup> The Multifactor Leadership Questionnaire (MLQ), Form 5X (copyright 1995 by Bernard Bass and Bruce Avolio), is used with permission of Mind Garden, 1690 Woodside Road, Suite 220, Redwood City, CA 64061. All rights reserved.

(e.g., inspirational motivation, individualized consideration). Consistent with past research (e.g., Bono & Judge, 2003; Kark et al., 2003), we also averaged all 12 items to form an overall measure of transformational leadership.

### 2.2.3. Project satisfaction

Project satisfaction in our teams is analogous to work satisfaction. We included three items in our survey to assess team-member satisfaction with the project: "I felt enthusiastic about our project;" "I found enjoyment in our projects;" and "I considered the project rather unpleasant" (reverse scored). Responses were provided on a 5-point scale, (1 = *Strongly disagree* to 5 = *Strongly agree*).

### 2.2.4. Team performance

Team performance was measured by the quality of the teams' final project proposals. A group of four research assistants rated each project proposal on four criteria: comprehensiveness, creativity, customer-friendliness, and practicality. Raters were undergraduate students who were enrolled in a hands-on research course and received 2 h of classroom instruction on how to identify the four criteria, which they rated on a 5-point scale, (1 = *Poor* to 5 = *Excellent*). The four criterion scores were highly correlated (average  $r = .53$ ) and a principal component analysis produced one factor with an eigenvalue greater than 1 that explained 68% of the variance among the four performance criteria. Thus, we averaged the four dimensions to form a final task performance score for each team.

## 3. Results

### 3.1. Data aggregation

When data are nested, as is often the case in leadership research, researchers must examine their data to determine the appropriate level of analysis. Both conceptual and empirical evidence is needed when aggregation decisions are made (e.g., Klein et al., 2000). In our study we have two theoretical levels of analysis: team level (i.e. team performance was measured with a single group project) and individual level (i.e., project satisfaction represents the extent to which each individual member of the team was satisfied with the project). At the team level, we will link leader behaviors (as assessed by objective observers) to team performance (testing H3). At the individual level, we will link individual team-member ratings of their leader behaviors to that same team-member's satisfaction with the project (testing H4). To test these propositions about the appropriate levels of analysis for our data, we examined interclass correlations and conducted WABA analyses (Dansereau, Alutto, & Yammarino, 1984; Dansereau & Yammarino, 2000).

Following formulas in Bliese (2000), we found significant ICC<sub>(1)</sub>'s ranging from .30 to .43 in the face-to-face team condition, and from .11 to .28 in the virtual team condition ( $p < .05$ ) for the observer counts of leadership, including inspirational motivation, intellectual stimulation, individualized consideration, and the transformational leadership composite. When ICC<sub>(1)</sub>'s are calculated on predictor variables, they are interpreted as a measure of interrater reliability, and are expected to range from .05 to .30 (Bliese, 2000). ICC<sub>(2)</sub>'s, on the other hand, are interpreted as the reliability of the group mean rating. In the counts data, ICC<sub>(2)</sub>'s ranged from .77 to .86 in the face-to-face team condition, and from .58 to .81 in the virtual team condition. These results are consistent with ICC levels reported in existing research with aggregated leadership reports (Hofmann & Jones, 2005; Judge & Bono, 2000). Similarly, we found adequate agreement among the team performance raters in the face-to-face teams condition (ICC<sub>(1)</sub> = .22,  $p < .01$ ; ICC<sub>(2)</sub> = .53) and in the virtual teams condition (ICC<sub>(1)</sub> = .31,  $p < .01$ ; ICC<sub>(2)</sub> = .64).

In contrast, results of ICC analyses did not support aggregation of the team-member ratings of leadership to the team level. Across conditions, only one of the ICC<sub>(1)</sub>'s (inspirational motivation in the face-to-face condition) was significant ( $p < .05$ ) and ICC<sub>(2)</sub>'s were consistently low, ranging from .01 to .46. Agreement between team members on project satisfaction was also low, with ICC<sub>(1)</sub> of .09 (ns) and .22 ( $p < .05$ ) and ICC<sub>(2)</sub> of .23 and .48 in the face-to-face and virtual teams, respectively. In sum, ICC analyses suggest that team performance and observer counts of transformational leadership are best treated as team-level data, while team-member ratings of transformational leadership and project satisfaction are best treated as individual-level data.

To provide further support for our aggregation decisions, we conducted WABA analyses (Dansereau et al., 1984; Dansereau & Yammarino, 2000). The first set of tests, referred to as WABA I, are analogous to ICC<sub>(1)</sub> tests in that they rely on a significant  $F$  statistic as an indication of large between-group variance. However, WABA I also includes a test of practical significance of the difference between the within-and-between variance components (the so-called  $E$ -test). The second set of tests, referred to as WABA II, aims to establish the appropriate level at which a bivariate (or multivariate) *relationship* should be analyzed. In order for WABA II tests to be performed, data must be matched. Given the analytical procedures associated with WABA I and WABA II, we performed WABA I tests on all of our variables, but only performed WABA II tests on the link between team-member ratings of transformational leadership and team-member ratings of project satisfaction. Results of the WABA analyses are presented in Appendices B and C. Specifically, WABA I results (Appendices B and C) provide additional justification for our aggregation decisions informed by the ICC results reported above. WABA II results (Appendix B) further show that *the relationship* between project satisfaction and leadership is best analyzed at the individual level of analysis.

