When Delayed in a Hurry: Interpretations of Response Delays in Time-Sensitive Instant Messaging

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When Instant Messaging (IM) users experience delays in receiving responses from a partner, they may interpret these delays in a variety of ways (e.g., a technological problem vs. the partner is avoiding interaction), and these interpretations can have social consequences. In a laboratory study, we explored whether the presence of a typing indicator shaped people's interpretation of delays. Participants collaborated with a confederate on a time-sensitive task and retrospectively reviewed their interaction. We manipulated delay condition (none, delay, delay with typing indicator) and time pressure (low, high). Participants rated their partners as significantly lower in conversational involvement, were more frustrated, and liked their partners less during a delay whether or not they saw a typing indicator. We discuss implications for the design of new features for IM clients that help people interpret delays appropriately.

CCS Concepts: • Human-centered computing → Collaborative and social computing → **Empirical studies in collaborative and social computing**

KEYWORDS

Computer-mediated communication (CMC), Texting, Instant Messaging, Retrospective analysis

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1 INTRODUCTION

Instant Messaging (IM) has become a staple part of many people's work and personal communication (e.g., [13][37]). People use IM tools such as Gchat and Facebook messenger for a wide variety of purposes, including coordinating their activities, socializing with others, brainstorming ideas, and collaborating on task work [10][13][14][26]. Although messaging is no

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longer the only activity these apps support, sending and receiving text messages is still a core part of many interactions on messengers.

Previous work has shown that while it can take some time to initiate a conversation via IM, once a conversation has started, participants expect responses in close to real time [13][14] in fact workers cite the possibility of getting fast responses as a primary reason for using IM as a communication channel [37]. Despite these expectations, however, users do sometimes experience delays in receiving responses from a communication partner. For the purposes of this paper, we define a delayed response as any message not arriving within the sender's expected time frame. There are many possible reasons for such delays. A partner might have a faulty internet connection or might not be online and available. He/she might be thinking about the message and composing a response or the partner may be intentionally withholding a response to signal that he/she is upset by a message or disinterested in the conversation [1][3][12][15][21][32]. Often, a delay may occur for a mix of various reasons. Studies of response speed in email and IM suggest that users interpret response delays in a variety of ways [12][21] and the type of interpretation can have social consequences [11][12][18][30][33][38]. For example, Park and Sundar [30] found that longer delays led to more negative impressions of the task and partner. Sheldon et al. [33] found that in a work setting, some individuals were judged as significantly less competent when their responses are delayed.

Features of IM interfaces often provide cues to help people interpret delays. For example, many IM clients include a "seen" indicator to show that a partner has looked at a message and a "typing" indicator to show that a partner is working on a message. Knowing that a message has been seen can influence people's interpretations of, and emotional reactions to, response delays (e.g., [12]). Research on teamwork has shown that time pressure is an important factor and affects teamwork outcome and team dynamics [25][24][39][31]. However, there is still little understanding of how contextual factors, such as the difficulty or time pressure of a task, influence interpretations of response delays, or of how these interpretations shape perceptions of partners and the interaction. Such an understanding could help us design IM interfaces that facilitate appropriate interpretation of delays and minimize their interpersonal costs.

In the present study, we investigated how people experience and interpret delays as a function of the messaging interaction surrounding them. Specifically, we examined how time pressure and the presence or absence of typing indicators during a delay affect people's interpretations of a delay and their perceptions of their partners. We conducted an experiment in which 60 participants collaborated with a research confederate via IM to complete a time-sensitive task. We manipulated delay (*no delay* vs. *delay with no typing indicator* vs. *delay with typing indicator*) and time pressure (*low* vs. *high*), to create six conditions. In contrast to most prior work, we examined participants' perceptions before, during and after the delay using a retrospective analysis technique [6][27]. Our results show that participants perceived their partners to be less involved after experiencing a delay. Individuals were also more frustrated and liked their partners less during a delay whether or not they saw a typing indicator. In the remainder of this paper, we first present related work on timing and delay in IM conversations. Then, we describe our hypotheses, study design, procedure and results. We end by discussing the implications of our findings for the design of IM tools.

2 RELATED WORK

We review related work on response delays in computer-mediated communication. We divide this section into two parts. First, we review work on the importance of context and expectations held before a delay, then we discuss how people seek various cues and use these to interpret delays. Although we focus on studies of IM for collaborative purposes, we occasionally draw on research findings on response delays other contexts, such as email or text messaging among teenagers.

2.1 Before a Delay: Context and Expectations

Context is crucial to understand delays in instant messaging. One of the main reasons for this is because different communication contexts inform different expectations about reply behavior of remote partners.

