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Virtual World Collaboration and Leadership: Effects on Team Process and Outcomes

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ABSTRACT

While the use of virtual worlds for business collaboration has increased, there has been no systematic research to date that examines the effects of virtual worlds on socio-emotional communication, which is considered to influence team performance variables, such as consensus and group cohesion. To increase our understanding of the effects of virtual worlds, this study seeks to explore: 1) the effects of communication medium (Second Life versus instant messaging) and leadership style (transformational versus transactional) on supportive and critical communication, and 2) the effects of supportive and critical communication on cohesion, consensus, and group efficacy. Through two experiments of small, ad hoc groups performing a management decision-making task, we found an interaction effect between communication medium and leadership style on the expression of support. We also found that greater expression of support can lead to higher group cohesion, post-discussion consensus, and group efficacy whereas critical communication can lead to lower efficacy and group cohesion. We discuss implications of these results for both theory and practice.

Keywords

Virtual Worlds, Collaboration, Leadership, Virtual Teams.

INTRODUCTION

Businesses use virtual worlds for collaboration expecting that remote workers will perceive being present with others (Ives and Junglas, 2008). Creating this experience is critical for promoting socio-emotional interaction and the team performance variables it affects, such as consensus and group cohesion (Chidambaram, 1996; Hiltz, Johnson, and Turoff, 1986). We report the results of two studies of the effects of communication medium (Second Life, a popular virtual world, versus instant messaging) and leadership style (transformational versus transactional) on supportive and critical communication in small, ad hoc groups performing a decision-making task. We also examined the effects of such communication on an important aspect of a team's performance: its ability to work together in the future.

We compared Second Life (SL) to instant messaging (IM) to learn whether the visual and audio channels in virtual worlds make a difference in the socio-emotional interaction that accompanies the feeling of being present with others. We employed transformational leadership and transactional leadership styles because of their relevance to virtual team collaboration in virtual worlds (Kahai, Carroll, and Jestice, 2007). Supportive and critical communication, or the expression of support or criticism for somebody's position on a discussion issue, is socio-emotional in nature because it impacts the social relationships that develop among team members as well as their emotional response to the team and its process (Hiltz et al, 1986; Kahai and Cooper, 1999).

BACKGROUND AND THEORY

Communication Medium: Second Life

Virtual worlds are software that allow users to connect and interact with each other in real time in a shared visual space. We employed Second Life, a popular virtual world. SL is interactive allowing many people from different locations to access it

and synchronously interact in a shared virtual space. It possesses physicality in that it simulates a physical environment with laws of physics, and gives a physical representation of the user in the form of an avatar. These visual components of SL allow communication partners to share a space, which can give important clues to the relationships of speakers and the contexts of conversations that are not possible in other media. SL is persistent because the world is maintained and the locations of people and objects are remembered by the program whether anyone is logged in and using it or not.

Leadership Style

The ability of the leader to direct, influence, facilitate and support team or organizational interactions can greatly impact how successful team and organizational members are in accomplishing their tasks. Leader behaviors can be distinguished using the transformational-transactional styles framework (Avolio, 1999; Bass, 1998). Transactional leaders influence followers by engaging in behaviors that emphasize an exchange, or *quid pro quo*, relationship. Specific behaviors that characterize transactional leadership are (1) clarifying goals and reward contingencies, and (2) providing contingent rewards based on performance. Transformational leaders influence followers by engaging in behaviors that offer followers an inspiring purpose or vision that transcends short-term goals and immediate self-interests. Specific behaviors that characterize transformational leadership are intellectual stimulation, individualized consideration, inspirational motivation, and idealized influence.

Intellectual stimulation behaviors encourage followers to challenge assumptions, take risks, and approach familiar situations in new ways. Individualized consideration behaviors focus on paying attention to followers' individual needs for achievement and growth. Inspirational motivation behaviors motivate followers by articulating an appealing vision that followers find meaningful and identify with. Inspirational motivation behaviors also include stressing teamwork, setting high expectations for the team, and expressing confidence in the team's ability to achieve those expectations. Idealized influence, or charismatic, behaviors include being a role model by displaying exceptional capabilities and strong commitment to the vision.

