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Abstract

This paper explores the critical role conversational coherence plays in facilitating the ongoing, distributed work of one virtual team as they engage in instant messaging (IM) conversations to communicate, coordinate, and collaborate. In studying the IM conversations of team members over the course of a month, a number of challenges to coherence emerged as they communicated with each other and worked together. These challenges include two previously identified challenges—lack of simultaneous feedback, and disrupted turn adjacency—and two additional challenges: multi-tasking, and authority. We describe the team's responses to these challenges and conclude by discussing implications for research.

1. Introduction

Computer-mediated communications (CMC) have been described as being incoherent (fragmented, agrammatical, and interactionally disjointed) [5], yet users are able to successfully use CMC [7], even in the course of doing work. Use of instant messaging (IM), one form of CMC, is increasing in the workplace, with up to 85% of organizations using some form of IM [1]. We explore issues of coherence in a work setting through an empirical study of a small geographically-dispersed software project team who primarily relied on electronic communication, especially IM, to coordinate themselves and conduct their work.

IM shares aspects of both verbal and written communication [15], and some of the tensions that arise in IM can be attributed to the differing conventions of verbal and written communication. These tensions, synchronicity versus turn taking, the persistence of and care taken in written communication versus the casualness of spoken communication, and issues of attention and availability threaten conversational coherence by entangling or disrupting the flow of conversation.

Several studies on IM in the workplace have suggested IM is primarily used for discussing quick questions and clarifications, arranging and coordinating scheduled and impromptu meetings, and keeping in touch with family and friends while at work [11, 13]. Other research [8] has found that the majority of IM conversations in the workplace were work-related (62%) with the average IM conversation lasting almost 4.5 minutes. In these studies, IM messages are treated as transient expressions, remaining on-screen for a short time before disappearing; our research suggests that users make use of IM's more persistent qualities to get work done. IM use varies as people adapt their work IM use in response to communication purposes, job characteristics, and work environment and structure [2]. Recent studies [2, 8, 13] demonstrate that IM is being used to facilitate collaborative work though studies have typically focused on dyadic interactions (e.g., [8, 11]).

Conversational coherence becomes especially important for working collaboratively when IM is the primary communication medium. Additionally, when the work team moves beyond dyadic interactions, maintaining coherence becomes an even bigger obstacle. In the research reported here, we studied IM conversations by members of one virtual team. Before discussing our findings, we will provide background on our organizational site and the methods we used to analyze the IM conversations. We next discuss the challenges to maintaining coherence in IM conversations and responses to those challenges, and conclude with implications for research.

2. Site and methods

IMSoft is a small, privately-owned Massachusetts-based software company working on contract software projects. The firm's co-owner, Frank, assembled small teams of contractors (up to 4 people) to work on each project. He was the final decision-maker, but often

worked collaboratively with his team and was the main contact between the IMSoft team and the client team.

Frank and four contractors comprised the IMSoft team. Sam lived in Texas, Peter and Eugene lived in Massachusetts, and Alexi lived in Pennsylvania. All worked in home offices though Peter and Eugene lived close enough to be able to work occasionally at Frank’s large home office. Alexi was employed during the day at a Fortune 100 company and worked on the team part-time, usually at night. Frank began assembling the IMSoft team to develop a telecom application for a client in mid-2003, Sam joined the team in November 2003 and the team stayed together until January 2005. The client continues to use their software application.

Members of IMSoft primarily used phone and email to communicate with the client team. Between project team members, IM was the preferred communication medium; email was frequently used and the phone infrequently. Over the course of the project there were several week-long face-to-face work sessions; one had been held in Massachusetts in January 2004. We observed a half-day of one of those work sessions and shadowed one IMSoft contractor for a day.

For this study, we analyzed primarily the IM logs belonging to one member of the IMSoft team who archived all of his emails and a portion of his IM logs. This member also served as a key informant. From the full IM archive (from November 2003 through April 2004), we narrowed our sample to logs from March 2004. We chose March for several reasons: the IMSoft team had worked together for 3½ months by then; the team communicated and coordinated heavily that month as they worked to complete a software demo; and we had complete IM and email archives as well as our informant’s daily work hours for the month.