Two approaches have been used to understand or ground delay studies in different contexts. The first approach explores how people react to response delays in multiple situations, such as through surveys of multiple messaging situations [12][19][22] or by studying IM use by a group of people in their daily life [21][32][38]. Findings suggest that people have different expectations and desires about receiving timely responses depending on the context. For example, Laursen [21] found that adolescents waited for a shorter period of time before sending follow-up messages to friends than more distant ties, suggesting that teens expect to receive faster replies from friends. Tyler and Tang [38] found that people sometimes feel anxious about whether and when their email will be read when emailing a person for the first time, even when that person is not a stranger. This suggests that although there may be general response norms in a culture [16][17] response expectations are formed through prior interactions using specific communication channels and that for new interactions these response expectations can be more ambiguous.

The second approach to studying delays focuses on one or several specific context(s) and carefully manipulates delay characteristics. For example, researchers have created vignette scenarios with varying message content, timestamps, or scenarios [16][40][42] conducted experiments with confederates who follow prescribed message timing rules [11][30] or both [33]. This work has shown that slight changes in the context can shape delay effects. For example, Sheldon et al. [33] suggest that there are negative delay effects for individuals delaying their reply if they have less work-relevant experience but this effect was not found for those with more experience. Both these approaches help understand response delays in IM, one in broader contexts and the other in narrower contexts. Overall, this body of research suggests that it is important to consider the communication context.

Another reason context is important is because prior interactions can inform people about how to interpret why they have not received a message within a typical timeframe. Individuals may scrutinize what occurred before the delay to form possible interpretations of the response behavior. For example, Kalman and Rafaeli [16] found that people perceive delays in email in light of judgments formed in prior interactions. If an applicant is described as a promising candidate, for instance, then a delayed response leads to lower social attraction; however this effect is not found for applicants described as less promising. In addition, Rendle-Short [32] found that negative responses to invitations or requests sent via text messages were more delayed than positive 'yes' responses. In the rare cases that 'yes' responses were delayed, the reply message often included lengthy explanations of the cause of the delay. This suggests that people take prior interactions into consideration when perceiving and interpreting delays.

2.2 During a Delay: Seeking Cues and Interpretations

During a response delay in IM, various cues can influence how people react that delay. There are several cues that people may refer to. Taking the example of Facebook Messenger, users can get cues about whether a communication partner has seen their message through the *seen* function, see if their partner is currently typing in their chat room through the *typing indicator*, and also get a sense of how active they have been in Facebook Messenger through *status indicators*. There may also be other cues outside an IM client, such as information on shared calendars or real-time posts from or about the communication partner on social media.

Research suggests that people can be vigilant seekers and interpreters of cues during delays. When experiencing delays in work, people may seek various cues, for example by browsing a communication partner's calendar [38]. Several researchers have also studied how the *seen* or *read* function can affect people's affective reactions to delays. For example, Hoyle and colleagues [12] and Kato and colleagues [20] found that IM users are more likely to feel negative emotions, such as anxiety or anger, when their messages have been marked as *seen* or *read* but they have not yet received a response. Thus, in some contexts, cues within a medium can shape people's affective reactions to delays.

Several scholars have looked into how people interpret delays before they receive a reply message. There have been two main methods to explore people's internal processes, one is to ask people to self-report their speculations based on past experiences [12] and another is to infer their interpretations through observable behavior (e.g., [21]). Among possible explanations, Hoyle and colleagues [12] found that the most common assumptions for a delay were that the recipient was busy (24.1%), was pointedly ignoring them (15.4%), or may be in trouble (5.7%). When there were delays for messages that were marked as 'seen', common interpretations were that recipients were pointedly ignoring them (27.9%), busy (11.7%), or may have misinterpreted the message (10%).

We may be able to infer prominent interpretations when people take action during a delay. Laursen [21] observed how individuals dealt with recipients who did not reply their text messages by categorizing potential problems they sought to address by sending a follow-up message. A potential flaw of this approach is that these behaviors may not represent exactly what interpretations they were having, since they may be entangled various communication goals, such as the desire to avoid seeming too clingy or forward. However, many studies have observed individuals engaging in various attention seeking behaviors, sometimes by switching to another medium (e.g., moving to text messaging to calling) [11][21][35][41]. This suggests that individuals with strong motivations to contact a person are vigilant and may engage in various communication attempts.

3.3 Inconsistent or Consistent Delays and Response Speed

Researchers have found that people have expectations about reply behavior under certain contexts [19][22][36]. When these are not met, in the case of a response delay, they may have certain affective reasons such as anger or anxiety [12][20][23]. Findings suggested that people may form various interpretations of delays between when they send a message and get a reply, which informs how they may seek and view different cues [12][21][38]. Some motivated individuals go a step further to engage in attention seeking behaviors to follow up on partners [11][21]. After receiving a reply, based on what the message says, individuals may update their interpretations, which may affect their evaluations of the message and the partner [16][30][33][40][42].

