Sharing Awareness Information Improves Interruption Timing and Social Attraction

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Abstract
In distant collaborations, interruptions increase significantly due to the limited awareness of colleagues' availability. In this paper we evaluate OpenMessenger, an instant messaging prototype that provides awareness information. Results suggest that the use of OM benefits group task performance and the social attraction developed between group members. Experiment observation also suggests that people use OM both to predict their partner's availability and to explain the causes of their partner's late response.

Keywords
Awareness, interruption, Instant Messaging, CSCW, Computer-mediated Communication

ACM Classification Keywords
H5.3. Group and Organization Interfaces: Computer-Supported Cooperative Work

General Terms
Human Factors, Design

Introduction & Related Work

Frequent interaction is a hallmark of the modern workplace and has clear benefits for quick information exchange and coordination [7]. While these interactions occur frequently and fluidly in face-to-face settings, they can be disruptive in virtual environment due to the lack of awareness information about distant colleagues' availability. These interruptions may negatively affect team task performance or even individual affective state (e.g. [2]). Substantial research has been conducted in the field of CSCW in developing collaboration tools that provide awareness information to help time interruptions and create smooth distant interactions (See [6] for a review). Various systems use sensors or video cameras to share environment cues in distributed workplaces [6]. However, they easily distract users' attention from work and raise their concerns about revealing private information [4]. To reduce the privacy concerns and help people infer others' availability in more work-related context, other systems provide activity relevant information (i.e. keyboard activity or window-title switches) [1]. Recently, a virtual approach that resembles the initiation of a face-to-face interaction has been proposed. It allows people to progressively have access to more detailed awareness information as their intention to initiate a conversation increases. The information ranges from a "glance" to assess presence, some indication of current activity, to a full two-way video connection (e.g. [3]).

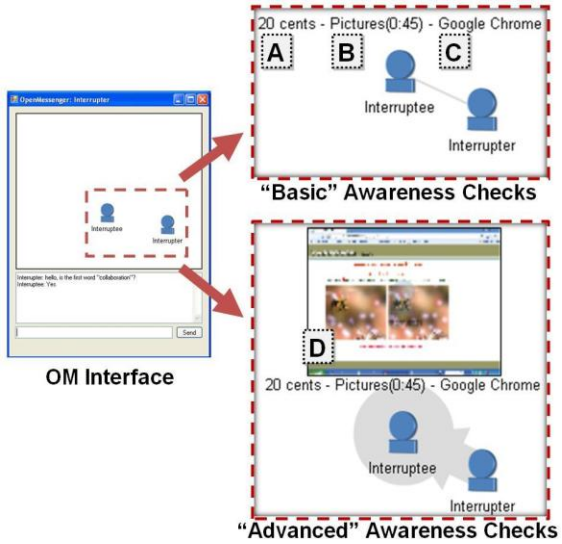

figure 1. OM System. Left: Chat and basic interface; Right: Awareness information display: (a) task value; (b) task name and length; (c) application name; (d) mini-screen shot. "Basic" and "Advanced" awareness checks are terms used for analysis purposes only; the transition was seamless for participants as the screen shot enlarged.

To better understand this virtual approach, its influences and effectiveness in improving distributed collaboration and people's behavior in using awareness information for interruption timing purposes in general, we conducted a laboratory study using an instant messaging prototype – OpenMessenger (OM).

The OpenMessenger System

OM uses the aforementioned virtual approach in that the amount of awareness information OM provides is positively correlated with the attention one pays to a potential conversation partner. Contacts in OM are represented by avatars placed in a window above a chat box (see left side of figure 1). When one user's cursor hovers over another user's avatar, the basic awareness information – window title is immediately displayed above the avatar (see the "basic" check in figure 1, note that in our experiment the window title indicated the name and value of the task being completed, as detailed below). After one second of hovering, more detailed information - a mini screen shot appears. The shot continues to enlarge for 6 more seconds (see the "advanced" check in figure 1), or until the cursor stops hovering over the avatar. The design

reflects the approach metaphor and thus prevents the distraction of a constant awareness information display.

Hypotheses

The focus of this experiment is on the utility and usage of the awareness information provided by OM in completing a task requiring frequent interruptions. We compared a version of OM that provides awareness information with an otherwise identical version that does not (we refer to this as IM).

