# Challenges of Online Group Chat for Productive Discourse at Scale

Viral S. Pasad

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Sang Won Lee, Chair
Deborah G. Tatar
Tanushree Mitra

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Viral S. Pasad

(ABSTRACT)

Group chat facilitates remote collaboration and idea exchanges. With the widespread use of group chat for productive information exchanges, it becomes difficult for members of groups to keep up and stay grounded during the long stream of conversation that is generated. I conducted a need-finding study where I simulated group chat conversations in the context of collaboration to learn about issues and behaviors in a group chat when the size of the group chat is 5 or 10. The study participants also filled out a survey post the group chat, describing their challenges and issues with the group chat. A grounded theory approach analyses of the data collected, and the chat conversation gave us several themes. Our results show that participants generally felt that there were too many messages. A majority of the participants found it was hard to keep track of what was happening. Information overload is a significant challenge that creates several other challenges for the participants, such as missed messages, redundant messages, wasted efforts, and difficulty in gathering consensus. I observed some behaviors such as broken utterances and other strategies employed by participants when overwhelmed with the high activity. I use this knowledge to motivate recommendations and suggestions for future redesigns and development of this indispensable tool of the workforce.

# Challenges of Online Group Chat for Productive Discourse at Scale

Viral S. Pasad

(GENERAL AUDIENCE ABSTRACT)

Group chat facilitates remote collaboration, idea exchanges. It becomes difficult for members of groups to keep up and remain on the same page during long conversations. I conducted experiments where I simulated collaborative group chat conversations to learn about issues and behaviors in a group chat with 5 or 10 members. The experiment participants also filled out a survey after the group chat, describing their challenges and issues with the group chat. Qualitative analyses of the survey data, and the chat conversation gave us several insights. Our results show that participants generally felt that there were too many messages. A majority of the participants found it was hard to keep track of what was happening. Information overload is a significant challenge that creates several other problems for the participants, such as missed messages, repeated messages, wasted efforts, and difficulty in obtaining agreement. I observed some behaviors and strategies used by the participants when overwhelmed with too many messages. I use this knowledge to motivate recommendations and suggestions for future redesigns and development of this indispensable tool of the workforce.

*I would like to dedicate this research thesis to my loving parents and their constant support. My father, Mr. Shrikant K. Pasad who is a man of science and rationale, the source of my analtyical skills and funds. My mother, Mrs. Jagruti S. Pasad who is a personification of selfless love and care, source of my empathy and sensitivity. I believe it is their upbringing and support which has enabled me to pursue my Master's degree and defend my Thesis.*

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# Chapter 1

# Introduction

Group chat applications have been a part of our daily use for a while now, and they have seen tremendous growth in utility and popularity, with regards to informal and social exchanges (Grinter and Eldridge (2001), Grinter and Palen (2002), Isaacs et al. (2002c)) as well as information interchange (Erickson et al. (1999), Fono and Baecker (2006), Isaacs et al. (2002b), Milewski and Smith (2000), Uthus and Aha (2013), Zhang and Cranshaw (2018), Zhang et al. (2017)). Chat systems allow richer collaborations and idea exchanges for geographically distributed teams with lower costs of communication (Cameron and Webster (2005)).

Furthermore, the COVID-19 pandemic has shown that these systems are dependable for communications and workflows in remote setups. There has been a tremendous growth in the stock prices and user bases of most of these messaging service companies. Slack acquired almost double the number of paid users (9000) just halfway through Q1 of 2020 than it acquired in each of the previous quarters of 2019(5000) (CNBC (2020)). Slack reported adding 2.5M connected users in a span of 15 days (Slack (2020)) in March 2020. Facebook also reported (Facebook (2020)) that the total messaging has increased more than 50 percent

over March 2020 in many of the countries that have been the most impacted by the COVID-19 virus. Microsoft recorded 44 million daily active users for their corporate group chat service Microsoft Teams, in late march 2020 (TechCrunch (2020)) which is a record high.

No matter how robust and dependable group chats are, they still possess several downsides. Users often prefer to communicate face-to-face or via voice/video based meetings when faced with complex discussions and collaborations. Furthermore, as the size of the group grows, there are multiple topics and perspectives in the chat during complex collaborative discussions and decision making. This may cause a conversational overload where the members of the chat feel overwhelmed by the number of messages flowing in and making the chat scroll very fast. Differentiation of important messages from the unimportant ones and thread disentanglement then, becomes difficult for the members of the group. This leaves the participants of the group chat confused and unclear about what is going on and "who is talking to who"(PS1_1). Participants then, in order to keep track of the conversation, often have to review and revisit conversation to make sense of fast-paced conversation in the chat. Furthermore participants may find difficulties in not only keeping track of the conversation but also being heard and conveying their ideas.

Previous research has explored communication at a large scale and how the size of the group affects discourse. Certain studies have looked at overload with regards to email and workloads (Savolainen (2007)). Nematzadeh et al. (Nematzadeh et al. (2019)) show that an increase in information load corresponds to a decrease in user activities and reduced information per message. A majority of the information overload research explores emails or virtual publics (Hiltz and Turoff (1985), Jones et al. (2004, 2008), Nematzadeh et al. (2019), Savolainen (2007)) such as Usenet groups, Twitch and Twitter. With collaboration and productivity oriented text-based Computer-Mediated-Communications (CMCs) having matured, studying how does overload in such media influence the overall productivity and

efficiency of these systems would be timely.

Research has also explored visualization designs where members of the group annotate the messages as they chat (Fono and Baecker (2006), Zhang and Cranshaw (2018)). However, these designs are either asynchronous and archival in nature. There is a need for real-time visualization of messages as well as the chat activities such as discourse acts (Zhang and Cranshaw (2018)) for better visual identification or differentiation of the important messages from the unimportant banter.

Furthermore, even though group chats allow deep collaborations at low communication costs, users often prefer to meet in person to complement the limitations of the group chat when they need to quickly reach an agreement or their collaboration needs to be highly coordinated. Studies of instant messengers (IMs) in the workplace Cameron and Webster (2005), Nardi et al. (2000) have shown that users often use IMs to negotiate availabilities or switch to a different medium (such as calls). When asked about the preferred medium of communication while co-ordinating with multiple people in a group, 21% of the participants showed a preference for face-to-face in-person or face-to-face meetings over online group chats. A participant said that to co-ordinate with multiple people in a remote setup, "face-to-face i'd say it's the most effective" (PL2_8). Based on the current state of group chat use and the explored literature, I formulated two research questions.

**Research Questions:**

- **RQ 1:** What are the challenges that participants in online group chat face in the context of group work?
- **RQ 2:**How do they cope with the challenges presented by the online group chat?

This work explores the challenges faced by members of group chats while engaging in productive discourse and attempts to understand the information overloads in them. Participants

were recruited to take part in an empirical study involving discussions and collaborative decision making in a group chat. I collected data from a total of 6 groups with 3 large groups (10 participants) and three small groups (5 participants). After the empirical study, the participants filled out a survey based on their group chat experience in general as well as the study that they just participated in. The data collected was then analyzed qualitatively to examine multiple aspects of the communication in online groups with different sizes to identify the challenges and behaviors that people exhibit during synchronous group conversations.

Results identify behaviours that are triggered by an overwhelming amount of activity in the chat. I found the challenges faced on online group chat during productive discourses. Participants complained that there were *"too many people"* (PL2_5) or *"too many messages"* (PS3_1). I observed some wasted efforts and unspoken thoughts along with difficulties in thread disentanglement and recovering from digressions. It was also challenging for the participants to successfully measure consensus, in spite of certain inline tools. I also identified some of the behaviours exhibited by the participants while participating in group chats for conversations with discussions and decision making. Over half of the participants agreed on having held back from saying something because the topic had already changed. A majority of the participants tended to participate only when needed or specifically addressed. A majority of the participants found it was hard to keep track of what was happening. The fast pace of chat, bringing in too many messages was observed to be a common complaint and source of overwhelm for the participants. Such an information overload can make it harder for continued participation in the conversation or result in shorter but more number of turns, thus inadvertently contributing to the overload thus leading to a vicious cycle where no conversational progress can be made. With the themes and insights obtained from the study, I make some design recommendations which may help alleviate the challenges

observed.

# Chapter 2

# Review of Literature

Clark and Brennan (Clark and Brennan (1991)) laid the groundwork on how grounding is a mandatory requirement for any kind of collaborative communication to happen. Grounding is "assuming a vast amount of shared information" which is constantly updated in the duration of the communication. Once an utterance is presented, it may be assumed that the speaker would need 'negative evidence' to detect miscommunication / incomplete grounding. The study states that there are three common forms of positive evidence, namely acknowledgements, initiation of the relevant next turn, and continued attention. However, due to constraints on textual chats like the lack of co-presence or visibility, it may be harder to distinguish between continued attention or no evidence at all. This chapter discusses CMCs and the text based Instant Messaging (IM) with respect to online collaborations and group decision making.

## 2.1 The advent of Instant Messaging

Previous research on CMCs has explored media spaces i.e. audio-visual settings (Bly et al. (1993), Fish et al. (1993), Tang et al. (1994), Whittaker (1995)). Media spaces use audio-video and computer systems and allow geographically distributed groups and individuals to work together (Dourish and Bly (1992), Tremaine et al. (1991)). However, since the arrival of the IMs, CMC based research has also explored this technology in various use cases including the workplace. Furthermore, studies advocated the integration of text-based messaging into media spaces since both supported informal communication for people collaborating at a distance (Nardi et al. (2000)).

However, in terms of the text-based messaging, several CMC systems such as MUDs (1970s), Email, IRC (1980s), and Usenet Groups have preceded the IM (Herring (1996), Werry (1996)). IMs allowed synchronous communication of string messages between users in chat-rooms, also known as channels in some literature. Research explored several new functionalities such as aliases, number of participants, and threads, to name a few. (Herring (1996, 2013), Werry (1996)).

## 2.2 Rise in popularity of IMs

IM quickly gained popularity thanks to its affordances, which enable communications to be polychronic, brief, and informal (Grinter and Eldridge (2001), Grinter and Palen (2002), Isaacs et al. (2002c), Nardi et al. (2000)). Research advocated persistent conversations as well, supporting the archival of conversation history for perusal (Erickson and Kellogg (2000), Erickson et al. (1999), Fono and Baecker (2006)). Since IM chats allowed multi participant conversations, it quickly found use in a plethora of applications.

### 2.2.1 Group Chat use in Software Development

Software development teams and organizations used group chat for collaboration on their projects. Group chat supported software developers, often distributed globally, to communicate while collaborating on open source projects. (Cataldo and Herbsleb (2008), Shihab et al. (2009))

### 2.2.2 Chat use in the Military

The US military also found group chats useful across all its branches. Being used by several divisions of the military for command and control further boosted not only the research and development but also the popularity of group chat. Studying the military use of chat provides a well-documented history of IM's growth as an indispensable tool(Uthus and Aha (2013)). As it grew, group chat came with several advantages, like the collaboration of a large number of synchronous participants, scheduling, persistent conversations, and lower network requirements (Duffy (2006, 2008), Eovito (2006), Fono and Baecker (2006), Heacox et al. (2004), Uthus and Aha (2013))

## 2.3 Instant Messaging in the Workplace

The growth of chat and rise in popularity motivated its use in the professional workplace (Bradner et al. (1999), Handel and Herbsleb (2002), Isaacs et al. (2002b)) for productive discussions, work related decision making, opportunistic interactions. The use of IM's in the workplace was studied to find that workers used IM to discuss a wide range of topics. Professionals who were power users would have many fast-paced long messages with interleaved threads and topics. The more light users would have shorter exchanges discussing

one thing over elongated periods (Isaacs et al. (2002a,c)). While there are expected benefits from chat use, there are studies that examined the unintended consequences of IM use in the workplace. They suggested the concepts of polychronicity and critical mass to understand communication technologies and their unfair interruptions in the workplace (Cameron and Webster (2005), Herbsleb et al. (2002)). The study reveals that IMs symbolized informality for the employees who often used it to supplement communication or negotiate availability. However, participants also felt that IMs' interrupting nature was unfair, and the study urged for more investigation regarding the same. Handel et al. (Handel and Herbsleb (2002)) present an empirical study of a synchronous messaging application with group chat functionality to support teams in the workplace. They categorised the group chat conversations into categories to understand content of chats. Their categories classified chat topics into work topic, non-work topics, greetings, humor and other. Furthermore, they subcategorised the work messages into categories related to technical, project management, meeting management and company.

IMs can support both synchronous and asynchronous communications. They also encouraged the "preferential use of this public chat space even for (non-sensitive) messages targeted at some subset of the group, or an individual" so that the users could have more context in the conversations such as concerns, interests and personalities of other group members. Such use of public chat would not be recommended today, as it is believed to be a hindrance to productive conversations. 61.7% of participants agreed that they "participate in conversations only when needed or specifically referred". Their results showed that while 69% of the messages were work related, other categories such as negotiating availability, greetings and humor were 13%, 7%, and 5% of the total approximately 4000 messages, respectively.