In the archive, our informant created separate IM session logs for each IMSoft member (multi-party IM sessions were logged to each participating individual’s file). We converted each log into an Excel file to facilitate analysis and combined the separate files. Four additional IM session logs, saved in another format when our informant changed computers during an IM session, were added into our file. The final file consisted of 9,586 IM messages (each Excel row or line contained one message). After deleting 1,315 duplicate lines, we were left with 8,271 IM messages.

We did an initial reading of the archive to determine whether the individual messages naturally clustered. Unlike email messages, IMs do not have the subject line heading that encourages participants in an email exchange to engage in explicit threading behavior. Drawing on Isaacs, et al’s research [8], we decided to use the *conversation*—defined as “a sequence of messages in which no two messages are separated by more than 5 minutes”—as the unit of analysis and

grouped the messages into 175 conversations, coding the beginning message of each conversation. We then did multiple, iterative readings of the archive. Because subsequent conversations were often topically related, we added a code to indicate when a conversation was the continuation of the preceding conversation. We also coded instances of concurrent conversations and references to multi-tasking. Finally, we coded the single messages that were unanswered (calling them unanswered queries/announcements); we included these 34 unanswered queries/announcements in our analysis.

Table 1. Conversation data in IMSoft IM log

March 2004	
# of IM messages (after cleaning)	8271
# of IM messages with 2+ receivers	1626
# of IM conversations	175
# of announcements/unanswered queries	34
Total IM conversation time	45 h, 39 m
# of conversation continuations	92
Conversations starting with a question	65
Average conversation length	15.66 m
Median conversation length	6 m
Shortest conversation	1 m
Longest conversation	3 h, 24 m

The following section presents the results of our analyses. When we quote from the IMSoft exchanges, for confidentiality reasons we have changed wording and details as needed to disguise the identity of the company, the client, the product and the team members. We also cleaned up obvious typos to aid readability but retained the typing conventions of the participants (e.g., members rarely capitalized) and we abbreviated names when necessary.

3. Creating coherence

In this section, we describe challenges to coherence that this particular team faced in their communications as they worked together, and their responses to those challenges. Previous work [7] identified two challenges to maintaining conversational coherence often encountered in this medium: lack of simultaneous feedback, and disrupted turn adjacency. We found instances of these challenges in the IMSoft IM conversations. We also identified two other challenges—multi-tasking and authority—that affected the team’s ability to maintain coherence and do work.

The IMSoft team was assembled to create a software product for a client, and their IM conversations were usually purposeful and related to the work. In this

geographically-distributed team, conversational coherence was closely related to work practices. This team was rarely able to meet face to face and IM conversations (along with emails) were important to getting work done as well as being part of the work itself. Conversations that wandered off topic did not support work. Although actual programming was done individually, this group's collaborative work included developing software specifications, debugging, and compiling the individual pieces into a release. Sam describes the process:

We chat for a while. He [Frank] tells me what we want. I write up a spec or proposal. He reviews it and then we start commenting on it. When we're done, I end with a document that I work on and then I'll go off and, usually these come in week to two weeks chunks of work. So then I'll go off and program for a week or two. . . . during a release cycle there's an intensive amount of communication between the three of us, often in a three-way or four-way chat. . . . it's usually Eugene and Frank and I. And we'll get into these festivals of like an all-day effort to get this stuff released, installed, shake it down, find the problems, debug it, do another installation, repeat, all day long. (Sam)

In this description of the work, note the importance of conversation to specifying the work, assembling together disparate pieces, debugging, and installing a completed piece of software. The programming itself was rather individual and solitary work but its framework (the specifications) was built through conversation. Focusing on conversational coherence is thus a lens for examining work and coordination. Below we consider the four challenges.

3.1 Lack of simultaneous feedback

Although IM is typically considered synchronous, a number of IMSoft's IM conversations exhibited a lack of simultaneous feedback (messages were sent after they were typed rather than while they were being typed, causing a lag [7]). Thirty-four of the 175 conversations are actually one-line queries and announcements that were not answered within five minutes (10 of those provided an answer to a previous conversation, 15 were eventually answered in the subsequent conversation, and 9 were never picked up). Yet, when IMSoft members were in the midst of a conversation, the exchanges were nearly simultaneous:

21:00:04 sam F i'm writing you and rupert [client]
a message about software
performance right now.
21:00:14 Frank s let me read it first please
21:00:18 sam F ok.
21:00:19 Frank s b4 you post to him

21:00:31 Frank s he has been particularly finicky lately

This example highlights differences between IMSoft external and internal communications. IMSoft members used email and phone with their clients, along with occasional face to face meetings, while they primarily used IM, along with some email and a very few phone calls, to communicate among themselves. In the above example, they are using almost-synchronous communication to discuss an asynchronous communication with a client.