While many have looked into reactions to response delays in general or how people perceive consistently delayed responses, there have been fewer explorations of delays as an inconsistent response behavior. For instance, two studies [11][30] found effects on evaluations of partners with a steadily fast or slow response speed. Park and Sundar [30] found that a customer service agent with a fast reply speed leads participants to have heightened feelings of copresence in IM and this feeling leads to more positive evaluations. Thus, a slower response speed dampens feelings of copresence, which leads to less positive impressions.

There may be situations in mediated interactions where a partner's response speed is not consistent but varies over time. However, it is unclear whether a momentary delay slowing down response speed would also lead to similar feelings as consistently delayed responses. We aimed to explore this phenomenon through an experiment. Specifically, we asked whether a response delay in the middle of a speedy interaction disrupting prior communication rhythm, would be salient enough to have social consequences. Also, we asked whether this would be a fleeting or localized effect in the middle of the interaction or be salient enough to have lasting effects depending on the context.

3 THE PRESENT STUDY

We designed an experiment in which participants collaborated with a confederate in a time-sensitive context. Participants had to multitask by both relaying and receiving messages from the confederate via IM while monitoring and manipulating an object in a game environment. Since participants were interacting with a stranger to complete the task and did not have specific prior expectations about their partners' typical response times, we chose a time-sensitive task to set a base expectation of immediate response for all participant [16][40].

To understand whether effects of delays were fleeting or lasting, we used a retrospective analysis technique [6][27][28] in which participants reviewed their experiences and reported how they felt or thought during 3 specific intervals, or moments *A*, *B*, and *C*. First, participants reviewed moment *A* that showed their interaction before a delay manipulation. During this time the confederate's response speed was fast and consistent. Then they viewed moment *B*, which showed the interaction in which we manipulated the delay. During this time, we had manipulated the delay to create three conditions, which were *no delay* vs. *delay with no typing indicator* vs. *delay with typing indicator*. This allowed us to see whether experiencing a delay and having cues during a delay would have an effect. Lastly, participants viewed moment *C* that showed the interaction after manipulation where the confederate's response speed returned to that in moment *A*. To understand how this relates to different collaboration context we also created two versions of the task that created different levels of time pressure. We introduce our hypotheses below.

3.1 Hypotheses

Our first set of hypotheses was about how perceptions and feelings would change from moment *A* to moment *B*. Since participants would receive fewer messages from the confederate in moment *B* in both the *delay with no typing indicator* and *delay with typing indicator* conditions, we believed that they would perceive the confederate to be less involved in the conversation compared to moment *A*. We believe this would not be the case in the *no delay* condition since they would receive similar amounts of messages at both moments *A* and *B*. Thus, we believed that:

H1A. Perceived confederate involvement will decrease when there is a delay compared to when there is no delay.

Next we thought about how these thoughts or feelings would change depending on the cues available about their partner's activities during moment *B*. Prior research has shown that people actively seek and interpret cues within an IM client, such as the *seen* or *read* function [12][22]. We hypothesized that the presence of the typing indicator during a manipulated delay would be interpreted as a sign that the confederate is attempting to formulate a message to them. Without this cue, we believed that perceptions of confederate involvement would change more severely between moments *A* and *B*.

H1B. Perceived confederate involvement will decrease significantly more for a delay with no typing indicator compared to a delay with a typing indicator.

Further, we asked whether the time pressure people were experiencing before the delay would affect the relationship between delay conditions (none, delay with no typing indicator, and delay with typing indicator) and perceived confederate involvement.

RQ1: Will the time pressure of the task mediate the relationship between delay condition and perceived confederate involvement?

Additionally, we hypothesized that participants would perceive this change in involvement as detrimental to the progress of their collaborative time-sensitive task. Thus, we believed participants would be more frustrated and like the confederate less during this time compared to before. Further, we predicted that seeing a typing indicator during a delay would be interpreted as a sign that the confederate was still involved in the task and trying to communicate. Without this cue, we predicted that participants would be more uncertain, and their frustration and liking would change to a greater degree between moments *A* and *B*.

H2A. Frustration will increase when there is a delay compared to when there is no delay.

H2B. Frustration will increase significantly more for a delay with no typing indicator compared to a delay with a typing indicator.

H3A. Liking of confederate will decrease when there is a delay compared to when there is no delay.

H3B. Liking of partner will decrease significantly more for a delay with no typing indicator compared to a delay with a typing indicator.

RQ2: Will the time pressure of the task mediate the relationship between delay condition and frustration?

RQ3: Will the time pressure of the task affect the relationship between delay condition and liking of the partner?

4 METHOD

To examine how people think and feel before, during, and after experiencing response delays, we conducted a laboratory experiment with a 2×3 between-subject design with a single participant

and a confederate. The between-subjects factors were time pressure (low vs. high) and delay (none vs. delay with no typing indicator vs. delay with typing indicator).