As discussed above, apart from the expected benefits of IM use in the workplace, there were several unintended or unexpected ways in which IMs were used. Workers used IMs informally

to have non-work related banter, water cooler conversations, and availability negotiations as well (Cameron and Webster (2005), Nardi et al. (2000)). Nardi et al. (Nardi et al. (2000)) present and encourage a study of outeractions. They describe outeractions as the communications that facilitate and support the work-based information exchange interactions. Other explorations of informal uses of IMs at work showed that it mainly supported four functions, variations of which echoed by other studies as well. The functions afforded by IM are (1) rapid back and forth questions and answers, (2) coordination and scheduling work tasks, (3) impromptu availability negotiations, and (4) social networking (Grinter and Eldridge (2001), Grinter and Palen (2002), Nardi et al. (2000), Uthus and Aha (2013)). These features made IM a notable tool used by the workforce and its managers as well as the general population including teenagers. The popularity of IMs grew as the affordances they support made it a lucrative/desirable feature to integrate into other existing video-based media spaces to support informal communications for workers distributed geographically (Cataldo and Herbsleb (2008), Tremaine et al. (1991)).

## 2.4 Information Overload

A growing popularity of group chat and significant feature enhancements and redesigns have now made group chat an irreplaceable medium of communication of the modern world. Chat is useful not only for users with geographical constraints but also with workers/users in the same physical location like a college campus or even a single conference room (Dennis et al. (2010)). A global pandemic imposing geographical constraints, makes the presence of these already ubiquitous group chat messengers even more essential. Furthermore, visual and cognitive constraints limit the human processing speed of written texts (Nematzadeh et al. (2019), Rayner (1986)).

Thus it might benefit us from exploring literature surrounding the information overload (Rogers and Agarwala-Rogers (1975)) or the conversational overload (Whittaker et al. (1998)). Rogers et al. explain Information Overload as "the state of an individual (or system) in which not all communication inputs can be processed and utilized, leading to a breakdown." Based on the medium in which the overload occurs, information overload is also known as a *conversational overload* (Whittaker et al. (1998)) or *information entropy* (Hiltz and Turoff (1985)). The term attempts to explain the phenomenon where the huge number and/or the lack of structure of messages makes it harder to process and respond.

Although significant number of works have studied the effect of information overload at the individual level (Bawden and Robinson (2009), Janssen and de Poot (2006), Savolainen (2007)), explorations at the group level are relatively fewer. Some (Whittaker et al. (1998)) have studied mass interaction with a focus on demographics, strategies, and interactivity. Their analyses of over six months of Usenet activity suggest that overfamiliarity of thoughts and people can gain common ground and staleness quickly, while a diverse population may seem interactive and lack conversational progress. Jones et al. have studied overload in virtual publics such as newsgroups (Jones et al. (2004)) and IRC (Jones et al. (2008)). These analyses of information overload in virtual publics tell us that with a rise in the number of incoming messages, the capacity of consumption and response decreases. Information overload has the potential to influence the structure and dynamics of the discourse (Jones and Rafaeli (2000)) as observed via fewer and shorter responses that may be oversimplified or redundant. (Hiltz and Turoff (1985), Jones et al. (2004), Nematzadeh et al. (2019))

## 2.5 Motivation

Strategies to tackle information overload have been explored before in different contexts. Certain studies have looked at overload with regards to email and workloads. Savolainen (Savolainen (2007)) identified two major strategies namely filtering and withdrawal. Jones et al. (Jones et al. (2004)) mention potential for empirical evaluation on the impact of individual strategies to deal with information overload. Furthermore with IM technologies having matured, it might be timely to study sensemaking Zhang and Cranshaw (2018) and information overloads in group chats. This work explores the challenges faced by members of synchronous group chats. It also attempts to understand the information overloads in collaborative group chats and the some individual challenges employed by the participant to tackle the same.

# Chapter 3

# Methodology

The goal of this work is to obtain deeper insight into the challenges and behaviors in online group chats with the goal of productivity. I conducted a need-finding user study with Slack and ran a qualitative analysis of chat history in group chat and their responses in a post-study online survey, to identify the challenges and common patterns that people exhibit during synchronous group conversations. Here, I introduce the detailed study procedure, participants, and our limitations.

## 3.1 Study Procedure

I conducted studies with 5 or more participants to converse in Slack and work on collaborative tasks. Prior to the study, the participants were asked to create a Slack account. In the time of each study, the subjects were invited into a group chat channel in Slack. Then, the moderators went through the transcripts and copied/pasted the task instructions. There were four tasks, the first of which was an icebreaker activity intended to warm up the conversation. The rest of the three tasks each designed to simulate a typical group chat scenario.

Here are the descriptions of the four tasks given to the participants during our lab studies:

**TASK 1:- Ice Breaking**

*"Please share with everybody at least 1 aspect you like and dislike about the town of Blacksburg. (eg Duckpond, TOTs, etc.) You may justify your pick and discuss it with others."*

**TASK 2:- Light Scheduling**

*"Your task is to discuss with the members of your group, a time for a lunch/dinner meeting. You have to show a new Faculty Candidate around Blacksburg. The faculty candidate will be in town next week. We want to show off the restaurant scene in Blacksburg. We are unaware of his dietary restrictions. You are supposed to select a (Restaurant) venue, meeting date, meeting time. Make sure that you are actually available at that time based on your schedule (for the sake of making this task more realistic). If impossible, find the time that works the best for most of you."*

**TASK 3:- Heavy collaboration and co-ordination**

*"You have been tasked with planning group travel. Plan a travel itinerary for a family trip from Blacksburg, VA to a destination of your choice for 7 days. The family includes a couple and two kids (Aged 5 and 9 years) with a budget of USD 4000-5000 which is inclusive of the airfare/travel costs. Plan the following:*

*- Travel Destination (Itinerary)*

*- Travel Dates*

*- Accommodation/Stay*

*- Travel Means (Car / Flight Details)"*

**TASK 4:- Subjective Opinionated Discussions**

*"This is a common fear that AI and Machine Learning will take away jobs from Humans.*

*What are your opinions on this? Discuss"*

For all tasks, I asked the participants to stop working on the task when they were satisfied with the outcome; I stopped task execution ourselves only if it took over an hour. The participants then were asked to complete a detailed post-study survey to gain further insights into the participants' experiences.

**Post-study Survey** In the survey, I began by asking participants' general experience with group chats such as how often and for what purpose do they use group chat, and what platform do they commonly use. I then asked about the dynamics of their group chat conversation, the challenge they face, and their strategies for effective communication. Lastly, I concluded the survey by asking about the tasks they just did in the study and their ideas on how to make the execution of the tasks better. The questions asked can be found in Appendix A.

## 3.2 Participants

I conducted studies with participants recruited from the author's university and 1-2 moderators from the research team. Each study was conducted remotely on an online group chat with two different scales: three of the group chats involved 5 participants and the other three involved 9, 10, and 13 participants. There were 47 participants (23 of which identified as male, 23 as females, and 1 participant identified themselves with a non-binary undisclosed gender) that I recruited. The survey filled out by the participants regarding their demographic details can be found in Appendix B.

### 3.2.1 Recruitment

I conducted studies with participants recruited from the author's university and 1-2 moderators from the research team. Participants were recruited for all six studies through email listservs and word-of-mouth and were compensated $10 for their time. Their ages range from 19 to 29 with an average age of 22.4 and the majority of them being college students. The participants were asked to for an alias in order to maintain their anonymity. Furthermore, in order to schedule the participants into studies with group sizes 5 or 10, the participants were asked to select suitable time slots from the multiple time slots provided to them via Doodle polls.

### 3.2.2 Scheduling

There were several difficulties I faces in successful scheduling participants into multiple studies. As one might expect, it was easier to schedule participants for a five person study than for a 10 person study. Out of the 186 registrations that I received, only 87 provided their availabilities to be scheduled. Out of the 87, barring the 25 no shows, pilot studies were conducted with 15 while 47 particpated in the different group chat studies. Often successfully scheduled studies would not take place due to the a number of participants not showing up and a quorum not being met. These participants contributed to the count of no-show participants. Most participants who were recruited were scheduled with groups. This largely depended on their availability which was requested using Doodle polls. However, scheduling ten participants each for a minimum of three studies atleast, proved to be a challenge, especially in the middle of the COVID-19 pandemic.

## 3.3 Data Analysis

In order to capture the complete chat activity during the study, the computer screen of the study moderator was recorded to capture the conversation history from the moderator's perspective. The entirety of the conversation was directly imported from Slack, such that each row of a message contains the message content, the timestamp (in unix time), a unique User identification and so on. The conversation time was further measured by calculating the time interval between each message (subtracting the timestamp of the first message from the timestamp of the second message).

I also further analyzed the textual content of the messages, evaluating the intent and impact of each message, and counted the frequency of specific semantic expressions. The goal was to look for specific behaviours that participants might employ when the chat is overwhelmed with the inflow of messages in the middle of an information exchange. Thus all the messages were annotated according to a coding scheme that was developed. Furthermore, iterative and inductive thematic analysis was conducted on the responses from the post-study survey data. Through the process, the goal was to identify emerging themes in relation to digression, activity, and strategies for sensemaking in an information overload. The results section below discusses the themes which can be kept in mind while developing updates for group chat systems.

## 3.4 Ethics

The protocol for study was reviewed by the IRB of Virginia Polytechnic Institute and State University. The identity of our participants is irrelavant to the analyses presented, hence all results presented in the paper are anonymous. The snippets of the conversation presented as

figures contain aliases instead of participant identities. The participants were asked to pick an alias for themselves while signing up for the study. Furthermore, the quotes presented from the survey data have also been anonymized and presented with a unique identifier for each participant. The unique identifier (for instance, PL1_3) contains just the information about the participant number and the size of the group they were a part of. PL1_3 implies that the participant participated in the first session of a large study and was the the third participant in it while PS2_5 signifies the fifth participant of the second session of a small study group. The mappings of these unique identifier and the identities of the participant are only accessible by the principal and co-investigators of the protocol as approved by the Institutional Review Board at Virginia Tech.

## 3.5 Limitations of the method

### 3.5.1 Ecological validity

One limitation of our study is that subjects' performance and behavior can be potentially impacted by the hypotheticality of study tasks. To best observe participants' group chat behavior in different workspace settings, all four tasks each represent one specific workspace scenario. For example, the second task is intended to simulate a scenario where team members need to collaboratively do quick scheduling and find a common time that would work for all or most of the members. In this task, the participants are required to find a common time slot based on their true schedule. Since the task itself is hypothetical, participants would bear no consequence if they were to provide a wrong or fake schedule and it is this less responsibility that would make participants' behavior vary from the real-life.

However, most of the concerns were alleviated when participants engaged in conversations

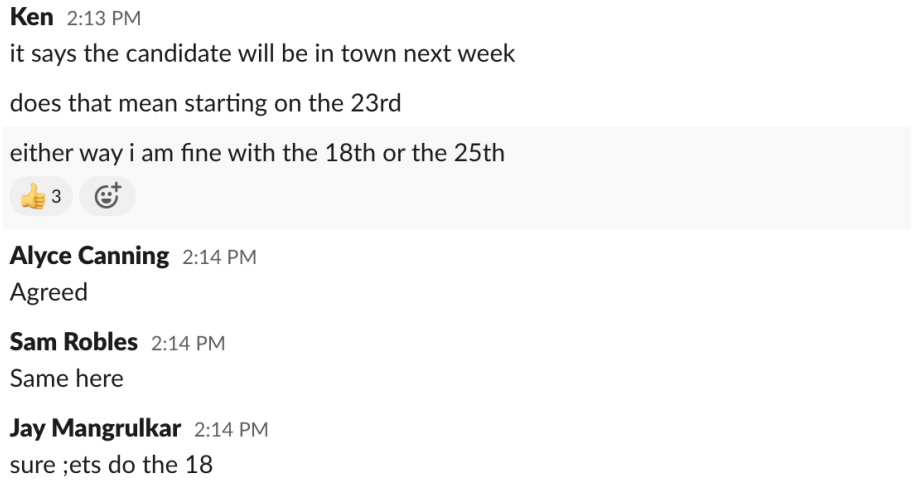


Figure 3.1: Participants alleviate concerns about ecological validity by being mindful of the dates and their availabilities.

and were evidently mindful of the dates, their schedules, and the venues being discussed with the personal vested interest shown in figures 3.1 (a participant (aliased Ken) exhibits mindfulness about the dates), 3.2 (participants (aliased Andrea Clarke and EpicGamer69 declare their unavailable times), and 3.3 respectively. The conversation snippet in Fig. 3.3 is particularly interesting to observe a participant (aliased Sam Martha) reconsider their availability for the convenience of the group, and participants (aliased Senpai and Mark Lawerence) voice their discomfort/concerns in relation to the proposed venue.

