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What makes IM users (un)responsive: An empirical investigation for understanding IM responsiveness

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ABSTRACT

Instant messaging (IM) communication has been widely studied due to its prevalence in our everyday communication. Numerous factors that contribute to (un)responsiveness have been identified. Yet an integrated view of the factors that influence IM responsiveness remains absent. This paper reports qualitative findings from interviews with 46 IM users, and identifies five main elements underlying IM users' response decisions: *response habits, need fulfillment, perceived obligation, perceived readiness/suitability*, and *pace/rhythm coordination*. To the best of our knowledge, this is the first integrated view of the key elements underlying IM responsiveness. Among these elements, we particularly highlight that regarding the influence of contextual factors on IM responsiveness, what may matters more is IM users' perceptions of their readiness and suitability of the contexts, rather than the contexts' objective properties. We also uncovered pace/rhythm coordination as a crucial factor behind IM responsiveness, which has been little discussed in the literature. Responsiveness, as our findings show, was often not a consequence, but a manifestation, of users' pursuit of specific responsiveness-related aims such as ongoing shaping and sustaining of a dyad's pace and rhythm.

1. Introduction

Instant messaging (IM) has established itself as an important channel for communication. The wide availability of the Internet and smartphones allows people to send and retrieve IM messages nearly anywhere and at any time. Despite the convenience provided by a state of perpetual contact (Katz and Aakhus, 2001), sometimes described as being "always connected, always on" (Vorderer et al., 2017), research indicates that it also heightens message senders' expectations about the speed of responses to their messages (Church and de Oliveira, 2013; Pielot et al., 2014; Tu et al., 2018). When a response is not received as soon as expected, it may result in senders' various negative feelings (Hoyle et al., 2017), losing a sense of belonging (Smith and Williams, 2004), and sometimes negative impressions of the message recipients (Heston and Birnholtz, 2017).

Message recipients were also found to feel the pressure to meet senders' expectations by responding more quickly than they want to, which sometimes provokes feelings of entrapment and reduces relationship satisfaction (Hall and Baym, 2012). Such pressure is reportedly strong when the message recipient thinks that the sender knows his/her messages have been read (Lynden and Rasmussen, 2017; Hoyle et al., 2017; Church and de Oliveira, 2013; Chou et al., 2022b). Despite the fact that being able to read messages does not necessarily mean being able to respond to them (Chang and Tang, 2015; Turner et al., 2017), some IM users regard reading and responding as highly similar (Wu et al., 2021) and thus feel pressure to respond immediately whenever they read a message (Wu et al., 2021; Hoyle et al., 2017; Chou et al., 2022b), or whenever they believe the IM application would show a "read receipt" (Chou et al., 2022b). Because of such pressure, some users simply avoid reading messages (Hoyle et al., 2017), while others feel the need to explain their response delays to message senders, sometimes deceptively (Birnholtz et al., 2013; Tu et al., 2018). In short, senders' expectations about recipients' prompt responses, and recipients' perceptions of those expectations, are important drivers of these groups' negative feelings. To address this problem, researchers have sought to enhance senders' awareness of message recipients' situations, as it may help senders make sense of message recipients' availability and nudge their responsiveness expectations in a more realistic direction (e.g. Cho et al. (2020a), Hincapié-Ramos et al. (2011), Wu et al. (2021), Chou et al. (2022a), Begole et al. (2004), Jain et al. (2022) and Podlubny et al. (2017)).

Another approach is to enhance the understanding of "what makes IM users (un)responsive on IM. Such an understanding can help researchers and practitioners design IM services that provide better experiences by taking these factors into account. Since the proliferation

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of communication technology such as emails and IM services, numerous studies have investigated individual factors that might affect people's responsiveness on these services. They included not only contextual factors (e.g., Lee et al. (2019), Pejovic et al. (2015), Czerwinski et al. (2000), Al-Saggaf and MacCulloch (2019), Maginnis (2011), Schneider and Hitzfeld (2019), Schulze and Groh (2014), Battestini et al. (2010)), but also recipients' relationships with senders (e.g., Wiese et al. (2015), Lee et al. (2019), Mai et al. (2015), Birnholtz et al. (2017), Devito (2018)) and the characteristics of the message (e.g., Tyler and Tang (2003), Vorderer et al. (2017), Dabbish et al. (2005), Lin et al. (2021a)).

Nevertheless, these studies tended to focus on a subset of factors, and many of them reported inconsistent results regarding the impact of individual factors on responsiveness, such as the influence of relationship characteristics (Lee et al., 2019; Pejovic et al., 2015; Czerwinski et al., 2000; Al-Saggaf and MacCulloch, 2019; Maginnis, 2011; Schneider and Hitzfeld, 2019; Schulze and Groh, 2014) and the perceived importance of the communication content (Cox et al., 2021; Tyler and Tang, 2003; Lanctot and Duxbury, 2022; Dabbish et al., 2005). As a result, our understanding of the factors that affect responsiveness remains fragmented and uncertain. To date, an integrated view of factors underlying responsiveness remains lacking. That is, there is still a lack of a broad exploration of the factors that underlie responsiveness as well as in-depth investigation of how each of these factors impact IM responsiveness.

This paper addresses these gaps by asking: *Why are IM users (un)responsive when receiving messages?*. To answer this question, we conducted semi-structured interviews with 46 IM users with diverse self-reported IM behaviors, with the goal of uncovering most, if not all, considerations that underlie their response decisions. We adopted this approach in order to broaden our knowledge of the range of possible elements that are vital to responsiveness, as well as to deepen our understanding of how each of these elements plays a role in IM users' responsiveness.

The findings of this paper constitute three major contributions: First, we identify five key elements that explain IM users' responsiveness: response habit, need fulfillment, perceived obligation, perceived readiness/suitability, and pace/rhythm coordination. Second, we highlight the importance of the perception of responsiveness: it may be the users' perceived readiness/suitability of the contextual factors on (un)responsiveness that matter to their actual response decisions, rather than such factors' objective properties. And third, we show that pace/rhythm coordination is an under-reported but crucial vital factor that affects IM. Importantly, we found that responsiveness often does not manifest as an outcome but instead, as an intention to coordinate pace/rhythm: i.e., in this case, an intention to shape and/or sustain a desired communicative pattern between our participants and their IM conversation partners.

In a nutshell, this paper suggests that future research take account of all five of these elements when considering, measuring, or conceptualizing responsiveness. We also recommend that future context-sharing systems reveal users' behavioral patterns in certain contexts, as they are behavioral outcomes of users' perceptions of the context, instead of sharing only objective context information.

2. Related work

2.1. Temporal patterns in computer-mediated communication

Researchers have long paid attention to the rhythms of synchronous face-to-face (FtF) and telephone conversations, including speech rates, tempo, pauses, gaps, and turn-taking (Davis, 1982; Feldstein, 1982; Jaffe and Feldstein, 1970; McLaughlin, 1984; Sacks et al., 1974). However, the advancement and increasing adoption of computer-mediated communication (CMC) technologies have drawn researchers' attention to studying the temporal aspects of CMC (Hesse et al., 1988), and to argue that such aspects differ substantially from those of synchronous conversations (Kalman et al., 2007). That is, in synchronous conversations, both verbal and nonverbal cues are transmitted to one's interlocutor in real time. In addition, synchronous dyads usually adhere to shared social rules and norms (Sacks et al., 1974; Thomson et al., 2018), and even a minimal response delay can lead to an impression that the delaying party is not paying appropriate attention (McLaughlin, 1984; Mehrotra and Musolesi, 2017). CMC, in contrast, has been argued to lack these temporal cues (Walther and Tidwell, 1995) or, indeed, any well-developed social norms or scripts for guiding conversations' rhythms (Hesse et al., 1988). Nevertheless, CMC dyads that are allowed ample time for communication are normally able to convey relational communication using verbal and also temporal cues (Walther, 1992); and, as in synchronous communication (albeit to a different degree), response delays can affect dyad members' impressions of each other (Liu et al., 2001; Walther and Tidwell, 1995). As Chesebro (Chesebro, 1985) has pointed out, the situation is further complicated by the fact that CMC enables direct time control and manipulation: i.e., it affords its users immense flexibility regarding the pace at which they open and read messages, and compose responses. This also enables users to multitask while exchanging messages (Grinter and Palen, 2002; Isaacs et al., 2002) and/or to engage in unconnected conversations with several people at once (Rao et al., 2009).

Before IM became pervasive, the rhythms of email communication were the topic of extensive research, such as how fast people respond to emails and the characteristics of emails to which people respond faster. Specifically, an early analysis of email logs from a large email dataset showed that the vast majority of the sampled population (97%) responded to at least 30% of emails within one day, suggesting a power-law distribution of response latency (Kalman and Rafaeli, 2005). Similarly, Kalman et al. (2006), based on an analysis of three very different CMC datasets, found that their response latencies yielded a similar power-law distribution – i.e., 70% of the responses were created within the average response latency of the responders – and concluded that people tend to reply quickly in CMC. A later study of email chronemics also indicated email users' generally high responsiveness: with half of replies being sent within 47 min (Kooti et al., 2015).

In terms of the characteristics of emails, prior research tended to show that perceived urgent and important emails were responded to faster (Cox et al., 2021; Tyler and Tang, 2003; Lanctot and Duxbury, 2022). However, recent studies showed that there still existed different degrees of responsiveness between important and urgent emails. For example, Cox et al. (2021) found that people generally prioritized responses to important messages, but urgent messages were still responded to more quickly regardless of other cues. Moreover, in their study, Dabbish et al. (2005) also only found a modest influence of content importance on the probability that users would reply. It is perhaps because, as Lanctot and Duxbury (Lanctot and Duxbury, 2022) indicated in their recent study, while urgent emails seemed to be considered important and addressed faster, important emails were not necessarily considered urgent. To be perceived as a urgent email, they found that a crucial element was that emails explicitly indicate key stakeholders who would be negatively impacted if the email was not acted on quickly.

Other than perceived importance and urgency, Barron and Yechiam (Barron and Yechiam, 2002) found that people's response rates were higher if the email they were replying to had been addressed to a single person rather than to several. Tyler and Tang (Tyler and Tang, 2003) reported that their participants responded more quickly to persons with whom they had a history of quick communication, and to messages that formed part of an ongoing conversation. Interestingly, the same study also noted that some of its participants attempted to project a "responsiveness image", i.e., they sought to indicate that their response was certainly coming, even if not necessarily soon. Dabbish et al. (2005), who studied relational characteristics, found that the existence of a work relationship between the parties did not increase the probability of replies being given.

Compared to email, IM is a relatively new form of CMC, which has been described as a *semi-synchronous* medium (Avrahami et al., 2008). In this paper, we extend the CMC literature regarding temporal patterns of communication, with a primary focus on IM responsiveness. In the next section, we discuss the relevant prior work on this subject.

2.2. Responsiveness in instant messaging

IM, as a *semi-synchronous* medium (Avrahami et al., 2008) that allows both rapid, continuous message exchanges as well as sporadic, intermittent ones, results in immense diversity in response-delay times: from a low of seconds, to a high of multiple days (Nardi et al., 2000). The dynamics and chronemics of texting in SMS/IM, notably in the workplace and on mobile phones, have also been of enduring interest to researchers. For instance, Rao et al. (2009) studied how people manage concurrent IM conversations at work, and found that controlling the pace of conversations was a common strategy. Others have studied the connections between responsiveness and work rhythms. Avrahami et al. (2008), for instance, showed that work-fragmentation was correlated with faster responses; and Sonnentag et al. Smith and Williams (2004) suggested that responding to interruptive messages (which are usually related to work) led to higher rates of task accomplishment. Nardi et al. (2000), who also observed both rapid and intermittent message exchanges, noted that IM was not only used for information exchange, but also for negotiating availability; creating and maintaining a sense of social connection to others; and coordinating the use of other media for communication.