In a task adapted to create a time-sensitive context, participants interacted with a confederate playing a game, in which the goal was to defuse a module within 6 minutes. Participants were randomly assigned to one of six conditions to perform a task (low or high pressure) with a confederate who made either no delay, a 90-second delay with no typing indicator, or a 90-second delay showing a typing indicator intermittently in the middle of the task. We determined the task length and delay duration through pretesting with 13 pilot participants.

After completing the task, participants reviewed a recording of their interaction separated into 3 segments (before vs. during vs. after delay manipulation). They watched and provided feedback on each segment on an online survey. This was based on the retrospective analysis technique [6][27][28].

4.1 Participants

The study consisted of 60 participants who were students or members of the surrounding community of a northeastern U. S. university (71.1% female). Most were undergraduate students ($N=56$), with a mean age of 21.3 years ($SD = 0.64$). Participants either received extra credit or \$10 for their participation.

4.2 Task and Materials

We created the task by adapting the game created by Steel Crate Games [34] in which two partners in separate rooms collaborate to defuse a module. One player role, the *defuser*, was played by the participant. The other player provided defusion instructions from a manual; this role was played by a confederate. When the game starts, the defuser sees a virtual room with a ticking count-down timer on a computer and an instant messaging client. As shown in Figure 1, the game included a countdown timer displaying the remaining time (labelled A) and a number of modules which must be disarmed in time (labelled B, C, and D). Modules could be disarmed by clicking certain buttons under certain conditions, for example, when the countdown timer displayed a specific digit. When modules were disarmed, a green light turned on in the upper right corner (as shown in C). The game allowed only two mistakes or strikes to be made.

Participants believed that the partner player (the confederate) was studying a lengthy manual with instructions on how to defuse different modules but that he/she could not see their screen. Thus, they were encouraged to describe the modules, in instant messaging so that the partner could message them correct instructions for what to do for each module.

The confederate was actually following a detailed script and monitoring the participant's progress on a mirrored monitor. We created this confederate script by pretesting with 13 participants. The script specified which module to talk about in what order, the type of messages to send, and prototypical phrases or messages. Specifically, the confederate first guided participants to broadly describe what they saw and then pointed out specific modules in a fixed sequence to ask questions, react to responses, and give correct instructions to. This was possible because the task was structured, and the pretesting showed consistent patterns in participants' responses. Therefore, confederate messages were very similar in all sessions.

Figure 1. Example of the Interface: The left shows the IM window and the right shows the game window

4.2.1 Time Pressure Manipulation. Two versions of the task were prepared to create two time pressure levels (low vs. high). Both had a 6-minute time limit but the low time pressure version had two components (labelled B and C in Figure 1) while the high time pressure version had the same two components plus an additional third component (labelled D), such that pairs had to work faster to complete all steps within the allotted period of time.

4.2.2 Delay Condition Manipulation and Time. Since the within-subject factor was time, the confederate script specified when the delay condition manipulation should take place such that the interaction could be divided into three phases: before, during, and after the delay manipulation. Because messages exchanged prior to a delay may also affect individual's delay interpretation, we chose a consistent moment that occurred in the middle of task. This was after the first module was described and identified (labeled C in Figure 1). We inserted the delay after the confederate conveyed the correct instructions of how to disarm that module (e.g., “when the countdown clock has a 1 in any digit, just click the button 1 time”). After sending this message, the confederate either did not delay the next message or delayed it for exactly 90 seconds. Half of the participants experiencing a delay saw a typing indicator during this time, the other half had no indicator.

We chose 90 seconds as the delay interval based on pretesting with 13 pilot participants, which showed that this delay length was long enough to be perceived as a significant deviation from the partner's prior response speed but short enough to be perceived as a realistic delay within the context of this task. Two confederates were trained at least 6 hours to closely follow the script and to coordinate the type and timing of messages sent.

4.2.3 Surveys. Participants completed two online surveys after the task, which were the retrospective analysis survey and the post-experimental survey.

First they completed a retrospective analysis survey adapted from prior studies [27][28]. This consisted of 9 rating questions and an additional open-response question which were answered 3 times after participants watched 3 edited recordings to recall and report how they were feeling during the task. All rating questions were asked on a 7-point scale (1 = Not at all, 7 = Very much). The first three questions asked participants to rate their own conversational involvement, focus on the task, and awareness of their partner. The next three questions asked the same questions, but about their partner (confederate). The remaining three rating questions participants asked how frustrated they felt, how much they liked the partner, and how much they liked the task. The last

open-ended question asked participants whether they experienced any problems during the time shown in the recording and, if there was a problem, asked to describe them as well as what may have been done to prevent or overcome them.