First, prior field studies (e.g. [7]) suggest that real-world interruptions can be less disruptive if they are better timed. We tried to replicate this in the laboratory by providing interruptees with tasks that varied in cognitive load. We expected that participants use OM so as to raise interruptions at times when interruptees are working on low cognitive load tasks. Thus:

H1: Interruptions will occur at better times when awareness information is available than when it is not.

Second, we believed that better-timed interruptions would benefit the interruptees because they would be less distracted and not have to switch tasks at inopportune times. As such, we expected:

H2: Interruptees' performance will be better with awareness information than without.

Third, we believed that better-timed interruptions could have relational consequences. From the interruptee's perspective, poorly timed distractions can cause negative affective states such as frustration or anxiety which may negatively impact how they treat their collaborators. From the interrupter's perspective, poorly timed interruptions are less likely to be answered right away, and response time can affect perceptions of others in terms of the quality of the perceived relationship (e.g. [2]). It therefore stands to reason that those who are interrupted or interrupt at better times should hold a more positive attitude towards their partners as measured via a social attraction scale.

H3: People who are interrupted at better times or interrupt at better times will have a more positive impression of their partner.

Methods

A 2 x 3 mixed design was used for the experiment. Awareness functionality was varied between participants (OM and IM), and task load (3 levels, see below) was varied within participants. Participants were forty-four students from a large US university. Of 22 two-person teams, half used OM to communicate, and the other half used IM. Within each team, one played the role of the interrupter, who needed information from their partner to finish their task. The other was the interruptee, who had the information their partner needed, in addition to their separate task to perform.

Interrupters' Task: Interrupters had to complete short text passages with several words missing. They had to select the most appropriate word from a drop-down menu of synonyms (see figure 2). The interruptee had a list of the correct answers, and interrupters could ask yes-no questions (as in [5]) about these. While it was possible to complete the task via trial and error, it had a higher chance to get correct words by asking for help.

Interruptees' Tasks: Interruptees' were given three tasks that varied in load and engagement. The low-load

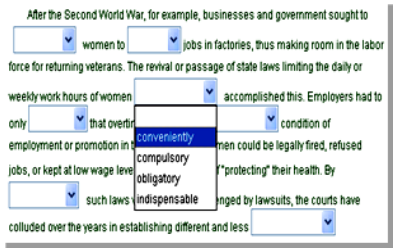

figure 2. The Interrupter's Task

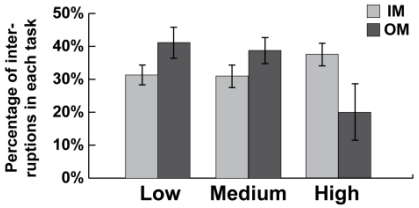

figure 3. Percentage of Interruptions during Each Task Type. Percentages were used because the overall number of interruptions was significantly different across conditions (M_{IM}=35.82, SD=8.58; M_{OM}=28.64, SD=5.95), $F(1,20)=2.28$, $p<0.05$).

task involved listing related items (e.g. 'Please name 3 state capitals'). This required the least constant attention from participants. The medium-load task was to find 3 differences between two similar pictures. The task is interruption-sensitive in that some attention is needed to spot the differences. The high-load task involved video clips in which numbers appeared briefly on the screen (for .5 second each) at random intervals. Interruptees had to write down as many of these numbers as possible, which requires constant attention.

There were three 4.5 minute task rounds, preceded by one trial period to familiarize participants with the task and system. While the interrupter only had one passage to complete in each task round, the interruptee was frequently switching from one type of task to another (i.e.: better or worse time for interruption). Each task type takes 1/3 of the time per round. The difference between tasks was reinforced via a compensation scheme that placed a higher monetary value on the high-load tasks. The collaboration scenario was induced by letting each participant receive compensation based on his or her team perforamnce. Participants had 2 minutes between rounds to discuss task performance or strategy. All activities were captured via chat logging and screen recording. In the end, participants filled out questionnaires with items regarding task load and their impression of their partner.