Socio-emotional Communication

Groups lacking socio-emotional communication find it challenging to reach consensus and become cohesive (Kahai and Cooper, 1999; Kiesler, Siegel, and McGuire, 1984). Bales (1950) classifies socio-emotional communication as either positive or negative. Positive socio-emotional communication is further classified into showing solidarity (e.g., raising each other's status and giving help and rewarding), tension release (e.g. joking, laughing, and indicating satisfaction), and agreement (e.g., affirming, showing understanding, concurring), whereas negative socio-emotional communication is further classified into showing antagonism (e.g. deflating other's status and defending or asserting self), tension (e.g. withdrawing from participation), and disagreement (e.g. rejecting and being critical). Among these categories, we are interested in those that Bales (1950) identified as relevant to decision-making, i.e., showing agreement or disagreement. Hereafter, we refer to communication expressing agreement with someone's position as supportive communication and that expressing disagreement as critical communication.

Team Performance

In the current study, we focused on a critical dimension of a team's performance: the ability of the team to work together in the future (Hackman and Wageman, 2005). This ability is indicated by group consensus, group cohesion, and group efficacy. Group consensus, or the extent to which team members' decision preferences are similar, determines how well team members are likely to work with each other to implement the team's decision (Kahai, Avolio, and Sosik, 1998; Watson, DeSanctis, and Poole, 1988). Group cohesion, which refers to members' attraction to the group and to each other, influences whether team members would like to affiliate with one another in the future (Hogg, 1992; Kerr and Jermier, 1986). Group efficacy, or a group's perceived capability to perform a future task, determines its success in future tasks (Bandura, 1986; Gibson, Randel, and Earley, 2000).

RESEARCH HYPOTHESES

We hypothesize that there is a substitution effect of SL and transformational leadership on promoting supportive communication and minimizing critical communication. Furthermore, we hypothesize that supportive communication improves team performance whereas critical communication hurts performance.

Media Effects on Supportive and Critical Communication

Compared to IM, SL is likely to lead to the feeling that one is in a social situation and influence socio-emotional communication. Specifically, relative to IM, SL is expected to provide additional cues through the visual and audio channels.

The user's avatar helps communicate a user's appearance, movement, and body posture, and the appearance of others' avatars and nearby objects is likely to enable the feeling of being with others. With such social awareness, team members, particularly those with no prior interaction histories and who do not know each other well, are more likely to engage in supportive communication because they will be motivated to present a positive impression of themselves (Kahai and Cooper, 1999). Similarly, group members in newly established virtual teams are likely to be less negative by using less critical messages that show rejection (Thompson and Foulger, 1996), so as to enable others to form positive impressions of them. Therefore, we expect SL to enhance the expression of support and reduce the expression of criticism.

Leadership Effects on Supportive and Critical Communication

Relative to transactional leadership, transformational leadership is likely to encourage supportive communication and reduce critical communication by promoting teamwork and positive emotions. While transactional leadership promotes task-focus through goal clarification and contingent feedback, transformational leadership promotes team work through inspirational motivation and individualized consideration (Bass and Avolio, 1994). Through inspirational motivation behaviors, the leader emphasizes the power of teamwork and cooperating with each other. As part of individualized consideration behaviors, the leader encourages consideration of each individual's inputs. The sense of teamwork and consideration inspired by these behaviors is likely to lead team members to express support for each other and be less critical. Furthermore, transformational leadership "has an intense emotional component" (Bass, 1985, p. 36) that leads to a positive mood via "emotional and motivational arousal of followers" (Shamir, House, and Arthur, 1993). Team members in a positive mood are more likely to engage in positive behaviors, such as expressing support, and are less likely to engage in negative behaviors, such as expressing criticism (Bono and Ilies, 2006; George and Brief, 1992). Therefore, from both the perspective of team goodwill and emotions, we expect transformational leadership to enhance supportive communication and reduce critical communication.

Interaction of Media and Leadership

Contextual characteristics in an organization, group, or task may provide the same function as leadership behaviors and substitute for leadership (Howell, Dorfman, and Kerr, 1986). Particularly, past research has observed the potential for a communication technology or its features to substitute for leadership behaviors (Ho and Raman, 1991; Sosik, Kahai, and Avolio, 1998). We expect SL and transformational leadership to substitute for each other in their effects on supportive and critical communication. The preceding sections argued that both SL and transformational leadership increase the saliency of the social situation for team members through either communication channels or leader behaviors, and that this saliency is likely to promote supportive communication and discourage critical communication. Though it is not clear whether SL or transformational leadership has a stronger effect on saliency, it is likely that one condition (say, SL) may partially or fully substitute for the other (transformational leadership). Specifically, for teams using IM, our arguments suggest that transformational leadership may substitute for the lack of additional channels provided by SL, providing an alternative means for increasing saliency and, thereby, increasing supportive communication and decreasing critical communication. By the same token, for those teams led by a transactional leader, SL may function as a substitute for enhancing saliency, thus increasing supportive communication and reducing critical communication. Furthermore, when teams led by a transformational leader are using SL, the salience promoted by one condition may render the salience promoted by the other condition as fully or partially redundant, leading to a net effect that is smaller than the addition of SL's effect under transactional leadership and transformational leadership's effect in IM. In other words, we expect communication condition to interact with leadership style to influence both supportive and critical communication, as hypothesized below.

