Effects of Message Content on Cognitive and Affective Processes in Cross-culture and Same-culture Instant Messaging Conversations

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ABSTRACT
In this paper we explore how and why communication problems such as lack of understanding, low involvement, and negative emotions emerged during the computer-mediated conversations of same-culture and cross-culture pairs. We used retrospective analysis, in which pairs of cross-culture and same-culture American and Chinese participants collaborated on a crime-solving task via Instant Messaging (IM), and later reviewed their IM conversations to report their thoughts and feelings on a minute-by-minute basis. We found differences in the types of messages people produced based on the cultural combination of the pairs. We also found that the content of their partner's messages influenced participants' involvement and negative emotions during the conversation. Our results provide insights into the conversational processes of computer-mediated intercultural teams, and have implications for the design of intercultural collaboration tools.

Author Keywords
Cross-culture communication; CMC; retrospective analysis

ACM Classification Keywords
H5.3 Group and Organization Interfaces: Computer-supported cooperative work

General Terms
Experimentation; Human Factors

INTRODUCTION
While global teams with members in different geographical locations, and from different cultures, collaborating via computer mediated communication (CMC) have been found to offer many benefits [30], previous studies have reported that challenges can arise during intercultural CMC communication [e.g. 32, 45, 7]. In order to enjoy the benefit of global collaboration, these communication problems should be prevented, or overcome. However, it is still difficult to understand the characteristics and causes of these problems. Two possible reasons may help explain this difficulty. First, while challenges often arise during the communication processes of intercultural teams [7], previous research [e.g. 27, 28] has typically assessed the presence or absence of these issues after the conversation is over, rather than associating them with aspects of the communication process. Second, prior studies of computer mediated intercultural communication show quite different patterns of results regarding the communication process of cross-culture teams, depending on the medium of communication [e.g. 39, 40], the type of task, and the cultural composition of the group [45]. Hence, the goal of the present paper is to increase our understanding of why, and how communication problems arise in intercultural CMC conversations by examining how what partners think and feel during the course of a conversation is associated with the types of messages exchanged in that conversation.

At least three interrelated types of issues can occur when communication takes place across cultural boundaries: (a) difficulty understanding a partner's message [e.g. 27, 40], (b) negative affective reactions, such as anger, anxiety, or annoyance [e.g. 32], and (c) reduced engagement or involvement in intercultural conversations [e.g. 4]. Some studies have pointed to the content of messages produced during the conversation as a source of influence on conversational outcomes such as satisfaction & recall [e.g. 29], but because participants' reactions to the conversation were measured after the conversation was over, it is impossible to pinpoint what specific aspects of the communication led to these effects.

To address the above issue, Nguyen & Fussell [32] used a *retrospective analysis* technique [14] in which cross-culture and same culture pairs of American and Chinese participants reviewed their instant messaging (IM) conversations after the fact and reported, on a moment-by-moment basis, what went wrong during the conversation. Nguyen & Fussell [32] found that the level of tension and annoyance were higher for both American and Chinese participants working with a Chinese partner than with an American partner. Qualitative analysis of participants' comments revealed that there were differences in communication styles among participants from different cultures, such as task-orientated versus relationship-

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orientated conversational style, which might explain the high level of annoyance and tension felt in cross-culture pairs.

Nguyen & Fussell, however, did not pinpoint how cultural differences in communication styles may lead to communication problems such as negative emotions. This is an important question to answer because it may suggest ways to improve intercultural collaboration through the prevention or remedy of communication problems. Moreover, it also contributes to the development of intercultural communication theories. It not only explores cultural differences in communication on a deeper level (specific message production practices), but also examines how such differences affect the communication process, which has not been discussed in many previous cross-culture studies. The current study extends the analysis in Nguyen & Fussell [32] to answer this question, by investigating the association between message content and participants' cognitive and affective processes, namely, the processes of developing mutual understanding, involvement, and negative emotions during an IM conversation. Pairs of participants collaborated on the crime-solving task described in Nguyen & Fussell [32]. They conversed via IM and then individually reviewed a recording of their conversation. For every two-minute period of the interaction, they reported on their cognitive and affective reactions. We also coded the messages exchanged during each two-minute interval, and examined the relationships among the cultural composition of the pair, the messages exchanged, and participants' cognitive and affective processes.

In the rest of the paper, we first review previous literature on issues in intercultural communication and present our hypotheses about the effects of message content on cognitive and affective processes in intercultural and intracultural CMC conversations. We then describe our retrospective method, explain our statistical approach, and present our findings. As we will show, the number of task-related messages produced during the conversation differed depending on the culture composition of the pair. Moreover, the type of messages produced by their partner influenced participants' self-reported levels of involvement and negative emotions during their conversations. We conclude by discussing some of the implications of our findings for theories of intercultural communication and the design of new CMC tools for intercultural communication.

BACKGROUND

In this section, we first point out several problematic cognitive and affective processes in intercultural teams. We then describe the types of message content often produced during these processes. Finally, we outline the specific hypotheses and research questions tested in our study.

Cognitive and Affective Processes in intercultural CMC

Previous studies of global virtual teams [e.g., 33, 21] suggest many issues arise during team conversations [7]. Our focus is on three interrelated types of communication problems: difficulties with cognitive processing, negative affective responses, and lower conversational involvement.

With respect to cognitive processing, participants in intercultural conversations sometimes report difficulty understanding their partners. Some of these problems arise from fluency issues or from differences in conversational styles [e.g. 27]; others arise from errors in the process of *grounding* [5], the interactive processes by which partners in a conversation establish mutual understanding. For example, Li [27, 28] found that European Canadians and Chinese participants differed in whether they would ask for clarification when needed during a conversation, and these differences affected task outcomes. The reduced affordances of CMC, such as lack of audio and visuals, may lead to even more difficulties in grounding [7, 21]. Lack of understanding, or misunderstanding may negatively affect both the team's performance and relationships among team members [21].