Participants also answered a post-experimental survey which asked questions about their impression of their partner (the confederate) and the task, their personality, and basic demographic information. It also included open-ended questions asking participants to list thoughts they had during any perceived response delays in the task and their thoughts of what factors were influential for their task outcome.

4.3 Software and Equipment

We developed an instant messaging (IM) application and a game mode to modify the original game for the task. There were two windows, one for IM and one for the game (see Figure 1).

The instant messaging window was where participants exchanged messages with the confederate. This application was built with Socket.io [43] to control the messaging environment and to log the messages exchanged. The application had a '{user} is typing' function. Thus, the confederate was able to manipulate typing indicator depending on the delay condition and participants could see this indicator. The game window was where participants interacted with the time sensitive game. The game included sound effects and graphics to facilitate a stimulating game environment. To create the low and high time pressure versions of the game, a customized game mode was developed and enabled to control various settings of the original game. Participants were seated in front of a Mac Pro laptop with a 13.3-inch monitor and were in a separate room from the confederate. A wired computer mouse and mousepad was provided for all participants. The confederate was in a different room with another Mac Pro laptop with a 13.3-inch monitor. In the pilot study, we found that it was very challenging for the confederate to accurately manipulate the delay without additional awareness of the participant. Thus, the screen of the participant's laptop was mirrored on a 24-inch ASUS LCD monitor in the confederate's room.

4.4 Procedure

Participants were randomly assigned to one of six conditions for time pressure (low vs. high) and delay (none vs. delay vs. delay with typing indicator). Before beginning the task, participants were seated in a separate room from the confederate and were told another participant was in another room. After signing consent forms, participants were introduced to the game and completed a brief game tutorial individually. They then completed a practice or warm-up task with the confederate so they would become more familiar with controlling the IM and game windows. After clarifying any questions participants had from the warm-up task, the experimenter explained that they would begin the real task. They were informed that the task would end either when all modules were successfully defused or when the game was over due to more than two mistakes. Participants were not told that the goal of the study was to examine the effects of delays and based on pretesting we knew that finishing the task in 6 minutes was not possible. The choice of 6 minutes was based on pretesting and for the reasons mentioned below: we wanted everyone to have the same total duration working on the task. Therefore, we decided to have a fix time for all conditions. Due the vignette nature of the study and the fact the we wanted to show participants parts of the conversation and have them respond to survey questions, we decided on

the 6 minutes total which was divided into 3 two-minute segments for survey. The choice of 3 segments was informed by the three significant phases we were interested in, before delay, during delay and after the delay.

We made screen recordings of each interaction. After the task ended, the experimenter edited the screen recording into three 2-minute segments. Participants watched the edited recordings and answered the retrospective analysis survey. They then answered the post-experiment survey. The experimenter was not present in the room during the experiment or when participants were answering surveys. After the study ended, participants were debriefed by the experimenter.

4.5 Measures

The dependent variables were the perceived confederate involvement, frustration, and liking of confederate. Because we were interested in seeing how these changed over time, we calculated the deltas of participants' ratings in the online retrospective analysis survey after they reviewed moments *A* and *B* to compare how they rated these variables before and during the delay manipulation.

4.5.1 Change in Perceived Confederate Involvement. Participants rated perceived confederate involvement in the conversation using a single item, "How involved in the conversation was your partner?", on a 7-point scale (1= Not at all, 7 = Very much). For each participant, we calculated the delta of how they answered this item in moment *A* and *B*, which are before and during the delay manipulation. We used the raw value of this score to reflect the changes in perceived involvement. A positive value indicates an increase in perceived involvement in moment *B*, and a negative value indicates a decrease.

4.5.2 Change in Frustration. Participants rated how frustrated they were using a single item, "How frustrated did you feel?", on a 7-point scale (1= Not at all, 7 = Very much). For each participant, we calculated the delta of how they answered this item in moment *A* and *B*. We used the raw value of this score to reflect the changes in frustration. A positive value indicates an increase in frustration in moment *B*, and a negative value indicates a decrease.

4.5.3 Change in Liking of Confederate. Participants rated how much like liked their partner using a single item, "How much did you like your partner?", on a 7-point scale (1= Not at all, 7 = Very much). For each participant, we calculated the delta of how they answered this item in moment *A* and *B*. We used the raw value of this score to reflect the changes in liking of confederate. A positive value indicates an increase in liking in moment *B*, and a negative value indicates a decrease.

4.5.4 Open-ended questions. Each retrospective analysis survey had one question at the end asking participants to explain how they felt during the experiment and if they have any comment about it. Participant typed their responses in the text box.

5 RESULTS

To test our hypotheses, we conducted two-way ANOVAs (delay condition by time pressure) for each measure: perceived confederate involvement, frustration, and liking of the partner. In keeping with standard practice in behavioral science, we used parametric tests for our Likert-style

data [29]. We also analyzed open-ended responses to survey questions as well as the scripts of conversations which we present in the second part of this section as qualitative analysis.