The process of using IM for coordination or indeed *"micro-coordinating"* availability for day-to-day activities, including communication, was not identified solely by Nardi et al. (2000), but also by other scholars (Ling and Lai, 2016; Ling and Yttri, 2002). In IM, such coordination sometimes involves deception, referred to as "butler lies", regarding one's response delays caused by unavailability or inattention (Birnholtz et al., 2013; Hancock et al., 2009; Reynolds et al., 2013). Wohn and Birnholtz (Wohn and Birnholtz, 2015) suggested that, in addition to explicitly negotiating and coordinating (un)availability, users implicitly expressed it via performing different levels of responsiveness in response to others' communication requests. Far from engaging in this behavior only to protect themselves against distractions, Wohn and Birnholtz's participants also did it to escalate or de-escalate their communicative partners' attentiveness to communication – a process they referred to as *attention management* (Birnholtz et al., 2017). Sometimes, coordination or attention (de)escalation occurs because a person feels s/he might otherwise violate communicative expectations or norms (including, but not limited to, being unable to respond fast enough) (Schönbach, 2010).

Other studies have highlighted the roles of moment-to-moment contextual factors in responsiveness, including activity engagement (Avrahami and Hudson, 2006b; Lee et al., 2019; Pejovic et al., 2015), the relevance of the message to the current situation (Cho et al., 2020a), and the recipient's perception of the appropriateness of responding to a message in his/her immediate social context (Al-Saggaf and MacCulloch, 2019; Maginnis, 2011; Schneider and Hitzfeld, 2019; Schulze and Groh, 2014). However, some research has indicated that certain people engage in IM conversations even when they perceive it to be socially inappropriate (Harrison et al., 2015).

As IM is considered a tool for maintaining and sustaining relationships (Dienlin et al., 2017; Kelly et al., 2018; Ramirez and Broneck, 2009), several studies have investigated how relational characteristics affect IM responsiveness. Vorderer et al. (2016), for example, showed that university students' response delays varied according to whether their interlocutors were romantic partners (typically, 15 min), superiors (30 min), or co-workers (1 h). Avrahami and Hudson (Avrahami and Hudson, 2006a) found messaging rates and durations differed significantly across work vs. social relationships. Dogruel and Schnauber-Stockmann (Dogruel and Schnauber-Stockmann, 2021) suggested that responsiveness was higher if the sender of the message was close to the individual, i.e., a family member, partner/spouse, or friend.

However, results regarding how relationships influence IM communication patterns have been diverse. For instance, Wiese et al. (2015) indicated that tie strength could not be accurately distinguished using call and SMS logs, and Lee et al. (2019) indicated that closeness was not a predictor of in-situ self-reported responsiveness. In another example, Mai et al. (2015) argued that perceived obligation to respond plays a key role: i.e., people are most responsive toward loose acquaintances and those they see as socially superior (see also Birnholtz et al. (2017), Devito (2018)). However, results from Lee et al. (2019) indicated that perceived obligation to respond was not a predictor to their study participants' responsiveness; instead, answering expectation, which was also proposed by Mai et al. (2015), referred to as the level of an IM user's expectation that a specific person to whom he/she has sent a message will respond immediately (Mai et al., 2015), was a predictor of the participants' responsiveness. It is likely that such inconsistency in the results was due to the existence of other factors. For example, response times can also be moderated by the intent to put effort and time in crafting a message (Kelly et al., 2018) for some social or relational purpose (Tikkanen and Frisbie, 2015; Walther, 1996), including the signaling of mutual affection and care (Burke and Kraut, 2016; Sosik and Bazarova, 2014). Lacking the information of possible factors that could impact IM responsiveness and consequently not taking them into account is thus likely to be the reasons behind the aforementioned inconsistent quantitative results. To address this issue, it is essential to establish an integrated understanding of a range of factors which underlie IM responsiveness.

Unfortunately, despite their abundance, most of the prior studies focused on different subsets of factors. To the best of our knowledge, there has been little in-depth or broad investigation of possible factors underlying IM responsiveness. Our study fills this gap, and reveals elements that have not been considered in previous research, including users' perceptions of their readiness and the suitability of the contexts (rather than the contexts' objective properties) and users' intention to coordinate rhythm/pace with the conversation partner, where responsiveness is more a manifestation of such an intention rather than an outcome. It is perhaps the existence of these elements that to some extent explains the inconsistency in prior research. As such, we believe our study provides insights and contributes to the knowledge of IM responsiveness in the literature.

2.3. Responsiveness in interruptibility research

Lastly, over the past decade, research interest in smartphone users' attentiveness and responsiveness to mobile IM messages has been growing, because such users have been found to prefer messaging notifications and to handle them first (Mehrotra et al., 2016). While comprehensive reviews of this line of research have been conducted (Anderson et al., 2018; Mehrotra and Musolesi, 2017; Puranik et al., 2019; Turner et al., 2015a), we feel we should provide a snapshot of the factors that have been identified as affecting responsiveness to notifications. First, it should be noted that studies of this topic tend to treat a response action as a step subsequent to attending to a notification (Chang and Tang, 2015; Turner et al., 2015b, 2017; Pielot et al., 2018). Thus, in theory, responsiveness should be impacted by factors that affect attentiveness, including the alert modality of the phone (Chang and Tang, 2015; Komninos et al., 2018; Pielot et al., 2014; Turner et al., 2015b, 2017; Chang et al., 2019a); the time of day (Dingler and Pielot, 2015; Turner et al., 2015b); and the recipient's location (Chang and Tang, 2015), current emotional status (Kushlev et al., 2017), recent app usage (Chang et al., 2019a; Dingler and Pielot, 2015), and recent attention to his/her phone (Chang et al., 2019a; Komninos et al., 2018; Pielot et al., 2014; Turner et al., 2015b, 2017). Broadly similar contextual effects have been reported by the slightly different, but likewise large body of research that aims to predict opportune (e.g., Fischer

et al. (2011), Iqbal and Bailey (2005), Pielot et al. (2017), Puranik et al. (2019)) or "interruptible" moments for handling notifications (e.g., Pejovic et al. (2015), Turner et al. (2017), Okoshi et al. (2017), Okoshi et al. (2015)).

It should also be pointed out that most interruptibility research has focused on observable measures, and leveraged quantitative methods such as statistical analysis or machine learning to quantify the impacts of its chosen factors. As a result, they have primarily involved testing correlations between contexts' objective properties and users' responsiveness, rather than focusing on how users perceive the suitability of their contexts for responding. This information is important for researchers and designers to create IM communication experiences that users actually want. In this qualitative paper, we show how such perceptions matter to IM responsiveness.

3. Methodology

To answer our research question, we decided to utilize semi-structured interviews. We chose this approach because our main goal was to explain IM users' responsiveness through uncovering factors that underlie IM users' responsiveness decisions and delving into the role they play. Semi-structured interviews enabled us to obtain this data through probing and asking follow-up questions, so that we could acquire IM users' perceptions of their own practices as well as their attitudes, desires, values, and concerns associated with the practices. We provide more details below.

3.1. Participants

We recruited our participants via several Facebook group-based subject pools in Taiwan that are intended for recruiting research participants. Initially, 160 people signed up; 46 were eventually selected based on our selection criteria, of which the objective was to increase the diversity within the participants' IM practices and demographic backgrounds. Of the 46 selected participants, who ranged in age from 20 to 56 (M=26.04, SD=6.7), 26 were students and 20 were non-students with diverse occupations (see Table 1); 18 were male, 27 were female, and one preferred not to disclose. All participants self-reported using Facebook Messenger and/or LINE Messenger as their primary IM application. Most (67%) of the participants said they generally talked with at least 10 contacts, with 52% of them saying they talked to between 10 and 30. Also, 91% said that on a normal day, they sent at least 10 messages to their contacts, and received at least 10: with 33% receiving 10–30; 24%, receiving 31–50; and 33%, receiving more than 50 messages, compared with 30% sending 10–30; 20%, sending 31–50; and 41% sending more than 50.

3.2. Data collection

3.2.1. Pre-interview questionnaire

When participants were invited to participate in the study, we asked them to provide 20 contacts that they had been in contact with on Facebook Messenger and/or LINE Messenger, the two most commonly adopted IM services in Taiwan, within the three months preceding the commencement of the study. This approach was inspired by Lee et al. (Lee et al., 2019), of which the purpose was to, firstly, obtain their perceptions of their own IM practices with contacts of diverse kinds such that we would know their communication habits across different contacts, as previous work has shown that this personal-level factor (Dogruel and Schnauber-Stockmann, 2021) has an impact on responsiveness. Secondly, the number of contact needed to be sufficient to accommodate enough diversity of contacts such that when researchers asked the participants about these contacts in the interviews, the participants had a wide range of contacts to compare their similar and/or different IM practices toward various contacts, allowing the researchers to extract the underlying factors that resulted in such similarities and differences.

Specifically, we instructed our participants to provide a list of contacts of diverse kinds and provided them with sample categories for their reference, which was a list of common relationship types including significant other (SO), friend, acquaintance, immediate family, extended family, colleague (close), colleague (not close), work superior, service provider, and client, which were adapted from (Mehrotra et al., 2016; Lee et al., 2019). We asked them to name contacts that covered as many types as possible, which could also be outside the list of sample categories.

For each participant, the research team generated 20 online questionnaires, one for each contact, and were given seven days to complete the questionnaires at their own pace. Our questionnaire items were designed to capture an overview of the characteristics of the participants' IM communication behaviors and relationship with their named contacts prior to the interview. For each contact they named, they answered a series of multiple-choice questions that included: their general responsiveness to that contact; the characteristic of the messages they exchanged with that contact (e.g., urgency of messages using a 5-point Likert scale); and the characteristic of their relationships with that contact (e.g., relationship type, closeness on a 5-point Likert scale). Their questionnaire responses were then used as prompts in the semi-structured interviews, of which we provide the details below. For relationship type, in addition to the aforementioned list of relationship types, an "Other" option was also included to allow participants to add any person they exchanged messages with via IM, but who did not fit into any category on the list. Notably, among the 920 IM contacts provided by the participants, 39 (4%) were self-reported as "Other", for which participants provided a range of relationships such as "my girlfriend's mother", "a barber at a hair salon that I frequently visit", "a buddhist monk I look up to", etc.

3.2.2. Semi-structured interview

In the semi-structured interviews, we focused on participants' decisions and the factors they perceived that affected when they would respond to their IM contacts. In order to effectively make contrasts in the responding behaviors participants had among their different contacts, we categorized participants' contacts into four social relationship categories: significant other, work, social, and family, as suggested in prior works (Farnham and Churchill, 2011; Ozenc and Farnham, 2011; Pettigrew, 2009; Min et al., 2013; Mehrotra et al., 2015) before each interview. We highlighted the IM contacts with whom participants perceived themselves as displaying different IM behaviors between and within the same relationship category (e.g. different responding delays for different work colleagues, family members), respectively. During the interviews, we started by asking the participants about their general IM habits and practices, followed by those with specific relationship types, and then, specific to individual IM contacts. While our interview prompts for each semi-structured interview started with the 20 IM contacts named by the participants, we encouraged them to talk about their communication with their other IM contacts who were outside the list whenever they wanted to. It is noteworthy that, given the aim of capturing a comprehensive list of factors that could affect IM users' responsiveness toward any IM contact, our interviews did not focus mainly on frequent IM contacts, but also infrequent ones. Broadening the range of inquiries about diverse contacts allowed us to make a variety of contrasts to extract as many factors that might have affected the participants' response strategies and responsiveness as possible. To make such contrasts effective, during the interviews, special emphasis was placed on the episodes where we noticed distinctive strategies or contrasts across contacts, situations, and/or message characteristics. When participants found it difficult to recall, we encouraged them to review their conversation history with their IM contacts on their phones to help them recall their IM behaviors with those contacts. Each interview lasted 45–60 min, and was recorded and transcribed for further analysis. Each participant received NT$750 (approximately US$25) as compensation for their participation. The study was approved by our university's Research Ethics Committee for Human Subject Protection.

Table 1
Study participants (total = 46; student = 26; non-student = 20).

