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Awareness in virtual workspaces: Influences on dispensability and consensus

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Abstract

When teams meet via computer-mediated communication to make a decision, awareness of who is present, whether other team members understand what is happening, and whether other team members agree with a decision is important to collaboration but more difficult to maintain via computer-mediated communication than face-to-face. The results of an experiment involving virtually collaborating teams is presented that examines the effects of a user interface "nudge" that indicates the presence of other team members, which team members need assistance, and whether team members agree with the team's decision. Teams with the nudge had higher perceptions of presence awareness, which in turn decreases feelings of dispensability and increases feelings that the team has reached consensus. Dispensability and consensus are linked with perceptions that the team is ready to execute their decision. Thus, a "cascade" approach to awareness via computer-mediated communication is offered and its implications are discussed.

Keywords: awareness, presence, collaboration, virtual teams

Introduction

During the Covid-19 pandemic, remote work became part of daily life for most knowledge workers. However, in spite of available video conferencing, employees reported problems with relationship building (Oliver, 2021), which echoes frequently reported findings from the text-based virtual teams literature where team members report difficulty with trust (Benbunan-Fich & Altschuller, 2007), and resort to sending messages of "anybody there" (Jarvenpaa & Leidner, 1999) when they attempt to communicate. Linking the user interface of an application to its ease of use and usefulness has been an indispensable part of system design and development for decades; however, teamwork in virtual workspaces involves collaboration with others and therefore judging interface design necessarily involves team processes and subsequent work performance. In the following paper, we demonstrate the importance of delineating the relationship between virtual workspace user interface elements, the emergence of attitudes toward the team and its work, and corresponding performance on a coordinated task in order to understand whether and how the design of virtual workspaces impacts team performance. Specifically, we examined how an interface designed to enhance awareness of who is available and whether they understood and agreed with their team's technique for completing their task impacted the perceptions of team members, and whether these perceptions in turn affected the team's coordination and performance on a task.

We take as a starting point the notion that communicating in virtual workspaces has fundamental issues for distributed teams, including tendencies to conform (Lee, 2007), a need to feel the presence of others (HEC

Paris et al., 2018), and a need to be aware of the activities of others (Haines, 2021). The focus of this paper is on enhancing awareness in virtual collaborative settings; specifically, awareness of who is present in the workspace and awareness of when someone needs assistance. To better design features aimed at enhancing awareness, we designed our awareness feature as a *nudge*. A nudge is defined as "any aspect of choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler & Sunstein, 2009, p. 6). We extend the notion of a nudge to team collaborative contexts, where our user interface element can be conceived of as a nudge to team members about the need to contribute to the team's decision-making process and think about the other team members more.

Theoretical Foundation

Awareness in virtual collaboration "can reduce effort, increase efficiency, and reduce errors" (Gutwin and Greenberg, 2002, p. 425). Awareness is typically confined to collaboration on artifacts such as reports or systems; thus, the use of awareness elements in collaborative decision-making contexts has not been considered critical because decision-making involves "less interaction with the artifact" (Gutwin and Greenberg, 2002, p. 414). However, the use of awareness elements to support tasks such as air traffic control (Gutwin and Greenberg, 2002) and collaborative learning (Gutwin et al, 1995) has been explicitly noted, suggesting the potential usefulness of awareness elements in decision-making tasks. Thus, in a collaborative decision-making environment, we suggest that the team decision can be considered the "artifact," and user interface elements can be designed that increase the awareness of team members relative to their work on that decision. The experimental task used in this study is described in detail later, but we note here that it involves having the teams complete two overarching tasks that are typical in collaborative contexts: 1) teams reach a decision on how to coordinate their activities, and 2) teams execute their decision on a subsequent task. The task and experimental setup is one that has been used in prior IS research (Haines & Mann, 2011), and which is patterned after a seminal social psychology experiment designed to examine these basic objectives of teams (Guetzkow & Simon, 1955). The experimental treatment employed in this study features an awareness element during the organizing session, which is conducted in a text-based chat room (shown in Figure 1). The element conveys in real time whether other team members understand and agree with the team decision, and whether the team members feel that the team has reached a satisfactory decision (i.e., We are Ready).

