"*Together but not together*": Evaluating Typing Indicators for Interaction-Rich Communication

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ABSTRACT

Messaging is a ubiquitous digital communication medium. It is also a minimal medium of communication because of its inability to convey immediate feedback, tone, facial expressions, hesitations, and pauses, or follow the train of the other person's thoughts. This paper combines quantitative and qualitative approaches for analyzing richer forms of typing indicators in messaging interfaces, such as showing text as it is typed. By assessing users' subjective workload and interpreting these findings in the context of users' experiences, we found that more expressive typing indicators were perceived as "rich in communication", as they helped people communicate more allowing for closer connections. These indicators also increased users' perceived co-presence. In addition, our research suggests there may be benefits of designing customized typing indicators for relationship maintenance and task-based communication.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design**; **Collaborative and social computing**.

KEYWORDS

computer-mediated communication, online interaction, typing indicators, media richness theory, social presence, texting

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1 INTRODUCTION

Due to the medium's lightweight interaction and ease of access, messaging has been adopted in a variety of different contexts. Messaging allows for personal relationship maintenance [46] in situations where spatial and temporal constraints limit face-to-face interactions. Elevated by the COVID-19 pandemic, text-based communication has increased for remote work with tools like Slack or Microsoft Teams where "managers felt instant messages were key to managing their teams from home" [59], and social groups centered on group chats or Discord. Further, certain features of messaging can help reduce feelings of social anxiety and inhibition [55], allowing individuals to communicate with less self-consciousness as opposed to a face-to-face interaction where there might be a fear of negative evaluation [55]. Messaging is also a growing medium for text-based psychological support in mental health care [31].

While messaging is technically asynchronous, they are often used in a quasi-synchronous way [21], with messages being replied to in near real-time. Yet, texts are still uni-modal; most of the multimodal cues that can enhance a medium's richness by conveying intention, engagement, and co-presence [61] are absent from a message. Although studies have compared different mediums in terms of Media Richness Theory (MRT) and social presence, there have been conflicting results on whether a medium's richness impacts user satisfaction, team's decision-making, and organizational performance [10, 57, 60]. This implies that subjective factors, which vary across different scenarios, can modify whether the richness of a medium has an impact on task performance and overall user experience.

Prior work has explored mechanisms that people adopt to compensate for the lower degrees of social presence in messages, giving rise to paralinguistic cues, emojis, and stickers [19, 38]. Despite the implication that users desire heightened co-presence in their text-based interactions, there has been little work done to compare different texting designs intended to increase the medium's richness.

Recent research has explored richer text-based mediums through synchronous messaging and found that restricting asynchronous communication in a text-based interaction can heighten a user's perceived co-presence but at the cost of making them feel overwhelmed and obliged to communicate [48]. These findings provide reason to believe that the asynchronous nature of texting has its own advantages. Instead of restricting asynchrony, there could be a focus on design strategies that could foster concepts of medium richness in textual interactions. Prior work has focused on exploring mandatory synchronous conversations in immediate close circles [48]. Although such results are important in studying textual cues in close networks, expanding our focus to include communities that engage in text-based communication outside of their social circles, such as distributed teams engaged in collaborative decision-making, text-based therapeutic sessions, and online written discussions, could lead to a deeper understanding on richer texts and their impact on users' text-based interactions.

In this paper, we designed and implemented two text-based typing indicators, *masked-typing* and *live-typing*, which incorporate richness characteristics posed by MRT. A mixed-method study was conducted in a task-based interaction to compare and evaluate these indicators. The task was chosen to create a sense of urgency to communicate and cooperate during the interaction. We focused on

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exploring the concept characteristics of MRT, i.e., exploring user opinions and reflections on texting re-designed for richness.

We found that while *masked-typing* helped users reach more agreements on the study task, the in-depth qualitative analysis revealed that users found *live-typing* to be more communicative, helpful, and effective for their task-based interaction. *Live-typing* also increased users' perceived social presence and reported low cognitive demanding metrics like *Frustration* and *Stress*. Even though *live-typing* was perceived as less demanding than instant messaging indicators such as *(*is-typing), users were apprehensive about the applicability of the indicator in their daily lives as it limited their selective self-presentation and commented that it is more befitting for goal-oriented and therapeutic interactions.

2 RELATED WORK

2.1 Media Richness Theory in Computer-Mediated Communication

Media Richness Theory claims that information is processed to reduce equivocality, clarifying uncertain information with multiple interpretations. MRT suggests that the ability for information to change understanding depends on the richness of chosen media [17], asserting that users prefer to communicate through richer or more expressive media because of its characteristics to support immediate feedback, multiple cues, natural language, and message personalization. MRT places audio-visual communication at a richer, more fulfilling social end than written communication [17]. Despite text being considered a lean communication platform, recent research shows that there have been reports of greater self-disclosure over texts as compared to richer mediums [14, 30]. Even with the lack of social cues and gestures inherent in messaging, simple messaging has emerged as one of the most popular forms of computer-mediated communication compared to audio and video calls, emails, and even face-to-face communication [39]. Compared to face-to-face interaction, messaging allows greater user control for reflection, revision, and composition, which can be more appealing when creating desirable social connections [63] and de-escalating conflict within romantic relationships [53].

2.2 Real Time Messaging and Collaboration

Prior studies have looked at how real-time messaging impact discourse and collaboration in text-based communication. For instance, Solomon et al. [58] discovered that real-time messaging, when compared to messages that are displayed to the recipient after being delivered (even when the *is-typing* indicator is present), caused increased coordination among users and less editing of their messages. Dringus [20] examined the performance of group decisions between delayed-time messaging (e.g., emails) and real-time messaging and found that groups took longer to reach solutions when using delayed-time messaging but did not impact the final decision-making. Phillips et al. [47] found that users who conversed with real-time turn-taking interfaces, compared to those without, performed lower on tasks that involve collaborative thinking and resulted in less effective communication.

These contrasting results suggest insufficient information is available to conclude whether typing transparency can be leveraged to enhance social and contextual awareness when remote communication is involved with collaborative workload. The field trial of Podlubny et al.'s Curtains Messenger showed that synchronous communication promotes cooperation and engagement within close relationships [48]. However, our study diverges from the visual aesthetic of their "curtain metaphor" and focuses on interaction techniques at the character level. Moreover, our study uses a cooperative task to facilitate urgency and collaborative decision-making among strangers and replicate an environment where feedback, presence, and awareness are needed.

2.3 Conveying Social Presence in Messaging

There has been an increased interest in making messaging applications richer by integrating techniques that accommodate different situations and user needs. Majority of today's messaging systems allow users to share real-time images, videos, activity statuses, location tags, and other visual components (e.g., emoticons, emojis, stickers, GIFs). Applications such as Facebook Messenger and WhatsApp have also provided users the ability to view when a message is delivered, received, or read. Sharing these types of information have shown to serve as a strategic tool to enhance social presence and a way to understand and maintain relationships within text-based environments [15, 16, 38, 43]. However, more can be done to close the socio-technical gaps of presence [64] and expression [9] during message exchange, as these current design solutions are incomplete to effectively convey social cues.

Recent research has proposed novel ways of generating social cues through affective and physiological sensing. For instance, EmoBalloon uses speech bubble shapes to share users' emotional arousal [1], HeartChat uses color-coded messages to share users' heart rate [29], ConChat uses temperature and environmental sensors to share users' whereabouts [49], and Hubbub uses ambient sound to share user's activities [32]. These supplementary methods of portraying contextual information change the dynamic in communication by enhancing social connectedness [5, 42], coordination [2, 51], understanding [35], and empathy [29].

2.4 Text Composition and Text Visibility Messaging

One approach to increasing social presence and contextual awareness is through text composition. Lee et al. found that kinetic typography, which changes the visual forms (color, size, position, etc.) of text over time, helps convey the emotional intention of a message in text-based communication [37]. The concept of typography is seen in Conductive Chat, where the color and size of each character in the typed text are generated from skin conductivity just before the message is sent to share users' arousal rate and level [18]. TapScript sends texts in the form of users' finger-drawn handwriting to reflect their moment-by-moment behavior [8].