IMSoft members tried to avoid the lack of simultaneity in the IM conversations when possible. They would often initiate a conversation with a brief attempt to establish contact—often as simple as “yo?”—repeated until they received a “handshake” (e.g., a responding “yo”) back. These openings (or “preambles” [11]) are a way of establishing contact and are important in attracting attention and signaling availability [15]. Using an opening, either a question or a call-out, invites a response and makes it more likely that the conversation will be more simultaneous. Many of the IMSoft conversations, once established, consisted of rapid back-and-forth exchanges.

Another important way of dealing with the lack of simultaneity was leaving IM on all the time. This practice kept the previous interactions on the screen for referral, making it more likely that the team members could keep a train of thought in spite of a gap in time:

I type, send him something and I just get up and leave. . . . You know, 30-40 seconds have gone by, you haven't really missed a lot and they don't even know you're gone. But you just can't do that on the phone. Because if you set the phone down, you miss what's occurring. (Sam)

Keeping IM turned on establishes textual persistence, “the availability of a persistent textual record of the preceding interaction” ([7], p. 8). This textual persistence is usually short-term (allowing rereading in the moment) in interactive chat systems such as IM (Sam's logs created long-term textual persistence). Previous lines and conversations stay on the IM pane for referral as long as IM is not turned off, although, as conversational turns are taken, the preceding lines and conversations eventually scroll off the IM pane. IMSoft members used this feature to keep track of the conversation, participating in what Nardi et al [11] call an “intermittent conversation.”

There's something particularly conversational about IM that is. . . low cost. . . . If you send somebody an IM and they don't respond right away . . . you send a message typically and then push the window behind and go back to work and when they do respond, then maybe a little bit of exchange happens or,

maybe it kind of happens at a very low rate. . .it's kind of like chatting over the cube wall. (Sam)

For the most part, IMSoft members considered the lack of simultaneity to be a characteristic of IM that they could both adapt to, and use to their advantage. IMSoft members relaxed their expectations about simultaneity in their conversations when using IM. They didn't always expect immediate responses, though they tended to expect an eventual response. That IM messages stayed on the screen for a while gave IMSoft members some control over when they could attend to the conversation and this in turn gave them some leeway in maintaining their programming time. They didn't have to respond immediately to a message if they were busy. And in the conversations where all the participants were present and engaged, lack of simultaneity was not particularly an issue.

3.2. Disrupted turn adjacency

Disrupted turn adjacency, which occurs when responses aren't received immediately after the message to which they refer, but are interrupted by messages on other topics or from other participants (caused by the system posting messages in the order in which they are received rather than as responses to particular questions) can lead to significant overlap between speakers, "dense and complex" exchanges, confusion and loss of coherence [7]. There were many exchanges in IMSoft conversations but they were not particularly complex in terms of interruptions and overlaps. Perhaps this was because the majority were dyadic conversations and typically focused around work topics where it was important to keep in synch.

Nevertheless, the archive reveals some instances of disrupted turn adjacency. In 2-person conversations, IMSoft members tended to recover quickly:

0:19:36 Frank s i saw you getting snippy with adam [client]. take it easy – these guys are not operating at our level but we can't piss 'em off until we execute evil plan to a large extent.
0:19:44 sam F i'm gonna crash, but tomorrow i'm going to try to hit a workserver.
0:19:51 Frank s ok
0:20:04 sam F then implement resource management.
0:20:57 sam F i suppose i did get a little cross there. sorry.
0:21:07 Frank s it's hard not to.

In this example, Sam's message telling Frank his plans for the next day comes only 8 seconds after

Frank's longer message about the client. This short interval suggests that Sam and Frank are each writing messages at the same time. Frank replies to Sam but Sam finishes his train of thought and then in his next message manages to reply to Frank's first message. Frank then moves to complete the exchange, repairing the disruption and continuing the conversation.