Identifier	Gender	Age	Occupation	Identifier	Gender	Age	Occupation
P1	Female	30	Information engineering	P24	Female	31	Freelance
P2	Female	23	Student	P25	Male	31	Government employee
P3	Male	22	Student	P26	Female	21	Student
P4	Male	21	Student	P27	Female	20	Student
P5	Male	24	Electronic engineering	P28	Female	23	Healthcare professional
P6	Female	21	Student	P29	Male	26	Administration
P7	Female	23	Student	P30	Male	36	Service industry
P8	Female	28	Government employee	P31	Male	43	Service industry
P9	Female	22	Student	P32	Female	23	Student
P10	Female	23	Student	P33	Female	23	Student
P11	Male	23	Student	P34	Male	27	Student
P12	Male	20	Student	P35	Male	24	Banking and insurance
P13	Female	25	Student	P36	Female	23	Student
P14	Female	21	Student	P37	Male	25	Student
P15	Female	23	Electronic engineering	P38	Female	21	Student
P16	Female	27	Student	P39	Female	28	Finance
P17	Female	26	Student	P40	Female	36	Service industry
P18	Male	22	Student	P41	Male	24	Finance
P19	Male	22	Student	P42	Male	22	Student
P20	Female	23	Student	P43	Male	23	Research assistant
P21	Undisclosed	36	Finance	P44	Male	23	Student
P22	Female	24	Service industry	P45	Female	29	Finance
P23	Female	31	Government employee	P46	Female	56	Banking and insurance

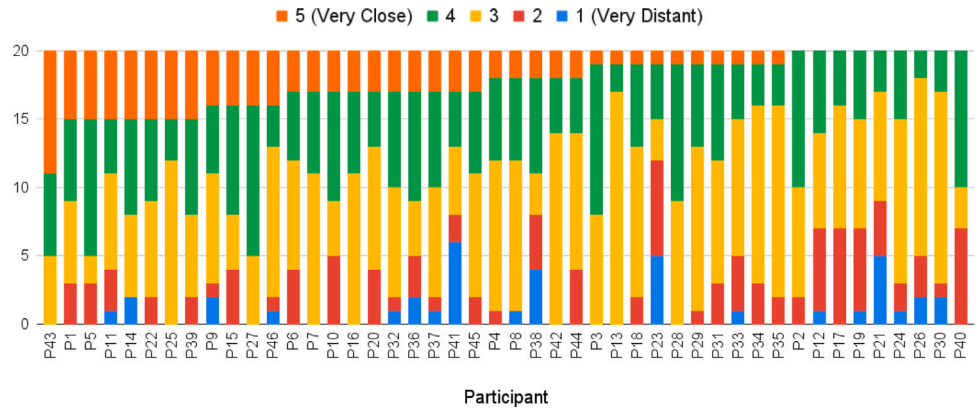

Fig. 1. Distribution of participants' closeness with their contacts (a 5-Likert scale).

3.3. Data analysis

We conducted thematic analysis of our interviews using the qualitative analysis software MAXQDA.[1] Generation of the initial codebook was guided by our interview protocol, and focused on participants' IM practices, responding decisions, and responding behaviors. To ensure the reliability of our coding process, two authors randomly selected one transcript at a time and coded it independently. For each coded transcript, these two coders calculated the agreement of their codes and compared/discussed the discrepancies until full consensus was reached. After all discrepancies were resolved, they updated the codebook, coded a new transcript, and repeated the same process. This procedure was performed iteratively until the coders reached an inter-coder agreement of at least 80% for three consecutive new transcripts. This process continued until the 17th transcript. Then the same two coders coded the rest of the transcripts individually.

4. Overview of participants' responsiveness

Before introducing our qualitative findings, we first present an overview of our participants' relationship characteristics with their selected IM contacts, including perceived closeness (Fig. 1) and known-time (Fig. 2), and their self-reported responsiveness to these contacts (Fig. 3). Overall, from a total of 920 IM contacts collected from the 46 participants (i.e., 20 contacts for each participant), we see diverse distributions of these two relationship characteristics between the participants and their IM contacts. These diverse IM contacts were those whom participants reflected on later in the semi-structured interviews. Participants' overall responsivenesses were also quite diverse, as shown in Fig. 3. Specifically, most participants (96.1%) reported responding to their contacts within a day, and nearly two-thirds (63.8%) claimed to respond within an hour. This distribution was quite similar to the CMC response latencies previously observed (e.g., Kalman et al. (2006)).

On the other hand, we also observed a large individual variance in responsiveness among our participants, as shown in Fig. 3. The proportions of fast responders, i.e., those who typically responded within several minutes (bars on the left in Fig. 3) and of slow responders, i.e., those who usually responded after an hour (bars on the right in Fig. 3) were fairly similar. This distribution resonates with the notion of responding habit (or, basal responsiveness (Tyler and Tang, 2003)) discussed previously in the literature (e.g., Dabbish et al. (2005), Whittaker and Sidner (1996), Weber et al. (2019)). The notion also emerges as a key element in our responsiveness framework that we will discuss later.

[1] https://www.maxqda.com/

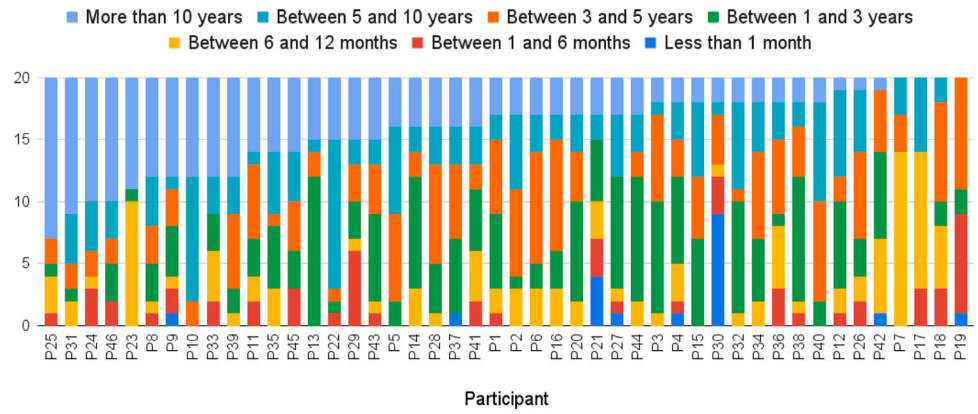

Fig. 2. Distribution of participants' known times with their contacts.

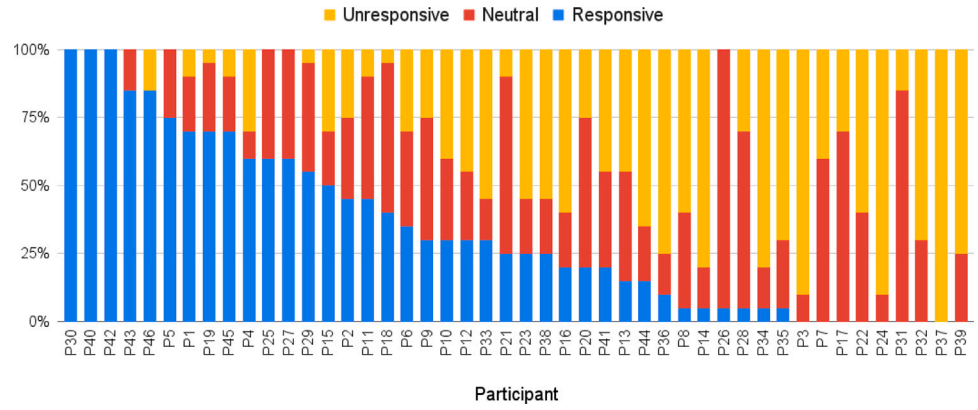

Fig. 3. Distribution of participants' responsiveness to their contacts, sorted by the number of responsive contacts.
Note. Responsive (Blue): contacts that participants typically responded to within several minutes; Neutral (Green): contacts that participants typically responded to within an hour; Unresponsive (Red): contacts that participants typically responded to after more than an hour.

5. Five key elements of IM responsiveness

In this section, we present five key elements that we found together explain IM users' responsiveness to their IM contacts. These elements together also establish an integrated view of main factors affecting IM responsiveness. They are: *Response Habits, Need Fulfillment, Perceived Obligation, Perceived Readiness and Suitability,* and *Pace and Rhythm Coordination* as shown in Fig. 4. Below we provide more details for each of these elements.

5.1. Response habits

The first element, also the most straightforward one, is participants' *responding habit*. This element is well aligned with the varying levels of the overall responsiveness participants self-reported in the questionnaire, as shown earlier. In the interviews, we also observed that most participants were highly conscious of how their habits, and their pace/rhythm comfort zones in particular, influenced their decisions about when to respond. We identified two broad types of response habits. The first was the pace/rhythm of IM conversation they saw themselves as following in the absence of any external influences; and the second was the pace/rhythm they said they followed (or felt they ought to follow) with particular types of other people, e.g., a new colleague, or a newly met acquaintance. This latter type of habit was formed based on pre-existing impressions of their interactions, either with that person or a categorically similar person:*"[Y]ou just have to be polite and respectful to people you don't know. So I'd reply more quickly"* (P36). When interacting with a person they had just met or had no prior experience of exchanging messages with, their personal habitual responsiveness would form their basal responsiveness to that person, which could be adjusted over time as more experiences of that contact

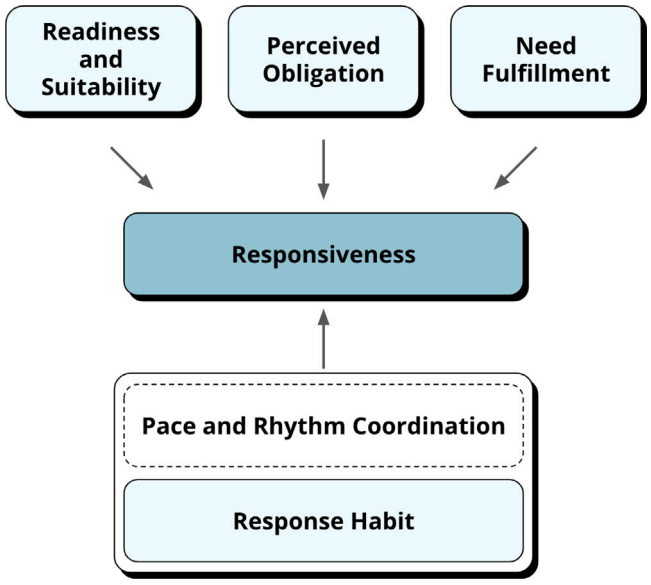

Fig. 4. The five main elements of IM responsiveness. The dotted line indicates conditionality, i.e., a factor that does not always affect responsiveness but is dependent on the membership of the dyad.

relationship accrued. A participant's choice about whether or not to stick to his/her own habitual conversational pace depended on both how aware s/he was of that "comfort zone", and how willing s/he was to leave it: factors that varied sharply from individual to individual. While many participants chose to adjust their conversational pace with those contacts they perceived as having a different pace (as will be more fully discussed later), some participants tended to maintain their own pace/rhythm. P24, for example, told us, *"On the whole I just felt too lazy to respond. I mean, myself, I'm too lazy to reply to everyone [. . .] probably because I feel tired of socializing"*; while at the other end of the spectrum, P30 said: *"I just don't like to see[. . .] the number indicator showing '1' on the LINE app icon. When seeing it I'd feel annoyed and really want to check what it's about and handle it."*

5.2. Need fulfillment

The second element is *need fulfillment*, which refers to participants' adjustment of their responsiveness as a means of fulfilling specific needs of their own. Many prior studies have indicated that individuals' IM behaviors manifest their intentions to escalate or de-escalate relationships, and are also important components of their presentation of self. Our qualitative results tend to confirm this, but also point to IM responsiveness behavior as fulfilling additional human needs mentioned in Ryan and Deci's (Ryan and Deci, 2008) self-determination theory – i.e., autonomy, relatedness and competence – as well as in Sheldon et al.'s (Sheldon et al., 2001) list of universal human needs.

5.2.1. Maintaining, escalating and de-escalating relationships

The first type of need was to maintain, escalate or de-escalate relationships with particular conversation partners. Many of our participants intentionally responded more quickly or slowly to achieve this purpose: behavior that would appear to reflect the concept of relatedness (Ryan and Deci, 2008). For example, P23 responded immediately to her boyfriend's messages *"to make him aware that I'm there for him."* P29, in contrast, intentionally replied to his female friend more slowly to maintain an appropriate distance from her: *"I'd respond to her more slowly because [otherwise] my girlfriend would be jealous"*. A particularly interesting example was provided by P28, who had just broken up with her boyfriend, and intentionally delayed her responses to his messages to convey her indifference, despite longing to receive them. *"I'd await his message, and sometimes seeing he had read one but not responded made me kind of upset [...]. But I'd not respond immediately even if he replied. It's like a 'playing hard to get' trick [laughs]. We're in much the same position: neither of us wants the other side to feel that they care more"*. Other participants mentioned that they would adjust their responsiveness when expecting to meet vs. not meet their conversation partners offline. P7, for instance, was more responsive to people whom she expected to meet at least weekly, and delayed her response, sometimes by more than a month if she did not anticipate a face-to-face meet-up happening soon. This was because she saw face-to-face interactions as a source of topics, *"which are needed to initiate a conversation on IM"*.