Based on these data, our analyses involving performance were conducted at the team level, linking aggregated observer counts of transformational leadership to team performance, and our analyses involving project satisfaction were conducted at the individual level, linking individual team-member ratings of transformational leadership with their ratings of project satisfaction. We aggregated follower ratings of transformational leadership only for purposes of assessing agreement between observer counts

**Table 1**  
Means (M), standard deviations (SD), and intercorrelations among study variables.

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Team type	–	–	–											
2. TF counts	3.02	1.52	–.07	–										
3. IM counts	1.21	1.19	–.01	.69**	–									
4. IS counts	3.85	2.46	–.37**	.69**	.29*	–								
5. IC counts	3.98	2.63	.23	.77**	.48**	.12	–							
6. TF ratings	2.99	0.82	–.08	–	–	–	–	.89						
7. II ratings	2.51	0.99	.00	–	–	–	–	.78**	.76					
8. IM ratings	3.38	1.02	–.04	–	–	–	–	.87**	.60**	.80				
9. IS ratings	3.15	0.94	–.13*	–	–	–	–	.79**	.44**	.58**	.75			
10. IC ratings	2.99	1.03	–.14*	–	–	–	–	.85**	.52**	.68**	.61**	.67		
11. Performance	3.27	0.46	–.08	–.06	.08	–.20	.06	–	–	–	–	–	–	–
12. Satisfaction	3.77	0.92	.06	–	–	–	–	.41**	.29**	.39**	.32**	.33**	–	.88

Notes: Team type is coded 1 = face-to-face team, 2 = virtual team; TF = transformational leadership composite, II = idealized influence, IM = inspirational motivation, IS = intellectual stimulation, IC = individualized consideration.

Correlations involving observer counts of leadership and team performance are based on team-aggregated data ( $N = 58$  teams).

Correlations involving follower ratings of leadership and satisfaction with project are based on follower-level data ( $N = 233$  followers).

Entries on the diagonal are scale reliabilities.

\*\* $p < 0.01$ ; \* $p < 0.05$ .

and follower ratings (unreliability in the measurement of follower ratings will downwardly bias correlations between our two measures of leadership). Our two measures of leadership (observer counts and team-member ratings) were moderately and significantly correlated for the transformational leadership composite ( $r = .32, p < .05$ ) and for inspirational motivation and individualized consideration ( $r = .27; p < .05$  and  $r = .33, p < .05$ , respectively). However, observer counts for intellectual stimulation were not significantly correlated with follower ratings of this dimension ( $r = .20, ns$ ).

### 3.2. Descriptive statistics

Table 1 reports means, standard deviations, scale reliabilities and correlations among study variables. Team type (face-to-face or virtual) was uncorrelated with either team performance or project satisfaction. Furthermore, observer counts of transformational leadership were not correlated with team performance, but team-member ratings of transformational leadership (the composite and all dimensions) were significantly correlated with project satisfaction ( $r = .41, .29, .39, .32$ , and  $.33, p < .01$ ).

### 3.3. Team type effects on leadership

Because our design involved repeated measures, we used repeated-measures  $t$ -tests (analogous to repeated-measures ANOVAs with one between-subjects factor) to test Hypothesis 1, which posits fewer transformational leadership behaviors in virtual teams. In Table 2, we report  $t$ -tests along with means and standard deviations for leadership behaviors in both types of teams. Results reveal no differences in mean level of transformational leadership (observer counts) in face-to-face and virtual teams. Among the dimensions, significant differences in leader behavior were found only for behavior counts of intellectual stimulation. We also conducted a series of one-way ANOVA's to determine whether follower ratings of leadership differed based on team type. Results in Table 2 reveal no differences in the transformational leadership composite, nor in idealized influence or inspirational motivation across team type. However, follower ratings were significantly higher in the face-to-face condition for intellectual stimulation and individual consideration. Thus, we have partial support for Hypothesis 1.

**Table 2**

Comparison of transformational leadership, team performance, and project satisfaction in face-to-face and virtual teams.