Similarly, immediate feedback in messages can carry contextual information by providing live feedback that resembles the cadence and feel of an in-person conversation. *Is-typing* indicators showing three moving dots "..." or that "Person X is typing" allows users to view and share when messages are being typed. However, they are not a reliable method of detecting a person's progress as they are composing a message [12]. Real-time text (or *live-typing* as we refer

to it) allows character-by-character transmission of messages and can convey contextual information regarding the flow of how messages are composed [50]. Kim et al. found that real-time messaging enriches conversational experiences by reducing silence duration and integrating nonverbal factors, such as delays and typing pace, within the message [34].

3 DESIGN CONSIDERATIONS

The four typing indicators were designed with the consideration of how users perceive information about others in text-based communication. The first indicator (or lack thereof) was the baseline used in SMS, showing no cues to the recipient while the sender composed their message. The second indicator, inspired by the instant messaging apps, had an awareness mechanism that increased the recipient's perceived social awareness by indicating if the other person is typing through displaying "Person X is typing" on the recipient's screen. This feature aimed to offer cues that the other user is present in the room and is crafting their response. Since the aim of our study was to explore typing indicators, we did not integrate other aspects of awareness mechanisms popular in instant messaging apps, like "last seen", the "online" status, and indicators to convey that a message has been read.

For the next two indicators, we consider Media Richness Theory to inform a richer texting platform. According to [17], the richness of the medium depends on its 1) immediacy of feedback, 2) conveyance of cues, 3) language variety, and 4) message personalization. Without compromising on the asynchronous nature of texting that has shown to place fewer demands on people's time [3], is less intrusive, and allows multitasking, we designed *masked-typing* and *live-typing* to retain multiple cues, immediate feedback and a personal focus in texting.

We initially brainstormed design questions about what it meant to provide immediate feedback in texting. In face-to-face communication, each word is transmitted as it is spoken. Alternatively, cases when individuals respond immediately to a text has shown to have increased the user's social presence since it conveys an immediacy toward the recipient, a salient feature of face-to-face interactions. We translated the immediacy of feedback in our typing indicators and displayed text as it was typed. Since we wanted a hierarchical richness in texting, for *masked-typing*, the characters appeared as they were typed, but the displayed characters were replaced by a '#' glyph. Therefore, the recipient could see that the sender was actively typing and the speed and number of characters typed or edited as they were happening, but not the actual content of the message, allowing the senders to hide the meaning in their message until ready. Meanwhile, for the *live-typing* indicator, the recipient could see the actual characters typed by the sender in real time, including edits and pauses as if they were watching the senders' screen.

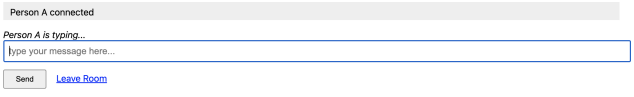

Figure 1: Person B waiting for a message as it is typed with the *is-typing* indicator.

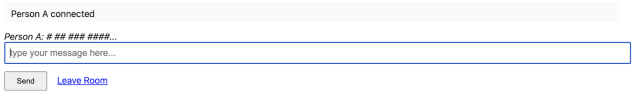

Figure 2: Person B waiting for a message as it is typed with the *masked-typing* indicator.

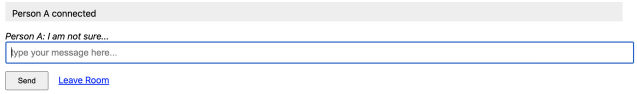

Figure 3: Person B waiting for a message as it is typed with the *live-typing* indicator.

Next, we asked what it meant to have a personal focus on the way users text. In face-to-face communication, speed of voice is a personal feature that entails fluency. Since our aim was to enhance the richness of texting without incorporating audio and visual cues, we tried to augment the speed of voice through typing speed. Lastly, for the conveyance of multiple cues, our former design strategies inherently conveyed multiple cues to the receiver. If the sender is thinking while composing their message, the absence of text would let the recipient know they are thinking while formulating their response. In addition to that, backspaces were another cue contributing to the enhanced awareness of the recipient that the sender is correcting themselves.

The richness of a medium is positively associated with its social presence which is a "moment-to-moment awareness of co-presence of a mediated body" [6]. Specifically, social presence varies in three degrees. The first level, or the perceptual level, is the awareness of a co-presence in a mediated communication. This is evident in the current messaging interfaces as the *is-typing* indicator. Level two, or the subjective level, is the awareness of the other person's attention, engagement, emotions, and behavioral interaction. Our design considerations enabled us to go beyond the first level as both *masked-typing* and *live-typing* conveyed cues related to the sender's attention, engagement, and behavioral patterns.

The conversational interface used for the experiment is artificial as it does not offer the users the ability to toggle the type of indicator for themselves or their partner, as would likely be possible in a real application. While the underlying typing indicator protocols may remain the same across multiple applications, a different richness of indicator would be preferable depending on the nature of the conversation. As noted in MRT, the equivocality of the information is a factor in how relevant the medium's richness matters; the forms of co-presence described above [6] and even the relationship between the participants is a factor that may determine the users' interest in each typing indicator.

As we believe that these indicators are a fundamental aspect of messaging, we release an open-source library for each interaction, that can be incorporated into existing web applications in a flexible way. The software is hosted at brownhci/live-typing[1].

[1]https://github.com/brownhci/live-typing

4 METHOD

We conducted a remote study to allow participants to experience the typing indicators without the constrictions of a lab setting. A within-subjects design experiment was used to understand and compare users' experiences across all four indicators.

To eliminate the carryover effect, a complete counterbalancing design experiment was adopted. Participants were divided into three sets of eight individuals. Dividing the participants into groups of eight individuals allowed us to ensure unique pairs and that no two participants talk to each other again. Four problem-solving tasks were presented in a shuffled order for every three sets of eight participants to reduce the practice effect. The problem space for the three sets was balanced using a 4×4 Latin Square where the last row of the square was not used (Table 1). Lastly, to reduce fatigue, we limited participants' interaction on each interface to 7–8 minutes to make the tasks shorter and less intense to perform. Before the actual study, we had conducted one pilot study and found that most people reached a consensus within the first 5–6 minutes. If any participant felt rushed to make a decision, it was reported through the *Temporal Demand* metric on the NASA-TLX.

Table 1: 24 participants arranged in conversation rooms: three sets of studies were conducted with 8 participants simultaneously

	Room A	Room B	Room C	Room D
Problem 1	(P6,P7)	(P1,P5)	(P2,P4)	(P3,P8)
Problem 2	(P1,P8)	(P4,P7)	(P3,P5)	(P2,P6)
Problem 3	(P3,P4)	(P2,P8)	(P1,P6)	(P5,P7)
Problem 4	(P2,P5)	(P3,P6)	(P7,P8)	(P1,P4)

4.1 Participants

A variety of social media apps are now used for messaging: Facebook Messenger, Instagram, Twitter, and Reddit (for anonymous conversations). In order to compare the four typing indicators across a diverse set of participants, electronic flyers were posted on authors' personal feeds on these platforms (Twitter, Facebook, and Instagram) and Reddit's r/SampleSize, an online discussion forum for recruiting participants. Combining these channels helped us recruit a diverse sample based on gender, occupation, and age, especially within the spaces where the target users of messaging are already inhabiting. Two authors were international students, which enabled them to recruit people from different backgrounds. In contrast, Reddit ensured that our sample is not entirely college students.

For eligibility, participants had to be 18 years or older and frequently use messaging platforms to communicate. A total of 98 people applied for the study. 24 participants were invited to be part of the study, as this number is often sufficient to reach saturation of results for qualitative data, and 50 people were placed on a waitlist to accommodate no-shows. Previous work has suggested that increasing participants for qualitative research can lead to data saturation and variability throughout analysis [24]. This saturation was visible in our last set of interviews. Participants ranged from 19 to 35 years old, and six were female. The ethnicity of the sample ranged from Caucasian, African American, Hispanic, Latino, Southeast Asian, and Indian American. Participants came from different occupational backgrounds (Table 2). At the end of the study, each participant was compensated with a $15 Amazon gift card for participation. Each participant had the opportunity to earn up to an additional $6 based on their performance. For each correct answer, the pair of participants earned $0.50.