Participants in conversations also experience a flow of affective reactions to the ongoing interaction, which can influence team interaction and performance [22]. Intercultural teams often report more negative emotions than intra-cultural teams, including anxiety, tensions [4], frustrations and annoyance. There are a variety of possible explanations for this finding, including the fact that people enjoy being around similar others [8], or that people find the extra effort required for grounding to be annoying. Effective team communication involves attention to others' affective states, emotions and feelings. However, the lack of contextual cues in CMC may make it harder for team members to detect others' emotions [23].

Another important aspect of communication is how engaged or involved participants are in the conversation, that is, how actively they participate [3]. Involvement has been shown to facilitate affiliation, expression of intimacy, regulation of interaction [35], conversational cohesion, and better understanding [42]. However, research has found less involvement in intercultural interactions [4], possibly due to the lack of familiarity and common ground between partners. Although previous studies suggested that the inability of CMC to support non-verbal cues such as gaze and touch might lead to lack of involvement [23, 24], few studies have directly measured levels of involvement.

Cognitive processes, affective processes, and conversational involvement can be related in complex ways. For example, difficulties in understanding a partner can lead to annoyance, which in turn can lower involvement in a conversation. Previous studies of intercultural collaboration mostly pointed to the cultural differences in communication styles as the possible causes for these difficulties. Few studies, however, examined how culture affects conversations, and how the differences in conversational behaviors caused by both the cultural orientation of the participants and their partners could lead to communication issues. In this study, we examine cultural

differences through the content of the messages participants said during their conversation. We also investigate how the types of messages that a person receives from his or her partner may have an impact on all three of the communication processes mentioned before. We turn to these topics in the next section.

Message Content in Task-Oriented CMC

Previous research suggests that many of the collaboration issues reported during conversations among virtual team members are associated with specific messages exchanged [7]. Thus, message content plays an important role in the emergence of collaboration challenges.

In many task-oriented conversations, participants exchange *task-related messages* that help them complete the task together (such as comments and opinions about the task content, suggestions of how to carry out the task). With respect to the crime-related conversations in our study (described in detail under Methods), two types of task-related messages can be distinguished: those that exchange facts about the case and those that express subjective feelings or opinions about the case [e.g. 34]. Since work-related conversations are composed of predominantly task-related messages, this type of messages is the main collaboration tool for any work team. Moreover, the amount of task-related communication a team member exchanged with his or her partners can shape their impressions of his or her knowledge and expertise [46].

Even when a conversation is primarily task-related, speakers use relational messages to establish and maintain their relationships with each other (such as greetings, compliments and ice-breaking small talk) [1, 40]. For example, partners who do not know each other often exchange self-introduction and greetings before starting the task, and offer compliments or congratulations to each other for doing well. While some studies found that CMC conversations were largely task-oriented and lacked relational exchanges [e.g. 23], other studies have found that CMC interaction could be used to support moderate social-emotional content [36] and develop close relationships [e.g. 44]. Studies of distributed work teams have also shown that building good team coherence and rapport is important for team success [e.g. 19].

Partners also exchange *backchannel responses* such as "uhm" or "uh huh" that are not intended to take the floor from the current speaker but rather indicate attention or understanding [37]. An addressee's back channel responses clarify whether he or she is paying attention and understanding one's messages [6, 25]. In text media, interactants produce back-channels by using transcriptions such as "uh huh", or shortcuts, and emoticons [18].

The Current Study

While previous studies have found issues in the communication processes of intercultural teams, they were not able to adequately explain these problems. Our study aims to bridge this gap by examining how culture influences the types of messages a participant produces, and how the message content, in turn, influences three types of cognitive and affective processes during CMC: (a) the grounding process of establishing mutual understanding; (b) affective responses to the ongoing interaction; and (c) participants' levels of involvement in the conversation. We focus on three types of message content: task-related messages, relational messages, and back-channel responses.

Culture differences in message production

Our first set of hypotheses pertains to the effects of cultural background on message production. In this study, we consider two cultures --American, and Chinese – which have been found to prefer different communication styles [e.g. 16, 45]. One key aspect of communication style is the emphasis placed on completing tasks vs. building rapport [41]. Some cultures, such as that of the U.S, place priority on getting work done efficiently, with minimal regard to building interpersonal relationships. Other cultures, such as that of China, tend to emphasize the need to achieve group harmony and solidarity. Consistent with these cultural differences, several studies have observed more relational communication in Chinese pairs than in American pairs, both in face-to-face communication and CMC [e.g., 27, 28, 40, 20]. Moreover, in intercultural teams, some participants may adapt to the conversational styles of their partners [e.g., 11]. For example, Wang, Fussell & Setlock [45] found that Chinese participants were more likely to reduce their use of relational communication when interacting with (more task-oriented) American partners. Based on these findings, we posed the following hypotheses:

H1A: American participants working with an American partner will produce more task-related CMC messages than Chinese participants working with a Chinese partner.

H1B: Chinese participants working with an American partner will produce more task-related CMC messages than Chinese participants working with a Chinese partner.

H2: Chinese participants will produce more relational CMC messages than American participants regardless of the culture of their interaction partners.

Less is known about the effects of culture on backchannel responses, especially in CMC. In a face-to-face setting, Li [29] found that Chinese pairs produced more backchannel responses than Canadian pairs, and that in intercultural pairs Canadians increased their use of backchannel responses although there was no effect of the cultural composition of the group on Chinese speakers. Since the implications of these findings for CMC is unclear, we asked the following question:

RQ1: In a text-based CMC environment, how does the number of back-channel responses a participant uttered during the conversation differ based on the various culture combinations of the pair?