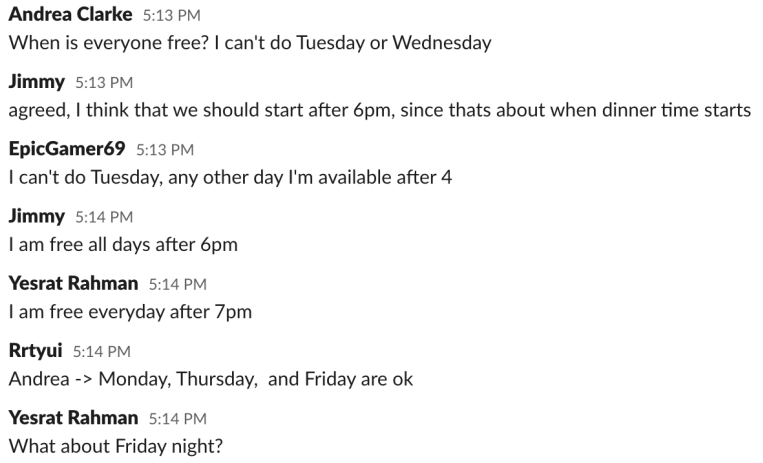


Figure 3.2: Participants alleviate concerns about ecological validity by communicating their availabilities as per their real schedule.

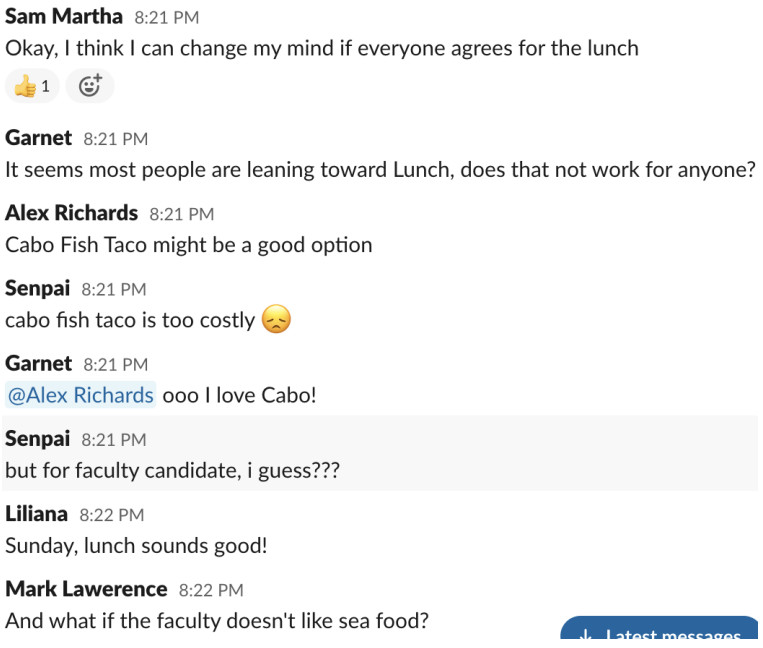


Figure 3.3: Participants alleviate concerns about ecological validity by voicing concerns about time and venue.

# Chapter 4

# Results

## 4.1 Current State of group chat use

Group chat has been around for a while, but I wanted to know how users utilize this technology currently. Using the survey, We asked certain questions to the study participants about their use-cases and mental models of the group chat. The questions asked to the users were both objective multiple-choice questions as well as subjective open-ended questions for them to express their mental models with us. A comprehensive list of questions asked can be found in the appendices. I learned about the participants' habits and thought processes behind how they used the technology. I also learned about the choice of chat messengers employed by the participants in their daily lives.

### 4.1.1 Participants' media choices

Participants commonly used group chat for work or study and social networking. Participants used a multitude of applications for group chat such as Facebook (66.0% of the

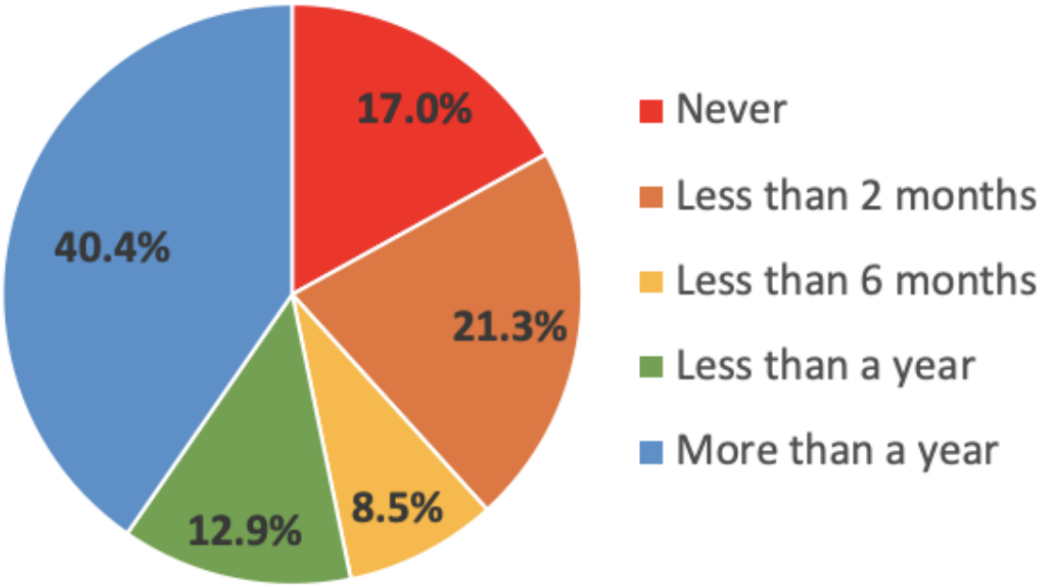


Figure 4.1: Participants' use of Slack.

participants), Mobile SMS(59.6% of the participants), WhatsApp(42.6% of the participants), Discord(49.0% of the participants) as shown in fig 4.2. The empirical study was conducted using Slack, which was used by 82.9% of the participants in varying capacities, while 17.0% of the participants had never used it at all, as shown in Fig. 4.1

### 4.1.2 Participants experiences with group chat and conversational overloads

The post-study survey that the participants filled out, revealed the following experiences experienced by frequent members of group chat and some of their strategies employed during periods of activity and overload. 61.70% of the participants agreed to participating in conversations only when needed or specifically referred while 25.5% even admitted to not

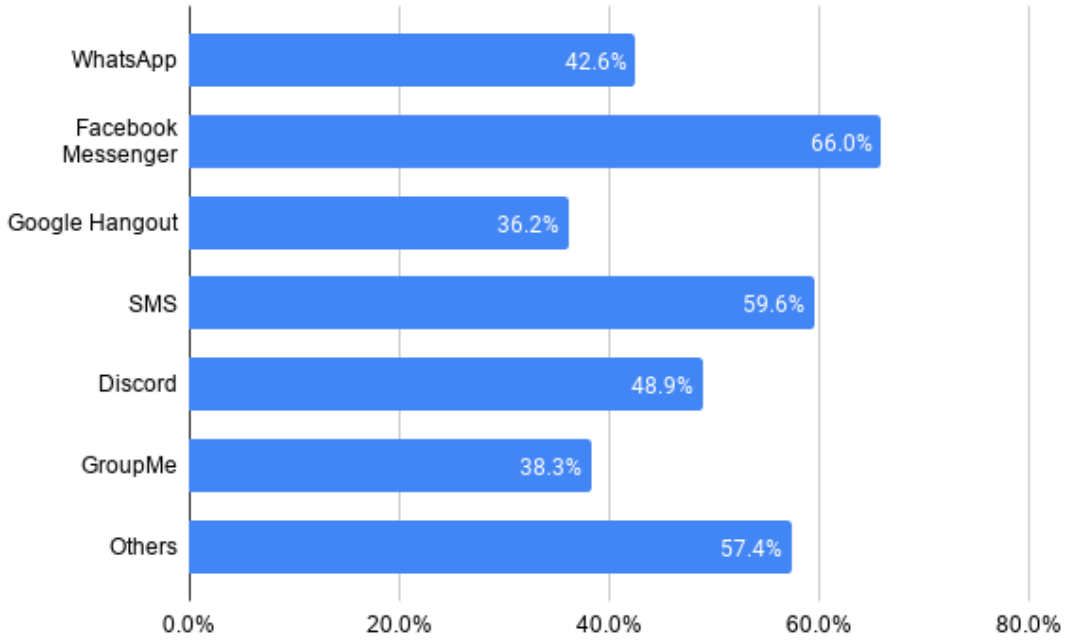


Figure 4.2: Participants' use of group chat messenger applications.

reading all the messages in the first place. 80.9% of the participants reported that they had seen people have conversations in larger group as if it were private chat. While this would be advised in very early days of the group chat (Handel and Herbsleb (2002)), such behavior in 2020 would most certainly avoided and looked down upon in terms of the 'chattiquette'.

## 4.2 Study comparisons

I evaluated the significance of the difference of the two study sizes using a Lower Tailed Mann-Whitney Wilcoxon Rank Sum test as shown in the table 4.1. This was evaluated based on the responses from the participants in the post-study survey where the participants were asked questions with responses based on the 5-point likert scale. The values in the small and large columns are average responses by the participants, normalised as per the number of

| Question | Alt Hypothesis | Small, ($\sigma$) | Large, ($\sigma$) | p-values |
|---|---|---|---|---|
| The discussion was fluent. | $\mu_{small} > \mu_{large}$ | 4.33, (0.72) | 3.88, (0.83) | 0.050+ |
| It was difficult to keep track of all the messages. | $\mu_{large} > \mu_{small}$ | 2.33, (1.11) | 3.22, (1.21) | 0.014* |
| It was difficult to reach to an agreement. | $\mu_{large} > \mu_{small}$ | 2.07, (0.88) | 2.78, (1.09) | 0.025* |
| During the task, there was a topic that I wanted to bring it up but I did not. | $\mu_{large} > \mu_{small}$ | 2.46, (1.13) | 3.06, (1.27) | 0.072+ |
| Comprehending all the messages was easy. | $\mu_{small} > \mu_{large}$ | 4.26, (0.59) | 3.31, (1.03) | 0.002** |
| I am satisfied with the discussion outcome. | $\mu_{small} > \mu_{large}$ | 4.26, (0.70) | 3.81, (0.82) | 0.058+ |
| There were too many people in the room. | $\mu_{large} > \mu_{small}$ | 2.13, (0.92) | 3.19, (1.18) | 0.004** |
| I felt I was ignored | $\mu_{large} > \mu_{small}$ | 1.67, (0.89) | 2.28, (0.96) | 0.013* |
| Members of the group understood me and what I had to say | $\mu_{small} > \mu_{large}$ | 3.87, (0.86) | 4.20, (0.79) | 0.089+ |

Table 4.1: Lower tailed Mann-Whittney Wilcoxon Rank Sum Test comparing the significance between the small and large study differences. (+ $p<0.1$, * $p<0.05$, ** $p<0.01$)

participants in the small and large groups. More on the survey questions is in the appendix A. There was no significant difference between the two studies except for a few statements. I saw significant differences in the two group sizes for the statement *"Comprehending all the messages was easy"* where the larger group members were more neutral while the smaller group members agreed. Furthermore the smaller group members were more satisfied with their outcome while the larger group members tended to stay more neutral.

## 4.3 Challenges in online group chats

### 4.3.1 Keeping up with the Overload

One major challenge that was consistent and influenced many other challenges was that members of a group chat could not keep up with the volume and speed of the communications. Participants were overwhelmed with messages being *"too many [and] too fast"* (PS3_1). In spite of the group sizes being 5 and 10 participants only, there were complaints

that there were *"too many people at some points"*(PS2_1) and that *"there were just too many people so the messages would get lost"* (PL1_6). Participants also reported *"keeping up with all the new messages and responding to each one"* (PS2_3) as a challenge during group chats. Participants also found it difficult *"to find the messages that you want to read specifically ... conversations take different turns and you're unable to keep track of important information"*(PS3_4).

Based on the above responses and complaints from the participants, I was motivated to find out the reading speed that the participants were subjected to. The rate at which text messages were generated, was 114.5 words per minute (WPM) on average across all studies. This reading speed is significantly lower than the average reading speed for the average English text which is 175300 WPM (Brysbaert (2019)). Inspite of a lower reading load, participants still experience a sense of overwhelm because of the additional tasks that present themselves with participation in group chats. This is because general English text is often static while a synchronous chat conversation is dynamic, with text messages flowing in and out of the screen. Thus participation in group chats in the overload regime (Nematzadeh et al. (2019)) may provide a general sense of instability and a cognitive load. This cognitive load and an optional assumed responsibility of contributing to the chat are overheads to the cognitive load of parsing the contents of an information rich message. Furthermore, the Fig. 4.3, shows the speed at which text in generated in the complex collaboration task in a study with 10 participants. As evident in the figure, while the reading speed is quite low through out the task, there are peaks where the reading speed is significantly higher and often double than the average human capacity.

The survey responses also confirmed the participants' perception on the challenge of keeping track of messages. Participants agreed or strongly agreed to the statement "I often read older messages because I couldn't keep up with messages arriving super quickly" (76.5%).