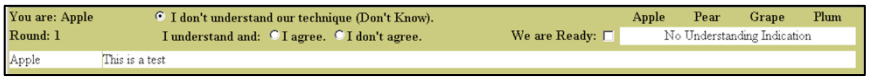


Figure 1: Treatment Condition used in this study

Although the primary purpose of the user interface element is to convey whether other team members understand and agree with the team's decision, it also provides a sense that other team members are present and able to participate in the decision-making process.

> *H1: A user interface element that conveys the names of other team members will increase perceptions of presence awareness.*

Research has shown that individuals perform better in their jobs when they are actively motivated (Bakker & Demerouti, 2017; Hakanen et al., 2008; Hobfoll, 2001). Motivated employees are more apt to sustain engagement and cultivate their own resources, including autonomy, feedback, and support, over time (Bakker & Demerouti, 2017). Therefore, actively involving team members in decision making meetings becomes crucial for increasing engagement and productivity.

A large amount of nudge research suggests that reminders or prompts can keep the opportunity to get involved at the top of people's minds, including activities such as going to the gym (Calzolari & Nardotto, 2017) and saving money (Karlan et al., 2016). For instance, Kahn et al. (2002) found that fitness apps employing GPS and sensor technology provide timely reminders, thereby increasing users' physical activity levels. Additionally, reminders bolster users' confidence in the app's utility and effectiveness. Here, our user interface element provides a reminder and prompt that every team member should understand and agree with the team decision. Thus, team members should feel a heightened sense of individual responsibility for getting the team organized.

H2: A user interface element that conveys whether other team members understand and agree with the team decision will lead to lower feelings of dispensability.

Presence awareness in turn aids team decision making because it allows team members to observe who is or is not participating in the discussion and thereby reduce social loafing and free-riding (Haines, 2021; Steiner, 1972). When an individual team member is known by other team members to be present in the discussion, the team member will be more likely to contribute to the team discussion because they face a higher probability of being targeted for involvement as other members notice that they are not participating (Parks & Sanna, 1999).

H3: Perceptions of presence awareness will be linked with lower feelings of dispensability.

Increasing awareness of other team members' presence should likewise be associated with an increased feeling that the group has reached consensus. Each team member being aware of the other members is a pre-requisite for determining whether the others have participated in the discussion, which in turn is necessary for ensuring that the entire team has reached consensus when a decision is made (McLeod, 2000). This could occur independently of whether user elements are employed that increase assistance awareness because team members can establish who is on their team via their interaction (Walther, 1996).

H4: Perceptions of presence awareness will be positively linked with feelings of consensus.

Returning back to the primary purpose of the user interface element, we contrast our awareness element with the awareness element used by Haines & Mann (2011), shown in Figure 2. In their study, they found that seeing whether other team members had indicated that they were ready for the task led to deindividuation, meaning that team members exhibited groupthink and clicked that they were ready faster, in spite of feeling like the team had not reached consensus.

Figure 2: Treatment Condition used in Haines & Mann (2011)

In contrast to Haines & Mann (2011), our user interface element provides a cue that team members should reach understanding and agreement with the team's decision, and has a team- rather than individual-level focus ("We are Ready" versus "Ready for Task"). We suggest that our user element will have an opposite effect on team members, reducing conformity and groupthink and increasing perceptions of consensus. Conformity is a problem in newly formed face-to-face teams and overcoming it can take many meetings (Wheelan et al., 2003). Extensive research supporting SIDE theory shows that conformity is heightened even more in teams that meet over computer-mediated communication (Postmes et al., 1998), which Haines & Mann (2011) argue is further heightened when the opinions of team members are presented. Here, we argue that our user interface element's cue that members should reach understanding and agreement will counteract the tendency of individuals to conform, in spite of the use of mediated communication coupled

with the expression of the opinion of other team members. Again, consistent with Haines & Mann (2011), we measure conformity as a team member's indication that their team is ready even while feeling that their team has not reached consensus.

