# PRIORITIZATION IN COMPUTER-MEDIATED COMMUNICATION: INFLUENCES OF URGENCY, NOTIFICATION, AND IDENTITY

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## INTRODUCTION

Instant messaging has gained increasing popularity as a form of electronic communication for conducting work-related interactions (Poe, 2001). The semi-synchronous nature of IM allows conversations to be interspersed with other work activities, meaning individuals are continuously making decisions about what to attend to. Yet we do not have a good understanding of how people direct their attention and prioritize certain incoming electronic communications over others. The two laboratory studies presented in this paper examine the decisions individuals make when dealing with communications on the computer, and the resultant effect on their task performance. The first experiment looks at both the decision to initiate a communication and to respond illuminating trade-offs between sender and receiver—interruption decision rules that help the recipient of a message harm the sender and vice versa. The second study focuses solely on the response decision and the influence of the recipient's current task state and social identity with the sender on how messages are prioritized for response. The results from both studies present implications for communication system design and suggest important areas for future research.

### Interruption and Notification Methods

Most previous work on communication interruption has been one-sided, focused on the disruptive impact of interruptions on the person being interrupted (Mark, Gonzalez & Harris, 2005; McFarlane, 2002; Zijlstra, Roe, Leonora, & Krediet, 1999; Gillie & Broadbent, 1989). Unfortunately, this one-sided and largely negative view of interruptions overlooks their benefits (e.g., knowledge transfer, coordination, and relationship maintenance), particularly for informal communications, as documented in research on workplace interaction (Kraut & Attewell, 1997). We address this gap in the literature by considering communication value for both parties.

Previous work has outlined four primary methods of delivering interruptions in human-computer interaction: *immediate*, *negotiated*, *scheduled* and *mediated*, (McFarlane, 2002) but not considered implications of these methods for communication interactions (Rennecker & Goodwin, 2005). For interpersonal communication, negotiated notification can be thought of as *receiver-controlled* in that the receiver controls when to attend to messages (e.g. email). On the other hand, the telephone can be thought of as an immediate, or *sender-controlled*, form of interpersonal communication. Sender and receiver control of message timing for dyadic communication have different implications for response and performance of both parties:

**H1**. *The sender's control of message timing will mean that the receiver will attend to messages immediately, meaning higher likelihood of response and faster response speed.*

**H2**. *The receiver's control of message timing will result in a longer time to respond to messages and a lower likelihood of response.*

Faster response to messages implies better performance for the sender, while the ability to defer a response implies better performance for the receiver (McFarlane, 2002).

### Displaying Message Information

Conceptually, receivers could make more informed response decisions if they were aware of senders' task constraints. In commercial email clients, priority flags are intended to signal the value of an email to the receiver(s), however these flags are not widely used. If receivers were motivated to make use of this kind of information from senders, we would expect the following:

**H3.** *When on the same team, displaying sender's valuation of the message to the receiver should increase the receiver's likelihood and speed of response for messages with higher value.*

**H4.** *When on the same team, displaying the urgency of a message to the receiver will increase the receiver's response speed for messages with short deadlines.*

## EXPERIMENT 1

### Procedure

Our goal in Experiment 1 was to understand at a basic level how senders and receivers prioritized messages for attention and action. The study set-up mimicked a general help-seeking scenario, cited as one of the most common uses of IM in the workplace (Quan-Hasse, Cothrel, & Wellman, 2005). The communication sender in the experiment completed a series of crossword puzzles on the computer. Each word in the sender's crossword puzzle had a time limit (short: two minutes, medium: four minutes, or long: six minutes) and value (low: \$0.05, medium: \$0.25, or high: \$1.00). Sender performance was based on the value of words in the crosswords that they were able to complete correctly within the time limit. The receivers' task was the jumpers game, a continuous attention video-game-like task susceptible to disruption from interruption (Dabbish & Kraut, 2004; McFarlane, 2002). The receiver also had a list of answers to the clues in the sender's puzzle, and the sender could ask the receiver for help on individual clues by sending messages over the computer. Participants were randomly assigned roles and seated in the same room as their partner separated by room dividers. Participants were told that they were part of a team with their partner, competing against other teams in the experiment, and that they would be rewarded based on their joint performance (the average of both players' performance).

### Manipulations

To test the hypotheses 1 and 2, pairs were assigned to one of two notification method conditions: sender-controlled message timing (the sender's messages showed on the receiver's screen immediately) or receiver-controlled message timing (the sender's messages went into a queue on the side of the screen). To test hypotheses 3 and 4, during receiver-controlled message timing receivers either saw information about the sender's word value and time limit for each message or did not (information versus no information conditions). Both manipulations were between subjects, with a 2x2 notification by information design, with the sender-controlled notification with information condition was excluded because it was not of interest.