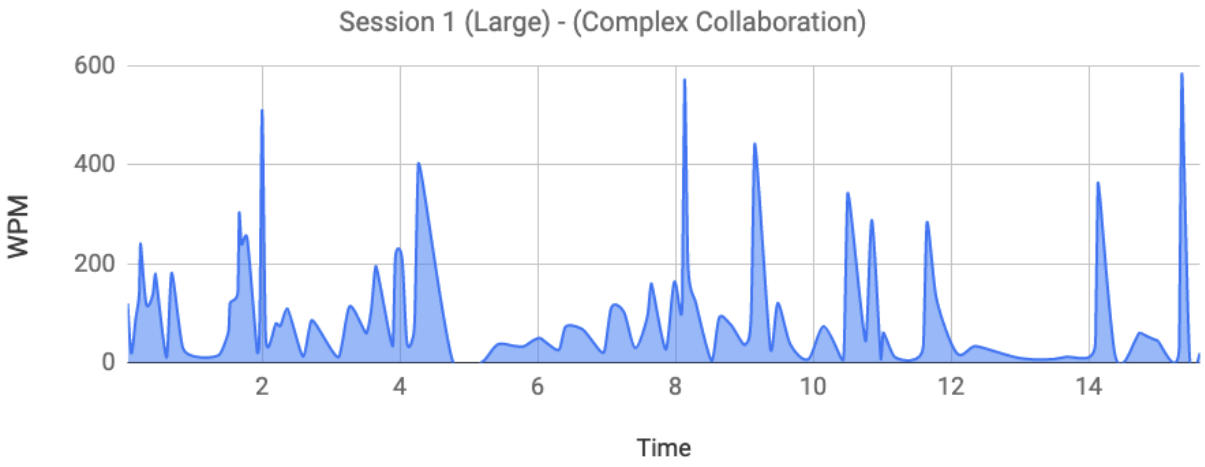


Figure 4.3: A plot showing the word per minute statistic during a complex collaboration task in a study with 10 participants.

Another observation regarding the overwhelm faced by the participants is that the use of multimedia accelerate the speed at which chat scrolls out of the view-port. The sending of a single multimedia content in the chat results in a few messages being pushed out of the view port because of the real-estate space consumed by the multimedia. This sudden change in the screen visual can worsen the overload and instability experienced by the participants. This observation holds true for any multimedia content used in the conversation. However, the use of multimedia can make the chat harder or easier to parse depending on the information density of the multimedia content.

One of the many reasons for an overload of information is the nature of conversations (which often involve on multiple threads of conversation simultaneously), combined with the group chat affordances (and the way they are) used today. Conversations involving complex decision making and deliberation, are often comprised of several smaller intertwined threads.Furthermore, when a relatively large number (5 or more) of minds are involved, each mind may approach the task at hand differently with a different point of view.

This can be observed in the snippet from the travel itinerary conversation shown in Fig.

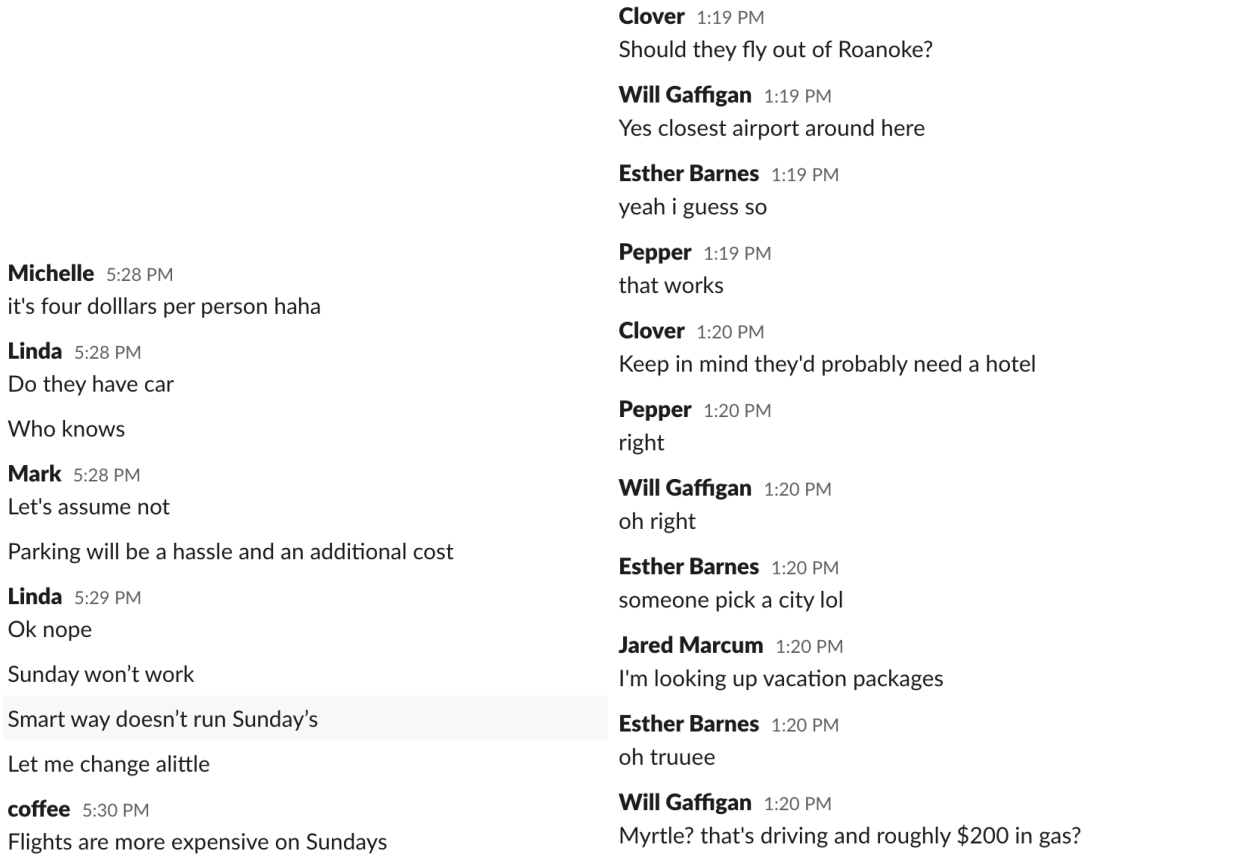


Figure 4.4: A snippet from the travel itinerary conversation showing that the collaborative nature of this task requires several threads to be discussed simultaneously.

4.4 where the participants are considering their budget, mode of travel and the dates of travel or their budget, mode of travel and the travel destination (Myrtle) simultaneously. Furthermore, as depicted in Fig. 4.5 the participants are discussing the tourist spots that could be visited in different places in order to decide the final city to be toured.

Different perspectives are great for discussion and always coveted for a comprehensive/complete and well informed discussion/decision (Dennis et al. (2010)). Multiple people attempting to tackle a problem from their respective points of view, calls for turn taking so that each point of view put forth can be satisfactorily discussed before the next one is evaluated. In verbal communication, typically only one topic is discussed at a time. Most utterances are linear/sequential and responses to previous utterances on the same topic. However, unlike

where should they stay at

**Alyce Canning** 2:23 PM
Some time could be spent at Kennedy Space Center and Cape Canaveral, if the trip was scheduled properly, the family could potentially see a rocket launch

**Donghan Hu** 2:23 PM
What about Miami?

**Caroline Turner** 2:24 PM
True. Or stay at a resort in Disney that has pools
👍 1

**Steve Marbles** 2:24 PM
At a small hotel the ones near the parts are expensive

You can get a better hotel for a lot less money

**Jay Mangrulkar** 2:25 PM
yeah a resort is good, also, disney has like 3 or 4 parks they could do a park each day
👍 4

epcot, universal, magic kingdom, islands of adventure

**Ken** 2:26 PM
i have never been to disney world so i'm not sure but how many days should we allot to disney world as opposed to other places in florida

**Jay Mangrulkar** 2:26 PM
i would say 4 days in disney and like 3 in other places
👍 2

**Hudson smith** 2:26 PM
I haven't been either so I might not be the best person for advice

**Sam Robles** 2:26 PM
I'd say that you can get away with 5 days at disney, especially since they have kids who will make things slower

But 4 also works.

**Alyce Canning** 2:27 PM
It's only a 90 minute drive from Orlando to Tampa, so if they are renting a car they could go to Tampa for a couple days

Figure 4.5: A snippet from the travel itinerary conversation showing that the collaborative nature of this task involves multiple participants bringing multiple topics/perspectives to the conversation.

verbal communications, turn-taking is not the way in which discourse is conducted/generated in agenda based group chats with a large number of participants.

In spite of being an unnatural way to communicate, speaking out of turns is observed in group chat unlike the spoken communication where non-verbal and speech-based cues indicate turns that are in progress. This is not only because of the affordances of the modern day chat application which allow members to raise multiple issues/topics simultaneously, but also because this is how the veteran/experienced users of group chat make use of these features. The modern day chat applications provide simultaneity but not cotemporality (where the reciever would recieved communication at the same time that the sender produces it, thus improving the visibility of turns that are in progress. As a result, there can be multiple speakers creating (not sending) an utterance at the same time which would rarely happen in spoken/face-to-face communication.

### Broken Messages

One interesting observation that came across was that participants of our study often participated in the conversation using broken utterances. Broken utterances are when users present utterances over multiple shorter incomplete turns instead of a longer complete turn as depicted in Fig. 4.6. This can be very perplexing for others in the group who are trying to find meaning and make sense of the vast sea of messages. This seems to be a behavior exhibited some of the participants. While it was briefly discussed by Chapanis (1975), it was found to not hinder communication and information exchanges in major ways. However, as the size of group chat increases, incomplete utterances are more prone to interruptions as shown in fig. 4.8. This is because, multiple turns maybe in progress which due to a lower degree of co-temporality are visible only when the producers hit send. Thus, turns which may not be related to the incomplete message, end up interrupting future ammendments and

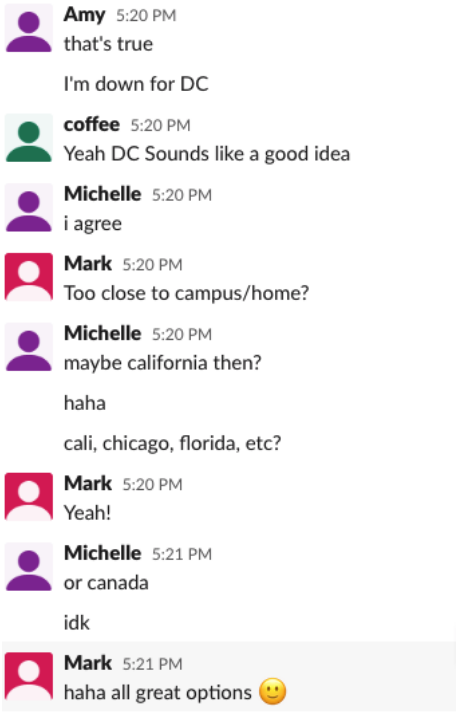


Figure 4.6: A screenshot of study. A chat snippet from a study of 10 participants, depicting a user with the alias Michele repeatedly texting in broken messages and monopolising the chat and further contributing to the information overload.

completions to the same thought. Thus while incomplete messages are also found in verbal communications, they are less prone to interruptions than group chat messages because the in progress turns are recieved by the group before others can simultaneously produce their utterances.

**Genuine ammendments to the initial utterance can cause broken utterance**

One of the obvious reasons for broken utterances is that the sender genuinely thought of an additional amendment or repair to the initial utterance that they believed would improve grounding in communication. I believe this can be observed in Fig. 4.7 where a participant aliased *Alex Richards* felt like providing justification for the question they asked. Such amendment messages tend to be generally innocuous because of their rarity.

Such a broken utterance when presented in high activity periods of the group chat might end

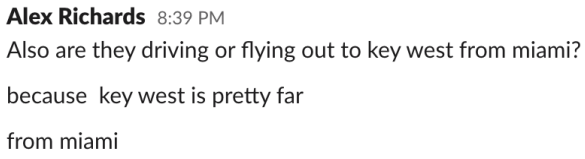


Figure 4.7: A snippet from a conversation where a participant, aliased *'Alex Richards* communicates using broken utterances, as an attempt to justify their question.

up getting interrupted or interrupting responses to itself. This leads to a complicated presentation and acceptance phase (Clark and Brennan (1991)). The conversation snippet in Fig. 4.8 shows how messages sent by the participant aliased *slacker* (in response to a participant aliased *Eliana*) keep getting interrupted by others. Not only that, but *slacker*'s messages also interrupt the general conversation that had stemmed from *Eliana*'s message. Such broken utterances and interruptions may be rare and occurring due to the sender's attention having been interrupted with something or having a slower typing speed. Furthermore, certain participants may interrupt an ongoing conversation with their broken utterances and repairs when they do not read the chat before sending their messages. This behaviour was reported by *"I think the task went well, I think some in some instances people would keep typing and sending messages without seeing responses first"*(PL1_6).