Disrupted turn adjacency was more common in the three- and four-person conversations, and it was not as easy to get these conversations back in synchrony:

Frank e, s eugene?
sam e, F to workservers.
eugene s, F what?
Frank e, s oh there you are.
Frank e, s i was about to say how do we univite him?
eugene s, F to what workservers?
Frank e, s sam & I are wondering what you are working on. :->
sam e, F i'm working on assignment to workservers.
eugene s, F watching porno ;)
sam e, F unless there is something higher priority
Frank e, s porno, do we have a URL for it?
Frank e, s xxx://playboy.com/
eugene s, F hold on, I'm almost done ;)
eugene s, F I mean I'm getting ready to check in
Frank e, s I want to see its design and invoke some operations on the object.

In this conversation, Frank interrupts Sam to call on Eugene. Sam stays on topic while Frank and Eugene begin bantering, with Eugene pausing to address Sam's comment. Sam waits for a response to his message about whether there is a higher priority than what he is currently working on. Frank and Eugene finish up the bantering and then in the final two messages get back on topic. When turns showed up out of sequence in such multi-party conversations, IMSoft members would often wait to participate until the conversation became synchronized again. Most of the disruptions were repaired in 10 turns or less.

IMSoft members used a variety of techniques, many of them visual, to create, maintain and recover conversational coherence in the face of turn disruption: opening separate windows for each conversation, assigning people different colors for their exchanges, and using parentheses to highlight off-turn interjections. The most common technique was to use a different window for each separate conversation, and to specifically invite other team members to join a conversation already in progress. This allowed IMSoft members to participate in several, often overlapping conversations at once, or to "multi-communicate" [14]. Multi-communicating, is particularly mentally demanding

and can lead to lapses in attention [14]. Rather than managing the turn adjacency within conversational interactions, IMSoft members managed windows, each containing a separate conversation. In the following

example, we show how Sam participated in two conversations at once and then suggested that the two conversations be combined as the work converged.

	Window 1	Window 2
9:23:42	F S .NET really has some cool things in the area of web services. No one else has anything close. Not even Java.	
9:24:04		E S sam, question
9:24:07	F S Too bad it only runs on Windows. :-(S E Yo
9:24:23		E S Hey
9:24:28		
9:24:36	S F sigh.	
9:25:46	S F well, i need to add soap to my resume anyway. :D	
9:26:01		S E yes
9:27:06		E S well, I'm going to ask about "restoring" session, disconnected session and so on. do we need lord-f in this discussion
9:27:27		S E ask, and we'll see. i've got him in another windows.
9:28:05	F S not so fast buddy, we don't want you to be too attractive.	
9:30:21		Frank has been added to the conversation.
9:30:25		S F, E Frank.
9:30:29		E S, F Frank
9:30:48	S F we're calling you on the other line.	
9:32:28	F S sorry	
9:32:58	S F did you get our invite?	
9:33:23		F S, E what's the problem dudes?

Figure 1. IM conversations in two windows

This example illustrates that even with separate IM windows, turn-taking can be disrupted if one of the conversational participants doesn't pay attention.

Color also helped IMSoft members visually differentiate IM responses. At least one IM program allowed each participant to set a color for his IM exchanges and IMSoft members regularly used this convention, setting it as a default. Most of the original IM logs used a different color for each IMSoft member, a technique that works well on the screen, though not on the page. Occasionally, when one member's system was not set for color, another member would remind him, as when Eugene messaged "Frank – could you change your color so we know who speaks?"

A third visual technique involved using parentheses when IMSoft members felt like interjecting something off-topic into the IM conversation that might disrupt turn-taking. If a colleague wanted to reply directly to the interjection, he would put his reply in parentheses to signal which exchanges belonged together, thus creating an informal thread:

Frank s now all Alexi needs to know is, given a

URL how to do an open session. IF he gets that to work (and if we have a case which has a correct URL in it) then he should be able to implement his thing and see it fail at Line 7.

sam F (victor [client] has fixed that problem. i just ran a full cycle of my test)
 Frank s i assume the resource, given an id, will return all the "related" parameters in URL form so Alexi will never have to accept one by part.
 Frank s (cool)

This technique was not explicitly stated but appears to be a pattern the entire team understood.

