

## **The Richer, the Better? Effects of Modality on Intercultural Virtual Collaboration**

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We conducted two experiments to learn how different communication modalities and modality combinations affected intercultural virtual collaboration. Study 1, a within-subjects experiment, compares the effects of text chat and audio chat on perceived communication difficulties, perceived language difference, task satisfaction, and performance. Study 2, a within-subjects experiment, explores the effects of modality combinations of text and audio chats with and without pictures and the linguistic accommodation strategies adopted by intercultural dyad members. The major findings are that (a) audio led to better collaboration outcomes than text when there was only one communication modality, (b) multimodality did not lead to better collaboration outcomes than single modality, and (c) visual cues boosted the influence of text chat but impeded the effect of audio chat.

*Keywords: modality, multimodality, intercultural virtual collaboration, social identity*

The availability of various information technologies makes it common for individuals to collaborate virtually across geographical boundaries (Wang & Fussell, 2009). The global virtual teams supported by these technologies have improved the flexibility and efficiency of organizations (Hung & Nguyen, 2008). Despite these benefits, members of global virtual teams also face significant challenges in intercultural collaboration because of diversity in ethnicity, cultural values, and languages (Bird & Osland, 2006). These challenges are further complicated by the communication media used in virtual collaboration (Setlock, Quinones, & Fussell, 2007), as computer-mediated communication (CMC) tools may interact with cultural and ethnic diversity to affect collaboration (Fulk, Monge, & Hollingshead, 2005; Olaniran, 2007).

To fully understand the roles of different modalities and modality combinations in intercultural virtual collaboration, we conducted two experiments. Study 1 investigates how text chat and audio chat affect task satisfaction and task performance of intercultural virtual dyads. Study 2 introduces another

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modality—visual cues conveyed by the profile picture of a communication partner—to explore how visual modality combined with either text chat or audio chat affect collaboration outcomes. Intercultural virtual collaboration goes beyond just information exchange to involve communication strategies that allow collaborators to manage their social identities through linguistic accommodation (Giles & Ogay, 2007). Therefore, Study 2 also explores linguistic convergence between intercultural virtual-dyad members.

### **Cultural Diversity and Social Identity in Global Virtual Teams**

The dispersion of team members across locations brings cultural diversity to virtual teams. Culturally heterogeneous groups are generally considered more challenging for communication than culturally homogeneous groups (Oetzel, 1998). Cultural diversity in global virtual teams includes both surface-level diversity and deep diversity (Staples & Zhao, 2006), with surface-level diversity including observable attributes of language, gender, and ethnicity and deep diversity including the less observable attributes of values and beliefs such as individualism or collectivism (Hofstede, 2001), power distance (Hofstede, 2001), and low-context or high-context culture style (Hall, 1981). These attributes define social identity by implying membership within a social category (Livingstone, Spears, & Manstead, 2009).

According to Tajfel & Turner (1986), individuals form social identity based on the knowledge that they belong to certain social groups and the significance this membership has for them. Studies in intercultural and small-group communication have demonstrated that knowledge about social identity could exert a powerful influence on the ways individuals perceive and interact with one another (Haslam, 2004; Oetzel, 1998; Oetzel & Ting-Toomey, 2003). If group members identify with their own respective cultural categories, they have difficulty establishing a common team identity. That is, a lack of unified intra-group identity is counterproductive to group cohesion (Haslam, 2004).

Language and cultural values serve as two important diversity attributes that might trigger perceptions of identity differences (Hung & Nguyen, 2005). It is common that intercultural team members do not share the same first language, and those using the common language as a second language might be perceived as having more out-group characteristics. If one notices the culture differences between team members but has limited experience with those differences, one may be inclined to apply stereotypes of the competence of others. These misperceptions could lead to attribution errors (Mearns, Oetzel, Torres, Derkacs, & Ginossar, 2007), could hinder knowledge-resource sharing, and could inhibit relationship development within intercultural teams (Fulk et al., 2005). Therefore, if intergroup identity is made salient by perceived differences in language and cultural values, intercultural virtual teams are more likely to experience dissatisfaction with their tasks and negative performance outcomes (Bird & Osland, 2006; Maznevski & Chudoba, 2000).