**Broken utterances due to habits and personal reasons**

Lastly, there were also incidents where a participant aliased *Senpai* used broken messages throughout the hour-long conversation with no apparent topic changes, initiation of repairs, or assuming authority. I believe that this behaviour may be just a residual effect of participation in super busy group chats and a habit of constantly sending in broken messages. Another example of the same can be seen in figures 4.6, 4.9 and 4.10 where the participants aliased *Michele*, *Kimberly* and *Jay* can be observed splitting their messages into multiple utterances with no clear reason for multiple broken utterances. These reasons can be attributed to factors that are extrinsic and outside the conversation.

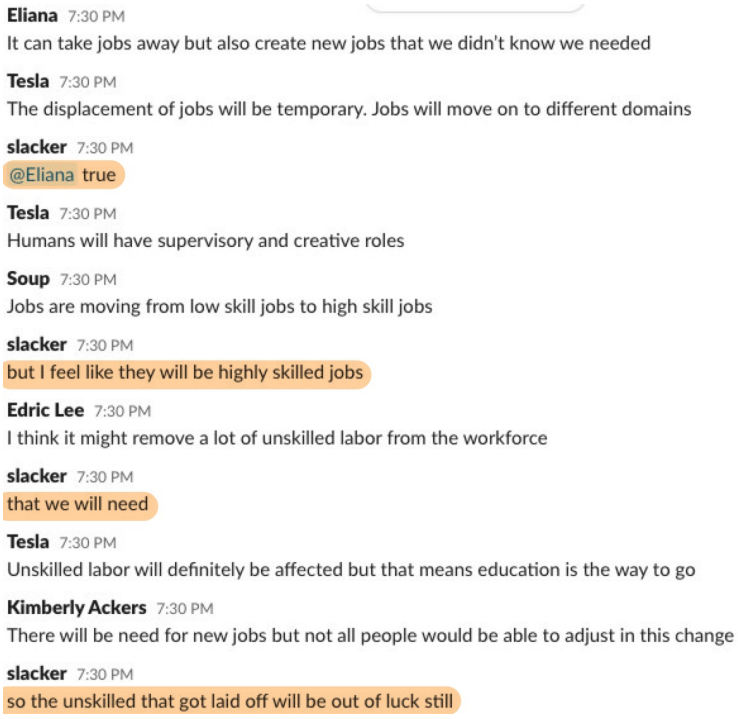


Figure 4.8: A snippet from a conversation where broken utterances by a participant (aliased *slacker*) interrupt an ongoing conversation as well as get interrupted themselves.

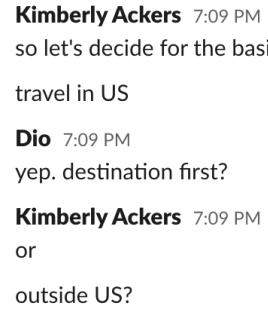


Figure 4.9: A chat snippet depicting a user with the alias *Kimberly* repeatedly texting in broken messages and making the chat scroll faster

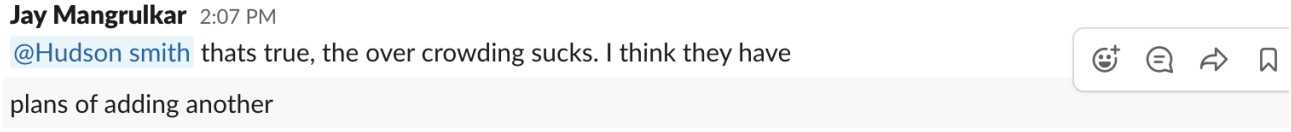


Figure 4.10: A chat snippet depicting a user with the alias Jay splitting an utterance at a random point for non-recurring personal reasons.

### 4.3.2 Wasted Efforts and Unspoken Thoughts

#### Redundant messages waste the effort

The nature of conversations and the scale of group chat often leads to redundancy in conversation. A lot of the efforts of the group members are wasted as repeated messages or ignored ideas. Such wasted efforts obviously contribute to the overload of information. The most common types of repeated messages are continuers or back-channel responses (such as "ok", "yeah" or "cool") which serve as acknowledgements to other messages (Clark and Brennan (1991)).

I was able to observe incidents where people reacted individually with different delays and creating redundancy. Furthermore, there were instances of users repeating ideas back to back and then issuing more utterances to address the redundancy thus increasing the number of messages for the rest of the group to parse and worsening the problem. This can be observed in the Fig. 4.11.

From the survey result, I found that the majority of the respondents agreed (or strongly agreed) to the following statement that they did enter a redundant message because they did not know someone else was going to type something similar before them (76.6%)". Participants said that *"Someone had already said what I was typing"*[so I did not end up sending the message](PS2_3) and *"Someone had already said what I was typing"*(PS1_4) While this was observed, one must recognize that there were wasted efforts unaccounted for when we include all the messages that were entered but not submitted. A majority of the participants (85.0%) agreed (or strongly agreed) that they did not enter some messages because someone else said something similar.

While rendundant messages can also be used for building consensus, however they could

have been avoided in the verbal modality (by just simple head nods or continued attention and lack of negative acknowledgements). Furthermore, consensus building via repeated text messages in agreement or disagreement would also create difficulty in counting the agreements while also actively keeping up and participating in the conversation. In group chat, the absence of positive acknowledgement can be categorised as either continued attention, or negative acknowledgement or simply an absence from the conversation (or away from keyboard (AFK)), but not conclusively.

Furthermore, the lack of a higher degree of cotemporality is another factor causing redundant utterances. This is because in spoken communication (with a higher degree of cotemporality), the listeners can receive and parse the speaker's utterance the moment it is produced by the speaker. In the textual group chat (with a lower degree of cotemporality, on the other hand), the receivers only receive the messages once the sender is finished producing the utterance as well as hit the send button. As a result, the lack of awareness of what turns are in progress, makes chat conversations more prone to interruptions while turns are in progress, unlike the verbal communications where this would be considered rude.

### Missed Messages

I observed a few examples of the the same, when participant were unable to keep up with the rate of incoming messages. They ended up missing messages due to an overload on incoming messages. An information overload in the chat, coupled with minor vagueness on the speaker's part, often costs the group chat a few extra turns in fixing the ambiguities and issuing repairs as depicted in the Figure 4.12. The figure shows a case where a participant's question (aliased as Sam Martha) was ambiguous and created confusion. This is partially originating from the participant using a demonstrative pronoun (*"Where is that?"*) but also from the fact two restaurants were suggested and were being discussed simultaneously

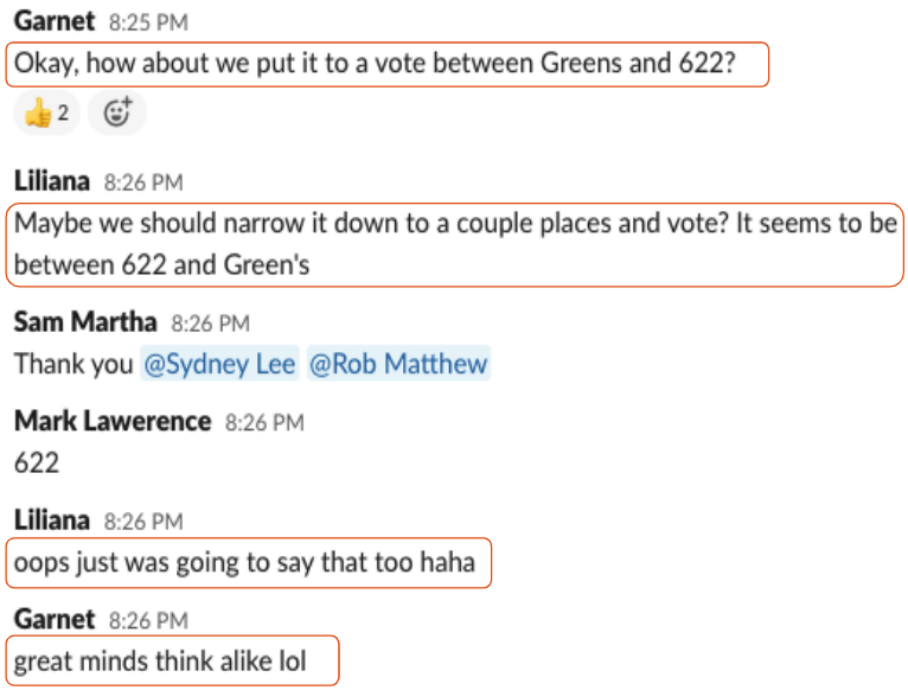


Figure 4.11: A chat snippet from a study of 10 participants, depicting users repeating ideas back to back and then issuing more utterances to address the redundancy thus increasing the number of messages for the rest of the group to parse

and another participant (aliased Senpai) had missed Sam Martha's message mentioning the 'greens' restaurant in the first place.

### 4.3.3 Digressions and Thread Disentanglement

As mentioned earlier, members of the chat often keep typing before reading, *"in some instances people would keep typing and sending messages without seeing responses first"*(PL1_6). I believe that this is partly due to the overwhelm experienced during the information overload and the hurry to get their thoughts to the group, in such a high speed dynamic situation. Sending messages without reading can often end up in digressions and derail an ongoing conversation.

Digressions may happen in verbal communication as well. However, the chances for the same is lower due to the the co-temporality provided by verbal communications, which makes in-progress turns visible, thus avoiding overlapping of sayings or interruptions of topic. In textual conversations however, there can be multiple presenters with no co-temporality which may result in a clash of topics and threads.

The studies showed digressions where a topic is interrupted prematurely by another, while both topics are related to the task at hand. This can be observed in Fig. 4.13 where the topics of accommodation and travel means can be accused of interrupting the other one. The participant aliased *Senpai* incorrectly assumes that the topic of 'travel' is 'done' and accommodation is what should be discussed next. This is supported in conversation by some participants aliased *Liliana* and *iKunHan* while someone else (*Alex Richards*) is not convinced with the discussion on travel means. Such a situation is subjective to the observer and opinions may vary for members in the chat.

One of the reasons for this is when a group member missed the last few messages of an

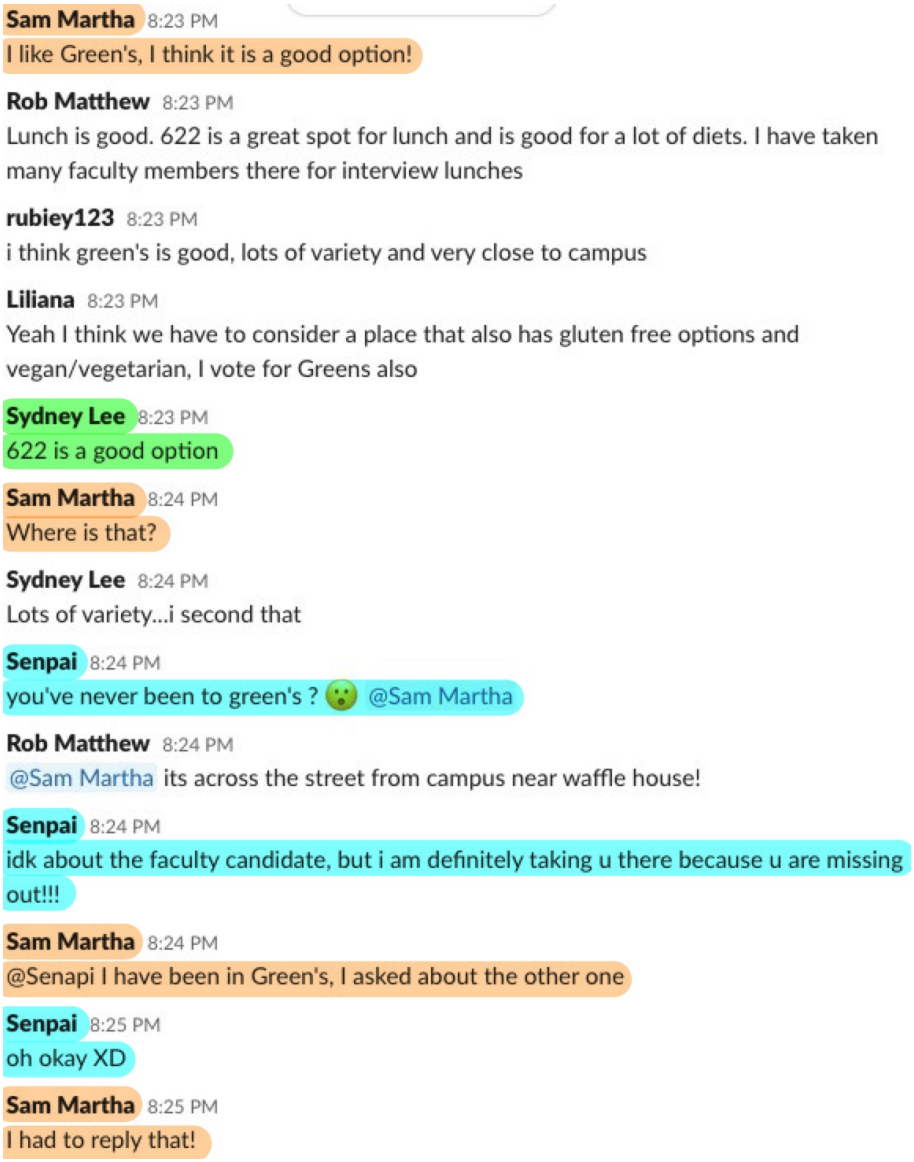


Figure 4.12: A screenshot of study. A chat snippet from a study of 10 participants, depicting multiple topics (two restaurants, namely Greens and 622 North) in a single thread leading to a confusion