5.2.2. Managing presentation of self

The second type of need commonly mentioned by study participants was an intention to present certain images to their communication partners. Some of the intentions echo with Tyler and Tang's (Tyler and Tang, 2003) projection of "responsive image" in the workplace; while others present images that connected to Ryan and Deci's (Ryan and Deci, 2008) conceptualization of competence. P1, for example, who was a designer, purposefully delayed her responses to her colleagues and supervisor to convey an image of being diligent and efficient. *"I pretended that I had not read the messages and used that time to complete all of the work. After I finished, I sent him a message. When he opened it, I immediately sent him my stuff. [...]. I wanted to create an illusion that I'm an efficient person, [. . . and] that I'd been so busy, I did not notice his messages"*. P36 reported a similar need to showcase her competence, and delayed messages to her mother *"I don't want her to have the impression that I have nothing to do and am able to keep replying to messages"*.

5.2.3. Maintaining availability and autonomy

The third type of need participants reported was delaying responses in an attempt to maintain their privacy and autonomy, which again resonates with Ryan and Deci's (Ryan and Deci, 2008) concepts of autonomy, as well as with the attention-management and availability behaviors described in other prior literature (Birnholtz et al., 2017). P14 explained delayed responses to parents in these terms: *"Sometimes I didn't notice their messages until late night. But I didn't want my mom to find out that I was staying up. So I replied to her in the morning. But I wouldn't need to do this to my sister"*. P39 expressed a need for autonomy after work hours:*"I respond quickly when I'm in my office. But after work I'd feel like 'No, this is my TV series time' and respond later"*.

5.2.4. Information, help, or item acquisition

Fourth, whereas the aforementioned needs were all toward the end of interpersonal or social needs (i.e., needs that bond with a dyad's relationship and/or communication), our participants also commonly mentioned that they changed their response speeds to fulfill impersonal ones (e.g., task-based messages (Walther, 1996)). One common example was responding faster to acquire further information, e.g., about a common interest such as gaming (P11). Likewise, participants delayed their responses, or did not respond at all, when they wanted to indicate their lack of interest in a topic, offer, or question, e.g., *"daily trivialities"* (P24) or *"just tips to eat more healthily or something related to politics, which I typically would just read and prefer not to respond to"* (P43).

Our participants were more responsive when they were stakeholders in the messages, such as when the messages were related to *"assignments or group projects"* (P12), imminent dining arrangements (P1, P9), or urgently needed work-related information (P46).

5.3. Perceived obligation

The third element is *perceived obligation*. That is, responsiveness was also reported as a way to reflect participants' perceived obligation while communicating via IM with contacts, which could lie somewhere between the spectrum of participants' interpersonal and impersonal needs.

Obligations that are more toward the interpersonal end of the spectrum typically involve a sense of agreed norms, responsibilities, or expectations, given the dyad's existing relationship, especially in cases where the participant perceived him- or herself as passive or reactive within that relationship. Typical examples of such perceptions included being in a submissive position in a dominance/submission relationship, or that politeness toward a particular contact was socially essential (Mai et al., 2015; Maginnis, 2011), for example, because they were one's academic advisor (P20) or grandparent (P9). On the other hand, at the more impersonal end of the spectrum, participants felt obligated to respond faster when they perceived that their responsiveness would impact things that bonded with the conversation, and thus could effect not only their conversation partners, but other people involved, usually at work: *"I'd respond immediately to those about business, those that would delay other people's schedules [if not responded to]. I'd try to respond to those as fast as I can"* (P2).

Another common scenario, which contain instances that fall between these two ends of the spectrum, was that the participant perceived a responsibility to assist a conversation partner in need, not just to offer help, but to offer it quickly to prevent negative outcomes. Some said that when a friend was in need of cheering up or emotional support, they would respond faster to *"find out what's wrong"* (P20) or*"calm him down"* (P1). Other such situations included friends having software problems (P1) or losing their keys (P5).

5.4. Perceived readiness and suitability

The fourth element is *perceived readiness and suitability*. The construct of it is intended to, specifically, reflect participants' tension between two types of perceptions: (1) the extent to which a reply *demands* them, and (2) how *ready* they are to meet that demand, and/or how *suitable* they find the situation is for that demand to be made. For example, a demand can be additional information, time to process, or energy. Participants might need to know certain information in order to answer questions; they might also find certain conversations more time- and energy-consuming, and therefore, feel required to allocate enough time to process the messages. This element is also the element most closely related to the contextual factors that are extensively studied in the literature, such as current activity and social context. However, participants' response decisions can be far more dramatically impacted by those subjective perceptions than by their objective context, which can help explain why there has been so much observed variation across similar individuals' response behavior in seemingly very similar places and situations (Harrison et al., 2015). In the current study, the participants explicitly or implicitly expressed six primary types of readiness and suitability: *mental, physical, time, content, social*, and *technology*. Despite adopting this categorization, we concede that it is not always easy to distinguish clear boundaries between them.

Mental readiness and suitability refers to how cognitively and emotionally prepared participants felt to respond to a message. As P39 simply put it, *"I'm not responsive when I'm busy or lazy"*. Mental readiness was commonly cited in the context of preoccupation with other activities, including a sense of nearing a "*eureka moment*" at work (P19), or being in the middle of an argument with someone else (P40); or an expectation that the contact's message will contain specific negative or otherwise unwanted content (P7).

Physical readiness and suitability is closely related to mental readiness, due to the blurry boundary between the mental and physical aspects of terms like "lazy" and "lack of energy". However, a clearly physical manifestation of this construct was sleepiness (P19, P43).

Time readiness and suitability referred to how much time participants perceived responding to the message would demand, and whether/when they could afford to spend it: *"If it's going to take half an hour, I'd finish up my other things before I start the conversation"* (P23) or *"I respond to my family only when I'm available [. . .] because I want to put more thought into my reply"* (P16). Conversely, a matter-of-fact contact not prone to *"chit chat"* (P20) might merit an immediate response, as there is little chance of the encounter being drawn out.

Content readiness and suitability is closely related to time readiness and suitability, since crafting the content of a reply also takes time. As P1 put it, *"I usually respond quite fast, unless I'm talking to a person whom I think I need to be more careful and deliberate about my word choice with, like my boss"*. However, some participants mentioned that when they perceived that they simply did not have the information demanded by the message sender, they often delayed their response until they had it, rather than sending a reply saying only that they did not know yet (P31, P36).

Even when participants perceived themselves as mentally and physically prepared and had the content for their response ready, their perception of the *social suitability* of messaging in their current context could also affect their response behavior. *"Sometimes I receive messages while tutoring children, but I think taking out my phone and texting back would not be a good thing to do at that kind of moment"* (P18). Other unsuitable social contexts commonly mentioned included meetings and serious conversations (P25).

Lastly, *technological readiness and suitability* constraints to responding included poor network connectivity (P31), and a personal preference for typing lengthy messages on computers rather than on phones (P3).

There were also contexts in which participants perceived multiple types of readiness and suitability, such as perceiving it neither mentally nor physically suitable for responding when driving or riding a scooter (P25, P43). Notably, our participants displayed highly varied standards of "readiness" and "suitability". Whereas some preferred to respond only when emotionally and cognitively ready, or when they found it socially suitable, others responded regardless of such factors. Moreover, we found that some participants were more comfortable than others about indicating their non-readiness to the sender, whereas others preferred to wait to respond until they were fully prepared. The immense diversity in such perceptions could help to explain some of the variance in the participants' responsiveness even in very similar settings. Participants' different "standards" regarding what constitutes a suitable or an unsuitable situation also suggests that IM users' subjective perception is more crucial, at least to many participants, than the objective property of the context.

5.5. Pace and rhythm coordination

Lastly, the fifth element is *pace and rhythm coordination*. Unsurprisingly, given that many of our participants could perceive their own responses' pace and rhythm, some of them also perceived the response paces and rhythms of their conversation partners. However, their choices about whether and how to adjust or adapt their own behavior on that basis also varied among individuals. Nevertheless, we were able to observe two key factors in such individual differences: (1) how much the participant intended to manage his/her own availability and attention, and (2) how prosocial or empathetic s/he intended to be toward a given contact. Both these main species of intention tended to be achieved through intentionally responding faster or more slowly. The strength of these two intentions also varied among participants: while some displayed strong concern about their own availability, others would adapt to conversation partners' apparent needs. Likewise, some participants displayed strong empathy toward their conversation partners, while others expressed concerns only about themselves.

For example, one of the more empathetic subset of the participants, P14, said of one conversation partner: *"I feel he's the kind of person who reads and responds late. So I'd think that, since that's his pace, I'd follow and reply to him late. It's like once you gradually learned his habits, you'd be more and more like him, following his pace"*. P8, meanwhile, expressed a similar intention, but to increase her rhythm to adapt to a new acquaintance's fast one. On the other hand, the less empathetic group, who were more self-centered, perceived the existence of or potential for rhythm coordination, but consciously elected not to engage in it: e.g., *"I won't change myself [. . .] it's not something you can make me do"* (P39).

In another example, P31, who also tended to maintain his own pace, had perceived a partner as having a slow rhythm, but still kept up his own original fast rhythm. On occasions when P31 needed a fast response, but found that this same partner was maintaining the same slow pace, P31 became accusatory: *"Why didn't you read my message?"* P38, too, maintained her slow pace after finding that her boyfriend had a faster one. *"I just don't want to respond to him right away. [...] I think I may be just afraid that he would reply immediately, then I'd just need to continue chatting with him"*.

Of special interest were those participants who showed empathy for their conversation partners but were also concerned about their own autonomy. The members of this subgroup were acutely aware of the tension between their own and their contacts' rhythms. Unlike the examples given above, these participants neither intended to fully adapt to their conversational partners' rhythms, nor to make those partners fully adapt to theirs. Instead, they tried to "tune" their mutual communication to an "ideal pace" for both parties, using responsiveness as a tool. The participants who reported this precise type of coordination intention each appeared to have a relatively sophisticated grasp of both their own and their contacts' habitual responsiveness behaviors, preferences, and feelings. For instance, P3 told us that he lowered his responsiveness when he perceived that his conversation partner's slow

rhythm was in danger of being altered by his own fast one: *"I don't want to respond immediately, because that would pressurize him to respond to me quickly. [. . . Responding fast] could also increase my pressure, because I also did not want to have an intensive chat. I can imagine that if I respond quickly, he would soon make himself available for a proper conversation, and reply immediately. Then we would just go on. So, I'd keep my rhythm low"*. On the other hand, P30 and P41 both shared their intentions to sustain existing rhythms between themselves and their conversation partners. Specifically, P41 attempted to maintain an existing slow pace chiefly for the sake of his own comfort, whereas P30 did the same so as not *"to increase [. . .] trouble"* on the part of the contact.

Two counter-intuitive rhythm-coordination attempts were also reported by our participants, of which they: responded faster to prevent the contact's further escalating; and responded more slowly to prevent the contacts' further de-escalation. For the former, perhaps unexpectedly, participants linked the attempts to recover the backfire caused by rhythm-coordination attempts. P8, a slow responder, hoped to maintain her slow rhythm. However, a work-related contact who tended to respond fast, took this information as an excuse to further escalate P8's attention in more intrusive ways if P8 did not respond fast enough. Thus, P8 felt compelled to increase her pace, simply to avoid further escalation in the contact's attempts to gain her attention. For the latter, P38, on the other hand, who had a fast rhythm and hoped ultimately to increase her boyfriend's responsiveness, decided to lower her own responsiveness to stimulate his empathy and transform him into a more responsive person over the long term. She said that, while the final outcome of this campaign was not yet clear, she had also applied it to a close friend.