5.1.1 Change in Perceived Confederate Involvement.

Hypotheses 1A and 1B predicted that participants would change how they perceived the confederate's involvement depending on the delay manipulation. We found main effects of delay on change in perceived confederate involvement ($F [2, 54] = 7.46, p = .001$), indicating significant differences between the three delay conditions. See Figure 2.

To test our hypotheses, we ran pairwise comparisons for the delay conditions. Consistent with H1A, participants reported significant decreases in perceived involvement for the two delay conditions (delay with no typing indicator was $M = -1.40, SEM = .33$; delay with typing indicator was $M = -1.7, SEM = .33$) compared to the no delay condition ($M = 0.00, SEM = .33$) ($p = .004$ and $.001$ for each; Cohen's $d = 1.7$). However, contrary to H2B, there were no differences between the delay with no typing indicator and delay with typing indicator ($p = .59$). Thus, H1B was not supported. With respect to RQ1, we found no significant main effect of time pressure ($p = .93$) and no interaction effect between delay and time pressure ($p = .82$).

Figure 2. Change in perceived partner (confederate) involvement during delay relative to baseline, as a function of time pressure and delay condition. Error bars represent standard errors of the mean.

5.1.2 Change in Frustration

Hypotheses 2A and 2B predicted that participants would change how frustrated they feel depending on the delay manipulation. We found main effects of delay on change in frustration ($F [2, 54] = 3.23, p = .047$), indicating significant differences between the three delay conditions. See Figure 3.

To examine differences between conditions, we ran pairwise comparisons for the delay conditions. Consistent with H2A, participants reported significantly higher increases in frustration for the two delay conditions (both were $M = 1.65, SEM = .31$) than the no delay condition ($M = .70, SEM = .31$) ($p = .03$; Cohen's $d = 1.0$). However, contrary to H2B, there were no differences between the delay with no typing indicator and delay with typing indicator ($p = 1.00$). Thus, H2B was not supported. In addition, with respect to RQ2, there was no significant main effect of time pressure ($p = .85$) and no significant interaction between delay and time pressure ($p = .84$).

Figure 3. Change in frustration during delay relative to baseline, as a function of time pressure and delay condition. Error bars represent standard errors of the mean.

5.1.3 Change in Liking of Confederate.

Hypotheses 3A and 3B predicted that participants would change how much they liked the confederate depending on the delay manipulation. We found main effects of delay on change in frustration ($F [2, 54] = 4.69, p = .01$), indicating significant differences between the three delay conditions. See Figure 4.

Figure 4. Change in liking of confederate during delay relative to baseline, as a function of time pressure and delay condition. Error bars represent standard errors of the mean.

Pairwise comparisons for the delay conditions showed that consistent with H3A, participants reported significantly greater decreases in liking in the two delay conditions (delay with no typing indicator was $M = -.70$, $SEM = .19$; delay with typing indicator was $M = -.95$, $SEM = .19$) compared to the no delay condition ($M = -.15$, $SEM = .19$) ($p = .045$ and $.004$ for each; Cohen's $d = .92$ and 1.33 , respectively). However, contrary to H3B, there were no differences between the delay with no typing indicator and delay with typing indicator ($p = .35$). Thus, H3B was not supported. In terms of RQ3, there was also no significant main effect of time pressure ($p = .23$) and no interaction effect between delay and time pressure ($p = .98$).

5.2 Qualitative Analysis

Using the recorded chat scripts, we analyzed participants' messages to better understand how participants dealt with the delay during the conversation. After coding the messages that participants in each condition sent during the delay, we found three categories described below. After this analysis, we coded the open-ended responses that participants provided in each survey to better understand potential reasons for category of behaviors we noticed during the delay time. We did not find any major differences among conditions in terms of what category was more or less common.

5.2.1 Not saying anything during the delay. Some of the participants waited for their partner to send a message and waited for a response during the delay time. The majority of the ones who didn't send any message during the delay switched to the game window and possibly tried to get more information that could be useful later when their partner replied. One reason for not sending messages during delay was a speculation that the partner was working on the task, so participants didn't want to add to the workload of the partner by sending messages.

"I was confused why my partner kept typing and stopping without sending anything. It made me feel like he/she needed more information, which he/she should've asked for or I should've prompted if he/she needed more. Maybe I should've went ahead and described the symbols from the beginning instead of waiting for the prompt later, but I was worried that he/she was busy looking at the manual and didn't want to overwhelm him/her." (P42, delay with typing indicator condition)

"I felt that my partner was not answering me and paying attention. There was about a full minute where they did not answer me. I was getting very frustrated and so I started to try things because I was not getting a response." (P58, delay with no typing indicator condition)

5.2.2 Trying to get partner's attention. Some of the participants tried to get partner's attentions by mentioning how much time is left or by saying other words such as "hello??".