Effects of message content on understanding

Backchannels are an important component of the grounding process, since they are used to confirm mutual knowledge during a conversation [25, [29]. Therefore, we hypothesize:

H3: A participant's level of understanding during CMC will be positively associated with the number of backchannel responses produced by his/her partner.

Little research has examined the effects of numbers of task-related and relational messages on the development of mutual understanding in CMC. Therefore, we posed the following research question:

RQ2: How is a participant's level of understanding affected by his/her partner's task-related fact-oriented messages, task-related subjective opinions, and relational messages?

Effects of message content on involvement

Involvement is the degree to which a person participates with his or her partner in the ongoing social interaction [10]. In task-oriented conversations, task-related messages from a partner can signal that the partner is actively participating and thus involved with the interaction. Since involvement is a social process whereby social actors rely on each other to maintain their own involvement [13], being confirmed about a partner's attention may in turn lead the speaker to feel more involved. Thus, we proposed that:

H4: A participant's level of involvement during CMC will be positively associated with the number of task-related messages (both fact-oriented task messages, and subjective opinions) produced by his/her partner.

Back channel responses can also signal that a listener is paying attention [29], and therefore, can also help increase the speaker's level of involvement with the conversation.

H5: A participant's level of involvement during CMC will be positively associated with the number of backchannel responses produced by his/her partner.

There have not been many studies about the effects of relational messages on involvement in CMC. Therefore, we proposed the following research question:

RQ3: How is a participant's level of involvement during CMC affected by his/her partner's relational messages?

Effects of message content on negative emotions

During a conversation, negative emotions may emerge as a result of cognitive processes, such as a lack of understanding [7], and a lack of involvement [3]. Because there been little previous work looking at how message content affects negative emotions on a moment by moment basis, we propose the following question:

RQ4: How is a participant's level of negative emotions during CMC affected by his/her partner's back-channel responses, fact-oriented task-related messages, task-related subjective opinions, and relational messages?

METHOD

In order to understand how cultural differences in communication styles affect intercultural interaction, we used a retrospective analysis technique [14]. Same-culture and cross-culture pairs first discussed and solved a crime case using a text-based IM program. Afterwards, they individually reviewed a recording of their interaction. At preset intervals, the recording was stopped and participants provided their feedback on the segment.

Participants

Participants consisted of 60 students (53% undergraduate, 65% female) studying at a large American university. Of these, 30 students were native Chinese speakers who had been born in the People's Republic of China (29) or Taiwan (1), and had spent less than 5 years in the United States or Canada. The Chinese participants spoke fluent or near-fluent English. The other 30 American participants were all born and raised in the United States or Canada and spoke English as their native language. Twenty-eight American were Caucasian and two were Asian.

Each participant was paired randomly with a partner from the same culture or from a different culture, resulting in three combinations: 10 Chinese-Chinese (CC) pairs, 10 American-American (AA) pairs, and 10 American-Chinese (AC) pairs. To control for age differences we paired graduate students with other graduate students and undergraduates with other undergraduates. Participants in a pair did not know each other prior to the experiment.

Materials

Task. The task consisted of discussing a crime story and identifying the culprit of the crime. The crime story, developed by the first author, involved a break in and a murder attempt on a victim named Alex. Alex is the leader of a rock band of four people. The other three members of the band were the three prime suspects, one of whom was the actual culprit.

Two different versions of the crime story were prepared, based on the reports of two witnesses. Each version contained 10 pieces of information important to solving the case. The two versions shared common information about the victim, crime location, and attack on the victim. They also included details complementing each other that needed to be combined to fully understand what happened, such as the time and location of each of the suspects before and after the crime. The two versions also contained three contradictory details about the crime: (a) the time of the attack, (b) the body builds of the culprit and (c) the color of the shirt the culprit was wearing as they were reported from the different perspectives of the two witnesses. These had to be resolved through discussion to identify the culprit. The details were presented on a single sheet of paper (622 words for version A; 644 words for version B). The crime-solving task was designed to reflect a common collaboration task for global virtual teams that requires not only information sharing, but also collaborative reasoning and conflict resolution.

Memory quiz. A paper and pencil *memory quiz* was created to test participants' understanding of the materials prior to discussion with their partner. The quiz consisted of 10 multiple choice questions on the key details of the crime (e.g., time, suspects).

Culprit identification form. Since every pair had to provide a common answer to the case, we created a shared Google document between the two participants in a pair, with two questions on it: one for indicating the culprit(s) of the crime, and another for the pairs' reasoning behind their identification of this culprit. Both participants in each pair were able to edit this shared document at the same time. At the end of the discussion they saved this document.

Post task survey. Participants completed an online survey asking about their reactions to the task and partner, their communication styles, and their basic demographic information.

Retrospective analysis survey. The online *retrospective analysis survey* consisted of 7 rating questions and an additional open response question that participants completed after each 2-minute video clip. The first three questions asked each participant to rate on 5-point Likert scales their level of tension (very tense-very relaxed), annoyance (very annoyed-not annoyed at all) and interest (not interested at all-very interested) in the conversation. The next two questions asked participants to rate how much their partners understood them and how much they understood their partners, respectively (1 = not understanding at all; 7 = very understanding). The remaining two questions asked the participants to rate how much their partners and they themselves felt involved with the conversation (1 = not involved at all; 7 = very involved). The final question asked whether the participant had noticed any problem with their interaction at the point of time shown in the video clip. If the answer was yes, we asked them to provide details about what went wrong and what they would have done to prevent/remedy the problem.

Equipment and Recording Processing

Participants in all pairs used identical Dell workstations running the same version of Gtalk for Window XP. We disabled the use of audio call in Gtalk. The Gtalk chat window of the two participants in each pair were recorded, synchronized and combined into a split screen video during their discussion using CamStudio 2.5 desktop capturing software and ShowMyPC 3011 remote desktop sharing software. The split screen video consisted of two frames, one for each participant's Gtalk chat window. During retrospective analysis, each participant was shown only the frame with his or her own chat window. The video clip of the participants' own chat window served to remind them as much as possible their experience during the conversation with the partner, and aspects of the dynamics of the conversation such as keystrokes and response time, which may be helpful for them to answer the retrospective analysis survey.