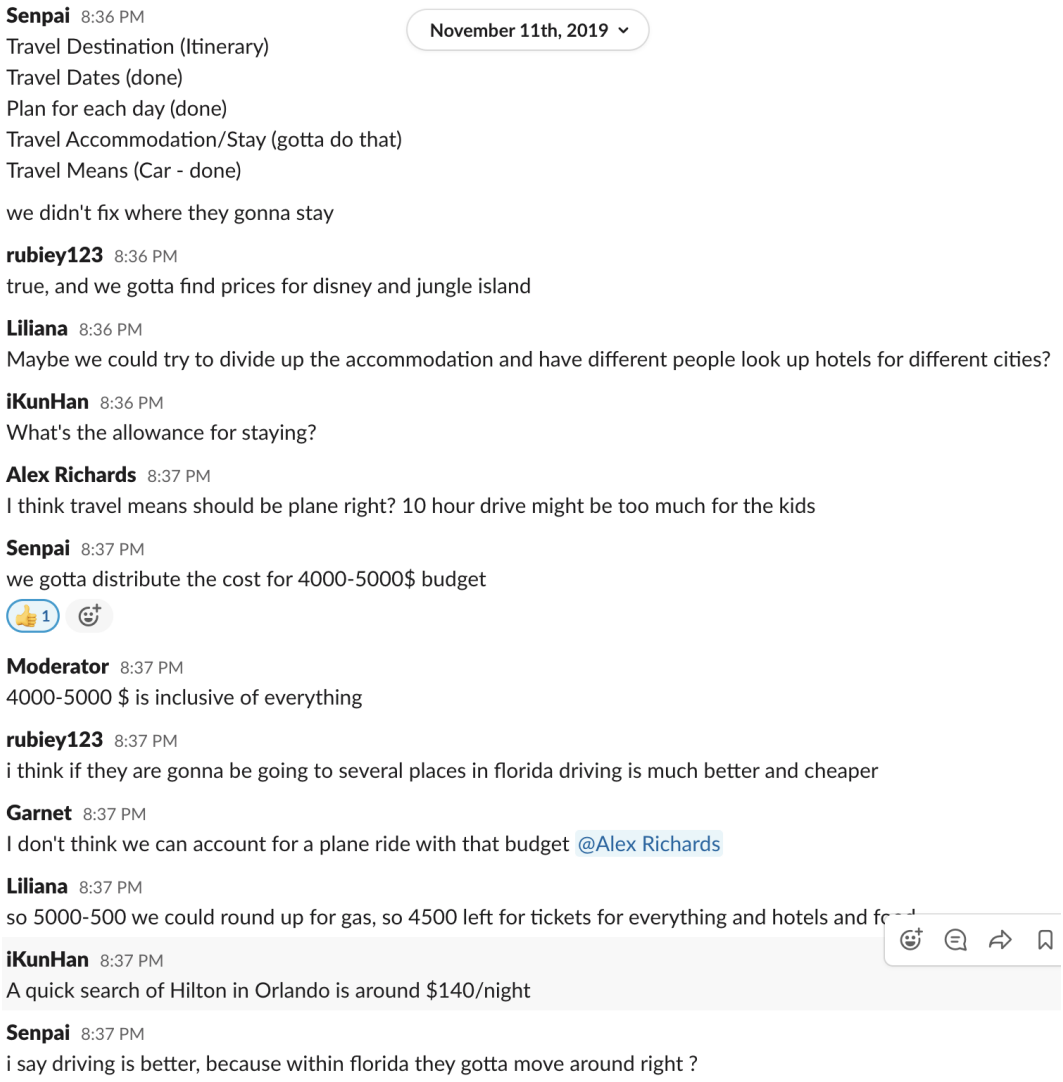


Figure 4.13: A chat snippet from a study of 10 participants where incorrect grounding causes interruption in an incomplete discussion and two parallel threads continuing in conversation subsequently.

in-progress topic unintentionally or otherwise. The other reason is the simultaneity and lack of co-temporality in chat which keeps the initiator of the new topic guessing whether a topic has ended and the time to pitch in a new topic has started yet.

This makes it harder to go back to the incomplete topic that was moved on from as members of work-chats or professional chats would want to avoid seeming stubborn or against a social/hierarchical norm.

Not only that, it also results in wasted efforts when a member is unable to send a message that has already been typed because *"A decision was made or the topic was moved on from"*(PL1_6). Multiple participants reported not sending a typed message because of similar reasons such as, *"I was calculating the budget, but then we agreed on another plan"* (PS1_1).

Sometimes the digression may take the conversation away from not only the topic that was/is being discussed, but also from the task at being accomplished. This is likely to be observed if the group does not have a fixed agenda or timeline before starting the conversation. This results in a conversation that is freeform discourse, not bound by any constraints and can stray anywhere but the ideal goal/outcome. Some participants suggested that it would be wise to *"Pick specific times to meet, and specific discussion points so we don't go off topic"*(PS1_5) in order to have more efficient discussions.

Members of the group having a separate conversation with just a subset of the chat members within the common group, unrelated to the task also contributes to the exacerbation of information overloads in already busy group chats.

Such 'offside' conversations are when two or more members of the group end up discussing their personal matter as a side sequence or major digression to the task at hand. These conversations sometimes interleave themselves in useful messages or worse, completely halt the progress of the conversation altogether. As explained above, in agenda based group chats

with a large number of participants, the discussion is already flooded by / expecting a flood of topics and perspectives. In such a discussion in a large group chat, having a private conversation (which was once encouraged (Handel and Herbsleb (2002))) often ends up adding to the overload of information that the group has to parse. Participants complained that they *" felt that some participants strayed off in the conversation and it was hard to end the conversation"* (PL1_7).

No matter the kind of digression, it is always undesirable in terms of productivity. Especially if the digressed conversation has to be brought back on track by sharing more messages and making the problem worse. This can end up worsening the cognitive information overload.

### 4.3.4 Consensus Gathering

A better structuring and organization of the chat data not only allows for better comprehension and understanding in real-time but also allows the quantification of data that would otherwise never be formally recorded. Participants seemed to want the *"ability to show how you feel without typing a whole message about it"*(PS1_1).

Different implementations of such an affordance exist in some commercial work based chats applications like Microsoft Teams and Slack. The study that the participants were a part of was conducted via Slack. The figure 4.14 shows the difficulty in consensus gathering that was observed in the study. For example, tasks such as decision making or scheduling often needed collecting responses from participants, and it was difficult to keep track of how many people agree or disagree with the ideas. Since it is very hard to keep track of who answered the poll or not and how, very often the textual answers to poll may go ignored if they are provided at all. The figure is a snippet from a study of 13 participants. Two participants responded via emojis, four participants agreed via text messages, two participants disagreed

with suggestions, while one participant presented a completely different idea. It is not clear how many did not respond because someone might have responded in text as well as emojis. Once a certain number of participants answer the question via 'thumbs up', 'thumbs down' or other symbolic emojis and textual responses, the topic was seen to be moved on from without waiting for responses from other members of the chat, who may have missed the poll altogether. Thus, to asses the results of the poll, one might have to scroll away from the live incoming of messages to fetch the poll results.

Furthermore, participants also said that *"The voting part seems a bit messy"*(PL1_10) and *"People also react to messages instead of responding, which reduces clutter but gets the opinions across just as easily"*(PL1_6). When asked about their strategies for comprehending all the messages without scrolling up or re-reading, one participant also mentioned *"Reacting to a message with a thumbs up instead of sending an extra message for acknowledgment"*(PS1_1).

## 4.4 Behaviors employed by participants to overcome the challenges faced while participating in online group chats

### 4.4.1 Scrolling and Re-reading

Participants were observed to *"scroll up and re-read"* (PS1_3) when they felt that there were overloaded by the vast majority of messages. Participants complained that they *"have to scroll up, read previous messages to understand all the conversations, just because people initiate tons of topics and it gets really mess as time going on"*(PL2_8). Another strategy that

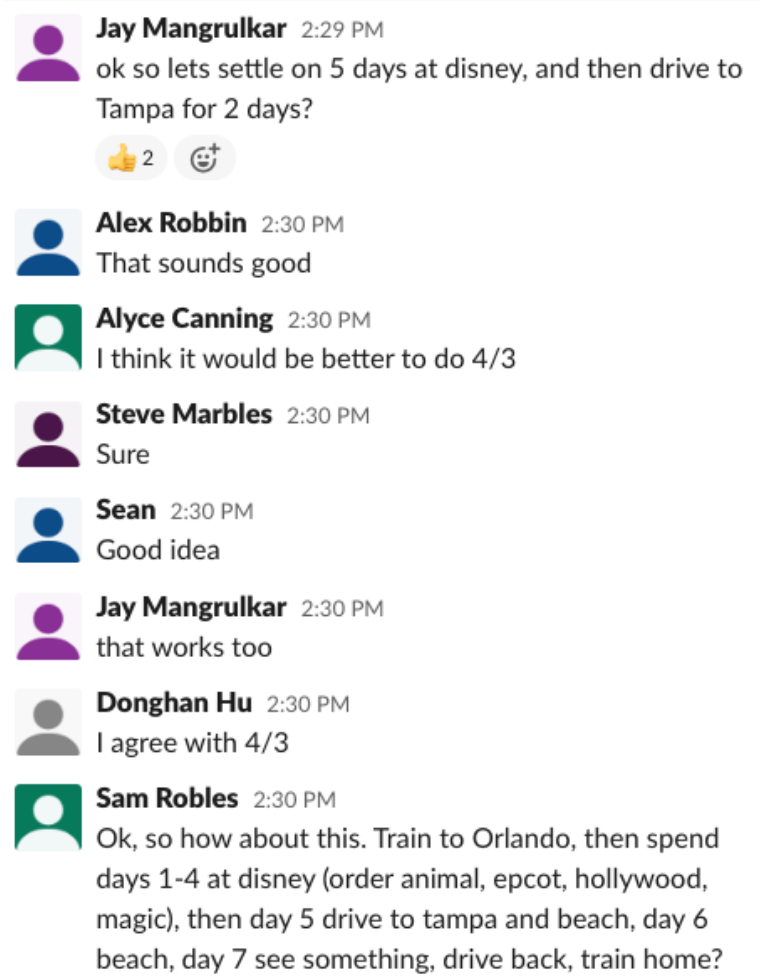


Figure 4.14: A snippet from a study of 13 participants, depicting how difficult it is to see if everyone agrees to a plan. Two participants responded via emojis, four participants agreed via text messages, two participants disagreed with suggestions, while one participant presented a completely different idea. It is unclear how many did not respond because someone might have responded in text as well as emojis.

the participants employed to deal with the overload of messages and information is that they would only skim through messages instead of going through all of them. *"sometimes I skim a couple messages per scroll, only going back to read everything if I'm really confused"*(PL3_7) While this was a technique to stay partially aware of the chat but remain up to date, some adopted ways to thoroughly read the conversation, but at their own pace instead of staying up to date with the live conversation. *"Holding the screen as you read messages so you don't have to scroll up as new messages come in"*(PL2_5). This way each and every message from the chat would be read but at the cost of not keeping up with the latest messages. The participants would consume a relatively stale conversation and not the latest happenings of the conversation.

### 4.4.2 Waiting

Speakers of the conversation, meanwhile, seemed to exhibit a different strategy out of consideration for the group members and their overwhelm. Participants suggested strategies such as *"Being patient and waiting for others to talk through their ideas/points first"* (PS2_2) or *"waiting 5 seconds before responding"*(PS1_5). Some participants also seemed to exhibit this behaviour while conversing in chat. They reported that they *"tried to wait sometimes for other people to enter something first, instead of always being the first person to respond to the question prompt"* (PS3_2). While this behavior can prove to be time consuming and delay inducing, it also shows that the participants are aware of the on-going information overload in the chat.

### 4.4.3 Signalling Intent

Another interesting behavior exhibited by speakers in conversation was the signalling of intent to speak. This behaviour not only help tackle the overload of information, but also garner attention for the speaker. Participants would intentionally send out incomplete utterances, with intentions of repairing and completing them later once they receive everyone's attention and the opportunity to speak without getting interrupted by others.

The initial message may often be ridden with errors in spelling or grammar or even clarity, because the goal of the message is to be a placeholder that signals for the group to stop typing/sending messages and listen to the send of the placeholder message. As shown in figures 4.16 and 4.15 the placeholder utterance after establishing the speaking rights for this member of the group, is then further augmented with additions, completion messages, repairs, or provisions of contexts and justifications,by the same member (now the assumed speaker) of the group.

There was another incident when a participant aliased *Sydney Lee* used broken messages to convey the accomplishment of a task for the entire group as shown in Fig 4.15. Another explanation for this behaviour can be that broken messages may be a preamble indicating that other members of the chat are supposed to listen and not spam the group. This may also be an attempt to vertically separate the messages visually.