> *H5: A user interface element that conveys whether other team members understand and agree with the team decision will lead to higher perceptions of consensus.*

Involving team members in a decision making task engages their executive functioning and self-regulation, which can lead to depletion of attention (Kaplan & Berman, 2010). To avoid this depletion or fatigue, we should draw effortless attention that does not require cognitive effort (Kaplan & Berman, 2010). The nudge literature notes that user interface elements that promote ease and accessibility can encourage people to participate by making the process of getting involved as easy and accessible as possible. For instance, Yoganathan and Kajanan (2013) discovered that smartphone fitness apps with easy and accessible designs boosted user self-efficacy by simplifying workout methods. Similarly, Murayama et al. (2023) found that simple and clear instructions increased the rate of people getting check-ups. Our user interface element shows participants that they have clear and immediate opportunities to get involved, which are proposed to serve as effective nudges.

> *H6: A user interface element that conveys whether other team members understand and agree with the team decision will lead to higher and more equal participation.*

Awareness of whether or not individuals in the team understand and agree with the team's decision are likely to aid in making team members aware that another needs assistance and thereby increase coupling, which is "assisting others with their local tasks" and is an integral part of collaboration (Gutwin & Greenberg, 2002, p. 431). Additionally, as others see that another member does not understand and/or agree with a decision, they can move from focusing on their own work relative to the decision and focus on the members that need assistance (Dourish & Bellotti, 1992). Thus, the factors discussed earlier all potentially feed into perceptions that the group is ready to execute their decision.

> *H7a: Perceptions of presence will be positively associated with perceptions that the team is ready to execute their decision.*
> *H7b: Perceptions of dispensability will be negatively associated with perceptions that the team is ready to execute their decision.*
> *H7c: Perceptions of consensus will be positively associated with perceptions that the team is ready to execute their decision.*

The research model is shown in Figure 3.

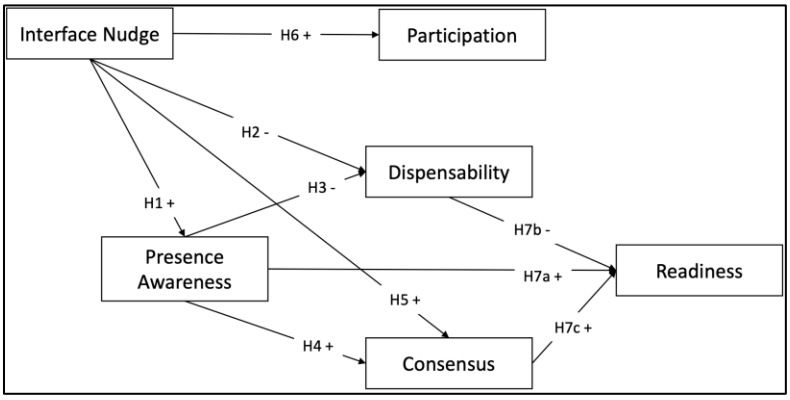


Figure 3: Research Model

Research Method

A laboratory experiment was used to examine the relationships among our user interface element, perceived awareness of the presence of others, perceived dispensability, consensus, and team performance. Participants in the experiment are identified by a randomly assigned alias. As noted earlier, the experimental task is completed in two stages. The first stage task is a decision-making exercise during which teams decide how to complete the second task. The first stage task is completed via a web-based chat room. The second stage task is derived from Haines & Mann (2011). During this stage, the team is to collect a list of colors from each team member via email and to determine which color every list has in common. The second stage is complete when every member has indicated the correct common color. Completing this task efficiently involves the coordinated execution of the team's chosen method from the first stage. The team that completed the second task in the fewest number of messages is awarded a prize of $2 per person.

The experimental sessions are conducted by the same administrator who read scripted instructions. Each session begins with participants completing an informed consent document. Next, participants complete a background questionnaire and are divided into teams and assigned an alias (e.g., Apple, Grape, Pear). Then, the administrator reads instructions that explained the team membership, task, the incentive, the use of the chat room and e-mail application, and were told several times, with emphasis, the purpose of the chat room (e.g., "Before determining the common color via e-mail, you will use a Chat Room to discuss your group's technique for determining the common color."). Once all of the subjects in the session finished the instructions, any questions are answered, and participants click an "Enter Chat Room" button and the exercise began.