Two Dell workstations with Dell Ultrasharp 19 inch monitors (1140 x 900 resolution) were used to present the video clips during the retrospective analysis. The 20-minute video of the discussion was divided into 10 sequential clips of 2 minute each to be played one by one in chronological order to both participants using Quicktime Player.

Procedure

The experiment consisted of two phases: a discussion phase and a retrospective analysis phase. In the *Discussion Phase*, pairs of participants were brought into a room and assigned seats at two separated workstations with a divider in between. They signed consent forms and received task instructions. Each participant received one of the two versions of the crime story. They were given 10 minutes to read the story and learn the details of the crime, after which the hard copies were taken away and they were given the memory test. The experimenter then corrected the quiz and left the corrected quiz with the participants for the rest of the experiment. Participants were then instructed how to use the Gtalk text chat client.

Each pair then discussed the story via Gtalk for 20 minutes (Figure 1). In order to solve the crime, the pairs needed to gather all the information from both versions of the story, resolve conflicting details, and identify the culprit. All pairs were encouraged to fully utilize their 20 minutes for discussion. After 20 minutes, the facilitators stopped the discussion, no matter what the pairs were doing. At the end of their interaction, each pair submitted their conclusion about the culprit and the reasoning behind their decision in the culprit identification form. Each participant in the pair then separately filled out the post-task survey.

In the *Retrospective Analysis Phase*, the two participants were seated as in the previous phase. They were shown a series of 10 two-minute video clips of their conversation in Phase 1. After each clip, participants filled out the retrospective analysis survey. After the last clip, participants were debriefed, paid and dismissed.

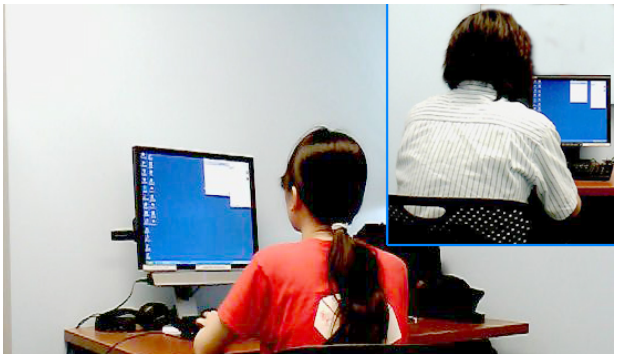

Figure 1. Setting of the discussion phase.

Coding of conversational messages

The experiment was conducted on 30 pairs for a previous study [32]. In this study, the IM chat logs of the conversations of each of these 30 pairs was broken down into 10 sub transcripts corresponding to the 10 two-minute

clips participants watched during the retrospective analysis phase. The first author parsed each of the 10 sub transcripts of each pair into conversational messages based on speaking turns. A conversational message was defined as a verbal structure expressing one and only one idea. Incomplete or non-meaningful structures were coded as sentence fragments and ignored in the analyses.

Two independent coders, blind to the conditions of the experiment, coded all the conversational messages in all sub transcripts of all pairs (kappa = 84.7%). The conversational messages are coded exclusively into one of the 5 categories: fact, opinion, relational messages, back channel responses, and others.

*Fact*s are those messages (including questions) about the task of solving the crime that express an objective fact or a clue that is already given in the stories handed out to the participants in the first phase of the experiment (e.g., "According to my story, Brian is tall.", "What is Brian's height according to your story?").

Opinions are messages (including questions) about the task of solving the crime that express a subjective opinion (agreement, disagreement, or neutral) (e.g., "I think Mr. Grover was lying.", "How do you think he could do that?", "No, I don't think Carl was the one.", "Yes, I agree Brian may be the culprit.").

Relational messages are messages (including questions) not related to the task of solving the crime, but are meant to establish relationships with the conversation partners or to promote team spirit. These messages include greetings, self-introductions, cheers and motivations; messages whereby the participants self-disclosed, but which are not directly related to solving the crime case (e.g., "Hi, nice to meet you!", "What's your name?", "I think our team did great, yay!").

Backchannel responses are messages that do not have any specific meaning, and do not add more meaning to the conversation, but still serve the communicative purposes of indicating involvement in the conversation and/or understanding of the partners' utterances or complimenting the partner's utterances (e.g., "uhm", "yeah", "ok", "and?").

Others are messages not fitting any of the categories above.

Measures

The dependent variables were number of problems, levels of understanding, involvement and negative emotions, subjective outcomes and performance.

Understanding. Participant's ratings, on a 7-point scale, of how much they understood their partner (self's understanding) during each minute of their conversation were negatively skewed, so we recoded the data into three categories (1 to 5 =1, 6=2 and 7=3), roughly corresponding to problematic understanding, good understanding and excellent understanding.

Involvement. Participants' ratings, on a 7-point scale, of how much they felt involved in the conversation (self's involvement) during each minute of their interaction were negatively skewed and recoded into three groups, representing the bottom, middle and top third of the responses (1 to 5=1 "low", 6=2 "middle", and 7=3 "high").

Interest. Participants indicated, on a 5-point scale, how much interest they felt in the conversation. This measure was also negatively skewed and recoded into three groups, representing the bottom, middle and top third of the responses (1 to 3 =1 "low", 4=2 "middle", and 5=3 "high").

Negative emotions. Participants' ratings on a 5-point scale of how tense and how annoyed they felt in the conversation were negatively skewed and recoded into three groups, representing the bottom, middle and top third of the responses (1=1 "low", 2 to 3=2 "middle", and 4 to 5=3 "high").