### 4.4.4 Asking Questions

Participants also seemed to ask for help from other participants in the group chat when they were unable to keep track with too many messages. 61.7% of the participants agreed that they had privately messaged someone after a super active group chat for more clarity and understanding. They said that *"I usually scroll up or I'll ask what's happening"*

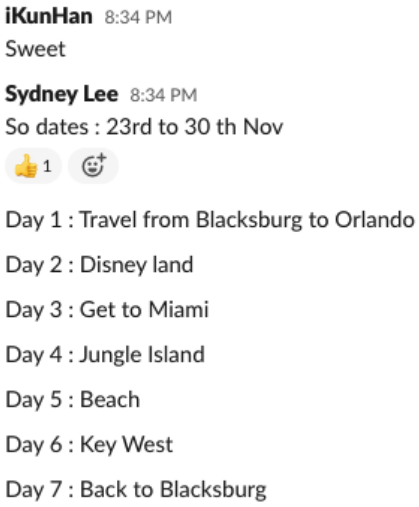


Figure 4.15: A chat snippet where a participant aliased *Sydney Lee* used broken messages to convey the accomplishment of a task for the entire group

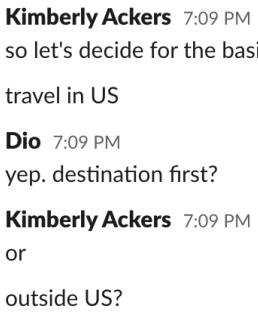


Figure 4.16: A chat snippet depicting a user with the alias *Kimberly* repeatedly texting in broken messages and making the chat scroll faster

(PL3_12).While some participants said that they *"could pose a question I have instead of scrolling,"* they were also aware that doing so *might annoy people if the question is clearly answered above"* (PL1_6).

### 4.4.5 Avoiding group chats

As a last resort, while dealing with information overloads and unsatisfactory conversation, participants would simply limit or avoid group chat interactions. 61.7% of the participants agreed that they interact with the chat only when needed or specifically referred. 85.1% of the participants agree that they have had smaller separate groups with people from larger groups, as the larger groups were just way too active.

While some of these strategies reported by the participants are consistent with the early strategies employed to tackle information overloads in a general (Hiltz and Turoff (1985)) and email-based (Janssen and de Poot (2006)) context, there are some new interesting strategies that emerge in a IM context which may not have been realized with the affordances of other applications.

# Chapter 5

# Discussion

## 5.1 Overview

This work tried to identify the challenges of online group chats for productive discourses via empirical studies. After analyses of the data observed from the experiments and survey responses from the participants, this section reflects upon some insights and inferences from this study. I start with an overview of key themes from this research that are behaviours and challenges that subsequently motivate recommendations for future redisgns and development of this indispensable tool of the workforce.

## 5.2 Observed challenges and behaviors in productive discourses

Firstly, an overwhelming number of messages is a major challenges which creates several other challenges for the participants of a chat such as missed messages, redundant messages,

wasted efforts and difficulty in gathering consensus.

Chat applications provide simultaneity but lack a high degree co-temporality which would increase visibility of turns that are in progress. This results in multiple speakers being able to create and present utterances simultaneously.

I observed redundancy in the chat due to participants being unaware of a similar turn in progress or failing to read the chat altogether. Even if participants catch the redundant message before sending it, it does amount to wasted efforts. This could prove quite expensive in the midst of an overload when attention and time are limited resources. Rendundant messages can also be used for building consensus. However, consensus building via repeated text messages in agreement or disagreement would also create difficulty in counting the agreements while also actively keeping up and participating in the conversation. Furthermore, failing to read the chat or lack of co-temporality may also create a digression which inhibits the productivity of the conversation or halts conversational progress completely. Especially if the digressed conversation has to be brought back on track by sharing more messages and making the overload worse.

Another interesting challenege that the partcipants complained of and was observed was difficulty in gathering consensus. This mostly stems from the lack of a 'chatiquette' or etiquettes to be followed while chatting. Responses to consensus gathering questions are submitted via text or emoji reactions or poll. It becomes a challenge to successfully retrive the poll results from multiple sources whie also participating in the group chat.

Broken utterances was an interesting behavior that may exacerbate an information overload. While I discussed how broken utterances are detrimental to productivity and coherent conversations, the very existence and repeated use of broken utterances piqued my interest. Furthermore a participant, when asked about strategies for effective discussions, said *"Type*

*in shorter snippets otherwise people have no idea what you're thinking and could move on without hearing something important"*(PL3_7). This incident and repeated use of broken utterances must be investigated. It also advocates the need for co-temporality in chats.

In an information overload, the strategies and solutions reported by the study participants are listed below. Some of these strategies are consistent with overload management strategies from other domains.

- Reading older messages as they could not keep up with messages arriving super quickly (76.6%).

- Having smaller separate groups with people from larger groups, because the larger groups were just way too active (85.11%).

- Private messaging someone separately after a super active group chat for more clarity and understanding on what was said (61/7%).

- Holding back from saying something because the topic had changed (61.7%).

- Holding back from saying something to avoid flooding the chat with another message (40.43%).

Most of these are applicable for an asynchronous chat. The last two strategies however, may help deal with a live overload of information. Using the reported strategies and observed challenges, I propose some recommendations for future redesigns of the chat interface and functionality.

## 5.3 Design Recommendations

### 5.3.1 Reduce wasted efforts

The challenges and behaviours observed presented redundancy and unspoken thoughts (wasted efforts), and broken utterances which can all be addressed by achieving co-temporality in the chat messenger. Modern group chat applications do provide a certain degree of cotemporality, with the the typing indicator affordance (Gnewuch et al. (2018)) as shown in fig. 5.1. While this would be a great affordance in one-on-one personal chats, group chat participants do not seem to wait for the their group members in the chat. For instance, a participant may not wait for the current speaker to finish, and instead type along with them as shown in fig. 5.2. In face-to-face and verbal conversations, creating a new utterance, while one is already in progress would be considered interruptive and rude. However, the low degree of co-temporality provided by the textual group chats fails to address this challenge. Furthermore, it must be noted, that in a synchronous group chat, with a large number of participants such as 5 and 10 there might be more than two participants typing simultaneously. The typing indicator then struggles to present an accurate picture of the number of turns in progress as shown in fig. 5.3. Then, without the knowledge of how many utterances are in progress participants would find it difficult to not only keep up with the conversation, but also remain patient and not start typing their own thoughts and aggravating the problem.

Thus the first design goal is to investigate the impact of realizing a higher degree co-temporality in the chat messenger by making the chat message appear as it is being typed to all members of the chat in real-time. This work draws an idea from a previous work that was tested in a one-on-one setting but not in a group setting (Solomon et al. (2010)). Furthermore, (Tang (1991)) also suggests that, in collaborative work, the process of creation can convey important information not found in the artifact. I believe such an affordance would


Figure 5.1: A snippet from chat where a participant aliased *rubiey123* is typing.


Figure 5.2: A snippet from chat where a participant aliased *Alex* does not wait for the current speaker aliased *rubiey123* to finish, and instead types along with them.

enforce social norms in the conversation leading to reduced interruptions and redundancies as shown in fig. 5.4 and 5.5. This is because of greater visibility of in-progress turns including their contents. Furthermore, different ordering strategies could be considered for the yet in-progress turns to compare their suitability for conversations involving collaborative planning and decision making. I believe that such a feature can naturally make people wait effectively and reduce wasted efforts (by providing visibility to turns in-progress), making the group communication closer to in-person communication. This has concerns about authority and power dynamics which would be interesting to investigate in a productive work-based context.

I conducted an informal pilot user study with the research laboratory. Participants said that *"lot of times when I wanted to type something, but saw someone else typing it, so [I] stopped. Reduces redundant messages"*(P4). This experience resonated with other participants as


Figure 5.3: A snippet from the study where the typing indicator displays that "several people are typing" instead of their names, losing any hierarchy, authority and context based cues that may be associated with the names of the typing participants.

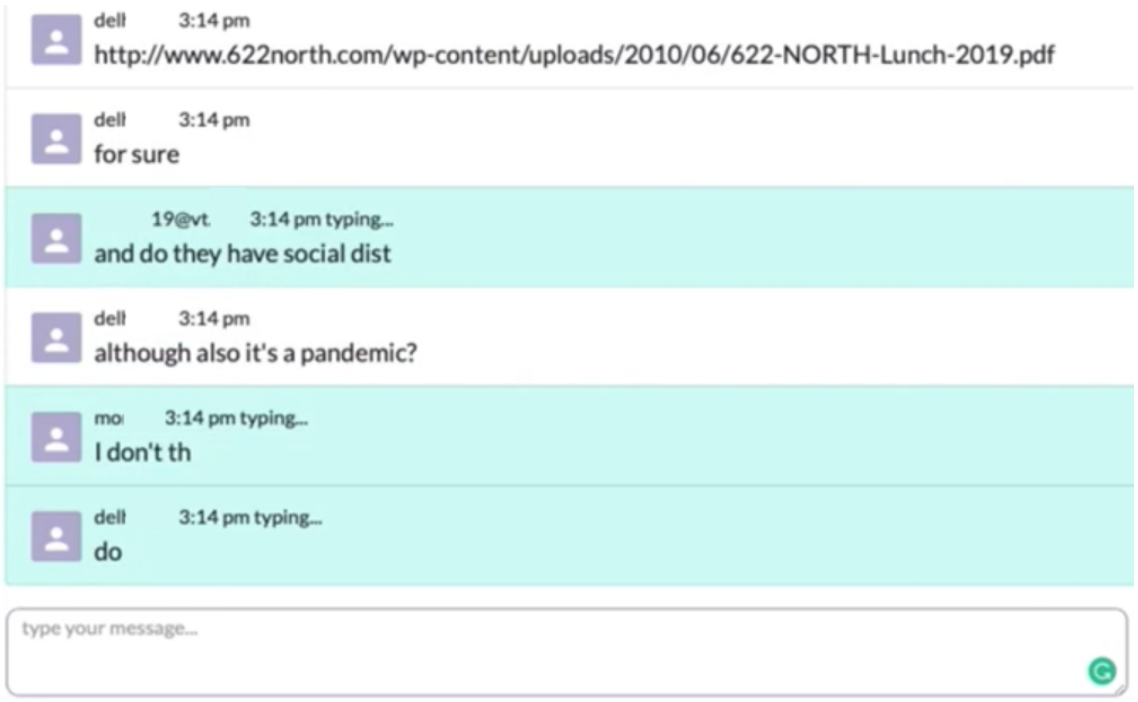


Figure 5.4: A snippet from the pilot user study where two participants are asking about restaurant's response to the pandemic.

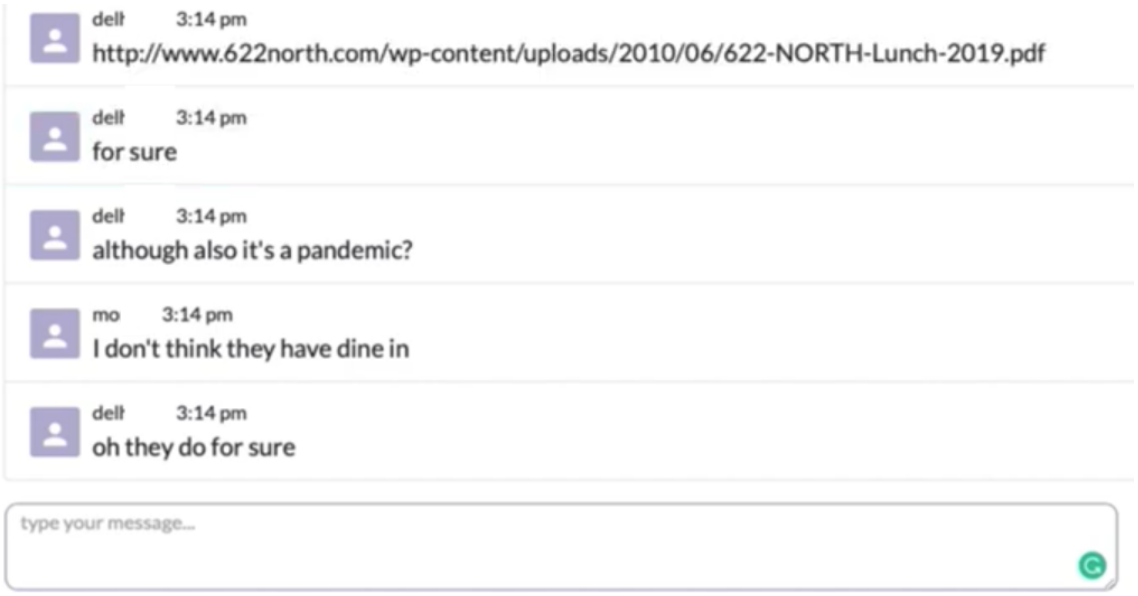


Figure 5.5: A snippet from the pilot user study where a participant terminated their in-progress turn, to avoid redundancy.

well. They said that, *"You can see someone as they're completing a thought, and this makes it feel more like a conversation ... stops that problem where the other person obsoletes what you're about to say because they type faster"*(P5) and that *"i can see what others are saying, so i can hold my thought"*(P2).