- H1. In short-term intercultural virtual collaboration, perceived language difference will lead to (a) less task satisfaction and (b) worse task performance.*
- H2. In short-term intercultural virtual collaboration, perceived cultural value difference will lead to (a) less task satisfaction and (b) worse task performance.*

### Communication Accommodation in Intercultural Settings

Communication accommodation theory (CAT) assumes that the language and behaviors adopted in communication processes can convey the social status of individuals (Gallois et al., 2005). The communication strategies used in these processes, called *accommodation*, could either increase or decrease social distance among group members (Soliz & Giles, 2014). In the accommodation process, individuals negotiate their social-category membership (Giles & Ogay, 2007). There are two commonly used accommodation strategies: convergence and divergence (Gallois et al., 2005). Convergence refers to the strategies through which individuals adapt their communication behaviors to be similar to their partners', whereas divergence describes the ways in which individuals maintain or emphasize differences in communication without adaptation (Gallois et al., 2005). Following social identity theory (Tajfel & Turner, 1986), if collaborators interpret differences in their social categories as intergroup variations, their communication will be less convergent.

However, knowledge of differences in collaborators' social category membership does not always lead to negative outcomes. If these differences are considered interpersonal variations rather than intergroup distinctions, the awareness of differences can be conducive to making decisions on ways to communicate adaptively in intercultural settings (Anawati & Craig, 2006). It is possible that those working in international firms that require virtual collaboration have already been exposed to and are sophisticated about cultural and ethnic diversity because of past working experience. They may interpret language and cultural differences as interpersonal attributes rather than intergroup differences. Moreover, most short-term virtual teams are goal oriented and task focused. The common goal is conducive to team cohesion (Widmeyer & Ducharme, 1997). The virtual communication among members is therefore considered intragroup rather than intergroup. To minimize intragroup differences, individuals tend to adopt convergent communication (Gallois et al., 2005).

The underlying motive for convergence lies in the desire to seek approval, affiliation, and/or interpersonal similarity (Soliz & Giles, 2014). It serves to enhance group identity by increasing group belonging. In intercultural communication, convergence in language and nonverbal behavior can also be an effort to reduce cultural barriers. In a meta-analysis of studies testing CAT, Soliz and Giles (2014) discovered a significant relationship between convergent behaviors and quality of communication, especially when the convergent behaviors were attributed to a positive intent. Lexical convergence was found to positively influence perceptions of trust and negotiation outcomes (Scissors, Gill, Geraghty, & Gergle, 2009; Taylor & Thomas, 2008). These positive effects are explained by convergence's ability to lower uncertainty and increase mutual understanding (Giles & Ogay, 2007).

Following these ideas, the differences in language and cultural values that signify individual identity could serve as prompts for adaptation, with early detection of these differences leading to earlier accommodation. The convergence associated with the accommodation would thus increase task satisfaction and collaboration performance. Therefore, we propose the following competing hypotheses to those derived from the social-identity framework:

- H3. *In short-term intercultural virtual collaboration, perceived language difference will lead to (a) more task satisfaction and (b) better task performance.*
- H4. *In short-term intercultural virtual collaboration, perceived cultural-value difference will lead to (a) more task satisfaction and (b) better task performance.*

### **Communication Media and Cultural Difference**

The difficulties caused by cultural diversity are further complicated by the nature of mediated communication. To identify the optimal modality for intercultural virtual teams, it is important to understand how different media interact with cultural perceptions to influence collaboration (Setlock et al., 2007).

The modalities of communication tools vary in feedback speed, number of cues involved, language variety, and level of personal focus (Daft & Lengel, 1986). The cues-filtered-out theories of CMC (Walther, 2011), including theories of social presence (Short, Williams, & Christie, 1976) and media richness (Daft & Lengel, 1986) and the lack of social context cues hypothesis (Sproull & Kiesler, 1986), predict that the number of cues afforded by a medium could influence virtual interaction such that leaner media convey fewer nonverbal and social cues. By comparing CMC to face-to-face communication, these theories propose that a lack of nonverbal and social cues might impede the process of communication.

More recent CMC theories, such as the hyperpersonal model (Walther, 1996) and the social-information-processing theory (Walther, 1992), propose that users can adapt their interpersonal interaction to the characteristics of media to achieve communication objectives. Given an extended period of time, users can still translate and accumulate nonverbal and social components via the simpler sensory channels supported by leaner media (Anderson, Beard, & Walther, 2010; Walther, Boos, & Jonas, 2002). Thus, these theories are most applicable to long-term intercultural groups that have substantial histories of interaction.

This study focuses on short-term virtual teams. Many of them are formed ad hoc (Olaniran, 2007). The temporary nature of these groups makes it harder for collaborators to adjust behaviors to allow social cues to seep through. They may still try to follow what they have used to in traditional group settings. For temporary virtual groups, we will probably find a pattern similar to that predicted by cues-filtered-out theories. Because richer media can carry more social and nonverbal cues, individuals in intercultural virtual collaboration will be able to perceive more cultural differences, including differences in language and cultural values, among them in audio chat than in text chat.