**Results**

Data was collected from 24 college undergraduates. Because each sender and receiver dealt with multiple messages per crossword puzzle, the data on both the sender and receiver sides was analyzed using a mixed-model analysis of variance with notification method (sender vs. receiver controlled), information (info vs. none), word value, and time limit included as independent variables in the model, and subject included in the model as a random effect.

***Message Response Behavior***. On the receiver side of the experiment, we measured the likelihood of response and time taken to respond to each message. Consistent with Hypothesis 1, receivers were 35% more likely to respond to messages in the sender-controlled notification condition (Mean = 84% response) than in the receiver-controlled condition (Mean = 62% response; $z=7.34$; $p<0.001$). Consistent with Hypothesis 2, receivers responded 80% more quickly during sender-controlled notification (Mean = 12 sec) than with receiver-controlled notification (Mean = 56 sec; $z=-3.63$; $p<0.001$).

Interestingly, in the receiver-controlled condition, the presence of message information significantly increased the likelihood of responding to a particular message by 39% (Mean[info] = 71%, Mean[no-info] = 52%; $z=4.37$; $p<0.001$), and prompted marginally faster response (Mean[info] = 27 sec, Mean[no-info] = 41 sec; $z=-1.43$; $p=0.15$). We also found that receivers responded significantly more quickly particularly to higher-value word requests if they knew the value of those requests to the sender (information by value interaction: $F(1, 607)=5.18$; $p=0.02$).

***Performance Results***. Individual words in the crossword were the unit of analysis for sender performance. Consistent with our expectations, the sender performed significantly better during the sender-controlled notification condition in terms of accuracy (62% more likely to answer a word correctly; Mean[sender]=45% likelihood, Mean[receiver]=29% likelihood; $z=3.04$; $p<0.001$) and money earned per puzzle (Mean[sender]=\$3.25, Mean[receiver]=\$1.78; $z=2.03$; $p<0.001$. However, presence of information about word deadline and value on the receivers' screens did not affect sender performance.

For receivers, the entire jumpers game was the unit of analysis, four games per trial. On the receiver side of the pair, the notification condition (sender- vs. receiver-controlled) had no effect on the percentage of jumpers saved in the primary task ($z=-0.05$; $p=0.96$) or money earned ($z=1.94$; $p=0.06$). Interestingly, the number of messages sent also had no effect on the receiver's performance, suggesting that the jumpers task as implemented in this experiment may not have been as susceptible to interruption as originally expected. Finally, the presence of additional on-screen information had no influence on the receiver's performance ($z=0.34$; $p=0.73$).

## EXPERIMENT 2

We looked to address the open questions and limitations from Experiment 1 in a second experiment, focused solely on receiver behavior.

### Motivation

***Message Priority Indicator.*** In Experiment 1, both message value and deadline had the same direction of effects on the receiver's decision to respond. To simplify our manipulation, we condensed our representation of message deadline and value into a one-dimensional binary representation of "priority". Based on our results from Experiment 1, we expected the following:

**H5.** *Receivers will respond to messages marked "high priority" faster than "normal" messages and, will be more likely to respond to "high priority" messages than "normal" messages.*

***Receiver's Task State.*** In Experiment 1, we saw that receivers took longer to respond when they could delay - during receiver-controlled notification. In Experiment 2, we controlled receivers' busyness in the game over time so that we could see how their choices to attend to messages were affected by their task state. Based on previous work (McFarlane, 2002) we expected workload to have a direct effect on response behavior:

**H6.** *If the receiver's workload is higher, the receiver will take longer to respond and be less likely to respond to a particular message.*

***Relationship with the Sender.*** In a real-world work situation, people respond to and choose among communications from many different individuals. Previous work on email and IM response behavior has found that certain senders are more likely to receive a response and receive responses more quickly than others (Avrahami & Hudson, 2006; Dabbish, Kraut, Fussell, & Kiesler, 2005). Based on this previous work, we expect receivers to prioritize messages from team members.

**H7.** *Receivers will be more likely to respond and will respond more quickly to messages from a sender with a common team identity.*

### Procedure

In Experiment 2, we isolated the receiver portion of Experiment 1 by constructing a stand-alone receiver set-up which used a simulated "sender." Participants came to the lab six people at a time, and were told they were divided into teams; on each team one player was playing the role of the receiver (jumpers game) and two players were playing the role of the sender (crossword). In reality, all participants were playing the role of the receiver and the messages in the task were generated by the computer to control for message timing and distribution of messages across conditions. Participants were also told that their earnings would depend on the combined earnings of the team, but, in reality, at the end of the study all participants were paid $15.