Variable	Repeated-measures $t$ -test <sub>(df)</sub>	ANOVA <sub>(df)</sub>	$M$ (SD) in face-to-face	$M$ (SD) in virtual	Paired-comparison correlations
Transformational leadership counts	0.50 <sub>(28)</sub>		3.12 (1.87)	2.91 (1.07)	–0.09
Inspirational motivation counts	0.10 <sub>(28)</sub>		1.22 (1.16)	1.19 (1.25)	0.04
Intellectual stimulation counts	3.12 <sub>(28)</sub> **		4.76 (2.77)	2.95 (1.74)	0.10
Individualized consideration counts	–1.91 <sub>(28)</sub>		3.39 (2.89)	4.58 (2.24)	0.17
Transformational leadership ratings		1.54 <sub>(1,226)</sub>	3.07 (0.74)	2.93 (0.89)	
Idealized influence ratings		0.01 <sub>(1,229)</sub>	2.51 (1.00)	2.51 (0.99)	
Inspirational motivation ratings		0.38 <sub>(1,231)</sub>	3.42 (0.94)	3.34 (0.94)	
Intellectual stimulation ratings		3.26 <sub>(1,229)</sub> *	3.27 (0.83)	3.03 (1.02)	
Individualized consideration ratings		4.54 <sub>(1,228)</sub> *	3.13 (0.96)	2.85 (1.09)	
Team performance	1.25 <sub>(28)</sub>		3.31 (0.40)	3.22 (0.50)	0.46**
Project satisfaction		0.79 <sub>(1,228)</sub>	3.72 (0.95)	3.83 (0.89)	

Notes:  $N$  for paired-comparison  $t$ -tests and correlations = 29 teams.  $N$  for ANOVAs = 233 followers.

Positive values for  $t$ -tests indicate higher values in the face-to-face condition than in the virtual condition. Positive values for correlations indicate that leaders who score high on transformational leadership in face-to-face counts are also likely to score high on transformational leadership in virtual counts. \*\* $p < 0.01$ ; \* $p < 0.05$ .

**Table 3**

Results of hierarchical moderated regression analyses.

	Team performance <sup>a</sup>			Satisfaction with project <sup>b</sup>		
	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Transformational leadership	-.06	-.06	-.22	.41**	.42**	.42**
Team type (face-to-face or virtual)		-.02	-.003		.09	.09
Interaction between team type and transformational leadership			.34*			.00
Multiple R	.06	.06	.30	.41	.42	.42
$\Delta R^2$ from Step 2		.00	.09*		.01	.00

Notes: Team type was coded 0 = face-to-face team, 1 = virtual team.

\* $p < .05$ ; \*\* $p < .01$ .<sup>a</sup>  $N = 58$  teams. Transformational leadership is observer counts of transformational behavior.<sup>b</sup>  $N = 226$  followers. Transformational leadership is team-member ratings of transformational leadership.

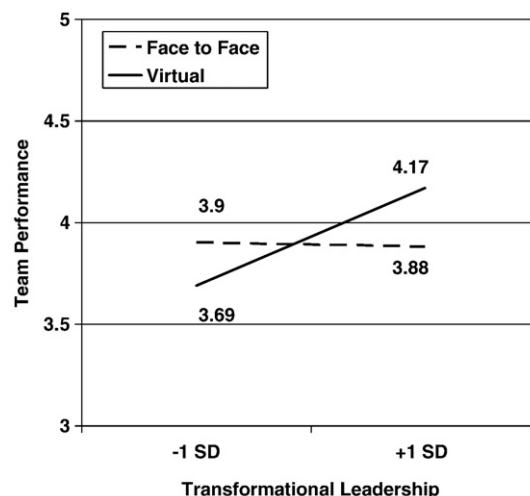
Whereas **Hypothesis 1** deals with mean level differences in leadership based on team type, **Hypothesis 2** addresses consistency in the behaviors of individual leaders in face-to-face and virtual teams. This hypothesis is tested with paired-comparison correlations (**Table 2**, column 5). Results revealed no consistencies in leader behavior across teams; in other words, the pattern of small, non-significant correlations suggests that an individual leader's behavior in the virtual team cannot be predicted by that same leader's behavior in the face-to-face team. Taken together, results from our repeated-measures  $t$ -tests and repeated-measures correlations (**Table 2**, columns 1 and 5) show that while the *average* amount of transformational leadership behaviors (counts) was generally similar in face-to-face and virtual teams, leaders' rank order within face-to-face and virtual teams was *not* preserved.

#### 3.4. Team type effects on leadership effectiveness

Hypotheses 3 and 4 deal with the effects of transformational leadership on team performance and team-member satisfaction, in face-to-face and virtual teams. We tested **Hypothesis 3** (team performance) at the team level and **Hypothesis 4** (team-member project satisfaction) at the individual level. Both hypotheses were tested with hierarchical moderated regressions, in which we entered transformational leadership in step 1, team type (i.e., face-to-face or virtual) in step 2, and the interaction between team type and leadership in step 3. Because we used a repeated-measures design, these analyses violate assumptions of independent observations. However, **Hollenbeck, Ilgen and Sego (1994)** showed that the gain in power in repeated-measures regression makes this analytical procedure desirable in teams and leadership research, where sample size is often an issue.

Results in **Table 3** reveal a significant interaction between transformational leadership (counts) and team type in predicting team task performance, supporting **Hypothesis 3**. To show the nature of the interaction, we plotted the association between transformational leadership and team performance at 1 standard deviation above and below the mean. **Fig. 1** shows that the effect of transformational leadership on team task performance was more positive in the virtual team condition. We also conducted hierarchical moderated regression analyses for each of the three leadership dimensions (individualized consideration, intellectual stimulation, and inspirational motivation), predicting team performance. For both inspirational motivation and individualized consideration, we found a similar interaction to that found for transformational leadership; however, no significant interaction was found for intellectual stimulation.