Table 2: Occupational Background of Participants

Background	# of Participants	Percent
Student	7	29.2
Educator / Researcher	2	8.3
Civil Engineer	2	8.3
Information Technology Consultant	2	8.3
Software Developer	2	8.3
Tax / Management Accountant	2	8.3
Investor	2	8.3
Sales Associate	1	4.2
Chef	1	4.2
Infantry	1	4.2
Architect	1	4.2
Unemployed	1	4.2

4.2 Task

We sought to choose a task with several characteristics: 1) paired participants had equal roles to control for that variable, 2) participants would be motivated by a reward to seek a "correct" answer, 3) some coordination and negotiation is involved to represent a non-trivial practical simulation, and 4) the outcome would be equivocal (i.e., with some ambiguity), testing the effectiveness of a medium with varying richness according to the Media Richness Theory.

In the original variant of the four presented tasks, participants are asked to imagine a survival scenario, where they have been able to salvage fifteen items. The task is to pick the five most important items and rank them in order of importance. These tasks are used to measure the perceived richness of a medium and how the medium impacts the quality of the solution [40, 60]. These tasks were chosen because of the equivocal nature of each participant's preferences, which Media Richness Theory posits should be affected by the richness of communication between the four types of typing indicators being compared. Further, they are used in numerous group decision studies [41], and as messaging tasks to evaluate collaboration in instant messaging (IM) [7, 11, 54].

For our study, we modified the task and presented eight items to be picked from instead of fifteen. Further, we ask paired participants to imagine that they are in the scenario "together" and have to negotiate on a common rank ordering for the top three items that are most important for their survival. These modifications helped us to redesign the task for the IM setting and keep it shorter to reduce the fatigue effect.

For each correct item that the pair chose, they were awarded $0.50. We added this criterion to allow room for discussion within the task. The added compensation based on performance helped

us avoid passive agreement within the session and allowed space for discussion when a pair had conflicting preferences for the top three items.

Tasks differed in their survival scenario and the list of items that were to be ranked by the participants. We selected the following four parallel versions of the survival tasks for balanced complexity:

- Desert Survival Task with validation provided by the Chief of the Desert Branch [36]
- NASA Moon Survival Task with validation provided by NASA experts [26]
- Lost at Sea Task validated by the US Coast Guard [45]
- Plane Crash Task validated by the US Army [33]

4.3 Procedure

Upon providing informed consent, participants were instructed to check their emails for the Zoom link. Once all the participants joined Zoom, they were emailed the links to their four chat sessions (one corresponding to each typing indicator). Each link opened a private chat session with their conversational partner. The link contained the participant ID, chat session ID, and indicator type in the form of GET parameters. Upon clicking the link, the application welcomed participants and notified them that their partner was in the room.

Participants were asked to click the link (at its respective time) and communicate with their partners. For each chat session, participants chatted for 10 minutes and worked to solve the survival task. The nature of the task involved moments of coordination and negotiation. Participants were notified that the task is simply logical in nature and would not elicit any information from them (i.e., their political or philosophical views). However, we did not place any restrictions on topics of conversation. During an informed consent process, participants were told that their conversations with be recorded.

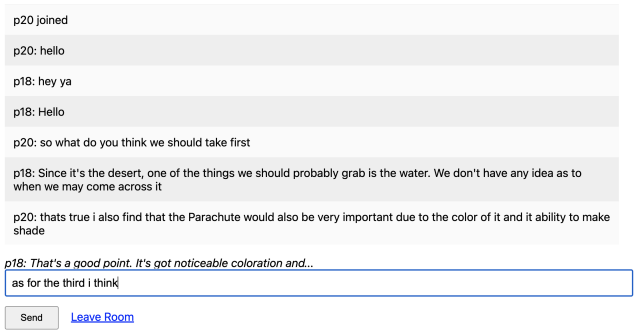

Figure 4: Chat log of *live-typing*: P20's screen.

4.4 Measures

We conducted a quantitative and qualitative evaluation to investigate the differences across the four typing indicators. After each interaction, the NASA Task Load Index (NASA-TLX) was used to quantify the cognitive demands of interacting with the indicator [28]. The NASA-TLX is a standardized tool for comparing tasks, enabling researchers to generate categorical differences across the

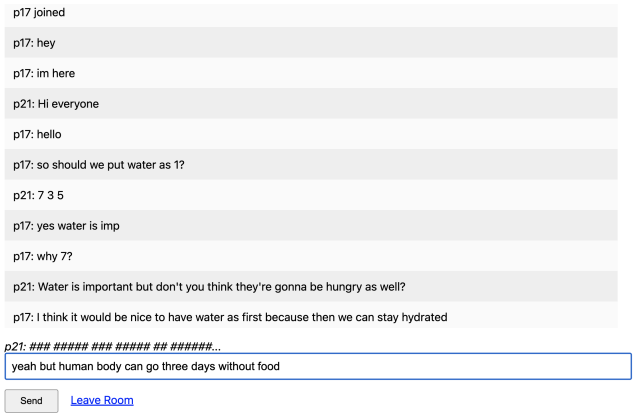

Figure 5: Chat log of *masked-typing*: P17's screen.

proposed systems and their alternative baselines. As teamwork is a common activity to measure with the NASA-TLX [27], it seemed suited for assessing the workload of communicating item preferences in the survival tasks, where aspects of *Stress*, *Frustration*, and *Time Pressure* are factors when trying to converge on a set of items in a time-limited scenario. Further, the scale is suitable for within-subjects experiments where users have filled out responses for each study condition [13]. Since one of our aims was to assess if the re-designed typing indicators (*live-typing* and *masked-typing*) were more cognitively demanding than the current typing indicators [56], the scale provided assessment across multiple metrics such as *Frustration*, *Stress* and the indicator's *Mental* and *Physical Demand*.

Prior work has also explored task performance and perceived workload in collaborative IM settings [25]. The total cognitive scores were calculated through the 5-Point Likert scale along the six dimensions of the NASA-TLX. The NASA-TLX questions were reordered for each typing indicator interface to reduce familiarity bias.

At the end of the four interactions, we also asked users to fill out a final questionnaire to report on metrics such as the indicator's helpfulness and effectiveness. Through these surveys, we were able to receive a representation of the typing indicators and their perceptions of an interaction. Lastly, we performed individual interviews to collect insights on user feedback on the four typing indicators and how each indicator influenced their interaction. The interviews were conducted in a semi-structured style to allow flexibility for following up on emerging topics. For each participant, the study took less than 60-–70 minutes. The sessions lasted about 50 minutes, whereas each interview lasted about 8—12 minutes. We collected 43 chat sessions logging the events exchanged between the client's socket and the server. These logs included when a participant connected, disconnected, and every keystroke pressed. These events were logged along with their UNIX timestamp. There was one no-show we could not substitute for, and one participant did not have internet connectivity for one of their sessions, which resulted in the loss of five chat sessions. Two of the participants had microphone issues during the interview. Their responses were not included in the qualitative analysis due to audio disruptions. We opted not to

redo the chats and interview sessions to minimize recall bias from being more familiar with the task.

4.5 Analysis

We used an inductive, open coding approach to qualitatively analyze user experiences and impressions with *live-typing* and *masked-typing*. Two researchers independently re-listened to the audios and transcribed the interviews that they conducted. We merged all the transcripts in Google Sheets, where one column represented all participants' answers to the question asked. Through the "open coding" process, we further re-organized interview transcripts into themes using a qualitative analysis [44]. We then met to identify and discuss themes guided by our research questions. Specifically, codes were developed for users' perceptions; level of communication; feelings of annoyance, stress, and frustration; level of comfort with the indicator, the indicator's helpfulness for the task, and its applicability to real-world communications. Coding results were then discussed in the second round, where we removed overlapping codes and codes not central to our research questions. Codes included 'isolating', 'express', 'communicate', 'helpful', 'mistakes', 'relationships', and so on. The final round of codes was then used to generate themes. The broader themes from our coding process focused on users' thoughts, feelings, and behaviors with *live-typing* and *masked-typing*, the effectiveness of the indicators in their interactions, and the implications of richer texts in real life.

5 FINDINGS

The typing indicators provoked contradicting views about the impact of richer texts in communication. Participants were able to reflect on how each typing indicator affected their communication behavior, how it contributed to their interaction with their partner, and how richness features within messaging platforms could be applicable beyond task-based scenarios.

5.1 The Cognitive Demands of Typing Indicators

According to the NASA-TLX comparison, richer indicators such as *live-typing* and *masked-typing*, improved in every metric over the baseline *(no-indicator)* (Figure 6). The overall cognitive score for NASA-TLX was significantly lower for *live-typing* compared to the baseline [t(39) = 3.22, p < 0.01].