Finally, some participants perceived that they and their IM conversation partners had successfully coordinated and established a pace that both were aware of; and they therefore assumed that, when either party changed his/her pace, both would notice and seek to interpret the change's meaning. As P20 explained: *"I'd send him more messages, and he'd suddenly stop talking. I'd be wondering if he's mad. Although he's probably not, I would be thinking, 'You're gonna get my response as late as you respond to me.' Kind of like a revenge"*.

To sum up, while this element has not been sufficiently discussed in prior research, our data show that pace and rhythm coordination was a vital element behind many of our participants' responsiveness. Interestingly, unlike the other elements which mainly involved participants' in-the-moment considerations of contexts and communication contents, this element was unique in that it concerned mainly the long-term outcome, i.e., a desired long-term communicative pattern with the conversation partner, such that this element served as an ongoing process aimed to achieve this outcome.

5.6. Tensions between elements

While the various responsiveness factors identified above all had their separate impacts, we also identified tensions between them. First, our participants described a general, overriding effect on responsiveness of power relationships, which link to our construct of *perceived obligation*. For instance, their own mental and physical preparedness to respond took a back seat when the person expecting a response was an academic advisor (P11, P28) or boss (P27). Second, however, not every participant gave such weight to perceived interpersonal obligation. P16, for example, considered that her *need* for message content mattered the most: *"I may be less responsive to some of my superiors at work when their messages are just for chit-chatting. I may see their messages, but respond after half an hour. [...] I'd respond to another supervisor though, because the things she's requesting tend to be more urgent"*. And third, interestingly, some participants shared experiences of remaining responsive to contacts even in situations that most identified as inappropriate to respond in, such as in the workplace (P17) or in class (P27, P38), citing motivations such as boredom (P38).

These examples again demonstrate large differences in participants' perceptions of how each of the elements is weighted in their responsiveness decisions. As a result, it may not be surprising to observed diverse response behavior among IM users (Fig. 3). We believe that the five elements together constitute a useful integrated view that explain such varying final responsiveness outcomes among IM users. Below we discuss our results in more detail.

6. Discussion

The results presented above resonate with those of many prior studies. However, they also provide new insights into responsiveness, including new elements that have been little discussed in the literature, as well as new ways of interpreting the impact of contexts on responsiveness. Below, we discuss these new insights and their implications for future research and design of IM services.

6.1. What makes people (un)responsive? perception is the key

As noted earlier, prior research has established links between context and IM users' responsiveness, such as participants not wanting to respond when concentrating (Pejovic et al., 2015) or when the social context is inappropriate (Harrison et al., 2015; Schneider and Hitzfeld, 2019). Therefore, researchers have sought to develop awareness systems that provide contextual information about conversation partners, to enhance their mutual awareness of and to shape their mutual expectation of likely responsiveness (Cho et al., 2020b; Griggio et al., 2019; Hassib et al., 2017; Fogarty et al., 2004; Consolvo et al., 2005; Bilogrevic et al., 2013; Bales et al., 2011), which hopefully, may release users' pressure of being constantly responsive even in unsuitable situations. To a large extent, our findings confirm this connection between context and responsiveness. However, they further show that what mattered to our participants' responsiveness was not merely the objective properties of context – the main focus of prior research – but their subjective perceptions of their own readiness and suitability: whether they perceived that themselves were ready to respond to messages, and whether their contexts were suitable for doing so. That is, with our broad and in-depth inquiry on participants' response decisions in various contexts, we observed a variety of attitudes, behaviors, and decisions about responding, even in highly similar conditions, due to the participants' varied perceptions of contextual and relational elements; factors and facets relevant to responding to a given message; the relative weights of each factor they were considering; and/or standards of behavior. As such, whereas some participants were reluctant to respond when concentrating or when it was socially inappropriate or physically inconvenient, some others perceived responding in parallel situations to be acceptable, or even necessary. Likewise, while some participants were reluctant to respond to messages before they had fully prepared their replies' content, others responded no matter what, even when they perceived that their reply content was rough, because they perceived it to be more important to show they were responsive than to show they were prepared (Tyler and Tang, 2003). The vital role of individual differences has been reported in connection with various behaviors broadly relevant to the topic of the current study, including IM usage (Nardi et al., 2000; Grinter and Palen, 2002), texting in inappropriate social environments (Harrison et al., 2015; Schneider and Hitzfeld, 2019), and multitasking (Grinter and Palen, 2002; Nardi et al., 2000; Pejovic et al., 2015). Thus, we were not surprised to observe large discrepancies in our participants' reactions to contextual factors. That being said, this reconceptualization of the influence of context has critical research implications, as it shifts focus from objective properties to users' perceptions of those properties.

For example, in addition to measuring objective properties of context (as is commonly done via phone logging and/or the experience sampling method (ESM) in mobile-receptivity research, e.g., Schulze and Groh (2016), Chang and Tang (2015), Lee et al. (2019), Lin

et al. (2021b), Chang et al. (2019b)) and sharing them with conversation partners, researchers may start seeking ways to measure study participants' perception of their own readiness and suitability and to present it in awareness-sharing systems, respectively. We suggest future work examines quantitatively the correlations and influences between these subjective perceptions and the objective properties of contextual factors, because directly inferring users' responsiveness from objective context information is likely to fail to take account of important individual differences. It would be worthwhile to explore: (1) whether there are common threshold(s) of readiness and suitability among the general population IM users, or, among different clusters of IM users who display similar response behaviors, (2) which subtypes of perceived readiness and suitability are the most and least influential to IM responsiveness, (3) and how these subtypes interplay with other elements, such as need fulfillment, perceived obligation, and the desire to sustain and shape communication rhythms, in affecting responsiveness. The current study identifies these elements qualitatively, but cannot compare their relative weights; future quantitative research is needed to further examine their relationships.

It also bring research implications for personalized awareness systems. That is, prior research (Wu et al., 2021; Chou et al., 2022a) has shown that users have different choices of ways to present an online status to indicate their availability for communication. Our results add that the differences in their ultimate choices may be partially explained by their different thresholds of readiness and suitability for making a response. Consequently, to investigate users' ultimate choices of presentation, future work in studying awareness systems should inquire not merely about the outcomes of the chosen presentations but also the users' perceptions of the readiness and suitability behind these outcomes, such that associations between the outcomes and the perceptions can be established. These associations can be potentially useful for clustering users into groups such that future awareness system can be tailored for these groups accordingly.

6.2. Responsiveness as a tool in rhythm coordination

Among the five elements identified in this study, we are particularly interested in the instrumental use of responsiveness for coordinating dyads' communicative rhythms, especially as this phenomenon has rarely been discussed in the literature before. Though on the surface it seems quite similar to two IM and SMS behaviors, i.e., availability coordination and attention management, it seems to go well beyond either. Availability coordination is an explicit process of coordinating availability verbally (Ling and Lai, 2016; Ling and Yttri, 2002; Nardi et al., 2000), such as indicating one's (un)availability at a specific moment, or coordinating a future moment or alternate channel for communication (Handel and Herbsleb, 2002; Nardi et al., 2000). Attention management (Birnholtz et al., 2017), on the other hand, refers to individuals' message-sending or message-delaying behaviors aimed at escalating or de-escalating their communicative partners' attention to serve their own momentary needs, such as implying their own high or low availability. Both of those previously identified behavior types are subsumed by our identified five elements, such as need fulfillment or readiness and suitability. But, importantly, the aims of pace and rhythm coordination go beyond satisfying needs in the moment; rather, it is an ongoing process characterized by an intention to shape and/or sustain the turn-taking rhythm in a dyad, for the sake of establishing an ideal and/or comfortable interaction for the future. Such behavior entails users (1) being aware of their own rhythms and those of their conversation partners; (2) anticipating the impact of specific response delays on the conversation partner as well as on themselves; and (3) using responsiveness as a tool for coordination. None of these three types of actions are entailed by either availability coordination or attention management (as shown in Table 2). Rather, such behavior, as theorized in Donath (2007), is intended to deliver a *signal* of one's general, or possibly future, responsiveness toward the conversation partner, for the purpose of shaping and/or altering the partner's belief and in turn his/her future responding behavior (Donath, 2007).

The existence of this previously un-theorized type of coordination has implications for future research on responsiveness. That is, such research should consider the possibility that an observed response delay, rather than simply being an outcome of numerous factors, could easily be the manifestation of a desire to escalate or de-escalate attention, or even an entire relationship, or to "tune" a dyad's communication over the long term. Nevertheless, because this behavior was uncovered only in our semi-structured interviews, we cannot speak to its prevalence or its relationships with other responsiveness factors. It would therefore be worthwhile to understand this phenomenon through further research, both quantitative and qualitative. Quantitatively, for example, researchers could use questionnaires to measure users' perceptions of the consistency of their individual contacts' responsiveness, their desired or ideal communication pace between them and their conversation partners, the frequency of changes in their response speed, their awareness of such phenomena, and their reactions/coping strategies to them, and use the resulting data to analyze the prevalence of rhythm coordination. Further qualitative study, on the other hand, could seek a deeper understanding of what drives people to alter their pre-existing communication patterns, and what strategies they adopt to consciously coordinate their communication rhythms.

6.3. Design implication for instant messaging

Awareness systems and status indications have long received mixed feedback: they provide smooth and efficient semi-synchronized communication experiences for IM users (Hincapié-Ramos et al., 2011; Anderson et al., 2018; Wu et al., 2021), but at the same time cause them additional pressures and stress (Wu et al., 2021; Hoyle et al., 2017; Chou et al., 2022a). Based on our findings, we can tentatively attribute the latter phenomena to the lack of customizability of the availability statuses that address the influence of individual variation on IM responsiveness, and the fact that such statuses also often fail to reflect IM users' actual responsiveness.

Firstly, given the evident variation in IM response patterns, stakeholders are encouraged to rethink the customizability of availability statuses. Current IM systems only allow a person to share the same availability status throughout the platform. Most of the time, users can only choose from limited pre-defined statuses, such as online/offline or online/idle/do not disturb/away (e.g., Facebook Messenger, Slack, Discord). Because our participants perceived different levels of obligation to respond to different contacts, and that their desire to fulfill specific needs also varied from one contact to another, we recommend that future systems consider allowing users to group contacts and assign availability indicators to groups separately; or, to assign themselves a primary and a secondary status that are presented to different audiences. Such systems may be able to better tailor users' needs to present distinctive levels of responsiveness and to shape specific contacts' expectations about their responsiveness. On the other hand, prior research has established that users may be inconsistent in updating their availability indicators and repeated adjustments of such may be effortful for users (Begole et al., 2004). Thus, including an automation mechanism that learns about users' frequent choices for specific groups of contacts and prompts them with these learned choices to reduce the effort may be necessary to make the suggested feature be better utilized.

Second, we recommend that future systems extend the notion of context-aware statuses, moving beyond the current focus on objective context information, to information that manifests users' perceptions of their context, its suitability for engaging in IM communication, and their readiness for IM communication in such a context. In other words, it may be worthwhile to start thinking about how to make such a system become *perception-aware* and thus more able to address the influence of individual variation on IM responsiveness.

Table 2
Summary of microcoordination, attention management, rhythm adaptation and coordination.