- H5. *In short-term intercultural virtual collaboration, audio chat will lead to (a) more perceived language difference and (b) more perceived cultural value difference than text chat.*

According to on the social-identity model of deindividuation effects (SIDE) (Lea & Spears, 1992), the lack of social and nonverbal cues in virtual collaboration will divert attention from the idiosyncrasies of individual members to the shared attributes of the group. Individuals are propelled to identify with a group's identity when their respective social-category memberships are less salient. Wang, Walther, and Hancock (2009) posited that this effect is likely to happen for both temporary groups and longer-term social entities. As mentioned earlier, social-category membership information is implied through perceptions of cultural differences of both language and cultural values within intercultural virtual groups. Compared to text chat, audio chat is more perceptually immersive. Cues indicating differences in language and cultural values are more easily conveyed through audio chat. If collaborators attribute these differences to the respective ethnic and cultural groups that they belong to, the collaboration is more likely to be intergroup rather than intragroup (Spears, Lea, Corneliussen, Postemes, & Haar, 2002), which would subsequently lead to less convergent communication. The intergroup differences these cues emphasize would lead to less group cohesion and negative collaboration outcomes such as more communication difficulties, less satisfaction, and worse task performance (Bird & Osland, 2006; Maznevski & Chudoba, 2000).

*H6. In short-term intercultural virtual collaboration, audio chat leads to (a) more perceived communication difficulties, (b) less task satisfaction, and (c) worse task performance than text chat.*

On the other hand, the current study focuses on the short-term collaboration among virtual dyads composed of individuals from two different cultures: American and Chinese. Compared to groups with more individuals unevenly representing multiple social identities, the dyadic context might nurture interpersonal communication. With common goals to achieve in a short period of time, collaborators might perceive less intergroup rivalry and might treat each other as individuals rather than as representatives of a particular social category. Working in a company requiring intercultural virtual collaboration might have also prepared the collaborators to be less concerned about intergroup identity than about the completion of task. Cues of cultural and language differences could thus serve as prompts for collaborators to adjust their communication strategies (Giles & Ogay, 2007). Compared to text chat, audio chat can convey differences in language and cultural values more quickly and thoroughly. Thus, individuals using this modality can detect culture differences earlier in the process of communication and be better prepared for potential communication difficulties. For example, if they hear an accent and lack of fluency in their partner's language, they are reminded to speak slowly and to offer more explanation to be understood (Anawati & Craig, 2006). Given that this study's participants were American students and Chinese international students, they may have been more tolerant about intercultural communication because of their exposure to diversity in college and, thus, consider the collaboration an interpersonal process rather than a rivalry between two social groups, which would lead them to apply convergence strategies. The convergence would then boost satisfaction and performance. Therefore, we propose a competing hypothesis to that derived from SIDE. In addition, we also explore the mediating roles of perceived language and cultural value differences and perceived communication difficulties through a research question.

*H7. In a short-term intercultural virtual collaboration, audio chat will lead to (a) less perceived communication difficulties, (b) more task satisfaction, and (c) better task performance than text chat.*

*RQ1: How will perceived language and cultural value differences and communication difficulties mediate the relationship between modality and intercultural virtual collaboration outcomes?*

### **Study 1: Effects of Audio versus Text on Intercultural Virtual Collaboration**

Participants ( $N = 40$ ) were recruited from a university in the northeastern United States. The average age was 25.15, with 57.5% of participants being female and 42.5% male. Half of them were American students with English as their first language. The other half were native-born Chinese with Chinese as their first language. Being in the United States for less than four years served as the criterion for selecting Chinese participants to ensure that although they were able to communicate in English, they maintained close connections with Chinese culture and Chinese communities in both host and home countries. Most American participants (80%) were Caucasians who had never traveled outside the United States. None of them spoke Chinese. We randomly paired these participants into 20 dyads with balanced gender combinations. Each dyad had one Chinese and one American participant.

#### ***Stimuli***

Google Talk was used to manipulate two modality conditions: text and audio. Under the text condition, participants were instructed to use only the text-chat function of Google Talk to complete the task. Under the audio condition, they were given headsets and microphones to complete the task by using only the audio-call function of Google Talk.

Each dyad was required to complete two decision-making tasks, one via audio chat and the other via text chat, with the order of modality condition and task type counterbalanced. One task was a shortened version of the NASA Moon Survival task (Hall & Watson, 1970). The other was a shortened version of a plane-crash survival task (Human Synergistics, Ltd., 2004). Both tasks have been used widely in team studies and of similar complexity (Setlock et al., 2007). Each task describes a survival scenario—the malfunctioning of a spaceship on the moon or the crashing of a plane in the cold countryside—and required dyads to rank seven items for survival.