Our next step was to test for interactions between team type and transformational leadership (ratings) in predicting team-member satisfaction with the project. **Table 3** reveals significant main effects for leadership (team members were happier with the



**Fig. 1.** The moderating effect of team type on the association between transformational leadership and team task performance.



**Table 4**

Correlations between leadership behavior change and leader effectiveness.

Variable	<i>r</i>
Transformational leadership counts	−0.40*
Inspirational motivation counts	−0.34†
Intellectual stimulation counts	−0.02 <sup>ns</sup>
Individualized consideration counts	−0.58**

Notes: Negative values for correlations indicate higher average leader effectiveness (across conditions) for leaders who increased transformational leadership behaviors in virtual teams relative to face-to-face teams.

*N* = 29 teams.

\*\**p* < 0.01; \**p* < 0.05; †*p* < 0.10.

project when they rated the leader higher on transformational leadership); however, no significant interactions between team type and leadership were found for project satisfaction. This pattern of results (significant main effects and non-significant interactions) was also found for the four specific leadership dimensions (idealized influence, inspirational motivation, intellectual stimulation and individualized consideration). Thus, [Hypothesis 4](#) was not supported.

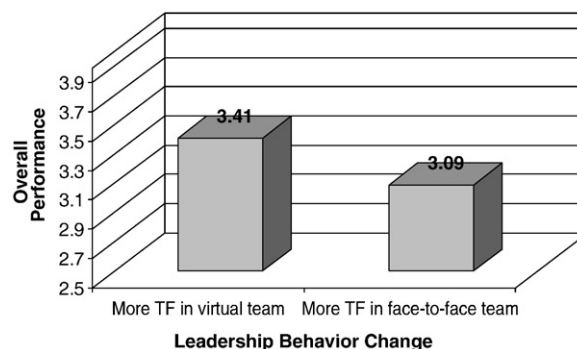
### 3.5. Post hoc analyses

We conducted two sets of post hoc analyses. First, as leaders led two consecutive teams in our study, a reviewer raised the question of whether leaders' second teams may have performed better due to practice effects. We checked for differences between leaders' first and second teams on performance and found no evidence for practice effects ( $F_{(1, 77)} = 0.015, p = 0.90$ ). Further, there was no interaction between type of team leaders led first (face-to-face or virtual) and practice effects (first or second team meeting),  $F_{(1, 77)} = 0.51, p = 0.48$ . Team performance did not differ based on whether leaders led a face-to-face team followed by a virtual team or vice versa.

Our second post hoc analysis addressed whether leaders who altered their behavior to match the team context (virtual vs. face-to-face) were more effective, overall, than leaders whose behavior was consistent across team type. Given that mean levels of team performance were equal in virtual and face-to-face teams, but individual leaders were not consistent in their behaviors across team type (see [Table 2](#), column 5), we decided to examine the extent to which leader flexibility (changing behavior across contexts) was linked to team performance. In other words, theory posits, and our data show, that transformational leadership is most impactful in virtual teams. We wondered whether leaders need to increase their transformational leadership behaviors in virtual teams in order to be more effective. To answer this question, we examined the association between changes in leader transformational behavior across their two teams to the level of team performance across leaders' two teams.

We first averaged team performance (which was significantly correlated across conditions; see [Table 2](#), column 5) across both teams led by each leader, creating a measure of overall effectiveness for each leader. Next, we computed a behavior change variable by subtracting the count of each leader's transformational behaviors in their virtual team from the count of the same leader's behaviors in their face-to-face team. Similarly, we created a behavior change score for inspirational motivation, intellectual stimulation and individualized consideration. A positive difference score indicates that leaders were more transformational with their face-to-face teams, whereas a negative difference score indicates that leaders were more transformational with their virtual teams. Although difference scores have been criticized on the grounds of low reliability and blurring of individual effects ([Edwards, 1993, 1994](#)), we do not have sufficient data to use more complex procedures, such as polynomial regression.

In [Table 4](#), we present correlations between changes in leadership behavior and average team performance. Results indicate that the most effective leaders, across conditions, were those who *increased* their transformational leadership behavior when they led a virtual team. Examination of the data for the leadership dimensions shows that increases in individualized consideration and inspirational motivation had the largest effects. To illustrate this effect, in [Fig. 2](#) we compare the average



**Fig. 2.** Overall team performance predicted by leadership behavior change (*N* = 29).

performance of leaders who used more transformational leadership behaviors in their virtual teams (as compared to their face-to-face teams) with the average performance of leaders who used more transformational leadership behaviors in their face-to-face teams (as compared to their virtual teams). Fig. 2 illustrates that leaders who increased transformational behaviors in their virtual teams had better overall team performance than leaders who decreased their transformational behaviors in their virtual teams.