"I was reminding partner of the time, but not to an overwhelming degree. If faced with the task again, I wouldn't second guess my partner for split seconds before acting. Because of the delayed responses towards the beginning of the last two minutes and 4th minute in the exercise, I think I was more weary" (P32, delay with typing indicator condition)

5.2.3 Trying lengthy follow-ups. Sending follow-up messages is a common strategy in showing attentiveness to partner as well as a way of getting attention from partner. While participants in the no-delay condition kept their follow ups and progress update short and limited to one or few words such as "done" or "wait, it didn't work", some participants in the delay conditions sent long updates when they were waiting for the confederate to respond.

"For over one minute, I could see my partner typing in the chat without sending concrete instructions. I kept trying to describe it further and reminded them of how much time was left in order to show urgency. It may have been more efficient for me to wait for their instruction as opposed to continuously disturbing them with more messages" (P3, delay with typing indicator condition)

5.2.4 Effects of Typing Indicator. To help understand why the typing indicator did not make a difference, we turned to the open-ended responses in the retrospective analysis survey, which asked participants to describe whether they experienced any problems during moment in which there was a manipulated delay, and then asked them to describe the problems and what may have been done to prevent or overcome them. We focused in particular on why individuals perceived partner's conversational involvement to be similar regardless of the presence or absence of a typing indicator.

One possible reason for this may be because a typing indicator may not have been a salient enough cue of conversational involvement during the delay. This may be because what is viewed as conversational involvement may change depending on the interpretations people have. When people see a typing indicator, they may have more specified delay interpretations and a heightened expectation of receiving replies in the near future.

First, the presence of the typing indicator did seem to limit the range of possible delay interpretations to speculate about compared when there were no typing indicators. For example, many people reported general uncertainty about what the confederate was doing during the response delay.

"My partner took a very long time responding when I was sent the messages after finishing the first box. I didn't know what the long pause was for but it took a lot of time." (P16, delay with no typing indicator condition)

And individuals also reported a variety of speculations for this delay, including that it might be caused by a misunderstanding or technical difficulty.

"My partner did not respond for what felt like a significant period of time after the first button was pushed. This could have been my fault in that I did not say the module was still not diffused. I could have overcome this by clearly saying" (P33, delay with no typing indicator condition)

"One problem was when my partner stopped responding during the task. He/she may have been looking at the manual, but I was scared that he/she may also have accidentally closed the chatting room" (P26, delay with no typing indicator condition)

However, most speculations about the delay when there was a typing indicator were about the cognitive processes the partner might be engaged in.

"There was a period where my partner did not respond or say anything. I figured that he/she was trying to come up with a question to find more info on the symbols, but it took he/she awhile to respond." (P17, delay with typing indicator condition)

"My partner kind of took a long time to respond. I assume they were just looking through the manual trying to interpret the things I was saying but it would have been nice to have a few updates because I was left idle for about 30 seconds" (P36, delay with typing indicator condition)

In addition, these speculations were often accompanied by a desire to get an update about the state or progress of these internal processes. However, this was less common when the delay did not have a typing indicator.

We believe this difference may be because a delay with no typing indicator accommodates for a wide range of possible interpretations, not only interpretations about the cognitive process of partners. This creates uncertainty about how much conversational involvement to expect from their partners. However, after individuals see a typing indicator, their expectations for involvement is heightened. They expect to not only see attempts at composing a message but to actually receive and see a crafted message pretty soon. Thus, when this is not the case, their perception of partner's involvement may be lower than their heightened expectations of involvement.

6 DISCUSSION

Our findings show that momentary response delays have significant effects on how people feel and think about their communication partners. While there are almost no changes when response speed was consistent with no response delay, perceptions changed significantly when there was a manipulated response delay. Perceptions of partner's involvement in the conversation dropped, frustration increased, and liking of the partner declined. Furthermore, the size of the changes was similar regardless of the degree of time pressure involved in the task. These findings are consistent with prior research suggesting that response delays can lead people to interpret possible meanings for these delays [21] and also generate strong negative affective reactions in response to them [12]. We also found that response delays changed evaluations of partners, like prior findings [16][33][42].

Contrary to our expectations, we did not find any effects of having or not having a typing indicator during a response delay. Although there were smaller decreases in perceived involvement and liking of the confederate when the delay was accompanied by the typing indicator than without the indicator, the difference was not significant. For increases in frustration, the two conditions were the same. However, while we did not find any statistically significant difference between the two delay conditions, our qualitative analysis shows that there are differences in how people interpret delays when a typing indicator is present vs. absent. When there is no typing indicator, people think the delay could be caused by a wide range of factors, from technical issues to lack of interest. However, when there is a typing indicator, people's interpretations of the delay focused on their partner's cognitive processes, such as reading and understanding the instructions.