When the chat room stage begins, an on-screen message explicitly instructs "Use the Chat Room to discuss your group's technique for determining the common color. Chat messages do not count toward your total number of messages." In order to exit the chat room and begin the second (color finding) task, every member of the team must indicate 1) that they understand and agree with their team's technique for finding the common color by clicking on the appropriate radio button at the top center of their web browser window, and 2) that they feel their team is ready by checking the box at the top right of their web browser window (see Figures 4 and 5). The "We are ready" box cannot be checked unless the team member indicates that they understand and agreed with their team's technique, and a team member's "We are ready" box will automatically be unchecked if they began to type a message. Once all members check the "We are ready" box, they are automatically redirected to a questionnaire containing the psychometric items. After all members have completed the questionnaire, they are automatically redirected to the web page for the second (color finding) task.

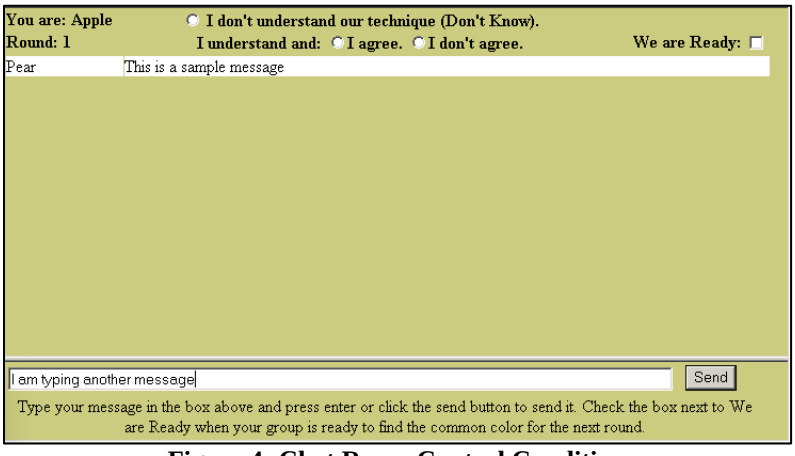


Figure 4: Chat Room Control Condition

Figure 5: Chat Room Awareness Element Condition

At the beginning of the color finding task, each team member receives an email message with a list of colors from "Admin" (see Figure 6). Each team member's list is different, such that only one color appears on every member's list. In order for the team to determine the common color, the team members need to share the information on their list. An effective technique for determining the common color is a two-tiered hierarchy: each member sends their list of colors to a central member, who finds the common color for the team by determining which color appears on every list and sends the answer to his/her team members. Answer indications were counted as messages to disincentivize guessing. Again, the team in each session that completes the color finding task using the fewest number of messages receives the $2 per member prize.

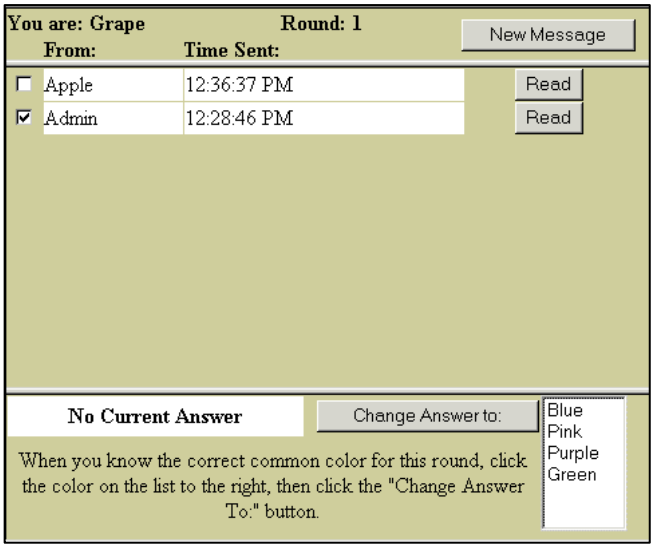


Figure 6: Email Screen

Variables

Treatments: In the control condition, members indicate whether they understand and agree with the team's decision, but this is not shown to the other team members (Figure 4). The treatment condition consists of

the awareness element added to the top right section of the chat interface (Figure 5). On this display, members are shown a list of team members and whether each one has indicated their understanding and agreement with the team's technique.