IMSoft members also used several purely verbal techniques to keep conversations synchronized: naming, sending partial sentences as a signal, and lexical repetition. When IMSoft members were collaboratively programming and debugging software they often named the intended recipient of a line or direction. Using names in the three- and four-way exchanges directed attention and separated ideas,

commands, and directions; this technique could also be used to help repair a disruption:

Frank E, s we want PARAMETER to be set to AB.
 Eugene s, F ok, say "eugene:" if you want me to reply. I get the last phrase was not for me, right?
 Frank E, s eugene: we were discussing how to pass CBs.
 sam E, F eugene: the id# is 7231507 from abc (. . .)
 Frank E, s Sam, just so we are on the same page, we are using Eugene's client to debug the product directly, we are using Alexi's client for the demo! ...

This technique extended beyond naming team members to an expectation that team members would explicitly name and describe their actions while they were working together online:

Alexi F, s no i tried mine. that was working
 Frank s, a alexi, use specific pronouns past 12am please.
 Frank s, l WHAT was working and what wasn't?

A second verbal technique used to keep colleagues from replying too quickly (a common cause of disrupted turns in this setting) was sending partial sentences as a signal that the writer was not finished with his thoughts:

9:45:34 eugene s, F the problem is:
 9:45:46 eugene s, F to get a session (or resource for that [m]atter)
 9:45:50 eugene s, F you have to ask for it
 9:46:08 eugene s, F because of the listener-nature of handlers
 9:46:42 eugene s, F currently, in our API there's nothing to support popping up a saved resource

Eugene needs to convey a complicated thought so he sends fragments, each of which logically follows the previous fragment. We coded instances of this technique in over 75% of the conversations.

Finally, in this team, conversational coherence was not only necessary within conversations but also across conversations. IMSoft's work took place over time, involved much starting and stopping, and was interdependent. IMSoft members were constantly checking in with each other to make sure their individual pieces fit together or to get information that would allow them to make progress. In fact, 92 of their conversations were continuations of previous conversations (after a gap of longer than 5 minutes) and 65 of those conversations explicitly referred to a question or an issue not previously resolved.

Lexical repetition [10], repeating key words from previous messages to emphasize continuity, was an important technique they used to keep individual conversations on topic, and to relate the conversations to each other. We see instances of specific language that focused the conversation. For instance, fourteen conversations, over the course of the month, had first lines that referenced "proxy" (these did not include conversations that referenced "proxy" later in the conversation) (see Table 2).

Table 2. Sample first lines including "proxy"

Date	First Line
3/2	it was a bug in the client's proxy cycling (. . .) Add review and testing of proxy cycling to the list.
3/3	sam, i [want] to have a phone conversation early this afternoon about using the resource kit, and replacing proxy server.
3/16	are you ready to try replay through the proxy ?
3/17	yo, eugene needs your help re: proxy server.
3/24	sam, we are debugging the new server, and need some help setting up proxy url etc. so that we can get a good test.
3/29	sam, good news, i think we just bought ourselves time for proxy rewrite!!! :-)

Other terms and phrases, specific to the client's business, also recurred within and across conversations.

In order to reduce long-term conversational disruptions, IMSoft members tried to wrap up a topic within a workday. Typically, the day's first conversation did not continue the previous day's conversation (only 3 work days began by continuing the last conversation of the previous day). The work itself stayed synchronized because IMSoft members tended to break down the work into "chunks" that could be completed in a short time and they used common terminology to focus the conversation.

IMSoft members used a variety of techniques to avoid short-term and longer-term turn disruptions and when there *were* instances of disrupted turn adjacency, they undertook to repair the disruption quickly. If the disruption was not repaired, work could not continue. In the case of work-related conversation, incoherence was an obstacle to completion rather than an impetus to playfulness.