Message counts. We counted the number of messages of each of the 4 categories (facts, opinions, relational messages, backchannels) that a participant uttered every minute of the 10-minute discussion.

RESULTS

We report the results in two parts: first, analyses of the culture differences in message content produced; and second, the effects of message content on participants' cognitive and affective responses as well as their levels of involvement in the conversation.

Cultural Differences in Message Content

Table 1 showed the distribution of each type of messages uttered per minute based on the culture of the participants.

To test H1, H2, and answer RQ1, we conducted mixed model Analyses of Variance (ANOVA) on the number of messages, with self's culture, partner's culture and the interaction of these two as the fixed effects, and pairs, individual within pairs, and time within individual as random effects. Note that in mixed models, when tests of fixed effects involve a linear combination of variances at different levels of the model (e.g., group and individual), it is standard to estimate the degree of freedoms associated with the denominators by using Satterthwaite's approximation. Therefore, non-integer degree of freedoms may occur [31]. Because our hypotheses concern the fixed effects of culture, we present only these fixed effects below.

Message Types	Number of messages per minute	
	American	Chinese
Facts	2.8 (2.54); 3	2.1 (1.73); 2
Opinions	2.0 (2.02); 3	1.6 (1.53); 1
Relational	0.5 (0.33); 0	0.2 (0.40); 0
Back channel	0.3 (0.62); 0	0.3 (0.54); 0

Table 1. Number of messages of each type uttered every two minutes by American, and Chinese participants (Mean (SD); Median)

Task related and relational messages. Hypothesis 1A proposed that Americans working with an American partner would produce more task-related messages (both facts and opinions) than Chinese participants working with a Chinese partner. Hypothesis 1B proposed that Chinese participants working with an American partner would produce more task-related messages (both facts and opinions) than Chinese working with a Chinese partner. Hypotheses 2 suggested that regardless of the culture of their partners, Chinese participants would produce more relational messages than American participants. To test these hypotheses, we conducted a mixed model ANOVA of the form outlined above, using the number of task-related facts, task-related opinions, and relational messages produced by each participant every 1 minute of the conversation as dependent variable. However, since these totals were heavily skewed, we did the analysis on the natural log transformation of these numbers instead. We did not find any significant main effects of self culture (F[1, 44.5]=1.02, n.s), partner's culture (F[1, 44.5]=1.59, n.s), nor interaction effects (F[1, 26.58]<1, n.s) on the number of relational messages, rejecting H2.

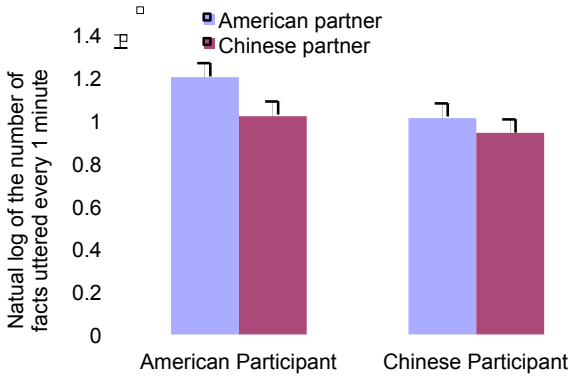

Figure 2. Culture difference in terms of the number of facts uttered every two minutes.

We found a significant main effect of self's culture (F[1, 45.49]=6.16, p=.017), and partner's culture (F[1, 45.49]=5.34, p=.025) on the number of facts, but no significant interaction effect (F[1, 27]<1, n.s). American participants said more facts (M=1.11, S.E=.048) than Chinese participants (M=.98, S.E=.048), regardless of whom they were working with. This is consistent with H1A. Participants, regardless of culture, working with an American partner produced more facts (M=1.11, S.E=.048) than working with a Chinese partner (M=.98, S.E=.048) (Figure 2). This is consistent with H1B.

We found no significant main effect of self's culture (F[1, 54.7]=2.48, n.s), or partner's culture (F[1, 54.7]<1, n.s) on the number of task-related opinions. But we found a significant interaction effect (F[1, 27]=8.99, p=.006). Same-culture American pairs said the most task-related opinions (M=.95, S.E=.06), followed by same-culture Chinese pairs (M=.87, S.E=.06), and lastly cross-culture pairs (M=.64, S.E=.07) (Figure 3). These results are consistent with H1A, but contradict H1B. Taken together, the results about the different types of task-related messages supported H1A, and partially supported H1B.

Back channel responses. RQ1 asked whether there would be any difference based on the culture combination of the pairs in terms of the number of backchannel responses produced. To answer this question, we conducted a mixed model analysis of the form outlined above, using the total of back channel responses produced by the participant every 1 minute of the conversation as dependent variable. However, since the total numbers of back channel response every minute were heavily skewed, we did the analysis on the natural log transformation of these numbers instead. We did not find any significant main effect of self's culture (F[1, 53.55]=2.17, n.s), or partner's culture (F[1, 53.55]=1.37, n.s), or any significant interaction effect (F[1, 27.20]<1, n.s) on the number of back-channel responses produced. So there was no significant difference across the culture combinations of the pairs in terms of the number of back-channel responses uttered during the conversation.

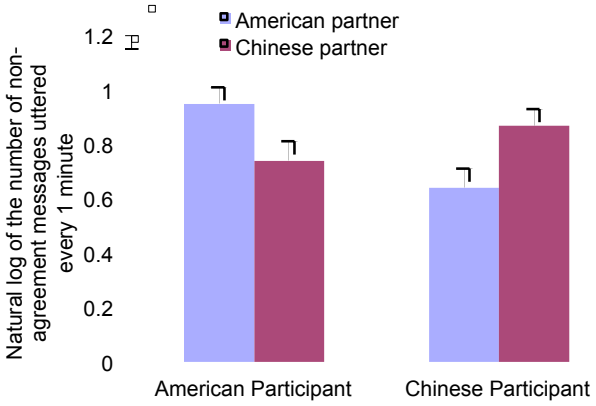

Figure 3. Culture difference in terms of the number of non-agreement messages uttered every two minutes.