Team members in both treatment conditions are shown the aliases of the people that will be in their team during the instructions. However, seeing the awareness element should heighten the ability of the team members to see which team members are present in the chat room, allowing team members to refer to a system-generated list rather than having to rely on their memory and suggesting that the other team members are at least lurking the chat room. Furthermore, as their status changes, other team members were implicitly acknowledged to be "present" even if they have not contributed messages to the discussion.

Teams are instructed "As you discuss your team's technique for determining the common color, indicate whether you understand and agree with your team's technique by clicking a response at the top of your screen." If a team member indicated that he/she does not understand the technique, other team members can recognize that the person needed assistance in the form of further explanation. If a member indicates that they disagreed with the technique, other team members can recognize that the team needs to discuss the technique further and consider alternatives. Thus, the awareness element provides "manifesting actions" (Gutwin & Greenberg, 2002, p. 428) that can replace textual communication like "I'm confused" and "I think we should do it another way."

Survey Instruments: The questionnaire is administered immediately after the team indicates that they are ready and before they begin the second task. *Presence awareness* measured the degree to which the team are aware of who is present, as used by Cooper and Haines (2008). The items are: 1) "Our group could easily see whether all of our team members were in the chat room," 2) "Our group knew immediately how many people were in the chat room," and 3) "It was easy for our group to see whether all of our team members were present in the chat room." *Consensus* measures the degree to which a team member feels their team has reached consensus about how to complete the subsequent task, as used by Cooper and Haines (2008). The items are: 1) "Overall, our group agreed on how we should determine the common color for the next round," 2) "Our group reached mutual understanding on how we should determine the common color for the next round," and 3) "Our group was able to reach consensus on how we should be organized to determine the common color for the next round." *Dispensability* measures the degree to which team members feel their contribution is important to the team's organization, and is adapted from Haines & Mann (2011). The items were reverse coded: 1) "Members of our group had a share of the responsibility for getting our group organized," 2) "Members of our group felt personally responsible for making sure our group got organized," 3) "Members of our group feel individually responsible for how well our group is organized," and 4) "Members of our group feel that their individual effort was necessary for making sure our group got organized." *Readiness* is developed specifically for this study and consists of: 1) "We feel that our group is ready to accomplish the next task," 2) "We are prepared to determine the common color during the next round," and 3) "We feel that our group is organized for completing the next task." All items were on seven-point scales anchored Strongly disagree – Strongly agree.

Behavioral Measurements: The other measures are gathered by the web application. *Participation* is the number of chat messages that a team sends during the chat stage, measured both by number of chat messages (individual utterances, or each time a person entered a message and pressed the enter/send key) and chat volume (total number of characters contained in messages). Gini coefficients of both are used to compare inequality of participation (lower Gini = more equal participation) *Performance* is the number of messages that it takes a team to complete the second (color finding) task, which, as noted earlier, teams are instructed to minimize. For a two-tier hierarchy that is working effectively, three messages will be sent to the central person, three answers will be sent back from the central person with the correct answer, and four messages will be sent to the experimental administrator, meaning a total of ten messages for the highest

performing teams. The message total is the minimum – miscommunications and wrong answers increase the number of messages necessary to complete the second task. If a team member is confused about the team's technique and/or misunderstands to whom they should send their colors, extra messages will be required to diagnose and fix the problem. Thus, teams can vary in their performance when completing the second (color finding) task depending on whether their technique is effective or not. An increasing number of messages indicates decreasing performance; therefore, a negative relationship is expected between perceived readiness and task performance.

Results

A total of 104 teams participated in the experiment. Means and standard deviations of the study variables, along with a summary of ANOVA tests of the differences between the treatment and control conditions are presented in Table 1.