Table 3: Weighted NASA-TLX Scores Across Six Dimensions for Each Typing Indicator

	Physical Demand	Mental Demand	Effort	Temporal Demand	Performance	Frustration**	Stress**	Helpfulness** (lower is better)
No Indicator	3.56	4.06	4.22	3.89	3.06	4.83	4.67	5.22
Is Typing	2.36	2.73	2.50	2.27	2.50	2.09	2.14	2.09
Masked Typing	2.65	2.91	2.61	2.39	2.70	2.65	2.48	2.52
Live Typing	2.09	2.45	2.05	2.32	1.95	2.14	2.50	2.00

*$p < 0.05$, **$p < 0.01$

The end-of-study survey reported that cognitive load decreased with increasing the richness of the typing indicator. Specifically, live-typing (M = 19.80, SD = 5.23) was found to be 43.45% less cognitively demanding than the baseline (M = 30.77, SD = 7.62). We then analysed the six task load dimensions individually and found

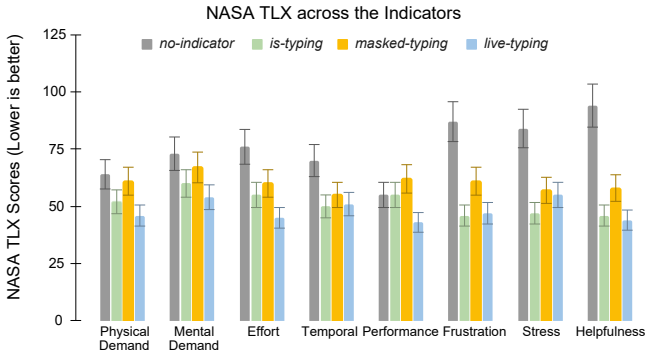

Figure 6: NASA Task Load Index assessment shows that *live-typing* significantly causes less *Frustration* and *Stress*, has lower *Temporal*, *Physical*, and *Mental Demand*, higher perceived *Performance*, and has less perceived *Effort*

that the typing indicators significantly affected perceived *Effort* [F(3, 86) = 3.72, p < 0.001], *Frustration* [F(3, 87) = 6.92, p < 0.001] and *Stress* [F(3,87) = 4.30, p < 0.005]. *Effort* required to complete the task over *no-indicator* (M = 4.22, SD = 0.99) was 69.22% higher than *live-typing* (M = 4.22, SD = 0.43) [Tukey HSD, p < 0.01]. Participants were also 79.20% more frustrated when interacting on the *no-indicator* (M = 4.83, SD = 1.14) as compared to *live-typing* (M = 4.83, SD = 1.03) [Tukey HSD, p < 0.01]. In addition, there was a 60.53% higher *Stress* for *no-indicator* (M = 4.67, SD = 1.10) compared to *live-typing* (M = 2.5, SD = 0.53) [Tukey HSD, p = 0.01]. These differences were also reflected in participants' interviews.

Participants' preferences also differed significantly across all indicators [F (3,79) = 11.69, p < 0.001] in addition to ratings collected for helpfulness [F(3,96) = 16.84, p < 0.001]. We found a statistically significant difference for overall preference [F (3,79) = 11.69, p < 0.001], preference for personal conversations [F (3,76) = 9.83, p < 0.001] and personal conflict [F (3,77) = 14.68, p < 0.001]. Post-hoc pairwise comparisons showed that *is-typing*, *live-typing* and *masked-typing* ratings are significantly higher for both preferences and helpfulness as compared to the baseline. For preference, no statistically significant differences were found among *is-typing*, *masked-typing*, and *live-typing*.

A one-way repeated ANOVA was performed to compare the number of messages and words that were exchanged across the four indicators. Although we could not find any statistical difference between messages [F(3,44) = 1.3, p = 0.27] and words exchanged [F(3,44) = 0.43, p = 0.73], both *live-typing* and *masked-typing* had a higher standard deviation for a total count of messages and words. This was reflected in the qualitative interview where twenty participants (83%) stated that they prefer *live-typing* and *masked-typing* for their interaction as it helped them communicate and "write more". Meanwhile, four participants (17%) found the new indicators challenging and limiting in their communication with their partners. In addition to these quantitative results, we found a striking qualitative difference in user experiences and perceptions for both modes of interaction-rich indicators.

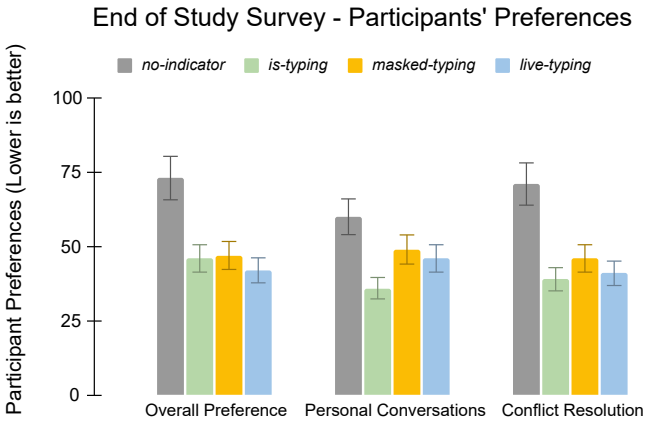

Figure 7: End-of-study survey shows that participants overall preferred *live-typing* however for personal lives and resolving conflict, most participants preferred the *is-typing* interface. None of the participants opted for the baseline (*no-indicator*).

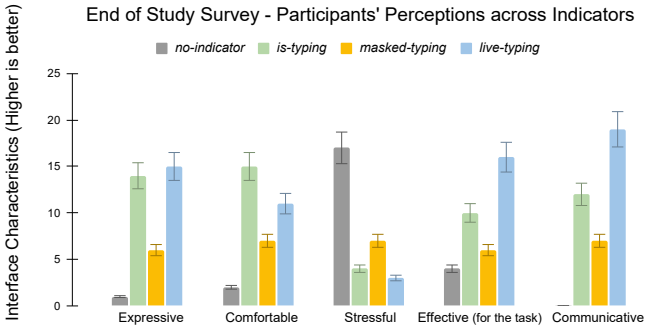

Figure 8: *Live-typing* was perceived to help participants share their thoughts (expressive), was effective for the task, and helpful in communicating with their partner. *Is-typing* was rated to be the most comfortable indicator.

Table 4: Number of Words Typed across Each Interface

	No Indicator	Is Typing	Masked Typing	Live Typing
Total	1192.00	1198.00	1282.00	1494.00
Mean	99.33	99.85	106.85	124.50
SD	42.07	47.90	88.96	57.94

5.2 User Experiences with Richer Text-based Interactions

5.2.1 Richer texting platforms are less frustrating and cognitively demanding.

Participants indicated that they found value in seeing immediate feedback in *live-typing*. People especially valued the indicator's helpfulness in the interaction, reporting it to be more communicative than the other indicators. Specifically, 62% of the participants reported that *live-typing* allowed them to share their thoughts more than any other indicator, and 79% participants stated that *live-typing* was the most helpful in communicating with their partner. For example, P7 felt *live-typing* allowed them to *"connect with their partner"* whereas their experience with *no-indicator* was isolating and *"limited them in their communication"*. P9 also felt this isolation: *"I would literally second guess and just be in my own head. It (the no-indicator interface) played on my mind."* This feeling of isolation was particularly associated with the inability to predict their partner's actions. The inability to perceive and acknowledge their partner's presence increased participants' task load to complete the task. P7 reported this perceived effort as: *"The one with no-indicator was so hard. I couldn't even see what was up with my partner, like whether they were seeing I was typing, if they were listening to me, or if they agreed with my choices, or if I needed to say more."*

Table 5: Number of Messages Exchanged across Each Interface

	No Indicator	Is Typing	Masked Typing	Live Typing
Total	210.00	248.00	190.00	246.00
Mean	17.50	20.71	15.85	20.50
SD	7.42	6.72	5.87	8.05

Participants also reflected on how frustrating and mentally demanding their interaction was on *no-indicator*. P20 associated this frustration with the inability to *"know if my partner was texting or when they were texting. It was so frustrating because sometimes I thought they disconnected, but they didn't and just took a minute to type"*. These qualitative findings were complemented by the NASA-TLX where participants reported 77.18% higher levels of *Frustration*, 60.53% higher *Stress*, 49.46% higher *Mental Demand* for *no-indicator* in comparison to *live-typing*.