H1: There will be an interaction effect of communication condition and leadership style on enhancing supportive communication.

H2: There will be an interaction effect of communication condition and leadership style on reducing critical communication.

Effects of Supportive and Critical Communication on Team Performance

Group cohesion indicates team members' attraction to the group and to each other. Members are likely to experience greater attraction when other members support their ideas; such support increases a member's feeling of self-worth and makes being with the team intrinsically valuable (Lawler, Thye, and Yoon, 2000). Expression of support also indicates that others think similarly. Individuals are more attracted to those similar to them (Festinger, Schachter, and Back, 1950). In the presence of criticism, we expect that members are likely to experience less attraction due to a lowered sense of self-worth and lack of feeling of similarity.

H3a: Greater expression of support will lead to higher group cohesion.

H3b: Greater expression of criticism will lead to lower group cohesion.

In a decision-making task, greater expression of support is expected to lead to higher consensus by promoting inter-personal attraction. Decision-making tasks have no demonstrably correct answer and consensus requires reconciliation of different values; this reconciliation occurs via social or normative influence and team members yield more to each other's influence when they are attracted to each other (Propp, 1999). Supportive comments promote this reconciliation by building inter-personal attraction (Kahai and Cooper, 1999). Likewise, critical comments are likely to hurt reconciliation by lowering inter-personal attraction.

H4a: Greater expression of support will lead to higher consensus.

H4b: Greater expression of criticism will lead to lower consensus.

Team members are more likely to feel that their team is efficacious when there is greater expression of support for two reasons. First, greater expression of support suggests similarity in thinking and a lower potential for conflict within the team. Second, expression of support serves as positive feedback for team member efforts and suggests that team members are capable (Bales, 1950; Jung and Sosik, 2003). In a similar vein, greater expression of criticism can be expected to reduce the feeling that one's team is efficacious by suggesting that the team may face conflict during a future task and that its members are not capable.

H5a: Greater expression of support will lead to higher group efficacy.

H5b: Greater expression of criticism will lead to lower group efficacy.

STUDY 1

Research Method

Participants

Undergraduate MIS students participated for course credit (N=286). Students completed a questionnaire that asked for demographic information, familiarity with relevant technology, and whom they knew well in the class. 62 five-member groups were created with an effort to keep participants who knew each other well in separate groups. Participants did not know who else was in their group. Groups had no previous history of working together. Attendance and scheduling issues caused groups to have final participation of 3-6 members (average group size = 4.61). One group was removed from data analysis because it ran over time.

Design & Experimental Session

A 2 (IM/SL communication condition) x 2 (transactional/transformational leadership) design was used. Groups completed a decision-making task with a trained confederate group leader in either IM or SL. Participants joined their group from any computer with the appropriate software. Computers were provided for those who did not have computer access. Text-based chat was used which allows users to enter text simultaneously and read others' comments in real time. All comments appeared tagged with the participant's user name and users could see a history of the chat conversation.

Participants completed an assignment prior to their session designed to familiarize them with basic functions in SL including creating their own avatar. Participants spent over two hours in SL designing their avatar, learning to move and interact, and visiting places of interest. Participants also created an AIM account using the same name as their Second Life avatar. This was done so they could identify with their alias in both conditions, and to prevent them from accessing their usual buddy lists. Two male and two female leader identities were created in SL and IM in order to limit possible gender biases in perceptions of the leader.

During the task sessions, groups completed an open-ended decision-making task. The task required the group to act as a management committee in a small company tasked with allocating available bonus money to eligible employees. Basic information on each employee and the company was provided. Before the group discussion, participants filled out an individual decision form with their initial bonus allocations. After the individual allocations were made, the group discussion began. Groups had 30 minutes for the discussion. Leaders encouraged the groups to reach a consensus about the issue in that time. The leader did not direct how groups should reach consensus or the content of the discussion. The task ended when the group reached consensus, or at the end of the 30 minutes whether consensus was reached or not. Afterward, participants

again filled out an individual allocation decision form. They were told their final decisions could match or be different from the group's decision.