Table 1: Means (Standard Deviation) of Study Variables by Treatment

	Control Condition	Treatment Condition	ANOVA p-value
Chat Messages	32.27 (19.02)	25.20 (14.20)	.033*
Gini Coefficient of Chat Messages	.19 (.07)	.17 (.09)	.263
Chat Volume	872.33 (585.90)	695.91 (465.22)	.0905
Gini Coefficient of Chat Volume	.33 (.10)	.28 (.12)	.0236*
Chat Time	346.96 (145.16)	298.87 (141.47)	.0905
Presence Awareness	4.81 (.85)	5.15 (.82)	.0386*
Dispensability	2.29 (.81)	2.04 (.91)	.146
Consensus	5.32 (1.24)	5.48 (1.32)	.521
Readiness	5.26 (1.20)	5.51 (1.02)	.261
Performance	22.57 (12.11)	22.13 (16.60)	.878

* $p<.05$

The research model, including item reliability and validity, is analyzed using SmartPLS version 4.1.0.2 (Ringle et al., 2022). Reliability is shown because Cronbach's alpha for each instrument is .778 or above, composite reliability (rho_a) is .834 or above, and average variance extracted is .689 or above (see Table 2). Discriminant validity is demonstrated because the items for each latent variable loaded more strongly on their own construct than on the other latent variables (see Table 3) and the square root of the average variance extracted for each latent variable exceeds its correlation with the other latent variables (see Table 4). All reliability and validity statistics exceed their recommendations for model evaluation (Hair et al., 2011; Sarstedt et al., 2023). The PLS model results are summarized in Figure 4.

Table 2: Instrument Reliability and Convergent Validity

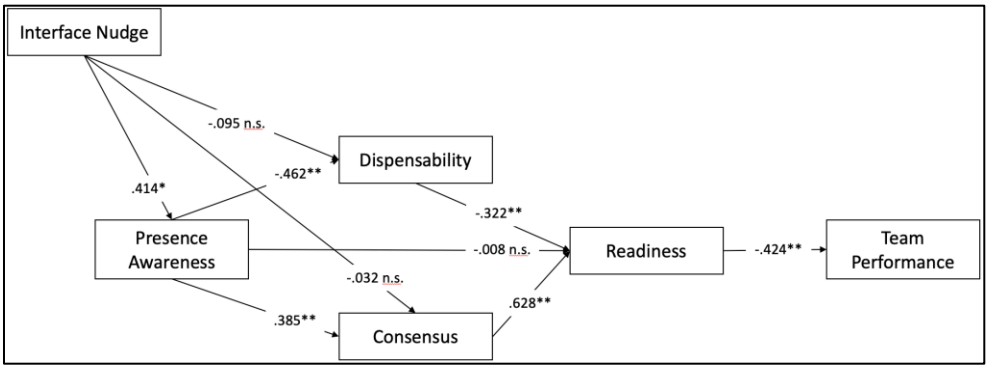
	Cronbach's alpha	Composite reliability (rho_a)	Average variance extracted (AVE)
Presence Awareness	0.778	0.834	0.689
Dispensability	0.874	0.877	0.727
Consensus	0.963	0.964	0.932
Readiness	0.960	0.961	0.926

Table 3: Item Loadings and Cross Loadings (Discriminant Validity)

	Presence Awareness (P)	Dispensability (D)	Consensus (C)	Readiness (R)
Our group could easily see whether all of our group members were in the chat room. (P1)	**0.886**	0.456	0.342	0.348
Our group knew immediately how many people were in the chat room. (P2)	**0.885**	0.441	0.373	0.359
It was easy for our group to see whether all of our group members were present in the chat room. (P3)	**0.707**	0.222	0.200	0.221
Members of our group had a share of the responsibility for getting our group organized. (rev.) (D1)	0.449	**0.848**	0.699	0.720
Members of our group felt personally responsible for making sure our group got organized. (rev.) (D2)	0.357	**0.903**	0.702	0.732
Members of our group feel individually responsible for how well our group is organized. (rev.) (D3)	0.359	**0.845**	0.628	0.684
Members of our group feel that their individual effort was necessary for making sure our group got organized. (rev.) (D4)	0.442	**0.810**	0.601	0.597
Overall, our group agreed on how we should determine the common color for the next round. (C1)	0.349	0.739	**0.966**	0.830
Our group reached mutual understanding on how we should determine the common color for the next round. (C2)	0.365	0.731	**0.967**	0.853
	Presence Awareness (P)	**Dispensability (D)**	**Consensus (C)**	**Readiness (R)**
Our group was able to reach consensus on how we should be organized to determine the common color for the next round. (C3)	0.390	0.769	**0.963**	0.848
We feel that our group is ready to accomplish the next task. (R1)	0.326	0.791	0.832	**0.961**
We are prepared to determine the common color during the next round. (R2)	0.397	0.746	0.845	**0.956**
We feel that our group is organized for completing the next task. (R3)	0.386	0.783	0.847	**0.969**