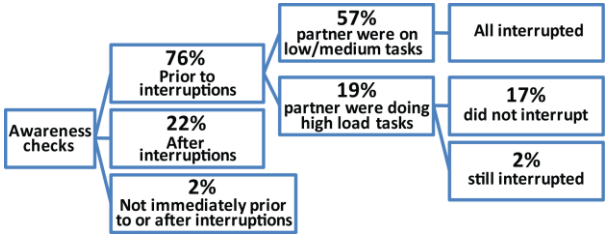

figure 4. Awareness Checks and Interruption Process. When checking prior to an actual or potential interruption, they clearly used the awareness information to time their interruptions. When their partner was doing the low-load or medium-load task, interruptions took place 100% of the time, compared with only 11.3% of the cases where the interruptees were engaged in the high-load task (i.e.: 2% of the 19% in the chart).

Results and Discussion

H1: Interruption Behavior

We first verified that the tasks differed in perceived load. As expected, there was a significant increase in task load according to how we characterized them (M_{Low}=8.17, SD=3.74; M_{Med}=10.92, SD=2.66; M_{High}=12.49, SD=3.49), $F(2,40)=14.45$, $p<0.01$).

As shown in figure 3, according to a mixed linear model test with task load as a within-subjects factor and condition compared between subjects, IM groups interrupted significantly more during the high-load task (M_{IM}=37.52%, SD=.07; M_{OM}=19.90%, SD=0.19, $F(1,154)=34.295$, $p<.01$) and significantly less during the low-load task (M_{IM}=31.39%, SD=.06; M_{OM}=41.25%, SD=0.09, $F(1,154)=10.520$, $p<.01$) and marginally less during the medium-load task (M_{IM}=31.09%, SD=.07; M_{OM}=38.85%, SD=0.08, $F(1,154)=6.364$, $p=.013$). The data thus supports H1.

To assess whether these differences resulted from the awareness information, we logged each "awareness check" in the screen recordings, defined as the interrupter hovering the cursor on their partner's icon long enough for the awareness information to appear. On average, each interrupter checked the awareness information 21 times (SD=8.88) over the 3 task periods. Of those, 76% (SD=7.87%) were prior to initiating interruptions as we expected. Surprisingly, 22% (SD=3.47%) occurred after the interruptions (see figure 4). We suspect that this was because, when the interrupters did not get a quick response, many used OM to see what their partners were doing instead. That is, they used OM both not just to *predict* whether their partner was available for interaction or not, but also to *explain* why they had not yet received a response.

H2: Task Performance

OM interruptee's scores were higher than IM interruptees' scores, $F(1,20)=1.9$, $p<0.05$, which supports H2 (see table 1). The same was not true, however, for interrupter scores, $F(1,20)=0$, $p=1.00$.

	IM condition		OM condition	
	Mean	SD	Mean	SD
Interruptee *	76.40	8.49	86.63	5.65
Interrupter	77.65	13.85	77.65	8.79
Team Total*	154.05	14.78	164.28	10.18
Note: Asterisks indicate marginally or statistically significant mean differences as follows: *p< .05.				

table 1. Individual and Team Task Performance. Interruptees and interrupters' scores are transformed to a 100-point scale

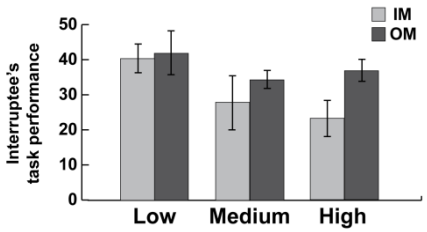

figure 5. Interruptees Performance in Different Tasks. The effectiveness of awareness information increases as the task gets harder.

As shown in figure 5, when breaking the performance data down to each task type, according to a mixed linear model test with task load as a within-subjects factor and condition compared between subjects, we found that the performance difference was mainly due to OM interruptees' better task performance in high-load task ($M_{IM}=73.23$, $SD=0.10$; $M_{OM}=86.77$, $SD=0.07$, $F(1,51)=10.095$, $p<.01$). No significant difference was found in low-load task ($M_{IM}=90.40$, $SD=0.08$; $M_{OM}=91.92$, $SD=0.11$, $F(1,51)=.115$, $p=.736$) and medium-load task ($M_{IM}=77.95$, SD=0.15; $M_{OM}=84.34$, SD=0.05, $F(1,51)=2.075$, $p=.156$).

H3: Social Attraction

Five questionnaire items regarding interpersonal attraction (Cronbach's = .81) were averaged, and there was mixed support for H3. OM interrupters (M=5.33, *SD*=0.49) rated their partners significantly higher than IM interrupters (M=4.76, *SD*=0.62), $F(1, 20)=-2.35$, $p<0.05$. This may be because some OM interrupters used awareness information in an *explanatory* way, and knew why their questions were not responded to quickly.