Manipulations

Leadership was manipulated using trained confederates as group leaders exhibiting either transactional or transformational leadership behaviors through comments made to the group. Leaders facilitated the discussion without giving explicit directions for the group's decision. Leaders were trained and instructed what message they should convey to the group at specific intervals for each leadership style. For example, transactional leader comments clarified reward contingencies, while transformational leader comments encouraged group members to question their assumptions during the task. Comments were semi-scripted so they fit more naturally in the conversation. As in past studies of leadership in computer-mediated environments (e.g., Sosik et al. 1997; Kahai, Sosik, and Avolio, 2003), there was no explicit attempt to build idealized influence by transformational leaders because it typically requires longer interactions.

Communication condition was manipulated by using either an IM chat room or a meeting space within SL (version 1.18) for the groups. Chat rooms were created on the Meebo IM client and participants were invited to join the rooms at the appropriate time. Rented land with two identical buildings and meeting space provided the meeting area for groups in SL. The SL meetings took place at a rectangular table with the leader sitting at the head and participants sitting on either side.

Operationalization of variables for manipulation checks

The leadership manipulation was tested using individual level perceptions of leader behaviors from leader comments during the task discussion. These perceptions were measured using post-test questionnaire items adapted from Kahai et al.'s (2003) study of leadership style effects in computer-mediated communication contexts. Scales measured perceptions of behaviors consistent with transactional leaders (clarification, contingent rewarding) or transformational leaders (intellectual stimulation, individualized consideration, and inspirational motivation). Reliabilities for all scales were at acceptable levels ($\alpha \geq .65$).

Operationalization of variables for hypothesis testing.

This section explains the measures used in hypothesis testing.

Cohesion and group efficacy: Perceptual measures for these variables were taken from the post-task survey. The perceptual scores for these items were obtained at the individual level and aggregated to the group level by averaging scores across group members. Scales to measure group cohesion and group efficacy were then created by averaging the group level scores across all items for that scale. Aggregation of individual level measures to the group level is justified by results of rwg analysis (James, Demaree, and Wolf, 1984) which showed that more than 75% of groups had r_{wg} greater than the recommended cut-off of .7.

Group cohesion scales employed measures previously validated by Salisbury, Carte, and Chidambaram (2006). These measures fall into two 3-item scales, which were averaged to obtain group cohesion: belonging ($\alpha = .95$) and morale ($\alpha = .92$). Belonging concerns whether or not team members feel that they are full members of the team. The morale scale measured one's sense of esteem in being a part of the group. The scale for group efficacy, which measures team members' beliefs that the team is capable of accomplishing a task given to it in the future, consisted of five items ($\alpha = .95$) developed by Avolio, Jung, Murry, and Sivasubramanian (1996).

Consensus: Consensus was measured using the method employed by Watson, DeSanctis, and Poole (1988). This method employs the pre- and post-discussion allocations made by members for each eligible employee to compute pre- and post-discussion consensus using a fuzzy logic algorithm proposed by Spillman, Spillman, and Bezdek (1980). Consensus thus produced ranges from 0 to 1, where 1 implies complete agreement.

Coded Variables: Two trained research assistants parsed and coded the discussion transcripts using a coding scheme adapted from Jessup, Connolly, and Galegher, (1990). The coding scheme breaks the thoughts of group members into different categories such as proposed solutions, supportive or critical arguments or remarks, and clarification statements. The coders were blind to the study's hypotheses and the conditions to which the transcripts belonged. Seven percent of the total transcripts were coded by both coders, and inter-rater reliability was 76%. The expression of support was operationalized as the sum of all simple supportive remarks and supportive arguments divided by the total number of comments within the group. Likewise, the expression of criticism was operationalized as the sum of all simple critical remarks and critical arguments divided by the total number of comments. The incidence of supportive and critical comments was operationalized in relative terms to adjust for idiosyncratic differences in the level of participation across groups.

Covariates: We employed group size as a covariate for hypotheses testing because team processes and outcomes could be affected by the number of people on a team. In Hypotheses 3 to 5, which focus on the effects of supportive and critical communication on team performance, leadership condition and communication condition were employed as covariates to control for the effects of leadership and communication media on team performance that are not mediated by supportive and critical communication. Leadership condition was represented as a dummy variable (0 = transactional leadership and 1 = transformational leadership) as was communication condition (0 = IM, 1 = SL).