#### 4. Discussion

The two primary aims of our study were 1) to examine the consistency of leaders' transformational leadership behaviors in face-to-face and virtual teams, and 2) to determine whether the effects of transformational leadership behavior differ by team type. Overall, our results suggest considerable variability in leaders' behavior across face-to-face and virtual teams. Further, transformational leadership behaviors were more strongly linked to performance in virtual than in face-to-face teams. Leaders who increased their transformational leadership behaviors with virtual teams achieved the highest level of overall team performance. Because there was considerable variability in whether and how leaders changed their behavior across team types, overall mean level differences in transformational leadership in virtual and face-to-face teams were not found.

One key finding of our study is that leaders changed their behavior across team types (i.e., a leader's leadership behavior in one team did not predict that leader's behavior in the other team). Further, the nature of the change (increasing or decreasing transformational leadership in virtual vs. face-to-face teams) was not consistent across leaders. Although it has been suggested that, *on the average*, technology-mediated leaders can exhibit exactly the same content and style as traditional face-to-face leaders (Avolio & Kahai, 2003; Zigurs, 2003), our results suggest that this may not always be the case. Our findings are more consistent with the literature on cross-situational consistency and specificity, which finds that when leadership behavior (as opposed to leadership emergence) is assessed, leaders tend to adapt their behaviors in response to situational demands (e.g., Hill & Hughes, 1974; James & White, 1983). Overall, our data suggest that leaders tend to adapt their behaviors based on context, but they do not do so in a uniform fashion.

In light of this finding, an important issue for future research is to examine the determinants of leaders' behavior change. Our results raise the intriguing possibility of individual differences in leaders' reactions to communication media. For example, it may be that more intelligent leaders, leaders high on adaptability or self-monitoring, or leaders who use electronic communication more frequently, know that increasing their transformational leadership behaviors is important in virtual teams. In contexts where managers are leading both face-to-face and virtual teams, it would be useful to predict which leaders will increase their transformational behaviors with their virtual teams, as these are the individuals who had the highest overall levels of team performance in our study.

Another important issue raised by our study is the extent to which mean level comparisons of leadership behaviors across team types can be misleading. On the surface, our comparison of mean levels of transformational leadership in virtual and face-to-face teams appears to suggest that leaders did not alter their behavior based on communication medium. Yet, our within-person comparisons suggest that behaviors do change with context, but not in a uniform manner for all leaders. We found no significant associations between leaders behavior across contexts because some leaders increased their transformational behaviors in virtual teams, and other leaders either decreased them or made no change at all.

A second key finding of our study is that transformational leadership had a stronger effect on team performance in virtual than in face-to-face teams. Our data suggest that transformational leadership behaviors are especially instrumental to team performance under the more ambiguous communication conditions created by electronic communication media. Hence, transformational leadership appears to be more "in demand" under virtual communication conditions. This finding is in complete agreement with theoretical predictions from both the leadership (i.e., Shamir & Howell, 1999; Waldman & Yammarino, 1999) and the communication literature (i.e., Reicher et al., 1995; Spears et al., 2001; Walther, 1996; Walther & Burgoon, 1992), which argue that effective leadership has a greater opportunity to influence people and outcomes under conditions of social and psychological uncertainty. Further, leaders who increased their transformational leadership behaviors in their virtual teams, relative to their face-to-face teams, led the most successful teams. This result provides support for Avolio and colleagues new theory of e-leadership (Avolio et al., 2001; Avolio & Kahai, 2002, 2003), which argues that leaders who "appropriate" technology effectively can overcome the challenges posed by virtual communication to lead effective teams.

While we acknowledge that our study was not designed to answer the question, Why is transformational leadership particularly important in virtual teams?, we offer several potential explanations which future research can investigate. One, it is possible that virtual team members feel less known when interacting with others in the impersonal environment created by virtual media. By developing high quality relationships with virtual followers, transformational leaders can increase followers' sense of being known, thus helping them feel appreciated and important. Second, virtual team followers might have a harder time bonding together in the absence of direct, face-to-face interactions. Transformational leaders can help followers identify with the team's task and goals by developing a sense of common mission, team cohesion and team identity. Third, much research reports that virtual team members are confused and overwhelmed by the less natural communication environment. Transformational leaders can introduce a sense of purpose and certainty by setting specific goals and developing agendas for goal achievement. Research by Kahai et al. (2003) suggests several additional mechanisms through which transformational leaders can impact team outcomes in virtual teams, such as increasing follower motivation and decreasing social loafing.

There were two other results of our study that deserve mention. First, when we looked at project satisfaction, we did not replicate the moderation effect we found for the link between leadership and team performance. Regardless of team type, members who perceived transformational leadership behaviors from their leaders were more satisfied with the project. Hence, an important prerequisite for follower satisfaction in both face-to-face and virtual teams is that leaders are seen as transformational. Second, there was a reasonable degree of convergence between our two measures of leadership – behavioral counts and perceptual ratings – despite the measurement error present in both. This highlights the point we made earlier, namely, that leadership is a complex phenomenon which can be measured in different, yet valid, ways.

Methodologically, our study has several strengths. One strength was that our data came from three different sources: project satisfaction and leadership ratings were based on team-member reports, team performance was based on objective ratings by four independent judges, and transformational leadership behaviors were assessed by independent observers, who were trained to identify these behaviors. A second strength of our study was our use of a repeated-measures design, which allowed us to examine consistency in leader behavior across contexts. Finally, because our study used an experimental design, we have some confidence that observed changes in leader behavior across team types were due to differences between conditions in communication media.