#### ***Procedure***

In multinational corporations, it is common for global virtual teams to be assembled for only a short time (Zakaria & Yusof, 2011). Because of the teams' temporary nature and their members' lack of interaction history, team members might not know each other prior to the interaction (Olaniran, 2007). Therefore, we separated the American from the Chinese dyad members in different computer labs. They were not able to see each other and were told not to disclose any personal information to each other prior to or during the experiment. This setting allowed us to prevent the potential influence of pre-interaction

impressions and to ensure that the variances in dependent variables were the results of independent variables.

After entering the lab, participants were instructed to read the first scenario and rank survival items on their own and then to log in to Google Talk using IDs created by the researchers. Following the completion of the first task, participants were instructed to log off Google Talk and to complete an online questionnaire. Before logging in to Google Talk again, participants were told that they would interact with a different partner for the second task. They were instructed to wait for a couple of minutes until their new partners were ready. In reality, they interacted with the same individual for both tasks. The post-hoc check revealed that none of the participants thought they had interacted with the same person for both tasks. Upon the completion of the second task, they finished another online questionnaire. The entire experiment was conducted in English.

### **Measures**

*Perceived language difference.* Perceived language difference was measured by a single item: "It is likely that my partner's first language is different from mine" on the same 7-point Likert scale ( $M = 5.48$ ,  $SD = 1.70$ ).

*Perceived cultural value difference.* Eleven items adapted from Boone, Meng, and van der Velden (2004) were used to measure the cultural values, including reflective thinking, working independently, initiative, assertiveness, decisiveness, persistence, ability to work in a team, adaptability, individualism, collectivism, and responsibility, that participants perceived in themselves and in their partners on a 5-point scale ranging from "not at all characteristic of me (my partner)" to "extremely characteristic of me (my partner)". Perceived cultural value difference was operationalized as the distance between the ratings for the self and the partner ( $M = .62$ ,  $SD = .63$ ,  $\alpha = .74$ ).

*Perceived communication difficulty.* Five items measured on the 7-point Likert scale were developed based on Sellen (1992) and Daly-Jones, Monk, and Watts (1998) ( $M = 1.93$ ,  $SD = .93$ ,  $\alpha = .80$ ). These items were "I was able to express myself comfortably," "I found it difficult to keep track of the conversation," "I was able to understand my partner with no difficulty," "It was very hard to communicate effectively," and "I felt that my partner sometimes did not understand me."

*Satisfaction with task.* This variable was measured by six items on a 7-point scale developed by Schweiger, Sandberg, and Ragan (1986), Mohammed and Ringseis (2001), and Zhang (2006) ( $M = 5.93$ ,  $SD = .91$ ,  $\alpha = .87$ ). The items were "I enjoyed collaborating with my partner," "I think our collaboration was effective," and "I would enjoy working with my partner again in the future," "I am satisfied with the group decisions that were reached," "The decision my partner and I reached was high in quality," and "I wish I could change the results of the task we just completed."

*Task performance.* This variable was measured by the number of correct rankings each dyad made, following the answer provided by Hall and Watson (1970) and Human Synergistics, Ltd. (2004).

## Results

Study 1 used the mixed-model analysis of variance with each participant's ID number nested with his or her group number as a random factor and the task type and participant's nationality as control variables to explore the effect of each modality on collaboration outcomes.

*Perceived language difference.* Participants perceived significantly more language difference with their partners in audio chat ( $M = 6.40, SE = .23$ ) than in text chat ( $M = 4.55, SE = .23$ ),  $F(1, 38) = 35.98, p < .01$ , which supports H5a.

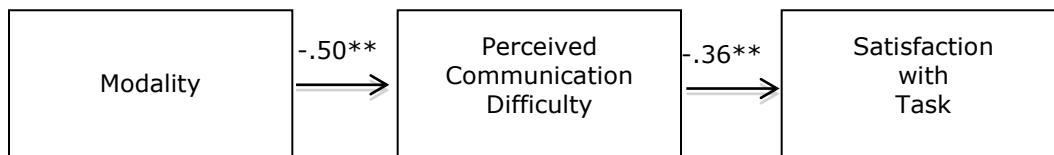
*Perceived cultural value difference.* Modality had no significant effect on perceived cultural value difference. H5b is not supported.

*Perceived communication difficulty.* Participants perceived more communication difficulty under the text condition ( $M = 2.18, SE = .13$ ) than under the audio condition ( $M = 1.68, SE = .13$ ),  $F(1, 38) = 8.95, p < .01$ , which supports H7a and undermines H6a.