Pre-discussion consensus was used as a control variable in all of the hypothesis testing.

Analyses & Results

Manipulation checks

Manipulation checks were done at the individual level using nested ANOVA. We controlled for group effect by nesting the effect of leadership style within group. Manipulation checks for Study 1 indicated that participants in the transactional condition were more likely to report that their leader clarified expectations and reward contingencies than members of the transformational condition ($p = .00$). However, there was no significant difference in perceptions about leader engaging in contingent rewarding behaviors across the leadership conditions ($p = .19$). Examination of the mean score for perceptions about leader engaging in contingent rewarding behavior in the transactional condition ($M = 5.94, SD = 1.24, N = 130$) indicates that this score was significantly greater than 4 ($p = .000$), which is the point of indifference on a 7-point scale. In other words, participants in the transactional condition did register their leader as engaging in contingent rewarding behavior. However, participants in the transformational condition too registered their leader as engaging in contingent rewarding behavior ($M = 5.77, SD = 1.34, N = 151$). This is likely due to appreciation of work displayed by a transformational leader (as part of inspirational motivation) as the leader tried to inspire the teams by indicating to them that they have performed well and that they could aim higher.

On the other hand, participants in the transactional condition were less likely, than members of the transformational condition, to report that their leader made intellectual stimulation comments ($p = .00$), individualized consideration comments ($p = .00$) and inspirational motivation comments ($p = .05$). These results demonstrate that the cues for transformational and transactional leadership were manipulated successfully.

Hypotheses testing

The hypotheses were tested at the group level of analysis to be consistent with their development at the group level. The aggregation of individual responses to the group level for cohesion and group efficacy is justified both conceptually and by the results of r_{wg} analyses. Group-level measure for group efficacy is appropriate because group efficacy is a group-level belief about the effectiveness of the group (Guzzo and Dickson, 1996). Likewise, cohesion measures how strongly team members stick together and, hence, exists at the group level. Table 1 presents the estimated means for socio-emotional communication variables under the study's different conditions.

Variable	Transactional Leadership				Transformational Leadership			
	IM		SL		IM		SL	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Expression of Support	0.31	0.02	0.36	0.02	0.32	0.02	0.29	0.02
Expression of Criticism	0.16	0.03	0.17	0.03	0.17	0.03	0.22	0.03

Table 1: Estimated Means (Study 1)

For Hypothesis 1, results indicated a marginally significant interaction effect of leadership style and communication condition on supportive communication ($F_{1,56} = 3.30, p = .08$). Analysis of simple effects indicated that there was no effect of communication condition under transactional leadership ($p = .11$), nor was there an effect of leadership condition for groups operating within IM ($p = .80$). Furthermore, unexpectedly, transactional leadership was associated with a greater expression of support than transformational leadership in the SL condition ($p < .05$). Thus, Hypothesis 1 was not supported. Hypothesis 2, which predicted an interaction effect of leadership style and communication condition on reducing critical communication, was not supported either ($F_{1,56} = 0.61, p = .44$). Furthermore, no simple effects of leadership style or communication

condition on the expression of either support or criticism were observed.

Regarding the effects of socio-emotional communication on team performance, we did not notice any effect of the expression of support on group cohesion, post-discussion consensus, or group efficacy. Therefore, Hypotheses 3a, 4a and 5a received no support. We also noticed that the expression of criticism did not influence group cohesion or post-discussion consensus. Therefore, Hypotheses 3b and 4b received no support either. However, greater expression of criticism resulted in lower group efficacy ($p < 0.05$), lending support to Hypothesis 5b.

Discussion

Results of Study 1 did not support the substitution effect that we expected in Hypotheses 1 & 2. Under transactional leadership, though groups using SL displayed greater support than groups using IM, this difference only approached significance but did not reach it ($p = .11$). Moreover, the combination of SL and transformational leadership led to the display of support that was significantly less than what the combination of SL and transactional leadership produced. This pattern of results suggests that rather than substituting for transformational leadership, SL may be neutralizing the effect of transformational leadership on the expression of support.