## Manipulations

In order to test hypotheses 5 thru 7, we compared receivers' responses to different types of messages under varying game conditions. The message types were: from a teammate or an opponent indicated by text at the top of the message box, with or without a priority flag indicated by the color of the message box border, and could occur anytime during the receivers' jumper's game (across varying level of busyness). This was a completely within-subjects experiment, with team by priority by busyness manipulated on a message-level basis. Participants received a total of 67 messages during the experiment, distributed evenly across these conditions. Notification method was similar to the receiver-controlled condition in Experiment 1. Messages appeared next to the jumpers game (up to six at a time), and the receiver had to select a particular message to open it. Once a message was opened, it covered the receiver's screen until they responded.

## Results

Data was collected from 19 participants, all college undergraduates and frequent IM users, across five experimental trials. We conducted a repeated measures regression with team (same team/different team), priority (high priority/normal), and busyness level (number of jumpers on-screen when a message appeared), two-way and three-way interactions in the model, with the messages as the unit of analysis, and participant included as a random effect to control for the non-independence of messages answered by the same participant. Our manipulation check indicated that participants were confused by the priority manipulation, so we include it in our analysis only to control for differences in visual salience but do not discuss it further.

***Response Likelihood.*** Using a probabilistic regression analysis, we looked at the likelihood that an individual message would receive a response. Receivers were significantly less likely to respond to messages as their busyness level increased ($z=-2.07$; $p<0.05$), supporting Hypothesis 6. Consistent with Hypothesis 7, receivers were significantly more likely to respond to a message if it was sent by a teammate than if it were sent by the opposing team (Mean[team] = 90% response, Mean[non-team] = 69% response; $z=3.36$; $p<0.001$). Interestingly, if a message was from a teammate, busyness did not affect likelihood of response (team by busyness interaction: $z=1.68$; $p=0.09$). However, if a message was from a non-teammate, a higher level of busyness decreased the likelihood that the receiver would respond.

***Response Delay.*** In Experiment 2, messages disappeared after being on screen for 30 seconds without a response. To deal with this data truncation, we ran a Tobit model of response speed. Our analysis indicated that an increase in workload significantly increased the time that a participant took to respond to a message ($z=3.37$; $p<0.001$). In addition, messages from team members were responded to significantly more quickly than messages from non-team members (Mean[team]=6.8 sec, Mean[non-team]= 7.4 sec; $z=-2.00$; $p<0.05$). Amazingly, messages from team members were answered faster the busier the receiver was, while messages from non-team members were postponed equally as long regardless of how busy the receiver was when the message arrived (team by busyness interaction: $z=-2.94$; $p = 0.003$).

# DISCUSSION

Both Experiments 1 and 2 focused on help-seeking communications in a dual-task scenario. The results from these experiments indicate a set of basic heuristics used by both parties in the communication interaction when prioritizing messages that can inform design.

**Notification Methods**

In Experiment 1, giving the receiver control of communication timing harmed the sender's performance because the sender did not get the help needed because the receiver's responses were delayed and the receiver ignored messages. Experiment 2 suggests that this delay occurred because receivers postponed messages when their task workload was high (many jumpers on-screen). This result highlights the importance of designing communication technologies that consider potential impacts on both parties of the communication.

**Message Priority Indicator**

In Experiment 1, during the information condition, receivers could see the deadline and value associated with a word request and in this condition used both parameters to determine whether or not to respond as well as how quickly to respond to a message. However, presenting an indication of message priority did not affect the receiver's behavior in Experiment 2, perhaps because combining time and value into a single-dimension indicator made it difficult for the receiver to translate priority into the action that should be taken. Providing a receiver with a very specific representation of the sender's task constraints related to corresponding action required by the receiver may better align receiver behavior with the sender task goals. Future work must examine the dimensions of comprehension, ambiguity, and trust in designing these kinds of indicators.

**Social Identity**

In Experiment 2, messages from team members were responded to more quickly than non-team messages. Receivers may have used the identity of the sender as a selection heuristic when choosing between messages on their screen. Helping common team members was also prioritized over primary task constraints. Receivers were equally likely to attend to messages from members of the same team regardless of how busy they were in their primary task, while messages from non-team members were more likely to be ignored the busier receivers became.

## CONCLUSION

The studies presented in this paper have attempted to shed light on sender and receiver decision making in a computer-mediated interaction. In particular, we have aimed to examine the impact of notification method, visibility of sender's task state, and social identity on interaction behavior, and we have looked at the consequences for performance of the pair as a whole. We have presented design considerations for electronic communication system developers based on the results from our studies. With these studies, we have begun to develop a picture of how attention is directed when balancing ongoing work and communications on the computer.

## REFERENCES AVAILABLE FROM THE AUTHORS