Table 4: Correlation of Latent Variables with Square root of AVE on Diagonal (Discriminant Validity)

	Presence Awareness	Dispensability	Consensus	Readiness
Presence Awareness	0.829			
Dispensability	0.472	0.852		
Consensus	0.383	0.773	0.965	
Readiness	0.384	0.804	0.874	0.962



* p<.05, ** p<.01, n.s. not significant

Figure 7: Summary of PLS Results

Hypothesis One As expected, the awareness element was associated with a significant increase in presence awareness (b=.414, p=.028). Thus, hypothesis one is supported.

Hypothesis Two It is hypothesized that the awareness element would decrease dispensability. However, the path coefficient linking the awareness element with dispensability is not significant (b=-.095, p=.593). Thus, hypothesis two is not supported.

Hypothesis Three As expected, perceptions of presence awareness are linked with lower feelings of dispensability (b=-.462, p<.001). Thus, hypothesis three is supported.

Hypothesis Four As expected, increases in presence awareness are significantly associated with increases in consensus (b=.385, p<.001). Thus, hypothesis four is supported.

Hypothesis Five It is hypothesized that the awareness element will increase feelings that the team has reached consensus. However, the path coefficient linking the awareness element with consensus is not significant (b=-.032, p=.864). Thus, hypothesis five is not supported.

Hypothesis Six It is hypothesized that the awareness element will lead to higher participation. As shown in Table 1, members of teams with the awareness element sent significantly fewer chat messages overall (32.27 versus 25.20, p = .033), but had significantly more equal participation as shown by a lower Gini coefficient for chat volume (.33 versus .28, p = .0236). Thus, hypothesis six is supported.

Hypothesis Seven It is hypothesized that perceptions of presence awareness, dispensability, and consensus will all be linked with perceptions of team readiness. Both dispensability (b=-.322, p=.004) and consensus (b=.628, p<.001) are significantly linked with team readiness, but presence awareness is not significantly linked with team readiness (b=-.008, p=.886). Thus, hypotheses 7b and 7c are supported, but hypothesis 7a is not.

Finally, as expected, there is a significant, negative path coefficient linking perceived team readiness and team performance (b=-.424, p<.001), showing that perceived team readiness is linked with actual performance on the subsequent (color finding) task.

Discussion

Support for five out of the seven hypotheses is found in the PLS analysis. The awareness interface element is a significant nudge for some important aspects of the team members' perceptions and behavior. It

positively impacts presence awareness and equality of participation (lower Gini coefficient), but negatively affects the overall amount of participation (number of chat messages sent). However, the interface element does not significantly affect perceptions of dispensability or consensus, which suggests that team members' perceptions may not align with the intended "spirit" of the awareness element (DeSanctis & Poole, 1994). Members can build these feelings by determining whose contributions are necessary and whether they agreed with the decision by observing the content of chat messages or by observing which members are not participating. Although team members may not have used the awareness element in the way that was intended, its relatively subtle nudge still had an important impact on team processes by increasing presence awareness (cf., Huber, 1990).

Increasing presence awareness is significantly associated with decreasing dispensability and increasing consensus. Presence awareness can reduce social loafing and free riding, which is crucial for building trust and coordinating action in virtual teams. We note here that virtual team members have been observed to initiate roll calls when their teams first meet, ostensibly because they are unsure about the presence of others in the workspace (cf., Jarvenpaa et al., 1988; Jarvenpaa & Leidner, 1999). Presence awareness also appears to be important for judgmental decision-making tasks – otherwise anonymous team members adopt nominal labels to facilitate coordination of jury award judgments (McLeod, 2000). Thus, when technical limitations like anonymity exist, teams introduce presence awareness elements such as roll calls or nominal labels. These elements contribute to the "sufficient time and message exchanges" that allow virtual interaction to mimic face-to-face interaction (Walther, 1992, p. 67).