Despite these strengths, we acknowledge several limitations as well. First, this was a lab study using college students who did not know each other and who worked on a contrived task for one hour. Thus, it is critical that our results be replicated in a work organization in which managers lead both face-to-face and virtual teams. It is important to note, however, the temporary and short-term nature of many virtual project teams in business organizations, which suggests that our simulation may not be all that different from reality. A second limitation of our study is that although our recruitment techniques were designed to encourage students to self-select into the leader role, our leaders had no formal training or experience. It is plausible that experienced managers and leaders, or managers and leaders who have received training on how to be effective in electronic communication environments, will alter their behavior more or less across contexts than our leaders did. A third limitation of our study was the youth of our sample. Although the use of electronic communication has become widespread in work organizations, these young college students have grown up with such communications, and both leaders and team members in our study may have adapted to electronic communication easily. It is possible that our results would not generalize to a sample of mature workers, especially those who are unfamiliar with electronic communication media. Furthermore, managers' experiences with electronic communication might also be an important determinant of the extent to which they would alter their behavior when assigned to lead a virtual project team. Fourth, close to 70% of the leaders in our sample were women. Although meta-analyses on gender and leadership have shown minute differences in leadership ratings and effectiveness between the sexes (e.g., [Eagly & Carli, 2003](#)), replication of these findings with a more gender-balanced sample is warranted. Finally, due to the short-lived nature of our project, we did not use all MLQ items in assessing team-members' perceptions of their leaders. Replicating this study in an organizational setting will allow researchers to tap team members' perceptions of a broader subset of transformational behaviors in which team leaders may engage.

In addition to the future research avenues already mentioned, this study can be extended in several other ways. First, future research should compare the effectiveness of other successful leader behaviors, such as contingent reward, or initiating structure and consideration, in face-to-face and virtual contexts. A second important issue for future research is to explore the role of time. It is plausible that the effects we found for transformational leadership on team performance may only be relevant during initial stages of team formation. Alternatively, early leader and team-member interactions may set the tone for all future interactions, thus leading to long-term effects of transformational leadership in virtual teams. Clearly, a longitudinal study of virtual leadership and team outcomes is needed. Third, in the spirit of experimental research, our study simulated the two most extreme ends of team virtuality – all team members communicating face-to-face for the duration of the project versus all team members communicating via text-based communication for the duration of the project. In practice, project teams can be characterized by different degrees of virtuality ([Griffith, Sawyer, & Neale, 2003](#); [Kirkman & Mathieu, 2005](#); [Martins, Gilson, & Maynard, 2004](#)). For example, hybrid teams consist of some members who share the same geographic location and who, therefore, are more likely to use face-to-face communication with members of their own subgroup than with members of other subgroups. Or, face-to-face project teams may still exchange emails to coordinate their work, while virtual project teams may use audio and video communication in addition to text. Such variations in team virtuality may constraint or enhance the effects of transformational leadership, an issue that was not addressed in our study. Lastly, virtual teams can be self-managed. Hence, a future study could investigate leadership emergence in self-managed virtual teams, as well as compare team outcomes of virtual teams with an assigned leader to outcomes of virtual teams with an emergent leader.

In conclusion, our study enriches the e-leadership and virtual teams literatures ([Avolio et al., 2001](#); [Avolio & Kahai, 2003, 2002](#)) in two respects. Theoretically, our study integrates extant leadership theory with new data relevant to e-leadership and communication. Our results are consistent with the notion that social and emotional forms of leadership are more important under conditions where modes of communication are leaner and greater uncertainty exists. Practically, our results highlight the role of leadership in virtual teams, demonstrating that findings from the existing literature linking transformational leadership to team performance can be extended to virtual teams. They also suggest a need for methods to identify leaders who appropriately adjust their behavior to the team context. Because the use of virtual project teams is on the rise in organizations, we hope that this study will stimulate ongoing research on how managers can be more effective when leading virtual teams.

**Appendix A. Coding sheet used by observers, and exemplar behaviors of inspirational motivation, intellectual stimulation and individualized consideration**