We analyzed participants' chat conversations between each the task sessions. We devised a coding scheme based on Bales' Interaction Process Analysis (table 2). There were significantly more positive socially-oriented messages in OM teams (M=43.18%, *SD*=0.09) than in IM teams (M=33.47%, *SD*=0.13), $F(1,20)=-2.01$, $p=.05$. This may help explain why a higher level of social attraction was observed in the OM condition.

Category	Content	Examples
Task-oriented	Give opinions or suggestions about the task.	"Ask more questions when you see I am doing the questions task.
Positive socially-oriented	Compliments; relieve tension	"We are doing great!" "The tasks are fun"
Negative socially-oriented	Show tension or dissatisfaction	"Not my strong point." "I don't know what else"

table 2. Conversation Coding Scheme. Two independent coders (Cohen's Kappa = .78) coded all 690 utterances from 44 conversations, of which 88.7% could be coded into following three categories.

Theoretical and Design Implications

First, the use of basic awareness information resulted in significantly improved interruptee task performance. However, that this came at the expense of greater perceived cognitive load for the interrupters. We suspect this was because they had to monitor their partner's status in addition to their own tasks. This resonates with Dabbish & Kraut's finding [5] and suggests the design of a cognitively efficient system.

Second, a meaningful extension to previous findings of awareness information use derived from our analysis of screen recordings is a distinction between awareness checks prior to and after interruptions. Awareness information is not only used for *predictive* reasons (i.e., is my partner likely to not be disturbed if I interrupt now?) for people to time their interruptions, but also used for *explanatory* purposes (i.e., why hasn't my partner responded yet?) to resolve the doubts of late or even no responses. The distinction needs to be confirmed by further qualitative studies. We believe it is useful in framing a more comprehensive understanding of the role of awareness in communication, especially in an online environment where rich context information in face-to-face settings is not available [7]. Moreover, experiment observations suggest that more detailed information is involved in the explanatory awareness checks. Therefore, we believe the distinction indicates a possibility to design collaboration tools which provide different categories of availability information that tailors to different awareness needs. For instance, a window title may be enough to determine whether to initiate of a conversation, whereas a screen shot is more useful when one party suddenly stops responding in an ongoing conversation.

The questionnaire and text analysis results also suggest some evidence of a novel relational effect. Interrupters who had access to awareness information developed a more positive impression of their partners, than those who did not have this information. We believe this positive relational effect may attribute to the transparency enabled by predictive and explanatory awareness checks: interruptees were less disturbed by poorly timed interruptions and interrupters understood better why their partner could not respond immediately. We aim to continue examining the consequence of this communication transparency, especially in a real-world collaboration setting: 1) how it raises people's privacy concerns; 2) to what extent people would be willing to trade their privacy for the information of their partner's availability; 3) whether the transparency could lead to negative relational effect in cases when one partner is trying deceive his or her availability to their partner.

References

[1] Avrahami, D., Fussell, S. R., & Hudson, S. E. IM waiting: timing and responsiveness in semi-synchronous communication. In *ACM CSCW*(2008), 285-294.

[2] Bailey, B. P. & Konstan, J. A. On the need for attention-aware systems: Measuring effects of interruption on task performance, error rate, and affective state. *Computers in Human Behavior 22*, 4 (2006), 685-708.

[3] Birnholtz, J., Gutwin, C., Ramos, G. & Watson, M. OpenMessenger: Gradual Initiation of Interaction for Distributed Workgroups. In *ACM CHI*(2008), 1661-1664.

[4] Boyle, M. and Greenberg, S. The Language of Privacy: Learning from Video Media Space Analysis and Design. In *ACM TOCHI*, *12,* 2 (2005). 328-370.

[5] Dabbish, L. and Kraut, R., Controlling Interruptions: Awareness displays and social motivation for coordination. In *ACM CSCW* (2004), 182-191.

[6] Tang, J.C. Approaching and leave-taking: Negotiating contact in computer-mediated communication. In *ACM TOCHI*(2007), 1-26.

[7] Whittaker, S., Frohlich, D. and Daly-Jones, O. Informal Workplace Communication: What is It Like and How Might We Support It? In *ACM CHI*(1994), 131-137