Limitations

This study involved ad hoc college student teams working on a simple intellective task, while exposed to a custom designed awareness element in a custom designed chat room. Thus, these results should be generalized to the behavior of teams in organizations with care. The students participating in the study expressed that they were adequately motivated to perform the task well, and a minimum level of involvement and adequate experimental controls are reasonable for examining the basic processes of teams (Greenberg & Eskew, 1993). Extending the notion of presence awareness via computer-mediated communication to standing teams, professionals, and other decision types such as judgment or negotiation presents opportunities for future research.

Conclusions And Implications

Like early virtual teams' text-based platforms, most video conferencing platforms have user elements like emotes for raising hands, clapping, or giving a thumbs up. While these might seem redundant in video calls where faces and hands are visible, they are useful when video is off or with many participants. These systems also include text-based features such as chat rooms and polling, indicating that modern teams face similar situations as past text-based teams, despite the richer communication medium (Dennis & Kinney, 1998).

Based on the results of this experiment, it seems reasonable to suggest that presence awareness can be heightened through nudged awareness elements, and that this has an effect on other team processes. Thus, a “cascade” approach to awareness is suggested: 1) teams eventually communicate and acquire the awareness they need by introducing awareness elements in whatever communication media are available, 2) heightening a particular area of awareness through user interface elements increases the “flow” of the awareness cascade from that point, and 3) the increased flow then cascades through other awareness components that depend on the precedent elements and accelerates the development of the teams (cf.,

Walther, 1992; Wheelan, 1994). Furthermore, awareness about a particular area seems to eventually reach a point where it can be taken for granted. For example, the presence information in an IM application can be taken for granted during a continuing conversation (Oemig & Gross, 2007).

Applying the cascade notion of awareness to the context of this experiment, teams with a nudged awareness element have heightened or accelerated perceptions of presence awareness, which in turn decreases dispensability and increases consensus, and finally team readiness and task performance. Teams without the nudged awareness element can introduce their own cues that communicate presence awareness, such as initiating a roll call or other message exchanges, meaning teams without the element could have experiences by their members in much the same way as the teams with the element. The increased number of chat messages in those teams suggests this might be the case.

Taking the cascade notion a step further, the awareness element's feature of indicating who did not agree with and/or understand the team's technique may not be seen as useful by team members because elements that indicate assistance awareness are readily available in the conversation. For example, assistance awareness can emerge from the conversation flow by observing that certain team members have not said that they understand the task. Thus, assistance awareness appears to build on presence awareness – knowing who needs assistance relies on knowing who is present in the workspace.

Tools that indicate the availability of people for communication via CMC are probably most important to team collaboration, in that additional message exchanges are needed when this information is not available. For example, if a team leader can see at a glance when a particular person is on-line, availability information would be immediately known. If he/she can only see when the person was previously online, he/she may be unsure as to whether a person is presently or even *possibly* available. Because online forums and e-mail typically provide only minimal availability information (i.e., time stamps on messages, which only show when a person was last online), team members may have to add availability information themselves to the contents of their messages (e.g., saying "brb" to indicate that they will only be away for a few moments).

Awareness about the activities that are being performed or have been performed (Gutwin and Greenberg, 2002) appears to be nearly as critical to collaboration (Haines, 2021). For example, if a team leader can see the degree to which particular team members have completed their assigned tasks, he/she can adjust the assignments as needed to increase the overall effectiveness of the team. In most CMC systems, including videoconferencing, such information is not provided and must be explicitly obtained.

It may also be beneficial to focus further down the cascade, as awareness of other team member attributes could be equally crucial for coordinating group work. For example, if a team leader has access to profile information about his/her team members, he/she may be able to quickly accommodate for an unexpected need in the team (e.g., loss of a member). Thus, the notion that awareness cascades presents additional opportunities for system developers and HCI researchers to work together on other aspects of interface design to support collaborative teamwork.

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