Most participants valued the heightened presence and immediate feedback in the new indicators. For instance, P11 reported that they *"just needed to know someone is working with me on the task"* whereas P18 valued the "involving nature" of the indicator. These findings were once again complemented by user's perceived level of *Success* on the NASA-TLX, where we found a 44.43% increase in perceived success for *live-typing* in comparison to *no-indicator*.

The findings implied that the immediacy of feedback in both indicators helped most of the participants to collaborate more. P2 noted this collaboration in the form of involvement as *live-typing* made them feel involved since "it shows that your partner is contributing to the topic." P16 preferred live-typing because *"it was faster to answer my partner's questions before they even finished typing"*, whereas P9 felt the *"seeing the responses in real time let their collaboration for the task flow naturally."* This was evident from the outcomes as more participants agreed on the solution(s), whereas this agreement was low in the baseline (*no-indicator*) and *is-typing* indicator (Table 6).

5.2.2 Richer texting platforms can be validating encouraging active listening.

Live-typing's awareness mechanisms with immediate feedback and features implemented for richness were found validating by the participants. The features helped engage participants and made them feel heard and seen.

Table 6: Agreements reached and the correct answers across each interface

	No Indicator	Is Typing	Masked Typing	Live Typing
Agreed on all 3 choices	3	4	8	7
Agreed on 2 choices	3	4	2	3
Agreed on 1 choice	2	2	1	1
No agreement	3	1	0	0
# correct answers	10	11	16	13
# correct answers (in order)	3	6	13	9

For instance, P7 felt comfort when someone read their response, and they received immediate visible feedback which helped them *"have a broader discussion about their lives"*: *"I really liked live-typing, it was so validating… It's more expressive, which helped me to communicate better. We even had a broader discussion about our lives. All because I could see them typing, it was a validation like they're listening"*

P14 echoed this and felt that *live-typing* helped them understand the other person better: *"Seeing what they are typing and erasing in real-time helped me pay more attention like someone is speaking their mind on the go."*

Participants noted that the heightened richness of the indicator opened room for more dialogue and gestures: "*I usually don't type that much, and that's what happened with my other partners, but here I felt kind of responsible for validating what the other person was saying like restatements, or it was my way of nodding."* (P13) and *"We were talking more and on different trains of thought because none of us had to wait for the other person to finish typing"* (P9).

The communication and attention the participants received encouraged them to experience closer connections with their partners: *"It was like face-to-face communication because I could see them making mistakes. One time they were testing if their keyboard was working, and I felt that we both were testing the keys "together"*: (P16). These shared experiences, with enhanced co-presence of the other, helped participants relate to each other. P11 reported this presence as "We were thinking together while not being together."

This validation was not only visible in *live-typing*). P17 noted this sense of validation in features incorporated in *masked-typing*: *"I wanted to know the person is there (compared to no-indicator) and is making an effort. I didn't want to see their message in real-time (like live-typing) because that overwhelmed me."* P18 also liked that *masked-typing* gave a general overview of the message showing *"summaries of your words like the rough outlines."* Likewise, P5 favored how *masked-typing* measured response length: *"It (masked-typing) helped me process that the other person is typing and see that they really care about me by writing a big response."*

5.2.3 Richer texting platforms limit selective self-presentation.

Five participants (20%) felt uncomfortable and found that either one or both transparent interfaces limited them in their discussions. For instance, P11 said that *live-typing* was *"like walking on eggshells"* and P21 found that they were *"formulating the perfect response in their mind before saying (typing) anything."* When informed that the problem encouraged them to "think together", P21 stated that *"they were not sure of their choices, and until they were, they would not type."* P19 resonated with this experience: *"It's (live-typing) not easy to use when someone is already typing at the moment."* Moreover, participants found masked-typing impractical and uneasy to adapt: *"I found it annoying as it's like playing hangman without the fun using more pixels than necessary,"* (P20), *"It (the # symbols) made it seem like my partner was not sharing any important information with me,"* (P2). Similarly, P12 found the design choices *unfamiliar"* and *"weird"*.

Further, some participants expressed privacy concerns. P21 said, *"live-typing made (them) feel raw and exposed,"* similar to P18 who mentioned: *"you can't use it (live-typing) in all situations, especially with personal and confidential information."* P11 also felt monitored and vulnerable when using the interface and said it: *"did not let me express my mind openly."* claiming that *"messages are likely to be corrected because of flaws and mistakes... like changing your mind"*. This freedom of change however was appreciated in *masked-typing* where participants reported that it has the *"It has freedom of privacy without the fear of someone monitoring you"*.

Conversely, there were participants who felt that *live-typing* did not have an impact on their privacy. When asked if they were concerned that their partners can see their mistakes, P12 opinioned indifference because they *"fat-thumb their keyboard anyway."* Likewise, P20 mentioned that they were generally *"a confident and transparent texture"* regardless of the situation.

5.3 Rich Text-based Interaction in Daily Life: Application, Navigation, and Discourse

In the reflective activity, we asked participants to speculate on the practical aspects of the typing indicators in their daily lives. Follow-up questions centered around situations where these interfaces could be beneficial and the effect of these texting indicators in messaging platforms for everyday conversations.

5.3.1 Richer texting platforms are suitable for collaborative and critical environments.

Most participants commented on the suitability of *live-typing* for task-based interactions. These results are also supported by NASA-TLX, where overall *Effort* and *Mental Demand* were lower for *live-typing* and *Performance* was significantly higher. P5 reflected that their performance was higher as they felt *live-typing* was effective for agreements: *"Seeing text in real-time helped me pay more attention and agree more with their first instincts."* When asked why they preferred this interface for collaboration, participants thought back to the study: *"it was like teamwork,"* (P19), *"it helped me contribute more,"* (P22), and *"solutions came more swiftly"* (P11).

When it comes to application, twelve (50%) participants said that *live-typing* would be *"amazing"* when applied in professional settings, which can be reflective of the task-based scenarios in the experiment. For instance, P7 reported that *"at work, the interface can help you express your mind on a project where you need to meet immediate deadlines"* whereas P20 mentioned the indicator's suitability for team business meetings stating that *"it can replace Zoom calls."* Participants also reported on its applicability in educational environments, reporting that the immediate feedback is helpful for learning activities: *"For learning, even with friends, like solving a math problem, it (live-typing) will be easier for the other person to pull me on the right path if I am making a mistake"* (P3) and *"it can be an add-on for group co-ordinations in final projects"* (P13).

These findings were also complemented by our end-of-study survey where sixteen participants (66%) chose *live-typing* as the most effective indicator for the collaborative task.

Additionally, participants suggested that the immediacy features in *live-typing* could be helpful for assisting customers. For instance, P4 mentioned that the indicator could be used for *"customer care service like chatting with Walmart about a product I thought wasn't good."* Likewise, P10 reflected on *live-typing*'s applicability in chat support when *"a website is not working to help with user satisfaction"*. Overall, the indicator was deemed helpful and effective for situations where users might not be satisfied with customer service.

Beyond work based settings, participants expressed that *live-typing* would be helpful in cases of urgency where people can *"seek help faster by saying less*" (P11) or cases where *"information needs to be shared with somebody immediately, for instance, in text-based medical situations"*. Along with urgent situations, the validating nature of *live-typing* in addition to its increased co-presence was considered a necessary tool for managing psychological and physical distress. For instance, P9 commented that *"In situations where someone is having a mental crisis, live-typing can give immediate affirmation or validation"*. This finding was echoed by sixteen participants stating that the heightened co-presence of the indicator would have been helpful in times where they felt "lonely" and "needed to connect for help" (P15).

5.3.2 User's apprehensiveness towards richer text in their interpersonal communication.

Despite *live-typing*'s high scores on metrics like expressiveness, communicative-ness and low cognitive demand, only ten participants (41%) stated that they would use the interface in their personal lives. Most participants were apprehensive and uncomfortable with the "raw exposure" it would cause in communication. P11 felt invasive to see the other person typing: *"It can be nice but also really rude to peek into someone's thoughts,* saying that people should be "free to make mistakes without committing to them". This was a contradictory finding since some participants reported on "having a richer communication because of their partner's mistakes" (P18). However, P12 felt that *live-typing* is too excessive saying that *"it's better just to let them know that you're coming up with a response"*.