Intention	Observed instances		
	Perceived partner's pace	Behaviors and quote examples	Responsiveness
		Microcoordination (Ling and Lai, 2016; Ling and Yttri, 2002)	
Coordinating availability	N/A	Coordinating available times or channels for communication by sending messages to contacts. "I'm at work tutoring and will talk to you later" (P6)	N/A
		Attention management (Birnholtz et al., 2017)	
(De)Escalating conversation partner's attention	N/A	(De)Escalating the partner's attention by sending (delaying) a message regardless of the current turn-taking in the conversation. "I will respond to her as quickly as I can, as she may only be available at that moment, and I would like to make sure that I could get her responses right away." (P34)	Respond quickly (slowly)
		Rhythm adaptation and coordination: Sustaining the current rhythm	
Sustaining the current rhythm	Slow	De-escalating one's partner's attention to maintain a slow rhythm "I don't want to increase his trouble. Every additional message would take him extra time to read. We both have a lot of messages. We both know it and we felt each other struggling to cope with them all. So yeah, I won't respond that soon." (P30)	Respond slowly
Preventing the conversation partner from changing the current rhythm	Fast	Responding faster to indicate one's own current availability, to prevent one's conversation partner from escalating one's own attention "Whenever I did not respond to him in an hour, he'd just call. So I'd try to respond to him as fast as I could." (P8)	Respond quickly
Reminding the conversation partner to return to the established rhythm	Becoming slower	Perceiving that one's conversation partner and oneself had coordinated and established a rhythm; responding slower to remind the partner that one has noticed the change in rhythm. "I'd send him more messages, and he'd suddenly stop talking. I'd be wondering if he's mad. Although he's probably not, I would be thinking, 'You're gonna get my response as late as you respond to me.' Kind of like a revenge. He's probably not mad, but then he'd think I'm mad [because I respond slowly.]" (P20)	Respond slowly
		Rhythm Adaptation and Coordination: Adjusting the Current Rhythm	
Adapting to the conversation partner's rhythm	Fast (Slow)	Being aware of one's conversation partner's faster (slower) rhythm, and adapting oneself to that faster (slower) rhythm. "I feel he's the kind of person who reads and responds late. So I'd think that, since that's his pace, I'd follow and reply to him late. It's like once you gradually learned his habits, you'd be more and more like him, following his pace." (P14)	Respond quickly (slowly)
Changing the conversation partner's rhythm to one's own comfortable rhythm	Fast (Slow)	Being aware of one's conversation partner's faster (slower) rhythm, and hoping that s/he adapt to one's own slower (faster) rhythm by indicating one's own rhythm or questioning the partner's pace "Sometimes I just don't want to respond to him right away. I don't know. I just don't want to. [...] I think I may just be afraid that he will reply immediately too, and then I'd need to continue chatting with him." (P8)	Respond slowly (quickly)
Returning the conversation partner's rhythm to his/her comfortable rhythm	Fast	De-escalating one's conversation partner's attention, to reduce his/her pressure to respond quickly "I don't want to respond [to him] immediately, because that would give him a pressure to respond to me quickly. [...Responding fast] could also increase my pressure, because I actually did not want to have an intensive chat. I can imagine that if I respond quickly, he would soon make himself available for the conversation, and would reply immediately too. Then we would just go on, spending some time on a not-really-important topic. So I'd keep my rhythm low." (P3)	Respond slowly
Hoping the conversation partner will ultimately change his/her rhythm	Slow	Imitating the conversation partner's pace to put him/her "in one's own shoes" and hopefully respond faster in the future. "He often suddenly becomes unresponsive in the middle of our conversation and says, for example, that he was watching a video. I can get mad about that. So I also sometimes intentionally and randomly stop responding to his messages. I am not doing anything else actually, I just want him to put himself in my shoes." (P38)	Respond slowly

Third, recent research has begun seeking ways to help IM users chat with newly met acquaintances, such as by providing topic suggestions that will help them build their friendships (Nguyen et al., 2015). Such research is demand-driven, in the sense that people increasingly have opportunities to meet, converse with, and form fairly close relationships with new people online (Masden and Edwards, 2015): a process in which responsiveness is crucial (Ramirez and Broneck, 2009; Walther, 1996; Reis et al., 2004; Vanlear Jr., 1987). Accordingly, we deem that it might be worthwhile to make users more aware of one another's habitual responsiveness, possibly even within specific periods or contexts, to help them set realistic and appropriate mutual-responsiveness expectations, such as displaying that the conversation partner "typically responds in 30 min", or "is often not responsive during this time". Prior research has explored the use of language and ways of presentation for indicating responsiveness on awareness systems (e.g., Wu et al., 2021; Chou et al., 2022a). We recommend developers interested in implementing this feature take their findings and design suggestions into account, such as that users may be worried about showing unavailability may signal themselves as being distant to their IM contacts (Chou et al., 2022a). This awareness is likely to reduce frictions and negative feelings caused by over-expectations or under-expectations regarding new conversation partners' responsiveness, which may cause pressure (Wu et al., 2021; Hoyle et al., 2017), frustration (Hoyle et al., 2017), and even termination of the relationship-formation process (Zytko et al., 2014).

As rhythm coordination is a means for users to negotiate their communication rhythms, recognizing partners' responsiveness as differing from one's own is a crucial first step for future coordination and negotiation.

Fourth, it might be worth exploring new means of detecting rhythm changes in responsiveness (often referred to as anomaly detection in pattern recognition), as such changes are another reason users initiate rhythm coordination. Such detection may remind users of their own changes that may feel unpleasant to their conversation partners. On the other hand, such reminders may backfire, i.e., become a new source of pressure to maintain responsiveness; and thus, more research would be needed to investigate users' acceptance of such cues.

6.4. Limitations

This paper has several important limitations. First, it has been based on findings derived from interview data, with the aim of identifying the factors that underlie our participants' responsiveness. As such, it was not possible to conduct quantitative analysis to make quantitative claims such as about prevalence of, strength of, and correlation between the five elements and the ultimate responsiveness of the participants. Such claims would need future research to investigate how one set of elements may influence another. Second, it focused on responsiveness to individual IM contacts, and thus, its findings may not be generalizable to group chats. Third, we did not formally analyze our participants' personalities or how they might affect their responsiveness. Fourth, while prior research has discussed how application features such as read-receipt (Chou et al., 2022b) and ephemerality of messages (Thomson et al., 2018) may impact IM users' behavior in handling messages, the current paper offers limited findings related to how technological affordances and features affected participants' responsiveness. We made the decision of not analyzing how application-specific features influenced the participants' responsiveness because we aimed to uncover elements of responsiveness that would be applicable across various IM applications regardless of their affordances and features. However, we note that this decision was under an assumption that if we were to associate the elements with specific features, elements that reflected these features would be irrelevant once certain features were modified. Alternatively, we categorized influences of features under the five elements whenever we found a participant's reflection about a feature, with appropriate follow-up, was a reflection of his/her experience or concern about one of the five elements. To gain more insights into how IM responsiveness relates to technological characteristics, future research is needed to further investigate this topic. Fifth, while we utilized the participants' questionnaire responses as prompts in the interviews, and encouraged them to check their conversation histories with their IM contacts pre-interview to recall their IM behaviors with particular ones, their responses could still have been affected by recall bias. Thus, we must emphasize that the findings of this study about the influence of each factor can only represent participants' own perceptions. Therefore, again, the prevalence/frequency of the five elements of our framework must await examination in future research, such as via experience sampling studies that sample messages and ask participants about how the five elements play a role in affecting their in-situ response decisions to these sampled messages. Sixth, the paper does not consider how the message receivers actually perceive the senders' intentions. That is, we did not know whether our participants' intentions that they received/delivered aligned with those of their contacts. Lastly, as our study was conducted in Taiwan and focused on the two most popular IM services there, it is uncertain how generalizable its findings might be to populations with different cultures, languages, and/or IM application preferences. Thus, we invite other researchers to examine the five elements of our proposed framework in their own cultural settings.

7. Conclusion

This qualitative research paper aimed to answer the question, *Why are IM users (un)responsive when receiving messages?* We identified five elements – response habits, need fulfillment, perceived obligation, perceived readiness and suitability, and pace and rhythm coordination – as underlying responsiveness. Together, they comprise a new framework for explaining and conceptualizing responsiveness. In particular, IM users' perceptions of their own readiness to respond, and the suitability of the situation for responding, appeared to be key to whether context actually influenced responsiveness, irrespective of such context's objective properties. We also observed that, often, responsiveness was not a consequence of external factors, but rather a manifestation of an intention to achieve specific purposes. One noteworthy such purpose was long-term shaping or "tuning" of the pace and rhythm of communication within a dyad. We believe that these results represent a major contribution to the responsiveness literature, and highlight some very promising avenues for future research.

CRediT authorship contribution statement

Hao-Ping (Hank) Lee: Conceptualization, Methodology, Formal Analysis, Investigation, Data curation, Writing – original draft, Writing –review & editing, Project administration. **Yi-Shyuan Chiang:** Data curation, Formal Analysis, Writing – original draft, Writing – review & editing. **Yu-Ling Chou:** Writing – original draft, Writing – review & editing. **Kung-Pai Lin:** Investigation, Formal Analysis, Writing – original draft. **Yung-Ju Chang:** Conceptualization, Methodology, Formal Analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Yung-Ju Chang reports financial support was provided by National Science and Technology Council.

Data availability

The authors do not have permission to share data.

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References

Al-Saggaf, Y., MacCulloch, R., 2019. Phubbing and social relationships: Results from an Australian sample. J. Relationsh. Res. 10, e10. http://dx.doi.org/10.1017/jrr.2019.9.

Anderson, C., Hübener, I., Seipp, A.-K., Ohly, S., David, K., Pejovic, V., 2018. A survey of attention management systems in ubiquitous computing environments. Proc. ACM Interact. Mob. Wearable Ubiquit. Technol. 2 (2), http://dx.doi.org/10.1145/3214261.

Avrahami, D., Fussell, S.R., Hudson, S.E., 2008. IM waiting: Timing and responsiveness in semi-synchronous communication. In: Proceedings of the 2008 ACM Conference on Computer Supported Cooperative Work. CSCW '08, Association for Computing Machinery, New York, NY, USA, ISBN: 9781605580074, pp. 285–294. http://dx.doi.org/10.1145/1460563.1460610.

Avrahami, D., Hudson, S.E., 2006a. Communication characteristics of instant messaging: Effects and predictions of interpersonal relationships. In: Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work. CSCW '06, Association for Computing Machinery, New York, NY, USA, ISBN: 1595932496, pp. 505–514. http://dx.doi.org/10.1145/1180875.1180954.

Avrahami, D., Hudson, S.E., 2006b. Responsiveness in instant messaging: Predictive models supporting inter-personal communication. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI '06, Association for Computing Machinery, New York, NY, USA, ISBN: 1595933727, pp. 731–740. http://dx.doi.org/10.1145/1124772.1124881.

Bales, E., Li, K.A., Griwsold, W., 2011. CoupleVIBE: Mobile implicit communication to improve awareness for (long-distance) couples. In: Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work. CSCW '11, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450305563, pp. 65–74. http://dx.doi.org/10.1145/1958824.1958835.

Barron, G., Yechiam, E., 2002. Private e-mail requests and the diffusion of responsibility. Comput. Hum. Behav. 18 (5), 507–520. http://dx.doi.org/10.1016/s0747-5632(02)00007-9.

Battestini, A., Setlur, V., Sohn, T., 2010. A large scale study of text-messaging use. In: Proceedings of the 12th International Conference on Human Computer Interaction with Mobile Devices and Services. pp. 229–238.

Begole, J.B., Matsakis, N.E., Tang, J.C., 2004. Lilsys: sensing unavailability. In: Proceedings of the 2004 ACM Conference on Computer Supported Cooperative Work. pp. 511–514.

Bilogrevic, I., Huguenin, K., Agir, B., Jadliwala, M., Hubaux, J.-P., 2013. Adaptive information-sharing for privacy-aware mobile social networks. In: Proceedings of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing. UbiComp '13, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450317702, pp. 657–666. http://dx.doi.org/10.1145/2493432.2493510.

Birnholtz, J., Davison, J., Li, A., 2017. Attending to attention: How do people attract, manage, and negotiate attention using mobile devices? Mob. Media Commun. 5 (3), 256–274. http://dx.doi.org/10.1177/2050157917714504.

Birnholtz, J., Reynolds, L., Smith, M.E., Hancock, J., 2013. "Everyone Has to Do It:" A joint action approach to managing social inattention. Comput. Hum. Behav. 29 (6), 2230–2238. http://dx.doi.org/10.1016/j.chb.2013.05.004.

Burke, M., Kraut, R.E., 2016. The relationship between facebook use and well-being depends on communication type and tie strength. J. Comput.-Mediat. Commun. 21 (4), 265–281. http://dx.doi.org/10.1111/jcc4.12162.

Chang, Y.-J., Chung, Y.-J., Shih, Y.-H., 2019a. I think it's her: Investigating smartphone users' speculation about phone notifications and its influence on attendance. In: Proceedings of the 21st International Conference on Human-Computer Interaction with Mobile Devices and Services. pp. 1–13.

Chang, Y.-J., Chung, Y.-J., Shih, Y.-H., 2019b. I think it's her: Investigating smartphone users' speculation about phone notifications and its influence on attendance. In: Proceedings of the 21st International Conference on Human-Computer Interaction with Mobile Devices and Services. MobileHCI '19, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450368254, http://dx.doi.org/10.1145/3338286.3340125.