Could it be that the combination of SL and transformational leadership made participants uncomfortable in expressing support? Transformational leadership encourages consideration and support for other participants' viewpoints and positions. Maybe participants felt uncomfortable being considerate and expressing support because they did not know the other participants well. By presenting others vividly via their avatars, SL may have made participants' unfamiliarity with each other much more salient to them because of which participants hesitated to be considerate and express support for others. Participants' unfamiliarity with each other may even account for the lack of effects of supportive communication on group cohesion, consensus, or group efficacy. The possibility of individuals being uncomfortable with considerate exchanges early on is supported by a recent study on the effects of personalization in marketing emails (White, Zahay, Thorbjørnsen, and Shavitt, 2008). The authors found that during initial marketing emails, recipients were less likely to respond to emails with a high level of personalization than to emails with a low level of personalization. The authors suggest that high levels of personalization may be seen as inappropriate during initial encounters and may even damage the customer-marketer relationship.

If this explanation is valid, then a possible way to alleviate the effects observed here and create the expected effects might be to help team members learn about each other and have an interest in one another early on so that (a) when team members are made salient by SL, the interest in others motivates positive and supportive exchange irrespective of the style of the leader, and (b) when a transformational leader prompts team members to be considerate and supportive towards each other, they know enough about each other already to make them comfortable to engage in such an exchange irrespective of the communication medium used. It is in these conditions that SL and transformational leadership would substitute for each other, as we have predicted. A way to help team members learn about each other and have an interest in one another early on would be to make the team do an ice-breaker exercise prior to its task. In a recent study on computer-mediated communication, Dabbish and Kraut (2008) observed that an ice-breaker exercise designed to acquaint team members with one another can create an interest among team members for each other. Hence, to determine if SL and transformational leadership can substitute for each other as hypothesized, we conducted a second study with the same design as the first study except that the virtual teams performed an ice-breaker exercise prior to their task.

STUDY 2

Research Method

Participants

Undergraduate MIS students participated for bonus credit. Preliminary survey information was collected as in the first study. Thirty-eight 5 member groups were created. Attendance and scheduling issues caused a final number of 35 groups with from 3 to 7 members ($N=165$; average group size = 4.71). One group leader's computer crashed, preventing her from saving a transcript. This was dropped from coding analysis. As in the first study, members did not know the other members in their group and had no prior history of working together. Participants completed the same assignment as in Study 1 to familiarize them with SL.

Design & Experimental Session

The task sessions for the second study involved the same task, but participants completed an ice-breaker exercise prior to the

group discussion. The exercise, facilitated by the leader, lasted approximately 10 minutes. The ice-breaker allowed participants to answer questions about their likes and dislikes and discuss them with the group members. The leader asked participants to respond to questions such as "What is your favorite restaurant?" and, "Which is better, living on or off campus?" When the conversation lagged the leader moved on to the next question. In the SL condition the leader also asked participants to stand and group their avatars based on similar answers.

After the ice-breaker the task began. The only difference in procedure for the task in the 2nd study was that participants had been given a copy of the task itself a short time ahead of the session. This was done to shorten session time and participants having to wait for others who might read more slowly.

Manipulations

The leadership condition and communication condition for the second study were manipulated in the same way as in Study 1. The only difference was in the SL condition in which different land was rented. Two new buildings were used, but the furniture inside remained the same as in the first study. Also, subjects used a slightly updated version of SL client software (1.19), which differed from the version used in the first study on features that the subjects did not use.

Operationalization of variables for manipulation checks

Leadership was measured using the same scales as in Study 1.

Operationalization of variables for hypothesis testing

Variables were operationalized in the same manner as for Study 1. The reliabilities for the scales in Study 2 are as follows: group cohesion belonging ($\alpha = .95$); group cohesion morale ($\alpha = .89$); and group efficacy ($\alpha = .95$). For the coded variables in Study 2, inter-rater reliability was 75% on 11% of the transcripts.

Analyses & Results

Manipulation checks

Similarly to study 1, manipulation checks were done at the individual level using nested ANOVA. We controlled for group effect by nesting the effect of leadership style within group. Results from study 2 for manipulation checks demonstrated that participants in the transactional condition were more likely to report that their leader clarified expectations and reward contingencies than members of the transformational condition ($p = .00$). Participants in the transactional condition were also more likely to report that their leader engaged in contingent rewarding behaviors than members of the transformational condition (one-tail $p = .05$).

On the other hand, participants in the transactional condition were less likely, than members of the transformational condition, to report that their leader made intellectual stimulation comments ($p = .00$), individualized consideration comments ($p = .00$) and inspirational motivation comments ($p = .00$). These results demonstrate that the cues for transformational and transactional leadership were manipulated successfully.