In contrast, P6 felt that the interface has the potential to *"improve long-distance communication"* and P24 viewed *live-typing* as preferable when there is continuous dialogue to be exchanged: *"I treat texting as informal emails: messages to be seen later. If I were to have a whole conversation, I'd use live-typing"*. P2 thought *live-typing* could be used in social media applications where "*you can say what you want without committing to your words (posting). It's freedom of speech for the mind."*

When it came to relationship maintenance, which is a strong reason why people use texts, we saw contradictory views on the impact of richer messaging platforms. P7 strongly believed that *live-typing* would hinder relationships: *"I don't think there would be any relationships at the end of the day. It's easier to express negative emotions through text than on calls. People are harsher on texts. What makes messaging appealing is a lot of anger is lost during message composition"* whereas P17 felt that *live-typing* would cause *"chaos in relationships"*. Most participants reported that the indicator's heightened co-presence conveys their "true feelings" and cannot let the person change their mind. However, they fell silent when asked how it compared to face-to-face communication, where there is no edit or taking back option.

In contrast, some participants addressed that *live-typing* could improve relationships as it fosters communication more than the current awareness indicator. For example, P8 noted that: *"The back and forth of exchange of real-time messaging is engaging"* claiming that anytime people engage in a communicative conversation, it positively affects relationships. This was also echoed by P6 who found that, *live-typing*) can be good for relationships where *"people feel like their friends are ignoring them,"* similar to P2 who commented that *"relationships will be better because you'll know your partner is into the conversation and not busy with something else."* P20 explained that *live-typing* will *"allow people to be more accepting of others' views and feelings,"* and P21 stated that *"we will not have a filter to screen through before expressing ourselves."* P11 felt that *live-typing* could mitigate the situations of *"late replies from (their) partner (significant other)."*

6 DISCUSSION

In this section, we present the trade-offs for designing for richness in text-based computer-mediated communication. We combine participants' experiences and reflections and real-world situations where *live-typing* was implied to help individuals connect and communicate better. Specifically, we present insights that can act as venues for redefining human connection over text-based mediums.

6.1 The Affective Demands of Interaction-Rich Mediums in Task Based Communication

At the end of the four interactions, the combination of quantitative and qualitative results suggested that participants felt that *live-typing* was the most effective indicator for their task-based interaction stating that the indicator *"helped them have a richer experience"*. A potential interpretation of why users felt their connection was richer could be because of the design considerations that were inspired by MRT. Participants perceived their partner's texts as effortful and contributing which was complemented by the indicator's ability to encourage mindful expression, active listening, and turn-taking. In addition, because of the validating nature of the indicator i.e. the ability to affirm one's words almost immediately, participants speculated *live-typing* would be most applicable in therapeutic communication. This was not true for *masked-typing* as more participants inhibited feelings of annoyance towards the indicator implying that the immediacy of feedback through real-time text enriched a participant's interaction.

In addition, we found that the richer messaging medium scored significantly low for perceived *Effort*, *Stress* and *Frustration* compared to the *no-indicator*. Given that prior work has significantly focused on comparing the traditional messaging systems that present no cues (*no-indicator*) with richer forms of media [17, 25, 57, 60], our work enquires future work to explore and revisit MRT and its definition of lean media through the lens of interaction-rich typing indicators. Messaging could be considered a lean and ineffective platform for collaborative communication because researchers might be comparing the *no-indicator* messaging systems which are associated with higher stress, and frustration and requires users

to work harder to reach the same level of collaboration as they could with richer modes of communication such as face-to-face and audio-visual interactions.

These findings also imply that we can redesign messaging to nurture richer communications in task-oriented settings. One such venue is problem-solving therapy where individuals are geared to think of stressful situations as goal-oriented problems to work through. Recent work has shown that messaging is considered a valuable safe space for patients to interact with their therapist in a problem-focused therapeutic setting like Cognitive Behavioral Therapy (CBT) [4]. However, support through traditional messaging can be challenging since the medium limits a session's length as users have to type their feelings and then wait for the responses leading to increased pauses and inefficient turn-taking. Further, the fact that patients are unable to see what or whether their therapist or peer support is typing can be discomforting as users are hesitant to write more without receiving validation on prior disclosure [4]. These challenges makes it difficult for users to connect and perceive social presence and empathy in a text-based therapeutic interaction. This opens room for future research that can investigate implementing *live-typing* in task-based therapeutic communication. Since our study demonstrates that *live-typing* increases task performance, reporting on the indicator's outcomes and reception in therapeutic conversations can further our understating of interaction-rich text-based indicators.

6.2 Personalized Expressions and Co-customisation

Eighteen participants (75%) reported that *live-typing* helped them communicate better with their partners. However, in the reflective activity, when participants were asked to reflect on the implications of messaging this way in their daily lives, fifteen participants were apprehensive and surprised at the idea. This was observed through recording interjections of surprise and shock ("oh my", "gee", "wow") implying that even though most participants preferred the "richness of the medium", they felt uncomfortable with the same platform in a different setting (their personal lives). One of the biggest concerns of participants was that *live-typing* enabled their partners to see their mistakes. When asked how it differs from real-life communication or a phone call where there is no taking back or a backspace option, participants fell quiet. Messaging was seen as a way to *"uphold an image where there can be no room for error, vulnerability, and a close human connection"*. The applicability of *live-typing* for interpersonal communication was seen as a threat since it limited participants' ability for selective self-presentation as they could no longer edit their messages in a "controlled and socially desirable fashion" [62]. However, we observed that none of the participants cared when their partner made a typo or a mistake, and in fact valued the richer experience of *"reading their partner's thoughts"*. This implies that even though senders consider these editable components of CMC necessary for their impressions, they do not hold necessarily true for the recipient. This opens venues for future work to investigate if controlling users' edits in CMC compromises their manageable impressions for a richer experience as supported by our findings.

While most participants reported hesitancy towards *live-typing*'s applicability for their interpersonal communication, some participants had opposite reactions and were thrilled at the use of the indicator for relationship maintenance. Participants in this subset reported that they would feel validated, heard, and seen. This discrepancy in participants' experiences provided us with an understanding of different user values in our trial. The distinction in values was prominent as the transparent nature of *live-typing* was perceived as *"privacy-invasive"* for some while *"validating and heard"* for others. The same applied to *masked-typing*, where users' reactions ranged from *"annoyed and irritated"* to *"it helped me wait for my turn."* In addition, the subjective, individual value towards richer texts on relationships ranged from *"relationships can be more honest and open*" to *"there will be no relationships at the end of the day"*.

These findings on participant's divergent reactions were in line with Schwartz [52] work on conflicting and compatible universal values where the authors found that human subjective values exist prior to users' interactions with evaluated systems, and that interaction with these systems helps to "detect" these values rather than instilling them. Recent studies on everyday messaging have built upon Schwartz's universal values advocating to design for subjective customizations and richer personalized expression in text-based communication [22, 23]. These findings were guided by participants' communicative behavior, as observed in their tendecy to switch apps in order to better suit their conversational needs. Therefore, building on prior research, our findings reflect on leveraging *live-typing*'s real-time richer communication based on users' needs and preferences where the medium's focus on co-presence could especially be appropriate in settings where users value social presence, high engagement and intimacy. Leveraging MRT concepts in messaging that focus on presenting *"our raw self"* could be helpful for individuals who use messaging for rich conversations. Our findings call for subjective customizations where a person *"hesitant of exposure can opt-out"* (P21) while the recipient valuing presence in their interaction *"can enable the setting"*(P8).

Prior work has investigated the effect of collaborative design customizations that conversation members select to represent their bond in their chat [23], also termed as *relationship-centered co-customization*. While negotiations around the co-ownership of shared customizations offer room for intimacy, future work must explore the effect of customizing *live-typing* on relationship dynamics i.e. who decides these customizations and how users negotiate on them. Customizing for colors and themes can be playful interaction strategies [23], however, since users in our trial found the medium a threat to their selective self-expression, the shared vulnerability and raw exposure associated with *live-typing* might lead to divergent outcomes.