Chang, Y.-J., Tang, J.C., 2015. Investigating mobile users' ringer mode usage and attentiveness and responsiveness to communication. In: Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services. MobileHCI '15, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450336529, pp. 6–15. http://dx.doi.org/10.1145/2785830.2785852.

Chesebro, J.W., 1985. Computer-mediated interpersonal communication. In: Information and Behavior. Transaction Books, pp. 202–222.

Cho, H., Oh, J., Kim, J., Lee, S.-J., 2020a. I share, you care: Private status sharing and sender-controlled notifications in mobile instant messaging. Proc. ACM Hum.-Comput. Interact. 4 (CSCW1), 1–25.

Cho, H., Oh, J., Kim, J., Lee, S.-J., 2020b. I share, you care: Private status sharing and sender-controlled notifications in mobile instant messaging. Proc. ACM Hum.-Comput. Interact. 4 (CSCW1), http://dx.doi.org/10.1145/3392839.

Chou, Y.-L., Chien, Y.-L., Lin, Y.-H., Lin, K.-P., Shih, F., Chang, Y.-J., 2022a. Because i'm restricted, 2–4 PM unable to see messages: Exploring users' perceptions and likely practices around exposing attention management use on IM online status. In: CHI Conference on Human Factors in Computing Systems. pp. 1–18.

Chou, Y.-L., Lin, Y.-H., Lin, T.-Y., You, H.Y., Chang, Y.-J., 2022b. Why did you/i read but not reply? IM users' unresponded-to read-receipt practices and explanations of them. In: CHI Conference on Human Factors in Computing Systems. pp. 1–15.

Church, K., de Oliveira, R., 2013. What's up with whatsapp? Comparing mobile instant messaging behaviors with traditional SMS. In: Proceedings of the 15th International Conference on Human-Computer Interaction with Mobile Devices and Services. MobileHCI '13, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450322737, pp. 352–361. http://dx.doi.org/10.1145/2493190.2493225.

Consolvo, S., Smith, I.E., Matthews, T., LaMarca, A., Tabert, J., Powledge, P., 2005. Location disclosure to social relations: Why, when, & what people want to share. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA, ISBN: 1581139985, pp. 81–90.

Cox, A.L., Bird, J., Brumby, D.P., Cecchinato, M.E., Gould, S.J., 2021. Prioritizing unread e-mails: People send urgent responses before important or short ones. Hum.–Comput. Interact. 36 (5–6), 511–534.

Czerwinski, M., Cutrell, E., Horvitz, E., 2000. Instant messaging: Effects of relevance and timing. In: People and Computers XIV: Proceedings of HCI 2000, vol. 2, People and Computers XIV: Proceedings of HCI 2000 pp. 71–76, URL https://www.microsoft.com/en-us/research/publication/instant-messaging-effects-of-relevance-and-timing/.

Dabbish, L.A., Kraut, R.E., Fussell, S., Kiesler, S., 2005. Understanding email use. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI 05. http://dx.doi.org/10.1145/1054972.1055068.

Davis, M., 1982. Interaction Rhythms: Periodicity in Communicative Behavior. Human Sciences Press.

Devito, J.H.A., 2018. Interpersonal Communication Book, global ed. PEARSON EDUCATION Limited.

Dienlin, T., Masur, P.K., Trepte, S., 2017. Reinforcement or displacement? The reciprocity of FtF, IM, and SNS communication and their effects on loneliness and life satisfaction. J. Comput.-Med. Commun. 22 (2), 71–87. http://dx.doi.org/10.1111/jcc4.12183.

Dingler, T., Pielot, M., 2015. I'll be there for you: Quantifying attentiveness towards mobile messaging. In: Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services. MobileHCI '15, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450336529, pp. 1–5. http://dx.doi.org/10.1145/2785830.2785840.

Dogruel, L., Schnauber-Stockmann, A., 2021. What determines instant messaging communication? Examining the impact of person-and situation-level factors on IM responsiveness. Mob. Media Commun. 9 (2), 210–228.

Donath, J., 2007. Signals, cues and meaning. Signals, Truth and Design.

Farnham, S.D., Churchill, E.F., 2011. Faceted identity, faceted lives: Social and technical issues with being yourself online. In: Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work. CSCW '11, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450305563, pp. 359–368. http://dx.doi.org/10.1145/1958824.1958880.

Feldstein, S., 1982. Impression formation in dyads: The temporal dimension. In: Interaction Rhythms: Periodicity in Communicative Behavior. Human Sciences Press, pp. 207–224.

Fischer, J.E., Greenhalgh, C., Benford, S., 2011. Investigating episodes of mobile phone activity as indicators of opportune moments to deliver notifications. In: Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services - MobileHCI 11. http://dx.doi.org/10.1145/2037373.2037402.

Fogarty, J., Lai, J., Christensen, J., 2004. Presence versus availability: the design and evaluation of a context-aware communication client. Int. J. Hum.-Comput. Stud. 61 (3), 299–317. http://dx.doi.org/10.1016/j.ijhcs.2003.12.016.

Griggio, C.F., Nouwens, M., McGrenere, J., Mackay, W.E., 2019. Augmenting couples' communication with lifelines: Shared timelines of mixed contextual information. In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems. Association for Computing Machinery, New York, NY, USA, ISBN: 9781450359702, pp. 1–13.

Grinter, R.E., Palen, L., 2002. Instant messaging in teen life. In: Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work - CSCW 02. http://dx.doi.org/10.1145/587078.587082.

Hall, J.A., Baym, N.K., 2012. Calling and texting (too much): Mobile maintenance expectations, (over)dependence, entrapment, and friendship satisfaction. New Media Soc. 14 (2), 316–331. http://dx.doi.org/10.1177/1461444811415047.

Hancock, J., Birnholtz, J., Bazarova, N., Guillory, J., Perlin, J., Amos, B., 2009. Butler lies. In: Proceedings of the 27th International Conference on Human Factors in Computing Systems - CHI 09. http://dx.doi.org/10.1145/1518701.1518782.

Handel, M., Herbsleb, J.D., 2002. What is chat doing in the workplace? In: Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work - CSCW 02. http://dx.doi.org/10.1145/587078.587080.

Harrison, M.A., Bealing, C.E., Salley, J.M., 2015. 2 TXT or not 2 TXT: College students' reports of when text messaging is social breach. Soc. Sci. J. 52 (2), 188–194. http://dx.doi.org/10.1016/j.soscij.2015.02.005.

Hassib, M., Buschek, D., Wozniak, P.W., Alt, F., 2017. HeartChat: Heart rate augmented mobile chat to support empathy and awareness. In: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. CHI '17, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450346559, pp. 2239–2251. http://dx.doi.org/10.1145/3025453.3025758.

Hesse, B.W., Werner, C.M., Altman, I., 1988. Temporal aspects of computer-mediated communication. Comput. Hum. Behav. 4 (2), 147–165. http://dx.doi.org/10.1016/0747-5632(88)90023-4.

Heston, M., Birnholtz, J., 2017. Worth the wait?: The effect of responsiveness on interpersonal attraction among known acquaintances. Lect. Notes Comput. Sci. Collab. Technol. 164–179. http://dx.doi.org/10.1007/978-3-319-63874-4_13.

Hincapié-Ramos, J.D., Voida, S., Mark, G., 2011. A design space analysis of availability-sharing systems. In: Proceedings of the 24th Annual ACM Symposium on User Interface Software and Technology. pp. 85–96.

Hoyle, R., Das, S., Kapadia, A., Lee, A.J., Vaniea, K., 2017. Was my message read? privacy and signaling on facebook messenger. In: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. pp. 3838–3842.

Iqbal, S.T., Bailey, B.P., 2005. Investigating the effectiveness of mental workload as a predictor of opportune moments for interruption. In: CHI 05 Extended Abstracts on Human Factors in Computing Systems - CHI 05. http://dx.doi.org/10.1145/1056808.1056948.

Isaacs, E., Walendowski, A., Whittaker, S., Schiano, D.J., Kamm, C., 2002. The character, functions, and styles of instant messaging in the workplace. In: Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work - CSCW 02. http://dx.doi.org/10.1145/587078.587081.

Jaffe, J., Feldstein, S., 1970. Rhythms of Dialogue. Acad. Press.

Jain, P., Farzan, R., Lee, A.J., 2022. Laila is in a meeting: Design and evaluation of a contextual auto-response messaging agent. In: Designing Interactive Systems Conference. pp. 1457–1471.

Kalman, Y.M., Rafaeli, S., 2005. Email chronemics: Unobtrusive profiling of response times. In: Proceedings of the 38th Annual Hawaii International Conference on System Sciences. (ISSN: 1530-1605) p. 108b. http://dx.doi.org/10.1109/HICSS.2005.231.

Kalman, Y.M., Ravid, G., Raban, D.R., Rafaeli, S., 2006. Pauses and response latencies: A chronemic analysis of asynchronous CMC. J. Comput.-Med. Commun. 12 (1), 1–23. http://dx.doi.org/10.1111/j.1083-6101.2006.00312.x.

Kalman, Y., Ravid, G., Raban, D., Rafaeli, S., 2007. Are you still waiting for an answer? The chronemics of asynchronous written CMC.

Katz, J., Aakhus, M., 2001. Perpetual Contact: Mobile Communication, Private Talk, Public Performance. http://dx.doi.org/10.1017/CBO9780511489471.

Kelly, R., Gooch, D., Watts, L., 2018. Its more like a letter. In: Proceedings of the ACM on Human-Computer Interaction, vol. 2, CSCW. pp. 1–23. http://dx.doi.org/10.1145/3274356.

Komninos, A., Frengkou, E., Garofalakis, J., 2018. Predicting user responsiveness to smartphone notifications for edge computing. In: Lecture Notes in Computer Science Ambient Intelligence. pp. 3–19. http://dx.doi.org/10.1007/978-3-030-03062-9_1.

Kooti, F., Aiello, L.M., Grbovic, M., Lerman, K., Mantrach, A., 2015. Evolution of conversations in the age of email overload. In: Proceedings of the 24th International Conference on World Wide Web - WWW 15. http://dx.doi.org/10.1145/2736277.2741130.

Kushlev, K., Cardoso, B., Pielot, M., 2017. Too tense for candy crush: Affect influences user engagement with proactively suggested content. In: Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services. MobileHCI '17, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450350754, http://dx.doi.org/10.1145/3098279.3098569.

Lanctot, A., Duxbury, L., 2022. Measurement of perceived importance and urgency of email: An employees' perspective. J. Comput.-Med. Commun. 27 (2), zmac001.

Lee, H.-P., Chen, K.-Y., Lin, C.-H., Chen, C.-Y., Chung, Y.-L., Chang, Y.-J., Sun, C.-R., 2019. Does who matter? In: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems - CHI 19. http://dx.doi.org/10.1145/3290605.3300756.

Lin, K.-P., Lee, H.-P., Chou, Y.-L., Shih, F., Chang, Y.-J., 2021a. Distinguishing IM communication patterns with relationship and conversation topics. In: Companion Publication of the 2021 Conference on Computer Supported Cooperative Work and Social Computing. pp. 121–125.

Lin, T.-C., Su, Y.-S., Yang, E.H., Chen, Y.H., Lee, H.-P., Chang, Y.-J., 2021b. "Put it on the top, i'll read it later": Investigating users' desired display order for smartphone notifications. In: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems. pp. 1–13.

Ling, R., Lai, C.-H., 2016. Microcoordination 2.0: Social coordination in the age of smartphones and messaging apps. J. Commun. 66 (5), 834–856. http://dx.doi.org/10.1111/jcom.12251.

Ling, R., Yttri, B., 2002. Hyper-coordination via mobile phones in Norway. In: Katz, J.E., Aakhus, M. (Eds.), Perpetual Contact: Mobile Communication, Private Talk, Public Performance. Cambridge University Press, pp. 139–169. http://dx.doi.org/10.1017/CBO9780511489471.013.

Liu, Y., Ginther, D., Zelhart, P., 2001. How do frequency and duration of messaging affect impression development in computer-mediated communication? J. UCS 7 (10), 893–914. http://dx.doi.org/10.3217/jucs-007-10-0893.

