Coordinating Communication: Awareness Displays and Interruption

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ABSTRACT
In this paper, we describe a laboratory experiment to determine whether peripheral awareness information about a remote collaborator's workload aids in timing interruptive communication. Our results indicate that a display with an abstract representation of a collaborator's workload is best in that it leads to better timing of interruptions without overwhelming the interrupter.

Keywords
Interruption, awareness, computer-mediated communication, instant messaging

INTRODUCTION
Interruptions are routine in the workplace. They enable informal communication but often disrupt concentration. Can we improve the timing of interruptions for distributed collaborators? Previous work has shown that there are points in a task where disturbance from interruption is reduced [1,3]. Therefore we believe that providing a collaborator with relevant awareness of a remote helper's task can aid them in timing communications. (The optimal communication timing would maximize the amount of useful information exchanged while minimizing the disruption caused.) We also believe that many CSCW awareness systems provide too much information [2]. Thus, our hypotheses about the effect of an awareness display on interruption timing are the following:

Hypothesis 1: *A display with information about a collaborator's workload will increase joint performance and improve help-seeking while minimizing disruption.*

Hypothesis 2: *There will be a curvilinear relationship between the detail in an awareness display and joint performance:*

Hypothesis 2a: *Providing too little information about the target's workload would harm the target's performance.*

Hypothesis 2b: *Providing too much information about the target's workload will distract the help-seeker.*

We tested these hypotheses in a controlled experiment, which allowed us to independently assess the impact of a workload display on a help-seeker and help-giver's performance.

METHOD
Thirty-six pairs (72 individuals) took part in an interdependent, 2-player game. One player (known as the Asker) had to guess the identity of a partially obscured image as it was slowly revealed (see Figure 1). The Askers' performance could improve if they paid attention to the image as it was slowly revealed on the screen.

The other player (known as the Helper) played the Jumpers video game used by McFarlane [3]. Helpers saved people jumping from a building by moving corpsmen holding a stretcher. The Helpers' workload varied over time. At random intervals, the program launched a new jumper, so that the Helper had between zero and nine jumpers on screen simultaneously.

The Asker and Helper's tasks were interdependent. The Helpers knew the image that the Asker was trying to guess and thus could provide the Asker with hints to its identity (see Figure 2). The Asker was able to send the Helper 20 yes-no questions about the picture. The questions took over the Helper's screen until they answered, thus interrupting the Helper's performance on the Jumpers game.

We manipulated within subject the information the Asker had about the Helper's workload, using three awareness display conditions. In the *full information condition,* Askers saw a 2.5" x 2.5", real-time replicate of the Helper's screen. In the *abstract information condition,* they saw icons representing the number of Jumpers on the Helper's screen. Finally, in the *no information condition,* they received no information about the Helper's workload. Figure 3 shows each of the three displays. Display order was counter-balanced using a Latin square design.

RESULTS
A pair's performance on an individual picture was the unit of analysis. Here *N* equals 432 (36 pairs times 3 display conditions times 4 pictures per display). Because pictures were nested within display condition and pairs, we used a repeated measure mixed-model analysis of variance to deal with the non-independence of the data.

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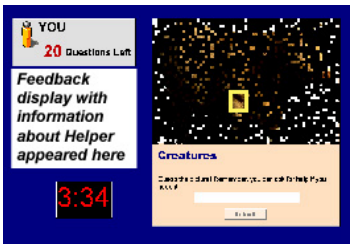

Figure 1 – Asker's screen in experiment, revealing square shown

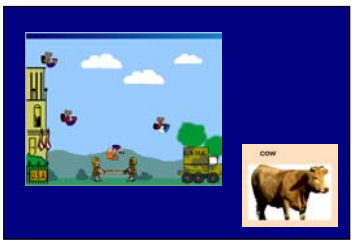

Figure 2 – Helper's screen in experiment

Figure 3 - Awareness display conditions (counter clockwise from top left: *No-information, Abstract, Full)*

Performance Results

Helper. The Helper's performance was measured by the percent of jumpers saved during each picture. Consistent with Hypothesis 2a, Helpers saved approximately 7% more jumpers in the full display and abstract display conditions than in the no display condition (For the planned contrast, $F(1,388)=5.52$; $p < .02$). The full and abstract displays did not differ from each other significantly. This suggests that simply providing the Asker information about a remote partner's workload helped them time their communication so that it was less disruptive, and thus increased the remote partner's performance.

Asker. The Asker's performance was measured by the accuracy in their identification of the pictures and the time, in seconds, it took them to identify each picture. Consistent with Hypothesis 2b, Askers took 12.5% longer to guess pictures in the full display condition than in the abstract display or no information condition. (For the planned comparison, $F(1,388)=3.98$, $p<.05$). The abstract and no display conditions did not differ significantly.

Interruption Behavior

Question Rate. Question rate, or average number of questions sent per minute, significantly decreased as information about the other player increased ($F(2,388)=10.40$, $p<.0001$). Questions per minute decreased by 7% from no information condition (*No information* M = 2.77) to abstract display condition (*Abstract* M = 2.57), and by 14% from abstract information condition to full information condition (*Full* M = 2.23).

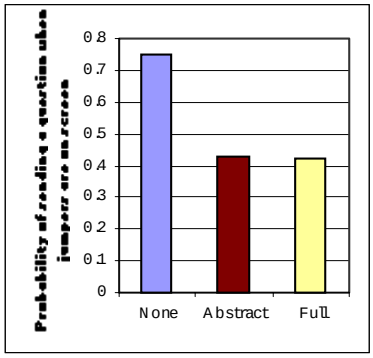

Figure 4 – Probability of Asker sending question when there were jumpers on the Helper's screen.

Question Timing. As can be seen in Figure 4, during the conditions where they had information about the Helper, Askers were 43% less likely to send a question when jumpers were on the screen (the *abstract* and *full* conditions; $F(2,382)=22.14$, $p < 0.0001$).

When they had *abstract* and *full* displays, over 60% of Askers indicated that they were using the information displays to time their questions. In the Abstract condition, they reported using a simple threshold model to time their questions (e.g., ask when fewer than N jumpers are on screen), while in the full condition they used more complex rules, which were not necessarily more accurate.

CONCLUSIONS AND FUTURE WORK

In our experiment, a pair performed best when the Asker received abstract information about the Helper's workload. In this condition, Askers received useful information from Helpers and caused the least disruption. Recommendations for designing awareness displays are clear: provide an abstract display with pertinent information about a remote collaborator's task, while minimizing extraneous detail. Providing more information in a display about a remote collaborator isn't necessarily better. In addition to privacy concerns, it can actually harm the productivity of the person using the display.

We next must investigate whether these results generalize to less stylized tasks, like those of a knowledge worker, and whether group identification influences a collaborator's motivation to use awareness displays.

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