6.3 Future Work and Limitations

The evaluation was designed as a within-subjects experiment, with each participant having a cooperative conversation with another participant for each of the four typing indicator interfaces with a different task (Table 1). While this experiment design assigns unique conversation partners, problem tasks, and typing indicator interfaces in each round, it was susceptible to participants not all

showing up for the study. Despite efforts to remind participants of their scheduled times, the simultaneous experimental design led to no-show participants being difficult to replace due to the simultaneous nature of the study pairings and resulted in 2 absent participants who could not be filled from the waitlist.

Future work might investigate the intersectional effect of typing indicators on different relationship dynamics, perhaps as an option that can be toggled. *Live-typing* was perceived as making participants feel connected, vulnerable, and have richer conversations, hence there are opportunities to investigate if these characteristics are perceived helpful and effective for users who prefer to use text-based mediums to seek social support in distressful situations.

Further, since the study was conducted remotely, there are uncontrolled factors that could have affected users' task performance. Future work might investigate if the nature of the study design (in-person vs. remote) has different effects on messaging-based collaboration. In addition, while we tried to recruit for a diverse sample of pool, our participants were largely men. This unfortunately created a male bias in the study. Acknowledging this limitation, other dimensions of demographics—ethnicity, age, and occupation—may moderate other factors in diversity.

7 CONCLUSION

This study explores the concepts of media richness theory for redefining human connection over text-based mediums. We designed and compared four typing indicators with varying degrees of immediate feedback, multiple cues, and message personalization. The typing indicator with the most cues, called *live-typing*, was perceived as deeply enriching. *Live-typing* was the preferred indicator for task-based interactions as the indicator encouraged collaboration and more communication. The indicator also increased users' perceived social presence but was perceived as a threat by some users since it limited their selective self-presentation. Participants in our study also reflected on the implications of each indicator's applicability in real-world communication. While simple awareness indicator, *is-typing*, was reported as the most comfortable indicator for relationship maintenance, *live-typing*'s engaging and validating nature was considered the most appropriate for deep personal conversations and therapeutic communication. We hope that this study will motivate future research on increasing media richness in written computer-mediated communication.

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REFERENCES

[1] Toshiki Aoki, Rintaro Chujo, Katsufumi Matsui, Saemi Choi, and Ari Hautasaari. 2022. EmoBalloon-Conveying Emotional Arousal in Text Chats with Speech Balloons. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–16.

[2] Elizabeth Bales, Kevin A Li, and William Griwsold. 2011. CoupleVIBE: mobile implicit communication to improve awareness for (long-distance) couples. In *Proceedings of the 2011 Conference on Computer Supported Cooperative Work*. Association for Computing Machinery, New York, NY, USA, 65–74.

[3] Nancy K Baym. 2015. *Personal connections in the digital age*. John Wiley & Sons, Cambridge, UK.

[4] Ivo Benke, Michael Thomas Knierim, and Alexander Maedche. 2020. Chatbot-based emotion management for distributed teams: A participatory design study. *Proceedings of the ACM on Human-Computer Interaction* 4, CSCW2 (2020), 1–30.

[5] Frank R Bentley and Crysta J Metcalf. 2007. Sharing motion information with close family and friends. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1361–1370.

[6] Frank Biocca and Chad Harms. 2002. Defining and measuring social presence: Contribution to the networked minds theory and measure. *Proceedings of PRESENCE* 2002 (2002), 1–36.

[7] Erin Bradner and Gloria Mark. 2002. Why distance matters: effects on cooperation, persuasion and deception. In *Proceedings of the 2002 Conference on Computer Supported Cooperative Work*. Association for Computing Machinery, New York, NY, USA, 226–235.

[8] Daniel Buschek, Alexander De Luca, and Florian Alt. 2015. There is more to typing than speed: Expressive mobile touch keyboards via dynamic font personalisation. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services*. Association for Computing Machinery, New York, NY, USA, 125–130.

[9] Daniel Buschek, Mariam Hassib, and Florian Alt. 2018. Personal mobile messaging in context: Chat augmentations for expressiveness and awareness. *ACM Transactions on Computer-Human Interaction (TOCHI)* 25, 4 (2018), 1–33.

[10] Fabio Calefato, Daniela Damian, and Filippo Lanubile. 2012. Computer-mediated communication to support distributed requirements elicitations and negotiations tasks. *Empirical Software Engineering* 17, 6 (2012), 640–674.

[11] Jeffrey D Campbell. 2005. Does spelling matter in instant messaging? answers from measuring error correction frequency. In *Extended Abstracts of the 2005 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1244–1247.

[12] Jeffrey D Campbell, E Stanziola, and Jinjuan Feng. 2003. Instant Messaging: between the messages. In *SMC'03 Conference Proceedings. 2003 IEEE International Conference on Systems, Man and Cybernetics. Conference Theme-System Security and Assurance (Cat. No. 03CH37483)*, Vol. 3. IEEE, IEEE, Washington, DC, USA, 2193–2198.

[13] Erin A Carroll and Celine Latulipe. 2009. The creativity support index. In *Extended Abstracts of 2009 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 4009–4014.

[14] Michael Chan. 2011. Shyness, sociability, and the role of media synchronicity in the use of computer-mediated communication for interpersonal communication. *Asian Journal of Social Psychology* 14, 1 (2011), 84–90.

[15] Yu-Ling Chou, Yi-Hsiu Lin, Tzu-Yi Lin, Hsin Ying You, and Yung-Ju Chang. 2022. Why Did You/I Read but Not Reply? IM Users' Unresponded-to Read-receipt Practices and Explanations of Them. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–15.

[16] Karen Church and Rodrigo De Oliveira. 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*. Association for Computing Machinery, New York, NY, USA, 352–361.

[17] Richard L Daft and Robert H Lengel. 1986. Organizational information requirements, media richness and structural design. *Management science* 32, 5 (1986), 554–571.

[18] Joan Morris DiMicco, Vidya Lakshmipathy, and Andrew Tresolini Fiore. 2002. Conductive Chat: Instant messaging with a skin conductivity channel. In *Proceedings of Conference on Computer Supported Cooperative Work*. Citeseer, Association for Computing Machinery, New York, NY, USA.

[19] Eli Dresner and Susan C Herring. 2010. Functions of the nonverbal in CMC: Emoticons and illocutionary force. *Communication theory* 20, 3 (2010), 249–268.

[20] Laurie P Dringus. 1991. *A study of delayed-time and real-time text-based computer-mediated communication systems on group decision-making performance*. Nova University, USA.

[21] Hugo Fuks, Mariano Pimentel, and Carlos Jose Pereira de Lucena. 2006. RU-Typing-2-Me? Evolving a chat tool to increase understanding in learning activities. *International Journal of Computer-Supported Collaborative Learning* 1, 1 (2006), 117–142.

[22] Carla F Griggio, Joanna Mcgrenere, and Wendy E Mackay. 2019. Customizations and expression breakdowns in ecosystems of communication apps. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (2019), 1–26.

[23] Carla F Griggio, Arissa J Sato, Wendy E Mackay, and Koji Yatani. 2021. Mediating Intimacy with DearBoard: a Co-Customizable Keyboard for Everyday Messaging. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–16.

[24] Greg Guest, Arwen Bunce, and Laura Johnson. 2006. How many interviews are enough? An experiment with data saturation and variability. *Field methods* 18, 1 (2006), 59–82.

[25] Ashish Gupta, Han Li, and Ramesh Sharda. 2013. Should I send this message? Understanding the impact of interruptions, social hierarchy and perceived task complexity on user performance and perceived workload. *Decision Support Systems* 55, 1 (2013), 135–145.

[26] Jay Hall and Wilfred Harvey Watson. 1970. The effects of a normative intervention on group decision-making performance. *Human relations* 23, 4 (1970), 299–317.

[27] Sandra G Hart. 2006. NASA-task load index (NASA-TLX); 20 years later. In *Proceedings of the Human Factors and Ergonomics Society*, Vol. 50. Sage publications Sage CA: Los Angeles, CA, Sage Publications, Los Angeles, CA, 904–908.

[28] Sandra G Hart and Lowell E Staveland. 1988. Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In *Advances in Psychology*. Vol. 52. Elsevier, 139–183.

[29] Mariam Hassib, Daniel Buschek, Paweł W Wozniak, and Florian Alt. 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*. Association for Computing Machinery, New York, NY, USA, 2239–2251.