One possible criticism of such a design is that it is *"Not a suitable for surprises/suspense or private chats unless brainstorming/planning*(P1) however participants agreed that *"saves time and energy in group settings"*(P1).

### 5.3.2 Improved consensus gathering

Freezing the poll temporarily (similar to the wireframe in Fig. 5.6) on screen might prove helpful in conversation. It would not only increase the visibility of the poll to participants who might miss it, but also facilitate response monitoring and collection. Additionally, as more messages flood the chat, the poll moves off the screen and gets ignored. I believe that exploring designs where answering a poll can be a dependency to access the conversation further (similar to the wireframe in Fig. **??**) has potential to alleviate some of the issues around consensus gathering.

## 5.4 Drawbacks

### 5.4.1 Limited numbers of different tasks

Although there were four tasks each to represent different workspace scenarios, the actual workspace scenarios are much more than these four cases and can vary between teams and organisation. It was decided to settle only on these four tasks partially due to the limited time

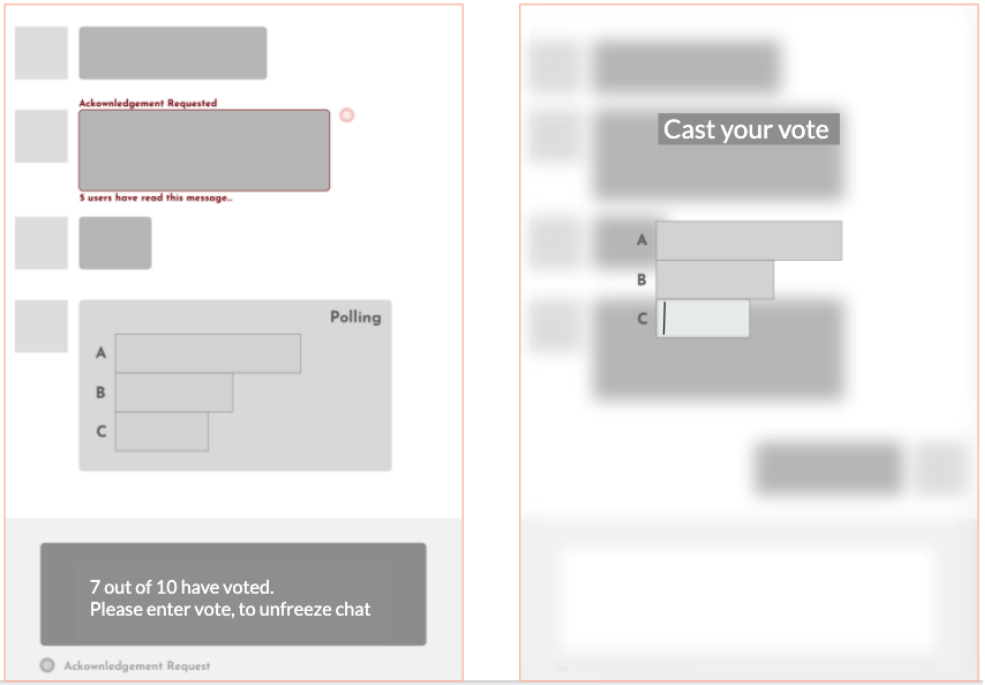


Figure 5.6: A wireframe suggesting freezing the poll temporarily, with better visibility of the poll for voting as well as response collection

that on the study session. More importantly, I believe that simple and complex scheduling and debate are the most common workspace scenarios which are the focus of this paper.

### 5.4.2 Limited number of trials

Another concern that should be addressed is the limited number of studies performed. There were three studies with 5 participants each, and there were three others with approximately 10 (9, 10, and 13) participants. While one might stumble upon a meta-realization of the difficulty of actually scheduling 10 or more participants for an empirical study (some in the midst of a global pandemic), they might also agree that a low number of trials (6) can be detrimental to finding evidence and insights that are conclusive and quantitative. Furthermore, I assumed independence between subjects within a group i.e. participants from the same group being independent from each other. Participants may exhibit individual

variance that may affect group dynamics for a group. This can be tackled by conducting a greater number of trials and treating each group as an independent data point.

### 5.4.3 Participants were strangers and did not have an established dynamic

Participants were recruited randomly and were practically strangers to each other. As a result they did not have an established dynamic which would have made a difference in the performance and behaviors of the group(s). In most real-life team, every team members are expected to have a fair knowledge of their teammates and it is common to have pre-established dynamic in every team. Individuals' behavior in the group chat can be greatly impacted by those explicit or implicit rules and dynamics. In our study, however, to protect the anonymity of the participants, prior to the study, participants would have no knowledge of each other, who they are and what kind of people they are. To minimize this unfamiliarity effect, the icebreaker task was specifically designed to help initiate a conversation in the group. Furthermore, since the participants were assigned in to groups randomly, there was no organisational heirarchy or leadership structure which would influence the outcome of conversations and behaviors of the participants.

## 5.5 Looking forward

### 5.5.1 Information overload in productive discourses

As discussed, most information overload in the textual modality has explored the virtual publics such as newsgroups (Jones et al. (2004)), IRC (Jones et al. (2008)) and twitch

(Nematzadeh et al. (2019)).There have been few other areas of information overload research which have looked at smaller sized communication media such as emails (Janssen and de Poot (2006)). Information overload has the potential to influence the structure and dynamics of the discourse (Jones and Rafaeli (2000)) as observed via fewer and shorter responses that may be oversimplified or redundant (Hiltz and Turoff (1985), Jones et al. (2004), Nematzadeh et al. (2019)).

There has been significant literature exploring information overload in large virtual publics, collaborative productivity-oriented group chats remain relatively under explored. This work thus explores information exchanges and overloads in productive discourse, in 2020, with matured IM and group chat systems and a pandemic that forced most knowledge workers to rely on CMCs.

### 5.5.2 Future work

As mentioned, the COVID-19 pandemic forced most knowledge workers to rely on CMCs for collaborations and work conversations. This sets the stage for more reasearch on information overload in the modern productive discourse. Furthermore, the greater use of chat systems due to the pandemic may create large datasets of real work-based conversations, which might help address the limitations of limited study trials and limited tasks simulations as mentioned in Chapter 3.

Furthermore, longer time use of chat based systems by teams in professional organisations might also have data over a longer period of time than this study recorded. This might enable research in not just productive discourses and information overloads but also organisational hierarchies, authority and how they change over a few months if at all.

# Chapter 6

# Conclusions

This work tried to identify the challenges of online group chats for productive discourses via empirical studies simulating collaborating decision making and group scheduling tasks. Participants were less active generally because there were too many messages. A majority of the participants found it was hard to keep track of what was happening. An overwhelming number of messages is a major challenges which creates several other challenges for the participants of a chat such as missed messages, redundant messages, wasted efforts and difficulty in gathering consensus. After analyses of the data observed from the experiments and survey responses from the participants I present some insights and inferences from this study. These insights subsequently motivate recommendations for future redesigns and development of this indispensable tool of the workforce.

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# Appendices

# Appendix A

# First Appendix - Post study survey

**Thank you for completing the study**

Please enter the group number assigned to you.

Please enter the alias you used while participating in the study.

**The following is a survey which will ask you certain question about group chat in instant messengers. Here, group chat is defined as *a chat (text-only) session that has more than two people in an instant messenger*. (e.g. one-on-one chat is not a group chat.)**

**Please explain and elaborate on answers wherever applicable.**

Have you ever participated in group chat (multiple people - more than two - in a room)?

- ○ Yes
- ○ No
- ○ Other

What application/platform do you use for group chats? List Multiple if applicable along with particular reasons (if any) for using them (eg- Slack, WhatsApp, We Chat, Snapchat, etc)

- ☐ WhatsApp

- [ ] Facebook Messenger
- [ ] Google Hangout
- [ ] Mobile Message
- [ ] Slack
- [ ] Discord
- [ ] Others (Please Specify as many as possible)

What purpose do you use group chats for? Rank the answers from _____to____????

Professional discussions (Work Study)

Social (Friends)

Social (Family)

Information Sharing (sending files, sharing urls) with others

Other purpose

Please select all that applies.

- [ ] I have created group chat rooms.
- [ ] I have been added to an existing group chat.
- [ ] I typically lead conversation in a group chat.
- [ ] I have group chat room that I do not participate but read all the messages.

Your participation in group chats can be best described as (select multiple options if your participation varies per group chat)

- [ ] I mostly initiate conversations
- [ ] I actively participate in conversations

- [ ] I participate in conversations only when needed or specifically referred
- [ ] I do not participate but read all the messages in the room
- [ ] I do not read all the messages.
- [ ] Others

If your participation level varies per chat room, could you explain the reason?

For the chat session that has the most number of participants that you experienced, how many people were in the session?

How many group chats are you actively involved in at the moment?

What is the biggest challenge when there are multiple people in a chat room?

Up to how many people do you think you can have have a sensible conversation?

Do you prefer other methods of communications over group chat when you have to coordinate with multiple people? If yes, please specify what you prefer. (e.g. group voice call, phone call, in-person, email, etc.) and explain why group chat is used in spite of your preference.

- Yes
- No

Can you describe any strategies that you (or other people) apply in a multi-user group chat (many people) for more effective discussion?

What do you think can be improved with regards to the application you use for group chats?

What strategies do you/can you use for comprehending all the messages in the group chat?

What strategies do you use for coordinating group discussion?

Do you individually/collectively use any additional tools/Add-Ons/APIs apart from the plain chat interface?

**In this section, we will ask a number of questions about the study that you just performed. Please answer the questions with as much detail as possible, if applicable.**

Please answer the following questions.

| | Strongly Disagree | Disagree | Neutral (or N/A) | Agree | Strongly Agree |
|---|---|---|---|---|---|
| The discussion was fluent. | O | O | O | O | O |
| I was active more than average during the discussion. | O | O | O | O | O |
| It was difficult to keep track of all the messages. | O | O | O | O | O |
| Only few people actively participate in the discussion. | O | O | O | O | O |
| It was difficult to reach to an agreement. | O | O | O | O | O |
| The conversation digressed too often. | O | O | O | O | O |
| There was a leader who lead the discussion. | O | O | O | O | O |
| During the task, there was a topic that I wanted to bring it up but I did not. | O | O | O | O | O |
| Comprehending all the messages was easy. | O | O | O | O | O |

| | Strongly Disagree | Disagree | Neutral (or N/A) | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I am satisfied with the discussion outcome. | O | O | O | O | O |
| There were too many people in the room. | O | O | O | O | O |
| The participation level was too low. | O | O | O | O | O |
| I felt I was ignored. | O | O | O | O | O |
| Some people were too quiet. | O | O | O | O | O |
| Members of the group understood me and what I had to say | O | O | O | O | O |

Could you talk about how the task went? What went well? and what did not go well?

Was there any topic do you think you should have covered but did not? If yes, what were they and what was the reason why the topic was not discussed?

What was your biggest challenge you faced in communicating with the members of your group?

At any point in the study, did you want to switch the topic but you could not? If yes, what was the reason why you could not switch the topic?

O Yes (please explain)

O No

At any point in the study, did you ever want to send a direct message (private, one-on-one) message to one of the participants? If so, could you describe why you thought so?

- ○ Yes (please explain)
- ○ No

Did you ever hold back from entering a message during the chat because of one or more of the following reasons? (Please explain wherever applicable)

- ☐ I did not want to flood the chat with another message.
- ☐ The topic had already changed.
- ☐ Other
- ☐ No.

Did you ever start typing but did not end up entering the message? If yes, could you describe what the case was?

- ○ Yes (Please explain)
- ○ No

Did you ever feel ignored in the task that we just performed?

- ○ No
- ○ Yes (Please Explain)

Do you have any suggestion on how the instant messenger can be designed differently to facilitate effective group chat?

Do you have any suggestion to us (user study host) in carrying out the task?

Is there anything that you would like to tell us regarding the study or the experience?

→

# Appendix B

# Second Appendix - Participant demographics

What is your email address you used while participating in the study? (vt.edu if possible)

How old are you?

Please name the gender you identify yourself as?

- ○ Male
- ○ Female
- ○ Non Binary
- ○ Prefer not to answer

How familiar are you with English? (check all that apply)

- ☐ Mother Tongue / First Language
- ☐ Grade school in English
- ☐ High school in English
- ☐ College in English

What is the highest degree or level of education you have completed?

- ○ High School
- ○ Freshman at college
- ○ Sophomore at college
- ○ Junior at college
- ○ Senior at college
- ○ Bachelor's Degree
- ○ Master's Degree
- ○ Ph.D. or higher
- ○ Prefer not to say

How familiar are you with Slack?

- ○ Not at all
- ○ Used it for a couple months
- ○ Used it for 6 months
- ○ Used it for a 12 months
- ○ Used it over a year

What is your current location?

→