Guidelines for coders: leadership dimensions and examples of behaviors	Exemplar behaviors	
	Face-to-face teams	Virtual teams
<p><b>Inspirational motivation:</b> This dimension refers to the way that leaders <i>inspire group members</i>, by talking about the purpose of the work and the project with confidence and enthusiasm. They:</p> <ul style="list-style-type: none"> <li>• talk about the project's purpose</li> <li>• are enthusiastic about task</li> <li>• express confidence that the project will be successful</li> </ul> <p><b>Intellectual stimulation:</b> This dimension refers to leaders who “think outside the box.” They come up with <i>new, innovative, creative ideas</i> and encourage others' ideas as well. These leaders:</p> <ul style="list-style-type: none"> <li>• get people to think about issues</li> <li>• encourage creativity and non-traditional thinking</li> <li>• look at problems from different angles</li> </ul> <p><b>Individualized consideration:</b> This dimension refers to leaders who are concerned about <i>the individuals</i> in the group. They focus on individual growth and development by doing the following:</p> <ul style="list-style-type: none"> <li>• looking for group member strengths and using them in project</li> <li>• treating individuals with respect</li> <li>• providing advice to individual group members</li> </ul>	<p>“We are judged on the quality not the quantity. I think we've done a pretty good job thus far!”</p> <ul style="list-style-type: none"> <li>• Leader #103</li> </ul> <p>“Ok. Let's get started. We can do that!”</p> <ul style="list-style-type: none"> <li>• Leader #310</li> </ul> <p>“It needs to be very user friendly, it needs to be creative, and remember, it needs to be able to take in packages.”</p> <ul style="list-style-type: none"> <li>• Leader #313</li> </ul> <p>“If we're part of the post office, but we're not part of the post office... Let's think of other possible locations.”</p> <ul style="list-style-type: none"> <li>• Leader #310</li> </ul> <p>“So who wants to work on just the physical location, who's more creative?”</p> <ul style="list-style-type: none"> <li>• Leader #313</li> </ul> <p>It's not that big of a deal. Actually, you're doing a really good job.</p> <ul style="list-style-type: none"> <li>• Leader #103</li> </ul> <p>“So have you been able to go over the general information and think of some brainstorming ideas? [...] That's ok, we can do it together.”</p> <ul style="list-style-type: none"> <li>• Leader #204</li> </ul>	<p>“We are doing great team... keep it up!”</p> <ul style="list-style-type: none"> <li>• Leader #216</li> </ul> <p>“Psychical Location and Appearance: this is the fun part!!!”</p> <ul style="list-style-type: none"> <li>• Leader #216</li> </ul> <p>“Follower #2: remember that businesses that operate on a 9 to 5 timeline will have other methods. So let's think – who will our customers be?”</p> <ul style="list-style-type: none"> <li>• Leader #108</li> </ul> <p>“Feel free to be a bit creative, beyond what we decided as a group; however, don't stray too far from our brainstorming. But feel free to add any missing pieces that come to mind!”</p> <ul style="list-style-type: none"> <li>• Leader #216</li> </ul> <p>Follower one says: sounds great. what do you think leader</p> <p>Leader says: all of these ideas are awesome. way to go! i'm typing them all down</p> <p>Follower four says: leader, you are very encouraging</p> <ul style="list-style-type: none"> <li>• Leader #303</li> </ul> <p>Follower three says: I sent you an update – I think I need help.</p> <p>Leader says: ok... hang on</p> <p>Leader says: good start follower 3...</p> <p>Follower Three says:</p> <p>I am not really sure what to do?I think I need help.</p> <p>Leader says: no, it sounds good...</p> <ul style="list-style-type: none"> <li>• Leader #203</li> </ul>

Note: This appendix was constructed post hoc for illustrative purposes. During the actual coding procedures, coders simply placed a tick mark next to each behavioral category when they observed a behavior. Thus, no direct links were made between counts and specific behaviors during the coding process. However, coders made notes of exemplar behaviors as they coded; these notes were used in the construction of this Appendix.

**Appendix B. Within and between analysis (WABA I and II) results in face-to-face and virtual teams for team member transformational leadership ratings and team member project satisfaction ratings**

Level and relationships	WABA I			WABA II					Components <sup>l</sup>	Raw score	Inference <sup>k</sup>	
	$\eta^2$ 's <sup>c</sup>		$F^d$	$E^e$	$r^2$ 's <sup>f</sup>		$Z^g$	$A^h$				$r^2$ 's <sup>j</sup>
	B/n	W/n			B/n	W/n						
<i>Face-to-face teams (leader–follower groups)<sup>a</sup></i>												
Satisfaction with project and	.533	.846	.794	.63 <sup>ns</sup>								
Transformational leadership	.625	.780	1.29	.80 <sup>ns</sup>	.49**	.30**	1.25	.21 <sup>ns</sup>	.33	.66	.36**	Individual
Idealized influence	.600	.800	1.13	.75 <sup>ns</sup>	.39*	.24*	.87	.16 <sup>ns</sup>	.32	.67	.29**	Individual
Inspirational motivation	.696	.718	1.88*	.97 <sup>ns</sup>	.40*	.30**	.60	.11 <sup>ns</sup>	.37	.61	.35**	Individual
Intellectual stimulation	.550	.835	.86	.66 <sup>ns</sup>	.42**	.22*	1.17	.21 <sup>ns</sup>	.29	.71	.28**	Individual
Individualized consideration	.658	.753	1.51	.87 <sup>ns</sup>	.31*	.22*	.51	.09 <sup>ns</sup>	.35	.64	.24**	Individual
<i>Virtual teams (leader–follower groups)<sup>b</sup></i>												
Satisfaction with project and	.628	.778	1.30	.81 <sup>ns</sup>								
Transformational leadership	.617	.787	1.09	.78 <sup>ns</sup>	.52**	.42**	0.66	.11 <sup>ns</sup>	.37	.63	.46**	Individual
Idealized influence	.495	.869	0.67	.60 <sup>ns</sup>	.25 <sup>ns</sup>	.30**	-.29	-.05 <sup>ns</sup>	.31	.68	.30**	Individual
Inspirational Motivation	.636	.771	1.42	.82 <sup>ns</sup>	.50**	.40**	.65	.11 <sup>ns</sup>	.40	.60	.45**	Individual
Intellectual stimulation	.598	.801	1.15	.75 <sup>ns</sup>	.43**	.33**	.61	.11 <sup>ns</sup>	.38	.62	.37**	Individual
Individualized consideration	.604	.797	1.17	.76 <sup>ns</sup>	.50**	.39**	.71	.12 <sup>ns</sup>	.38	.62	.44**	Individual