3.3. Multi-tasking

Multi-tasking, especially communicating and programming simultaneously, was considered business as usual at IMSoft, although it affected both work and communication. Though multi-tasking is common during IM conversations [8], it has not been

analyzed as a potential source of incoherence [7]. During our observation of a “coding party,” Frank was seen talking on the phone, kibitzing about the software, looking at email, and writing IMs. At the same time, Sam and Peter worked side-by-side at computers with IM panes open on the left side of the screen and a programming environment open underneath the IM panes. In the March archive, we coded 33 instances of IMSoft members specifically mentioning other activities they were doing while IM’ing. IMSoft members addressed the challenge of multi-tasking—juggling conversation and work—much like they addressed the challenge of multi-communicating: they tried to keep the two activities (or conversations) separate.

Multi-tasking was commonplace at IMSoft in part because of the expectation that IM exchanges would be attended to in a timely manner:

It's harder to not answer IM when they've seen you online, right? It's like people coming to your cube. At least the phone, . . .you have plausible deniability. They can't see that you're sitting there in your office when the phone rings. But if you have a cube or even an office, people can come, they can see you sitting there and they feel free to interrupt you. . . .The worst is it's just this invasive thing that, you know, either you have to explicitly manage it to ward off unwanted chatting or you start to feel like you're this bull's eye waiting to be hit, you know, by the random chat. (Sam)

Multi-tasking was difficult even though IMSoft members expected it of themselves and others. It was distracting, and affected both communication and work. In the following example, we see Sam trying to program while his colleagues converse and try to draw him into the exchange. Sam protests that he is unable to work amid “the racket” and they ease up:

Eugene s, al, F sam, talk to us
 Frank s, a, E okay we will stop making fun.
 Eugene s, a, F naaah
 Frank s, a, E we NEED YOU!
 Eugene s, a, F only fun.client.com [a server]
 sam a, F, E i'm try to fix the thing, and i
 cannot with all this racket!
 Frank s, a, E okay, we will be quiet.
 Eugene s, a, F you're not multitasking, man.
 you-msdos-can't-do-more-
 then-one-thing-at-a-time

IMSoft members adjusted their communication practices to deal with the challenge of multi-tasking. Day-to-day, IMSoft members wove programming and IM exchanges together, with conversation sometimes taking precedence over work:

I see programming as a background task. . . .mentally it's high priority, but the reality is everything trumps programming because the other stuff usually happens and needs immediate response and then is dismissed. (Sam)

When IMSoft members wanted to engage equally in programming and communication, they used two machines, one to program, and one to IM and email (see Figure 2) and there were references in the archive of IMSoft members discussing their work set-up. In one instance, Sam says to Frank, “(you'd think i'd walk into the next room and get the mac to solve this problem...)” This technique allowed an IMSoft member to ignore the IM windows until he was ready to respond to an exchange. A recent overview [3] suggests this is an effective way to manage work and interruptions.



Figure 2. Using two computers

Finally, when maintaining coherent conversations interfered with getting work done, IMSoft members went off-line to preserve their ability to work, either by posting a message on IM saying they were busy (“I can set myself as being offline, all right. [But] I'm still here.”), or by going physically off-line and turning off IM:

When I'm working on the weekend. . . .unless we're in the middle of a release cycle. . . .I try to keep IM turned off, just because I don't want to get sucked into any [conversations]. (Sam)

We saw instances of this when we examined Sam’s timesheets in conjunction with the March IM archive. Sam worked 28 days (some full, some partial) in March; during 6 of those days, he IM’d sparingly (logging fewer than 60 IM lines on those days).

Multi-tasking challenged conversational and work coherence in IMSoft because it diverted atten-

tion. In most cases, the conversations took precedence but IMSoft members used a variety of techniques to avoid being drawn into a conversation when they had complete work. If they tried to converse while doing complicated work, either the coherence or the work would suffer. Using two machines minimized multi-tasking cues. Eliminating multi-tasking altogether by either conversing or working but not both, allowed members to maintain coherence or do work without interruption.

3.4. Authority

It has been noted that setting the direction for a team involves wielding authority and managers have to balance between maintaining control and ceding all authority to the team [4]. Many studies examine IM in the workplace (e.g., [6, 8, 11]) but how authority affects IM conversations is not widely discussed (studies done in educational settings (e.g., [12]) implicitly acknowledge authority with the emphasis on the teacher/student relationship). In a recent study [13], IM messages coming from higher status individuals were answered more quickly than others.