Lynden, J., Rasmussen, T., 2017. Exploring the impact of'read receipts' in Mobile Instant Messaging. Tidsskrift for Medier, Erkendelse Og Formidling 5 (1).

Maginnis, J.A., 2011. Texting in the presence of others: The use of politeness strategies in conversation. URL https://uknowledge.uky.edu/gradschool_diss/147.

Mai, L.M., Freudenthaler, R., Schneider, F.M., Vorderer, P., 2015. "I know you've seen it!" individual and social factors for users' chatting behavior on facebook. Comput. Hum. Behav. (ISSN: 0747-5632) 49 (C), 296–302. http://dx.doi.org/10.1016/j.chb.2015.01.074.

Masden, C., Edwards, W.K., 2015. Understanding the role of community in online dating. In: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems. pp. 535–544.

McLaughlin, M.L., 1984. How talk is organized. Beverly Hills-London-New Delhi.

Mehrotra, A., Musolesi, M., 2017. Intelligent notification systems: A survey of the state of the art and research challenges. CoRR arXiv:1711.10171.

Mehrotra, A., Musolesi, M., Hendley, R., Pejovic, V., 2015. Designing content-driven intelligent notification mechanisms for mobile applications. In: Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing. UbiComp '15, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450335744, pp. 813–824. http://dx.doi.org/10.1145/2750858.2807544.

Mehrotra, A., Pejovic, V., Vermeulen, J., Hendley, R., Musolesi, M., 2016. My phone and me: Understanding People's receptivity to mobile notifications. In: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems. CHI '16, ACM, New York, NY, USA, ISBN: 978-1-4503-3362-7, pp. 1021–1032. http://dx.doi.org/10.1145/2858036.2858566, URL http://doi.acm.org/10.1145/2858036.2858566.

Min, J.-K., Wiese, J., Hong, J.I., Zimmerman, J., 2013. Mining smartphone data to classify life-facets of social relationships. In: Proceedings of the 2013 Conference on Computer Supported Cooperative Work. CSCW '13, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450313315, pp. 285–294. http://dx.doi.org/10.1145/2441776.2441810.

Nardi, B.A., Whittaker, S., Bradner, E., 2000. Interaction and outeraction. In: Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work - CSCW 00. http://dx.doi.org/10.1145/358916.358975.

Nguyen, T.T., Nguyen, D.T., Iqbal, S.T., Ofek, E., 2015. The known stranger: Supporting conversations between strangers with personalized topic suggestions. In: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems. pp. 555–564.

Okoshi, T., Ramos, J., Nozaki, H., Nakazawa, J., Dey, A.K., Tokuda, H., 2015. Reducing users' perceived mental effort due to interruptive notifications in multi-device mobile environments. In: Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing. UbiComp '15, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450335744, pp. 475–486. http://dx.doi.org/10.1145/2750858.2807517.

Okoshi, T., Tsubouchi, K., Taji, M., Ichikawa, T., Tokuda, H., 2017. Attention and engagement-awareness in the wild: A large-scale study with adaptive notifications. In: 2017 IEEE International Conference on Pervasive Computing and Communications (PerCom). pp. 100–110. http://dx.doi.org/10.1109/PERCOM.2017.7917856.

Ozenc, F.K., Farnham, S.D., 2011. Life "modes" in social media. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI '11, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450302289, pp. 561–570. http://dx.doi.org/10.1145/1978942.1979022.

Pejovic, V., Musolesi, M., Mehrotra, A., 2015. Investigating the role of task engagement in mobile interruptibility. In: Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct - MobileHCI 15. http://dx.doi.org/10.1145/2786567.2794336.

Pettigrew, J., 2009. Text messaging and connectedness within close interpersonal relationships. Marriage Family Rev. 45 (6–8), 697–716. http://dx.doi.org/10.1080/01494920903224269.

Pielot, M., Cardoso, B., Katevas, K., Serrà, J., Matic, A., Oliver, N., 2017. Beyond interruptibility. In: Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, vol. 1. pp. 1–25. http://dx.doi.org/10.1145/3130956.

Pielot, M., de Oliveira, R., Kwak, H., Oliver, N., 2014. Didn't you see my message? Predicting attentiveness to mobile instant messages. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI '14, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450324731, pp. 3319–3328. http://dx.doi.org/10.1145/2556288.2556973.

Pielot, M., Vradi, A., Park, S., 2018. Dismissed! a detailed exploration of how mobile phone users handle push notifications. In: Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services. MobileHCI '18, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450358989, http://dx.doi.org/10.1145/3229434.3229445.

Podlubny, M., Rooksby, J., Rost, M., Chalmers, M., 2017. Synchronous text messaging: A field trial of curtains messenger. In: Proceedings of the ACM on Human-Computer Interaction, vol. 1, CSCW. ACM New York, NY, USA, pp. 1–20.

Puranik, H., Koopman, J., Vough, H.C., 2019. Pardon the interruption: An integrative review and future research agenda for research on work interruptions. J. Manage. 46 (6), 806–842. http://dx.doi.org/10.1177/0149206319887428.

Ramirez, A., Broneck, K., 2009. 'Im me: Instant messaging as relational maintenance and everyday communication. J. Soc. Pers. Relationsh. 26 (2–3), 291–314. http://dx.doi.org/10.1177/0265407509106719.

Rao, S., Chen, J., Jeffries, R., Boardman, R., 2009. "You've got ims!" how people manage concurrent instant messages. In: International Conference on Human-Computer Interaction. Springer, pp. 500–509.

Reis, H.T., Clark, M.S., Holmes, J.G., 2004. Perceived partner responsiveness as an organizing construct in the study of intimacy and closeness.

Reynolds, L., Smith, M.E., Birnholtz, J.P., Hancock, J.T., 2013. Butler lies from both sides. In: Proceedings of the 2013 Conference on Computer Supported Cooperative Work - CSCW 13. http://dx.doi.org/10.1145/2441776.2441862.

Ryan, R., Deci, E., 2008. Self-determination theory and the role of basic psychological needs in personality and the organization of behavior. In: Handbook of Personality: Theory and Research.

Sacks, H., Schegloff, E., Jefferson, G., 1974. A simple systematic for the organisation of turn taking in conversation. Language 50, 696–735. http://dx.doi.org/10.2307/412243.

Schneider, F.M., Hitzfeld, S., 2019. I ought to put down that phone but I phub nevertheless: Examining the predictors of phubbing behavior. Soc. Sci. Comput. Rev. 089443931988236. http://dx.doi.org/10.1177/0894439319882365.

Schönbach, P., 2010. Account Episodes: The Management Or Escalation of Conflict. Cambridge University Press.

Schulze, F., Groh, G., 2014. Studying how character of conversation affects personal receptivity to mobile notifications. In: Proceedings of the Extended Abstracts of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI EA 14. http://dx.doi.org/10.1145/2559206.2581320.

Schulze, F., Groh, G., 2016. Conversational context helps improve mobile notification management. In: Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services. MobileHCI '16, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450344081, pp. 518–528. http://dx.doi.org/10.1145/2935334.2935347.

Sheldon, K., Elliot, A., Kim, Y., Kasser, T., 2001. What is satisfying about satisfying events? Testing 10 candidate psychological needs. J. Personal. Soc. Psychol. 80, 325–339. http://dx.doi.org/10.1037/0022-3514.80.2.325.

Smith, A., Williams, K.D., 2004. R u there? Ostracism by cell phone text messages. Group Dyn.: Theory Res. Pract. 8 (4), 291–301. http://dx.doi.org/10.1037/1089-2699.8.4.291.

Sosik, V.S., Bazarova, N.N., 2014. Relational maintenance on social network sites: How Facebook communication predicts relational escalation. Comput. Hum. Behav. 35, 124–131. http://dx.doi.org/10.1016/j.chb.2014.02.044.

Thomson, L., Lee, A.J., Farzan, R., 2018. Ephemeral communication and communication places. In: International Conference on Information. Springer, pp. 132–138.

Tikkanen, S.A., Frisbie, A., 2015. When bad timing is actually good: Reconceptualizing response delays. In: Debates for the Digital Age: The Good, the Bad, and the Ugly of Our Online World [2 Volumes]: The Good, the Bad, and the Ugly of Our Online World. ABC-CLIO, p. 305.

Tu, P.-Y., Yuan, C.W.T., Wang, H.-C., 2018. Do you think what I think: Perceptions of delayed instant messages in computer-mediated communication of romantic relations. In: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems. CHI '18, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450356206, pp. 1–11. http://dx.doi.org/10.1145/3173574.3173675.

Turner, L.D., Allen, S.M., Whitaker, R.M., 2015a. Interruptibility prediction for ubiquitous systems: Conventions and new directions from a growing field. In: Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing. UbiComp '15, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450335744, pp. 801–812. http://dx.doi.org/10.1145/2750858.2807514.

Turner, L.D., Allen, S.M., Whitaker, R.M., 2015b. Push or delay? Decomposing smartphone notification response behaviour. In: Human Behavior Understanding Lecture Notes in Computer Science. pp. 69–83. http://dx.doi.org/10.1007/978-3-319-24195-1_6.

Turner, L.D., Allen, S.M., Whitaker, R.M., 2017. Reachable but not receptive: Enhancing smartphone interruptibility prediction by modelling the extent of user engagement with notifications. Pervasive Mob. Comput. 40, 480–494. http://dx.doi.org/10.1016/j.pmcj.2017.01.011.

Tyler, J.R., Tang, J.C., 2003. When can I expect an email response? A study of rhythms in email usage. Ecscw 2003 239–258. http://dx.doi.org/10.1007/978-94-010-0068-0_13.

Vanlear Jr., C.A., 1987. The formation of social relationships: A longitudinal study of social penetration. Hum. Commun. Res. 13 (3), 299–322.

Vorderer, P., Hefner, D., Reinecke, L., Klimmt, C., 2017. Permanently online, permanently connected: Living and communicating in a POPC world. Routledge.

Vorderer, P., Krömer, N., Schneider, F.M., 2016. Permanently online – Permanently connected: Explorations into university students' use of social media and mobile smart devices. Comput. Hum. Behav. (ISSN: 0747-5632) 63, 694–703. http://dx.doi.org/10.1016/j.chb.2016.05.085, URL http://www.sciencedirect.com/science/article/pii/S0747563216304216.

Walther, J.B., 1992. Interpersonal effects in computer-mediated interaction. Commun. Res. 19 (1), 52–90. http://dx.doi.org/10.1177/009365092019001003.

Walther, J.B., 1996. Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. Commun. Res. 23 (1), 3–43. http://dx.doi.org/10.1177/009365096023001001.

Walther, J.B., Tidwell, L.C., 1995. Nonverbal cues in computer-mediated communication, and the effect of chronemics on relational communication. J. Organ. Comput. 5 (4), 355–378. http://dx.doi.org/10.1080/10919399509540258.

Weber, D., Voit, A., Henze, N., 2019. Clear all: A large-scale observational study on mobile notification drawers. In: Proceedings of Mensch Und Computer 2019. MuC '19, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450371988, pp. 361–372. http://dx.doi.org/10.1145/3340764.3340765.

Whittaker, S., Sidner, C., 1996. Email overload: Exploring personal information management of email. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI '96, Association for Computing Machinery, New York, NY, USA, ISBN: 0897917774, pp. 276–283. http://dx.doi.org/10.1145/238386.238530.

Wiese, J., Min, J.-K., Hong, J.I., Zimmerman, J., 2015. "You never call, you never write": Call and SMS logs do not always indicate tie strength. In: Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing. CSCW '15, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450329224, pp. 765–774. http://dx.doi.org/10.1145/2675133.2675143.

Wohn, D.Y., Birnholtz, J., 2015. From ambient to adaptation: Interpersonal attention management among Young adults. In: Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services. MobileHCI '15, Association for Computing Machinery, New York, NY, USA, ISBN: 9781450336529, pp. 26–35. http://dx.doi.org/10.1145/2785830.2785865.

Wu, T.-W., Chien, Y.-L., Lee, H.-P., Chang, Y.-J., 2021. IM receptivity and presentation-type preferences among users of a mobile app with automated receptivity-status adjustment. In: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems. pp. 1–14.

Zytko, D., Grandhi, S.A., Jones, Q., 2014. Impression management through communication in online dating. In: Proceedings of the Companion Publication of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing. pp. 277–280.