Message Content and Communication Processes

To test H3, H4, H5, and answer RQ2, RQ3, RQ4 we conducted regressions using our cognitive and affective measurements as dependent variables. First, we included the effect of gender, self's culture, partner's culture, and the interaction of these two as covariates. Second, the number of messages in each of the 5 categories mentioned above was included as covariates. Since the cognitive and affective measurements (level of understanding, involvement, interest, tension, and annoyance) were taken every minute of the 10-minute long discussion for each participant in each pair, we included the lagged dependent variable (the cognitive and affective measurement taken 1 minute before the dependent variable) among the regressors, to control for the effect of the previous level of affective and cognitive responses [9]. Finally, we accounted for the non-independence of multiple observations per individual within pairs and per pair.

While there are reasons to believe that culture may also influence the effects of message content on communication processes, and thus the need to include the interactions of

culture and message content as covariates, a model with these covariates added showed no significant interaction effects of culture and message content on communication processes. Removing these interaction effects from the model did not significantly change the results. Therefore, we decided not to include the interaction between culture and message content in our final model. Consequently, the independent variables consist of 4 groups: 1) random effect of 30 pairs and 60 participants nested in each pair, 2) culture variables including self's culture, partner's culture, and the interaction of these two, 3) Yt-1, or the conversational reaction being analyzed at the t-1 time, and 4) message content variables: natural log of number of facts, opinions, relational messages and back channel response each minute

We carried out this analysis in JMP statistical package. Table 2, 3, 4, 5 and 6 present the results of these regression analyses on 5 dependent variables: level of understanding, involvement, interest, annoyance and tension, respectively. As can be seen from table 2 to 6, the R^2 for the regression on all 5 dependent variables were high, implying that the models provided good explanations for communication processes. For the level of understanding, R^2= .69 (see table 2); for level of involvement R^2= .73 (see table 3); for level of interest R^2= .70 (see table 4); for tension R^2= .70 (see table 5); and for annoyance R^2= 64. (see table 6).

Effects on the level of understanding. H3 and RQ2 were about the effects of message content on the level of understanding, and tested using a regression of the form outlined above on the level of understanding reported every minute as dependent variable. Results are shown in table 2.

Dependent variable: Level of understanding				
Variables	**β**	**SE**	**DFDen**	**p**
Intercept	1.51	0.13	135.7	***
Self culture [A]	-0.05	0.08	29.7	
Partner culture [A]	0.04	0.08	29.7	
Self [A] x partner culture [A]	-0.03	0.08	19.26	
Lag_understanding	0.24	0.05	459.4	***
Fact	0.03	0.04	433.9	
Opinion	-0.03	0.04	441.1	
Back channel	0.09	0.07	424.8	
Relational	0.12	0.11	473.7	
R^2	**.69**			

Table 2. Effects of message content on understanding. *Notes:* 2-tailed p values: + p<=.08, * p<= .05, ** p<=.01, *** p<=.0001, A=American

H3 predicted more back channel responses uttered by the partners would lead to higher level of understanding of the participant. The regression result showed no significant effect of the number of back channel responses uttered by the partner on the participant's level of understanding (F[1, 424.8]=1.54, n.s). H1 was not supported.

RQ2 asked what the effects of task-oriented fact, task-oriented opinions, and relational messages by the partner were on the level of understanding on a moment-by-moment basis of the participant. The result showed no significant effect of the number of factual messages (F[1, 433.9]<1, n.s), opinions (F[1, 441.1]<1, n.s), and relational messages (F[1, 473.7]=1.20, n.s) uttered by the partner on the participant's level of understanding. So in this study, we did not find any effect of task related messages and relational messages by the partner on the level of understanding of the participant.

Effects on the level of involvement and interest. H4, H5 and RQ3 were about the effects of message content on the level of involvement, and tested using a regression of the form outlined above on the level of involvement, and interest reported every minute as dependent variables. The results are shown in table 3 for the level of involvement, and table 4 for the level of interest.

Dependent variable: Level of involvement				
Variables	β	SE	DFDen	p
Intercept	1.47	0.12	163.1	***
Self culture [A]	-0.02	0.07	25.23	
Partner culture	0.06	0.07	25.35	
Self [A] x partner culture [A]	-0.06	0.06	18.08	
Lag_involvement	0.32	0.05	395.4	***
Fact	0.03	0.04	452.1	
Opinion	0.04	0.04	428	
Back channel	0.02	0.07	416.9	
Relational	-0.19	0.1	465.9	+
R^2	**.73**			

Table 3. Effects of message content on involvement. *Notes:* 2-tailed p values: + p<=.08, * p<= .05, ** p<=.01, *** p<=.0001, A=American

Dependent variable: Level of interest				
Variables	**β**	**SE**	**DFDen**	**p**
Intercept	1.19	0.12	152.8	***
Self culture [A]	0.04	0.06	25.12	
Partner culture [A]	-0.01	0.06	25.14	
Self [A] x partner culture [A]	-0.04	0.06	18.52	
Lag_interest	0.35	0.05	392.5	***
Fact	0.15	0.04	458.9	***
Opinion	0.04	0.04	428.8	
Back channel	-0.09	0.07	418.8	
Relational	-0.14	0.11	472.6	
R^2	**.70**			

Table 4. Effects of message content on interest. *Notes:* 2-tailed p values: + p<=.08, * p<= .05, ** p<=.01, *** p<=.0001, A=American

H3 predicted more task-related messages uttered by the partner would lead to higher level of involvement of the participant. We did not find any significant effect of the number of facts (F[1, 452.1]<1, n.s), or opinions (F[1,

428]<1, n.s) uttered by the partner on the participant's level of involvement (see table 3). H3 was not supported.