[30] Gabriela Hoefer, Talie Massachi, Neil G Xu, Nicole Nugent, and Jeff Huang. 2022. Bridging the Social Distance: Offline to Online Social Support during the COVID-19 Pandemic. *Proceedings of the ACM on Human-Computer Interaction* 6, CSCW2 (2022), 1–27.

[31] Simon Hoermann, Kathryn L McCabe, David N Milne, Rafael A Calvo, et al. 2017. Application of synchronous text-based dialogue systems in mental health interventions: systematic review. *Journal of medical Internet research* 19, 8 (2017), e7023.

[32] Ellen Isaacs, Alan Walendowski, and Dipti Ranganathan. 2002. Mobile instant messaging through Hubbub. *Commun. ACM* 45, 9 (2002), 68–72.

[33] Spencer Kelly, Kelly Byrne, and Judith Holler. 2011. Raising the ante of communication: evidence for enhanced gesture use in high stakes situations. *Information* 2, 4 (2011), 579–593.

[34] Chang Min Kim, Hyeon-Beom Yi, Ji-Won Nam, and Geehyuk Lee. 2017. Applying Real-Time Text on Instant Messaging for a Rapid and Enriched Conversation Experience. In *Proceedings of the 2017 Conference on Designing Interactive Systems*. Association for Computing Machinery, New York, NY, USA, 625–629.

[35] Ravi Kuber and Franklin P Wright. 2013. Augmenting the instant messaging experience through the use of brain–computer interface and gestural technologies. *International Journal of Human-Computer Interaction* 29, 3 (2013), 178–191.

[36] J Clayton Lafferty and Alonzo William Pond. 1974. *The Desert Survival Situation: Problem: a Group Decision Making Experience for Examining and Increasing Individual and Team Effectiveness*. Human Synergistics.

[37] Joonhwan Lee, Soojin Jun, Jodi Forlizzi, and Scott E Hudson. 2006. Using kinetic typography to convey emotion in text-based interpersonal communication. In *Proceedings of the 6th Conference on Designing Interactive Systems*. Association for Computing Machinery, New York, NY, USA, 41–49.

[38] Joon Young Lee, Nahi Hong, Soomin Kim, Jonghwan Oh, and Joonhwan Lee. 2016. Smiley face: why we use emoticon stickers in mobile messaging. In *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services*. Association for Computing Machinery, New York, NY, USA, 760–766.

[39] Amanda Lenhart, Mary Madden, Aaron Smith, and Alexandra Macgill. 2007. *Teens and social media*. Technical Report. Pew Research Center.

[40] Karolina Lisiecka, Agnieszka Rychwalska, Katarzyna Samson, Klara Łucznik, Michał Ziembowicz, Agnieszka Szostek, and Andrzej Nowak. 2016. Medium moderates the message. How users adjust their communication trajectories to different media in collaborative task solving. *PloS one* 11, 6 (2016), e0157827.

[41] Glenn Littlepage, William Robison, and Kelly Reddington. 1997. Effects of task experience and group experience on group performance, member ability, and recognition of expertise. *Organizational behavior and human decision processes* 69, 2 (1997), 133–147.

[42] Fannie Liu, Chunjong Park, Yu Jiang Tham, Tsung-Yu Tsai, Laura Dabbish, Geoff Kaufman, and Andrés Monroy-Hernández. 2021. Significant otter: Understanding the role of biosignals in communication. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–15.

[43] James Lynden and Teis Rasmussen. 2017. Exploring the impact of 'read receipts' in Mobile Instant Messaging. *Tidsskrift for Medier, Erkendelse Og Formidling* 5, 1 (2017).

[44] Sharan B Merriam and Robin S Grenier. 2019. *Qualitative research in practice: Examples for discussion and analysis*. John Wiley & Sons.

[45] Paul M Nemiroff and William A Pasmore. 2001. *Lost at sea: A consensus-seeking task*. Pfeiffer, Zurich, Switzerland, 165–172.

[46] Kenton P O'Hara, Michael Massimi, Richard Harper, Simon Rubens, and Jessica Morris. 2014. Everyday dwelling with WhatsApp. In *Proceedings of the 17th ACM conference on Computer Supported Cooperative Work & Social Computing*. Association for Computing Machinery, New York, NY, USA, 1131–1143.

[47] Bruce Phillips. 2000. Should we take turns? A test of CMC turn-taking formats. In *Extended Abstracts of the 2000 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 341–342.

[48] Martin Podlubny, John Rooksby, Mattias Rost, and Matthew Chalmers. 2017. Synchronous text messaging: A field trial of curtains messenger. *Proceedings of the ACM on Human-Computer Interaction* 1, CSCW (2017), 1–20.

[49] Anand Ranganathan, Roy H Campbell, Arathi Ravi, and Anupama Mahajan. 2002. Conchat: A context-aware chat program. *IEEE Pervasive computing* 1, 3 (2002), 51–57.

[50] Mark Rejhon, Christian Vogler, Norman Williams, and Gunnar Hellström. 2013. Standardization of real-time text in instant messaging. In *Proceedings of the 15th International ACM SIGACCESS Conference on Computers and Accessibility*. 1–2.

[51] Emily Schildt, Martin Leinfors, and Louise Barkhuus. 2016. Communication, coordination and awareness around continuous location sharing. In *Proceedings of the 19th International Conference on Supporting Group Work*. 257–265.

[52] Shalom H Schwartz. 1992. Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. In *Advances in Experimental Social Psychology*. Vol. 25. Elsevier, 1–65.

[53] Lauren E Scissors and Darren Gergle. 2013. " Back and forth, back and forth" channel switching in romantic couple conflict. In *Proceedings of the 2013 Conference on Computer Supported Cooperative Work*. Association for Computing Machinery, New York, NY, USA, 237–248.

[54] Leslie D Setlock, Susan R Fussell, and Christine Neuwirth. 2004. Taking it out of context: collaborating within and across cultures in face-to-face settings and via instant messaging. In *Proceedings of the 2004 Conference on Computer Supported Cooperative Work*. Association for Computing Machinery, New York, NY, USA, 604–613.

[55] Robin-Marie Shepherd and Robert J Edelmann. 2005. Reasons for internet use and social anxiety. *Personality and individual Differences* 39, 5 (2005), 949–958.

[56] Jaewook Shin and Mincheol Shin. 2016. To be connected or not to be connected? Mobile messenger overload, fatigue, and mobile shunning. *Cyberpsychology, Behavior, and Social Networking* 19, 10 (2016), 579–586.

[57] Andrew F Simon. 2006. Computer-mediated communication: Task performance and satisfaction. *The Journal of social psychology* 146, 3 (2006), 349–379.

[58] Jacob Solomon, Mark Newman, and Stephanie Teasley. 2010. Speaking through text: the influence of real-time text on discourse and usability in IM. In *Proceedings of the 2010 ACM International Conference on Supporting Group Work*. Association for Computing Machinery, New York, NY, USA, 197–200.

[59] Jared Spataro. 2020. *How remote work impacts collaboration: findings from our team*. Microsoft. https://www.microsoft.com/en-us/microsoft-365/blog/2020/04/22/how-remote-work-impacts-collaboration-findings-team/

[60] Kil Soo Suh. 1999. Impact of communication medium on task performance and satisfaction: an examination of media-richness theory. *Information & Management* 35, 5 (1999), 295–312.

[61] Robin L Wakefield, Kirk L Wakefield, Julie Baker, and Liz C Wang. 2011. How website socialness leads to website use. *European Journal of Information Systems* 20, 1 (2011), 118–132.

[62] Joseph B Walther. 2007. Selective self-presentation in computer-mediated communication: Hyperpersonal dimensions of technology, language, and cognition. *Computers in Human Behavior* 23, 5 (2007), 2538–2557.

[63] Joseph B Walther and Monica T Whitty. 2021. Language, psychology, and new new media: The hyperpersonal model of mediated communication at twenty-five years. *Journal of Language and Social Psychology* 40, 1 (2021), 120–135.

[64] Xiaolei Zhang, Chun-Fai Law, Cho-Li Wang, and Francis CM Lau. 2009. Towards pervasive instant messaging and presence awareness. *International Journal of Pervasive Computing and Communications* 5, 1 (2009), 42–60.