IMSoft members had to balance getting work done, and engaging in IM conversations while also responding to Frank, the boss, as it appeared that Frank structured conversations and work so that he could maintain control. He regularly gave instructions to team members, much like the following: “sam, i think we just crashed the server with webui. Critical fix needed, please take a look and fix it ASAP. (Demo tomorrow.)” Most of the IM conversations in the archive were between Frank and Sam (122 of 175 conversations). Sam IM’d other team members but not to the extent that he talked to Frank. This type of communication pattern, (a wheel with Frank at the center), reinforces the authority of the central person [9]. In addition, Frank initiated most of the conversation (82 of 175 conversations).

Frank expected his team to be available and to quickly respond to his messages: “Our team members are generally maximally available but they are minimally present.” Sam concurred: “If Frank did not see me online, he would get worried and call – ‘You OK? You’re not online.’” and “Frank never lets me log on without sending me mail or without chatting me.” Frank was an intense person to work for. As Sam put it, “Frank is the Energizer Bunny.” Once he reached an IMSoft member, he often dominated the conversation:

. . .he asks a question. He hears the first three words or your reply, and then [SOUND OF EXPLOSION] he’s all over it, . . . he starts talking again. And he thinks he’s heard what you were

going to say, but he won’t let you finish the thought. . . writing him in IM, you have to deal with that thing too. (Sam)

This style interrupted the conversational flow and turn adjacencies. Team members adjusted to Frank’s expectations and interaction style by employing some of the tactics discussed earlier, such as splitting IM messages to signal unfinished thoughts. Sometimes IMSoft members dealt with Frank like they dealt with the pressure to multi-task: they didn’t log in. This tactic helped with getting work done but was an obstacle to communication.

Another way of dealing with IM interruptions was to use IM itself to make appointments and share schedules, giving an IMSoft team member more control over his time, and his work and his communication. Sharing schedules helped to facilitate coordination and collaboration. In one exchange, Eugene tells Sam “ok, i’ll have to get onto vpn now, but will be back in 5 min.” This allows Sam to know he can work uninterrupted for 5 minutes and it’s a heads-up that any messages that Sam sends will not be answered. By sharing his working schedule, Eugene is heading off any coherence issues that might arise from delayed feedback. At other times, IMSoft members used IM to make appointments to talk:

10:32:50 Frank s sam, i what to have a phone conversation early this afternoon about using the resource kit in client, and replacing proxy server.
 10:43:08 sam F i should be around 1.30 or 2.00.
 10:43:54 sam F i’m going to run some errands, have lunch, and give blood in about 10 minutes.
 11:30:25 Frank s is that 1.30C or 1.30ET?
 13:24:44 sam F 1.30 CST

Sharing schedules and making appointments also gave IMSoft members some short-term control over their communication and work. In this example, Frank wants Sam’s uninterrupted time (note that he is suggesting a phone call, a common IM use in Nardi et al’s work [11]). Sam responds with a time and indirectly lets Frank know he won’t be working or available for any conversations until then.

Negotiating work and communication patterns with Frank was facilitated by IM, which allowed for a quick back and forth of proposals. Frank engaged in a lot of conversation and kept a lot of the work goals to himself. Entering into a negotiation was one way to pin Frank down on the work that had to be done and to give some structure to the work:

[B]etween my specific deliverables, we enter a phase of negotiation where Frank tells me what he wants and I tell him why he can't have it and what he can have instead and he tells me why that's not good enough and we go around and around and come up with a spec. Usually, often it takes a two or three hour very intensive session of Instant Messaging. . . it's kind of a continuous process because as we go, the plan is never stable. (Sam)

IMSoft contractors adapted their work and communication to their boss's patterns. By accommodating and adapting to Frank's inclination to engage in rapid conversational exchanges (which IM supported), IMSoft members were able to gain information and control.

4. Discussion and Implications

Our study of the IMSoft IM archive reveals that members of a small, geographically-distributed team, collaborating to write software, used a variety of techniques to maintain coherence in their IM conversations. In particular, we were interested in understanding how this team used IM conversations to coordinate their ongoing work over time and across distance, and the implications that techniques for maintaining coherence had on the work. As Nardi, et al ([11], p. 79) note, current media theories tend to assume "that communication is best studied one interaction at a time, rather than in a temporal sequence spanning multiple discrete interactions." The analytic lens of conversational coherence allows us to study persistent communication not in terms of discrete encounters but as ongoing flows of conversation and work activity.