H4 predicted more back channel responses by the partners would lead to higher level of involvement of the participant. No significant effect was found for back channel responses (F[1,416.9]<1, n.s) by the partner on the participant's level of involvement (see table 3). H4 was not supported.

RQ3 asked what the effects of the frequency of relational messages of the partner on the moment-by-moment level of involvement reported by the participants are. The results in table 3 showed a near significant negative coefficient (β=-.19, F[1, 465.9]=3.67, p=.056) for the number of relational messages by the partner. So we found that higher number of relational messages by the partner lead to lower level of involvement of the participant.

Table 4 displays the results on the level of interest. It showed a significant positive effect of the number of factual messages (β=.15, F[1, 458.9]=14.02, p<.001) by the partner on the level of interest of the participant. In summary, we found that high number of task-related fact messages by the partner lead to higher level of interest in the participant. This is consistent with H3. We found no other significant effect of the number of opinions (F[1, 428.8]<1, n.s), relational messages (F[1, 472.6]=1.77, n.s), and back channel responses (F[1, 418.8]=1.43, n.s) by the partner on the participant's level of interest.

Effects on the level of negative emotions. RQ4 asked what the effects of message content said by the partner on the participant's level of negative emotions. We used a regression of the form outlined above on the level of tension, and annoyance reported every minute as dependent variables. The results are shown in table 5 for the level of tension, and table 6 for the level of annoyance.

Dependent variable: Level of tension				
Variables	**β**	**SE**	**DFDen**	**p**
Intercept	1.32	0.12	176.6	***
Self culture [A]	0.03	0.05	30.85	
Partner culture [A]	-0.06	0.05	30.94	
Self [A] x partner culture [A]	-0.08	0.06	19.44	
Lag_tension	0.33	0.05	440	***
Fact	0.10	0.04	471.7	**
Opinion	0.06	0.04	427.1	
Back channel	0.07	0.06	419.9	
Relational	-0.14	0.09	468.7	
R^2	**.70**			

Table 5. Effects of message content on tension. *Notes:* 2-tailed p values: + p<=.08, * p<= .05, ** p<=.01, *** p<=.0001, A=American

First, as can be seen in table 5, there was a significant positive effect of the number of facts uttered by the partner (β=.10, F[1, 471.7]=8.16, p=.004) on the participant's level of tension. So we found that the higher the frequency of fact messages said by the partner, the more tense the participant reported. We did not find any significant effect of the number of opinions (F[1, 427.1]=2.65, n.s), relational messages (F[1, 468.7]=2.43, n.s), or back channel responses (F[1, 419.9]=1.50, n.s) by the partner.

Second, as shown in table 6, we did not find any significant effect of the number of facts (F[1, 471.7]<1, n.s), opinions (F[1, 427.1]<1, n.s), relational messages (F[1, 468.7]<1, n.s), or back channel responses (F[1, 419.9]=2.54, n.s) by the partner on the participant's level of annoyance.

Dependent variable: Level of annoyance				
Variables	**β**	**SE**	**DFDen**	**p**
Intercept	1.25	0.11	116.2	***
Self culture [A]	-0.03	0.06	38.27	
Partner culture [A]	-0.14	0.06	39.7	*
Self [A] x partner culture [A]	-0.01	0.07	21.96	
Lag_annoyance	0.23	0.05	523	***
Fact	0.03	0.04	434.1	
Non-agreement	0.03	0.04	458	
Back channel	0.1	0.06	448.2	
Relational	-0.08	0.09	480.2	
R^2	**.64**			

Table 6. Effects of message content on annoyance. *Notes:* 2-tailed p values: + p<=.08, * p<= .05, ** p<=.01, *** p<=.0001, A=American

DISCUSSION

The motivation for this study is the communication problems encountered in virtual intercultural teams such as lack of understanding or negative emotions, which were often associated with the cultural differences in communication styles of team members collaborating via CMC [e.g. 33]. While Nguyen & Fussell's preliminary analysis of similar data found that American participants reported being more annoyed when they worked with a Chinese partner than with an American partner [32], this study examined the specific process and patterns of such communication problems during dyadic CMC conversations. We investigated the cultural differences in communication styles that manifested itself in message content production during the conversation in pairs of various cultural combinations. Moreover, we explored the relationships between the content of the messages exchanged and the level of understanding, involvement, and negative emotions participants reported during the interaction using retrospective analysis.

Our first set of results showed that in CMC, participants from different cultures differed in communication styles. We found that, consistent with previous studies [e.g., 15, 20], Americans participants tended to produce more task-oriented messages than Chinese participants, regardless of who they were working with. We also found that Chinese participants tended to say more task-related messages when working with an American partner than with a Chinese

partner. This confirmed previous findings that Chinese would tend to adapt to the task-oriented communication style of their American partners [45]. Our results also showed that same culture pairs produced more opinions than cross-culture pairs. This may be explained by the fact that people are often more open with similar ingroups than outgroups [8]. Our results thus pointed to an issue with cross-culture teams, where team members may be less likely to share their honest opinions and restrain disagreements, while such open discussion may be beneficial for the group performance.

In summary, all the cultural differences that we found are consistent with well-known dimensions of cultural differences such as task-relationship focus, communication adaptation of high context participants, and ingroup-outgroup dynamics in communication. Our results, however, further describe how such cultural differences in values and communication strategies may manifest into specific communication behaviors during intercultural conversations. As mentioned before, the collaboration task designed for this study requires a variety of communication activities, from information sharing to collaborative sense making, which are characteristic of the collaboration task that global virtual work teams usually face [20]. Previous studies, using different experimental tasks, have found similar cultural differences in brainstorming, problem solving, or information sharing [40, 45]. Our results, therefore, may enhance our understanding of intercultural conversations in global work teams.