Hypotheses testing

As in Study 1, hypotheses were tested at the group level of analysis. r_{wg} analyses provided justification for the aggregation of individual responses to the group level for cohesion and group efficacy. Table 2 presents the estimated means for socio-emotional communication variables under the study's different conditions.

Variable	Transactional Leadership				Transformational Leadership			
	IM		SL		IM		SL	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Expression of Support	0.30	0.05	0.33	0.07	0.42	0.08	0.33	0.05
Expression of Criticism	0.15	0.09	0.15	0.06	0.16	0.07	0.16	0.08

Table 2: Estimated Means (Study 2)

Results indicated a significant interaction effect of communication condition and leadership style on the expression of support ($F_{1,29} = 8.68, p < .01$). Pairwise comparison shows that transformational leadership led to greater expression of support than transactional leadership ($p < .01$) in the IM condition as expected. However, for groups operating under transactional leadership, though SL was associated with greater expression of support than IM, this effect was insignificant ($p = .26$). Moreover, under transformational leadership, IM groups engaged in higher levels of positive socio-emotional communication than SL groups ($p < .01$). Taken together, these results do not support our expectation that SL and transformational leadership will substitute for each other's effect on supportive communication. Thus, Hypothesis 1 was not supported.

Hypothesis 2, which predicted an interaction effect of leadership style and communication condition on reducing critical communication, was not supported ($F_{1,29} = 0.31, p = .59$). Furthermore, no main effects of leadership style or communication condition on the expression of criticism were observed.

Regarding the effects of socio-emotional communication on team performance, we noticed that greater expression of support resulted in higher group cohesion, post-discussion consensus, and group efficacy (all effects significant at $p < 0.05$), supporting Hypotheses 3a, 4a and 5a. On the other hand, greater expression of criticism resulted in lower group cohesion ($p < 0.05$), lending support to Hypothesis 3b. However, we did not observe any significant effects of the expression of criticism on post-discussion consensus or group efficacy. Therefore, Hypotheses 4b and 5b were not supported.

Discussion

Results from Study 2 did not support the substitution effect that we expected in Hypotheses 1 & 2. Our expectation of the substitution effect was based on the premise that both SL and transformational leadership were capable of leading to a greater expression of support by making the social situation more salient to team members. Furthermore, when both SL and transformational leadership are present, the salience promoted by one condition may render the salience promoted by the other condition as fully or partially redundant. Though leadership style and communication media interacted to influence the expression of support during group discussion, as expected by Hypothesis 1, examination of the simple effects reveals a pattern inconsistent with expectations. For groups supported by IM, transformational leadership led to a greater expression of support than transactional leadership whereas for groups supported by SL, there was little difference in the expression of support under transactional and transformational leadership.

This pattern of results suggests that under the conditions where team members have opportunities to learn about each other early on, SL may be neutralizing the effect of transformational leadership on the expression of support rather than substituting for transformational leadership. In other words, instead of rendering the salience promoted by transformational leadership as redundant, SL may have neutralized the salience promoted by transformational leadership. Maybe the presence of avatars distracted team members due to which they were unable to respond to a transformational leader's calls for teamwork even though they had an opportunity to learn about each other early on (in the form of an ice-breaker exercise). In the IM condition, there was no similar distraction due to which team members were able to respond to a transformational leader's calls for teamwork. The ability of visual cues in computer-mediated communication to distract participants from the task has been noted in prior research (e.g., Yoo and Alavi, 2001). We also saw that under transactional leadership, SL did not lead to a greater expression of support than IM. Though it is possible that the presence of avatars in SL highlighted the social situation, the presence of avatars may have also highlighted individual differences, which can discourage expression of support (Hobman, Bordia, and Gallois, 2003). This may have led to no net effect of SL relative to IM on the expression of support under transactional leadership.

We did not observe the interaction effect of leadership condition and communication condition on the expression of criticism that we expected according to Hypothesis 2. Neither did we observe the significant impacts of expression of criticism on group consensus or group efficacy as proposed in Hypotheses 4b and 5b. Given that these hypotheses all dealt with the expression of criticism, we suspect that the non-significant results were due to the nature of the task. Unlike an emotional task, the rational bonus-allocation task used in our study may have little room for the generation of negative comments. In other words, the total number of criticism comments may not have passed a threshold to demonstrate any effects. Future research is needed to examine the antecedents and consequences of expression of criticism.