Our findings regarding the detrimental effects of delays on one's perception of involvement of the partner as well as feeling of frustration as a result of the delay, are generalizable to similar situations such as team conversations when the team face a deadline or with teams that their tasks are inherently time sensitive such as emergency response teams. Another example of every day scenario is customer conversation with a help desk representative in which the customer expects quick replies when the conversation is started. Our study, similar to any other lab study, has limitations in how much we can generalize the findings and we have explained these in the limitations and future work section.

6.1 Design Implications

Our findings suggest some strategies for designing features to help individuals interpret delays and to reduce possible negative social consequences. We suggest different ideas depending on what the communication partner is doing.

First, in the delay with no typing indicator condition, many participants entertained a variety of possible speculations about what might be causing the delay. Even when there was a typing indicator, it was not enough information to reduce the frustration of the waiting person. Inspired by Gao et al.'s [8] work, we believe that the medium, the IM interface in this case could provide useful information to the person who is waiting for a response to reduce the ambiguity of the situation. This information could be about the status of the other person such as information on whether they are working at their computer or not. This could be cue for the waiting person that their partner is actively working and are present at their working station. Depending on the context and the privacy settings chosen by the person, the waiting party would be able to get details of what the other person is doing. As our participants mentioned, the delay when there is no update or information about the other person is very frustrating and knowing the status of the partner can help the waiting person manage their waiting time by helping them decide and plan their actions. Participants could be provided with the option of selecting levels of privacy vs. awareness (e.g., [4]). When the privacy settings are set to low transparency about status or when the situation calls for lower level of details (e.g., boss-employee conversation), the information could be more generic messages such as a template apology message that reassures the waiting person that the chat window is active and they will be answered in certain time (e.g., 5 minutes).

Second, based on the qualitative analysis, we know that some of our participants were worried about interrupting their partner when they were waiting for a response. Previous work has shown that interruptions could have detrimental effects on one's performance [7] especially in fast stimulus-driven tasks compared to slower tasks [6] so people's concern and preference for not distracting the other person is a valid concern. However, there are points in task completion that are more appropriate for interruption, which results in less frustration and annoyance [1]. Inspired by previous work [3], we think that an improved IM platform could help the waiting person by storing the messages during the long delays and showing them to the other person in the times that are appropriate for interruptions. Knowing this would help waiting partner saying their thoughts without feeling overly anxious about distracting their partners in the wrong time.

Finally, in the delay with typing indicator condition, it seemed that participants revised their expectations of when they would receive a reply the moment they saw cues that the partner was formulating a message. However, this cue can form misguided expectations when partners take a long time to craft their message. Individuals may be motivated to adjust this expectation by sending quick updates about what they are doing but doing so can also disrupt their message formulation process since they may need to delete what they wrote and re-write from the beginning again. Thus, a design suggestion may be to have a list of candidate messages, emojis, or gifs appear on top of the IM text box when the IM client detects that people have been typing but not sending a message for a period of time. Thus, people can choose to send these updates with minimal disruptions and also buy time by adjusting response expectations of partners.

6.2 Limitations and Future Work

In this section, we discuss the limitations of our study as well as directions for future work. First, in this study participants did not know their partner (the confederate). While this allowed us to control for factors that could have affected our results such as prior knowledge of partner's texting habits (e.g., speed of response), more work is needed to look at delays in IM conversations among friends and acquaintances, especially in light of previous work showing that delays and low responsiveness in text-based conversations can negatively affect social attraction [11].

Second, our study looked at only one form of typing indicator. Even though we did not find a statistically significant difference among conditions where the typing indicator was shown vs. the ones it wasn't shown, the qualitative section of our study shows that exploring the effect of presence, absence, and even the duration in which this indicator is visible are important for future work. Also, designing and studying other types of awareness tools to help people interpret delays, such as the ones we mentioned in design implications, would be extremely valuable.

Third, our study focuses on one particular type of real time collaboration. Future work will be needed to examine the role of typing indicators in other scenarios such as when participants are doing other types of tasks (e.g., decision-making), multitasking or working asynchronously. The relationship between type of task and context is another promising path for researchers to examine this seemingly simple but practically complex feature of IM.

7 CONCLUSIONS

In this study we explored the problems that arise during response delays in Instant Messaging. We conducted an experiment and used retrospective analysis to understand how perceived partner involvement, frustration, and liking of partner change over time before and during response delays. We found that response delays decrease perceived partner involvement and liking of partner while increasing frustration in the interaction. We did not find significant differences in these changes whether or not typing indicators were shown during the delay. However, across these two situations, individuals seemed to vary in the breath of interpretations they held about the delays and how soon they can expect to receive a reply. Our findings help understand negative social effects of delays and inform potential design of new features in IM to help offset these.

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