In our analysis, we saw instances of challenges to conversational coherence—lack of simultaneous feedback and disrupted turn adjacency—that had been identified in previous research [7]. Interestingly, IMSoft members seemed to adapt to the lack of simultaneous feedback. They used the IM window as a repository, creating at least a temporary persistent conversation. They employed openings that invited response and were thus able to delay entering a conversation until the other person was available to chat. The lack of simultaneity coupled with the short-term textual persistence of IM could be advantageous, allowing IMSoft members to more easily multi-task and multi-communicate [14], though this in turn proved to be challenging.

Disrupted turn adjacency, both short-term and longer-term, could cause more serious problems in getting work done. IMSoft used IM conversations to plan their work, to answer questions about work, and

to work together preparing software releases. IMSoft members liked each other but the reason they conversed was to accomplish their work. We saw some disrupted turn adjacency but we identified a number of techniques that IMSoft member used to keep the number of turn disruptions down: visual techniques such as using color, verbal techniques such lexical repetition that focus attention, and mechanical techniques such as using two panes to separate conversations. Some of the techniques that were used in this setting have been mentioned in other work, for instance, using a signal of some kind to indicate that the writer has not yet completed his train of thought [7] and naming the intended message recipient [7]. Conversational drift caused by turn disruption was an obstacle to sharing pertinent information and coordinating and IMSoft members seemed to try to stay on-topic when discussing work. Previous work [7] has hypothesized that topic drift can encourage language playfulness. We found such instances of playfulness but IMSoft members always brought the conversation back around to work.

We identified two additional attributes of IM use in a distributed work setting that may create challenges to coherence. One was the expectation that people could *and* should multi-task. Working in a computer-based work environment allows a person to do two or more things at the same time, and in this case the team had a positive normative view of multi-tasking, especially of working and IM'ing at the same time. IMSoft team members were able, using IM, to have two concurrent conversations or discuss software problems while writing or debugging software. At the same time, their colleagues expected them to attend to interruptions, thus creating a situation where both conversational coherence and work were threatened. Recent work on multi-communicating (a form of multi-tasking) [14], notes that multi-communicating is a cognitively complex activity and there can be lapses in attention, which can contribute to incoherence. We found a number of responses used to manage the demands of multi-tasking and multi-communicating: technical (e.g., using two computers), social (e.g., withdraw from colleagues), and a mixture of the two (e.g., combining two conversations into one).

The second newly-identified attribute of a work setting that can threaten conversational coherence, authority, is purely social. Work settings usually have bosses and workers. Conversations with people who have more authority usually have a different tenor than conversations with colleagues [13]. In IMSoft, the boss exerted his power through conversation in subtle but influential ways. For instance, Frank insisted that everyone use IM. IM fit his man-

agement style and communication preferences and IMSoft contractors had to adapt. Frank was prone to interrupt and felt he could. IMSoft contractors then used some of the turn-saving techniques to keep their messages from being overrun by Frank's overabundance of messages. Although managerial styles vary, in most work settings we might expect authority to affect conversation, and thus potentially to pose challenges to conversational coherence.

Maintaining conversational coherence in a setting where conversations not only support but actually are work requires participants to draw upon and use a variety of techniques, many of them concurrently. Responses can address overlapping challenges (i.e. keeping several panes open continually helps manage turn adjacency and multi-tasking).

Results of this study suggest that challenges to conversational coherence in a work setting can arise from areas besides the technical system. The social setting of work, including norms, social structure and power relations, affects how people collaborate, communicate, and coordinate. Work environments are often more complex than strictly social settings because people both communicate and work, and sometimes, as is the case in this study, the communication is the work. In addition, in a work setting, there is an authority structure, which workers also have to accommodate and adapt to. We may not have considered all of the social techniques and responses that help maintain coherence. For instance, emotion and humor may be important in keeping conversations focused; alternatively they may make it more difficult. Taking work and social, as well as technological factors, into account when studying electronic communication will create a more nuanced picture of how workers maintain coherence as they do their jobs.

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