## Appendix C. Within and between analysis (WABA I) results in face-to-face and virtual teams for transformational leadership counts and team performance ratings

Level	$\eta^2$ 's <sup>a</sup>		$F^b$	$E^c$
	B/n	W/n		
Face-to-face condition				
Transformational leadership	.663	.749	5.62**	.89 <sup>ns</sup>
Performance	.641	.768	2.12**	.83 <sup>ns</sup>
Virtual condition				
Transformational leadership	.434	.901	2.39**	.48 <sup>ns</sup>
Performance	.693	.721	2.84**	.96 <sup>ns</sup>

Notes:  $\eta$  = eta, B/n = between; W/n = within. Analyses for transformational leadership counts are based on  $N = 230$  video counts and  $N = 319$  chat transcript counts provided by 14 independent coders. Analyses for team performance are based on  $N = 156$  project ratings for the face-to-face teams and  $N = 156$  project ratings for the virtual teams provided by 4 independent raters.

<sup>a</sup> Between and within variance components;  $\eta_B = \sqrt{\frac{SS_B}{SS_T}}$  and  $\eta_W = \sqrt{\frac{SS_W}{SS_T}}$ .

<sup>b</sup>  $F$ -test from one-way ANOVA with leader as grouping variable; \*\*indicates a significant  $F$ -test ( $p < 0.01$ ), and therefore – a “wholes” scenario.

<sup>c</sup>  $E$ -ratio ( $n_B/\eta_W$ ); <sup>ns</sup> indicates no evidence for wholes by the 15° or the 30° test, and therefore, an “equivocal” scenario.

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## Notes to Appendix B:

Notes:  $\eta$  = eta,  $r$  = correlation, B/n = between; W/n = within.

<sup>a, b</sup> Analyses are based on  $N = 115$  face-to-face followers and  $N = 118$  virtual followers, and  $J = 39$  leaders–follower groups. All relationships are based on leader–follower matched reports. Relationships are tested based on ratings of each variable made by the followers.

<sup>c</sup> Between and within variance components;  $\eta_B = \sqrt{\frac{SS_B}{SS_T}}$  and  $\eta_W = \sqrt{\frac{SS_W}{SS_T}}$ .

<sup>d</sup>  $F$ -test from one-way ANOVA with leader as grouping variable; \* indicates a significant  $F$ -test ( $p < 0.05$ ).

<sup>e</sup>  $E$ -ratio ( $n_B/\eta_W$ ); <sup>ns</sup> indicates no evidence for wholes by the 15° or the 30° test.

<sup>f</sup> Between correlations are performed on the leader-aggregated data ( $\bar{X}$  with  $\bar{Y}$ ); Within correlations are performed on the deviations of the follower ratings from the leader means ( $X - \bar{X}$  with  $Y - \bar{Y}$ ); \* $p < 0.05$ ; \*\* $p < 0.01$ .

<sup>g</sup> Test of the difference between the between-correlations and the within-correlations.

<sup>h</sup> Tests of the practical significance of the differences between the between-correlations and the within-correlations; <sup>ns</sup> indicates no evidence for wholes by the 15° or the 30° test.

<sup>i</sup> Between components are weights equal to  $\eta_{BX} * \eta_{BY}$ , where  $\eta_{BX}$  and  $\eta_{BY}$  represent the correlation of the follower scores for  $X$  and  $Y$  with the between-leader scores (means) for  $X$  and  $Y$ . Within components are weights equal to  $\eta_{WX} * \eta_{WY}$ , where  $\eta_{WX}$  and  $\eta_{WY}$  represent the correlation of the follower scores for  $X$  and  $Y$  with the within-leader mean deviations (e.g.,  $X - \bar{X}$  and  $Y - \bar{Y}$ ) for  $X$  and  $Y$ .

<sup>j</sup> Raw score correlations are performed on the follower-level data; \*\*indicates significant  $r$ 's ( $p < 0.01$ ).

<sup>k</sup> Conclusion about whether data is best conceptualized as “wholes,” “parts,” or “equivocal.” In this case, the 4 major tests ( $F$ ,  $E$ ,  $Z$  and  $A$ ) produce mixed results, failing to indicate a clear wholes or parts scenario. Therefore, an equivocal scenario, in which data are analyzed at the individual level, is recommended.



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