CONCLUSIONS

In order to increase our understanding of the effects of virtual worlds, we conducted two studies to examine how the use of virtual worlds interacts with leadership style to influence socio-emotional communication in virtual teams and how socio-

emotional communication, in turn, influences team performance. To learn about the effects of virtual worlds, a popular virtual world, Second Life, was compared with instant messaging.

Our results suggest that the innovativeness of virtual worlds requires revisiting theories on communication media for enrichment and extension. Currently, media characteristics such as the capacity for immediate feedback, number of cues/channels used, personalization, language variety, and synchronicity (Daft and Lengel, 1986; Dennis and Valacich, 1999) are considered when examining the effects of media on group interaction. Based on this, we had expected that SL would lead to a stronger feeling than IM that one is in a social situation and influence socio-emotional communication. Specifically, relative to IM, SL was expected to provide additional cues through the visual and audio channels and make the social situation more salient to team members. With such social awareness, team members were expected to engage in supportive communication in order to make others form a positive impression of them.

Our results, however, suggest that additional cues provided by virtual worlds may not necessarily be better. While it is often assumed that virtual worlds may be better than other media used by virtual teams because they are closer to face-to-face communication, the visual cues provided by avatars may have a less than positive effect or at least not a beneficial effect. Specifically, in virtual teams in which team members don't know each other well, individual differences highlighted by avatars may discourage expression of support for the efforts of other members.

Results confirmed our expectation that it may be too simplistic to study the effects of virtual worlds in isolation from the context in which they are used. We found that communication medium and leadership style interacted to influence the expression of support within a virtual team. Specifically, evidence suggests that SL may have neutralized the effect of transformational leadership on the expression of support within a virtual team. At this stage we can only speculate that SL may have neutralized transformational leader's effect on enhancing the expression of support within a team by highlighting individual differences via the visual channel. Future research should study the reasons for neutralization carefully. At a broader level, the interaction of communication medium and leadership style suggests that technological features alone do not influence communication in virtual teams and that contextual variables, such as leadership, can also influence communication patterns. Although theories such as media richness theory propose that features of the communication media affect the perceived richness and sociability of the medium, our results suggest that this is too simple of an answer.

Our results suggest that socio-emotional communication matters for virtual team performance if the team has had an opportunity for an ice-breaker exercise, as demonstrated by the positive effects of supportive interactions on group outcomes (cohesion, consensus, efficacy, and satisfaction) in Study 2. Virtual team leaders should, therefore, make efforts to start off their teams with an ice-breaker exercise and ensure that the virtual team environment is conducive to supportive group interactions. In order to encourage such interactions, it is important for team leaders to understand different leadership styles and their interaction with communication media. Specifically, if a team is using SL or a virtual world like it, there is little difference in the expression of support when a leader is transformational or transactional. However, if a team is using IM, transformational leadership should be preferred over transactional leadership for promoting supportive communication within the team.

Limitations and Future Research

This paper's conclusions should be tempered with an understanding of the conditions in which the research was conducted. Laboratory experiments enabled control over key variables, thereby increasing our confidence in the internal validity of our results. The use of laboratory experiments, however, limits the generalizability of our results to virtual teams with members who are not well acquainted with one another and are made to interact synchronously over electronic media for a short-term decision-making task. Generalizability is also limited by the use of students who lacked an organizational context defined by workplace politics, culture, and pressures. Additionally, voice capabilities offered by Second Life and AIM were not used.

Future research could study intact organizational groups with a history of interacting with each other and expectations of continuing to work together. Longitudinal studies may also be conducted because group interaction could potentially change over time (Walther, 1995). Longitudinal studies would also provide an opportunity to incorporate the "idealized influence" or charisma dimension of transformational leadership. In this study, we focused on a decision-making task with no right answer and unlikely to evoke strong emotions among decision-makers. Future research could extend this study's findings by examining the effects of leadership style and communication medium on socio-emotional communication and team performance using other tasks in McGrath's (1984) circumplex. When examining socio-emotional communication, future studies could include Bales' categories (1950), beyond the supportive and critical communication categories that we studied. Future research could also examine effects of leaders who combine both transactional and transformational leadership styles.

Despite these limitations, we believe that this research elucidates how leadership style and communication media interact to

influence socio-emotional group processes and outcomes in computer-mediated contexts. Due to the increasing interest in leadership and use of electronic communication media in organizations around the world, continued research seems timely and warranted.

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