While we did not find any significant culture difference in terms of relational messages exchanged and back-channel responses, the insignificant results might be due to the small number of relational messages and back-channel responses spoken in a task-oriented conversation. Since the crime-solving task was rather complicated, and time was limited, most participants focused on discussing the crime case instead of exchanging pleasantries. Moreover, the reviewability and revisability of IM messages allowed participants to carefully contemplate partners' messages, as well as craft their own messages before sending. Thus, we found participants tended to send more long, thoughtful messages in their IM conversations rather than short, and less meaningful backchannel responses. Another factor that may also contribute to the small number of backchannel responses exchanged was the fact that participants in a pair might be able to hear each other despite being visually separated by a divider. Some audio cues such as typing or clicking noises may provide contextual information about one's partner, reducing the need to use backchannel responses in text.

Our second set of results helped to explain why lack of engagement and negative emotions might emerge in conversations by describing the effects of message content on these communication processes. Moreover, our retrospective analysis allowed us to separate this effect from the confounding sequential effect of the past level of involvement and negative emotions. We found a trend that more relational messages from the partner led to lower involvement in the participant. This, again, may be explained by the high focus on task completion of our pairs, as the difficulty of the task is high. Relational messages might be regarded as off-topic and distracting. In fact, Nguyen & Fussell's qualitative analysis showed that some participants thought the pair discussion should be entirely dedicated to the task, and were annoyed if their partners digressed [32]. This result appears to be consistent with our other finding that the more task messages heard from a partner; the more interested in the conversation the participant reported being. Fact messages from a partner not only helped the participants understand the task more, but also indicated cognitive effort of the partner dedicated to the task, consistent with the definition of involvement [3], and therefore, could help increase the participant's interest.

In terms of negative emotions, we found that, interestingly, more facts uttered by the partner tended to increase tension felt by the participant. As we outlined in the method section, the crime case used in our study was built on some contradicting details. It is possible that by discussing these contradicting facts from the two different versions of the crime case, the participants might feel more confused, and tense. Nguyen & Fussell's qualitative analysis also found that some participants reported being frustrated with the contradictory details [32].

Our results, taken together, could help clarify the finding in Nguyen & Fussell [32] that participants, particularly American, tended to be more annoyed working with a cross-culture partner than a same-culture partner. We found that while task-related messages from a partner could help to increase the participants' level of interest and involvement in the conversation, American participants said significantly more task-related messages than Chinese participants. We also found that more task-related opinions were exchanged in same-culture pairs than in cross-culture pairs. Nguyen & Fussell [32] found that lack of involvement was one of the main causes for frustration and annoyance. Hence, our results show that cultural differences, in terms of task focus, influence the conversational dynamics of intercultural team through the content of the messages exchanged during team interaction. The content of the messages, in turn, influence the involvement of team members in conversations. Mismatch in the level of involvement might lead to communication issues such as negative emotions. By linking culture differences in message content production and the influence of message content on communication processes, our results could provide insights into the conversational dynamics of intercultural teams, thus contributing to the development of intercultural communication theories. Moreover, they also help explain why and how intercultural teams face the various challenges in communication previous studies have reported, thus enhancing our understanding of intercultural collaboration, and providing

design implications for intercultural collaboration tools which will be discussed next.

Design Implications

Our findings indirectly suggest some strategies for designing new tools to support intercultural communication. First, our results pointed out the issue of fewer subjective opinions being expressed in intercultural teams, while task-related discussion could help increase team members' involvement in team conversations. Therefore, one way tools may help improve intercultural teamwork is by encouraging more open discussion. A system might display feedback about each participant's contributions to the conversation, particularly the number of personal opinions exchanged, similar to the GroupMeter system [e.g. 26], making it obvious when one partner is providing fewer opinions than the other, to encourage more contributions from that member.

Second, our results indicate that in some situations, task-oriented discussions with a lot of task-related messages could increase pressures on team members and introduce negative emotions. Therefore, tools might incorporate strategies to minimize the negative emotions that result when team discussions become intense. We believe this is especially important given evidence that negative emotions can be contagious in CMC [17]. Significant progress has been made identifying emotions from CMC [e.g., 12], which could in turn drive interventions to increase positive mood (e.g. via pictures of positive events, color, music).

Limitations and Future Directions

There are several important limitations to the current study. First, we examined dyads, not larger groups of cross-culture members, which may be more typical of global teamwork. Our small sample size might have limited the significance of some of our results. We also focused only on two out of the many cultures of the world. Furthermore, our Chinese participants were studying or working in the U.S and do not represent the larger population of Chinese people with whom Americans might collaborate. In the future, we plan to replicate the study using a more culturally diverse sample. We also did not control for participants' experiences working in multicultural settings, which may have affected the experience of participants during the experiment.

Our next steps include exploring the influence of communication processes on the production of message content. We also want to examine how our various measures of the communication process change over time during the interaction. With the findings from these analyses, we hope we can uncover the mechanism by which the communication process could lead to communication problems in intercultural collaboration. This in turn will help us characterize these problems at a deeper level, which hopefully will provide insights into how intercultural collaboration can be improved.

CONCLUSION

In this study we explored cultural differences in message production in cross-culture and same culture teams, and examined the effects of message content on team members' cognitive and affective processes. Cross-culture and same-culture dyads of American and Chinese participants discussed a crime case together via IM, and later reviewed their conversations and reported their thoughts and feelings on a minute-by-minute. We found differences in the frequency of task-related messages produced, based on the culture combination of the pairs. Moreover, the content of a partner's messages affected participants' levels of involvement and negative emotions. Our results provide insights into the conversational processes of computer-mediated intercultural teams and implications for the design of intercultural collaboration tools.

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