*Satisfaction with task.* The analysis revealed a significant effect of modality on task satisfaction,  $F(1, 38) = 23.87, p < .01$ , but no other effect. Audio chat ( $M = 6.35, SE = .13$ ) led to more task satisfaction than text chat ( $M = 5.52, SE = .13$ ), which supports H7b and undermines H6b.

*Task performance.* Modality had no significant effect on task performance. Neither H6c nor H7c is supported.

*Mediating effects.* The bootstrapping method with 5,000 iterations and bias correction, a resampling procedure that does not impose the assumption of normality of the sampling distribution (Hayes, Preacher, & Myers, 2011), were used to identify the mediation path. Modality had a significant indirect effect on task satisfaction via perceived communication difficulty,  $b = .18, 95\% \text{BCa CI of } .04, .44$  (Figure 1). Although we did not find a significant mediating effect of perceived language difference, we did find a positive significant influence of perceived language difference on satisfaction with task,  $F(1, 54) = 4.83, p < .05$ , which supports H3a and undermines H1a. There was no significant relationship between perceived language difference and task performance. Neither H1b nor H3b is supported. Perceived cultural value difference did not significantly influence task satisfaction or task performance. H2 and H4 are not supported.



**Figure 1. The mediation effects of perceived communication difficulty.**

*Note:* In this mediation model, the modality condition was dummy coded with 1 representing audio and 0 representing text. \*\*  $p < .01$ .



### Summary and Discussion for Study 1

The findings of Study 1 demonstrate strong positive effects of audio over text on a variety of collaboration outcomes. Compared to text chat, audio chat led to less perceived communication difficulty, more task satisfaction, and more perceived language difference. The underlying reason for the richer modality increasing task satisfaction is that it reduced perceived communication difficulty, as shown in the mediation effect. These results provide further support for the cues-filtered-out theories (Walther, 2011).

Although the audio modality led to more perceived language difference, this perception did not negatively impact collaboration. In fact, as shown by the positive relationship between perceived language difference and task satisfaction, the more individuals noticed the language difference, the more satisfied they were with the task. This finding confirms the assumption that the collaboration is considered interpersonal rather than intergroup. Participants primarily perceived language difference as an individual characteristic rather than a group attribute. Based on this perception, it is likely that participants adopted convergent strategies to minimize their linguistic dissimilarities, as predicted by CAT (Giles & Ogay, 2007). The convergent styles shortened the perceived social distance between dyad members and enhanced the reciprocation and cohesion of dyads (Gallois et al., 2005).

Unlike with perceived language difference, we did not observe any impact of modality on deep cultural diversity, such as cultural value difference. Compared to language difference, cultural value difference is more subtle and harder to discern (Staples & Zhao, 2006). Given the design of this study, which required participants to complete a ranking task in a short time, it could be hard for both audio and text to allow cues about this difference to seep through.

It is interesting that the positive effect of richer modality on task satisfaction did not extend to task performance. The attitudinal measures—the sociometrics—seemed more easily affected by modality than by performance indices. Since audio allowed participants to more easily identify language difference and to more quickly develop accommodation strategies than text did, participants' contentment resulting from their resolving communication problems may have overridden the objective assessment of effectiveness, as predicted by the efficiency framework (Nowak, Watt, & Walther, 2009). Even though text chat might be deemed more demanding and less favored, it did not do any harm to the completion of tasks.

In the context of decision-making tasks, sociometrics such as perceived consensus and persuasion are also important outcomes for virtual collaboration (Yoo & Alavi, 2001). Therefore, we included them as two additional dependent variables in the follow-up study. In this context, persuasion is defined as the extent to which an individual can convince another about his/her opinion (Setlock et al., 2007). Following media richness theory, richer media are necessary to reach a higher level of consensus for equivocal tasks that involve negotiation between team members (Daft & Lengel, 1986). Similarly, social presence theory (Short et al., 1976) suggests that a high level of social presence is conducive to reconciling differing opinions and to reaching consensus. Therefore, we proposed the following hypotheses for the second study.

*H8. In short-term intercultural virtual collaboration, audio chat will lead to more persuasion than text chat.*

*H9. In short-term intercultural virtual collaboration, audio chat will lead to more perceived consensus than text chat.*

In Study 1, we compared the influence of two single modalities: text chat and audio chat. It is not uncommon for intercultural virtual teams to communicate via media with more than one modality. Therefore, we included one more modality, conveying visual cues, in the follow-up study to explore whether multiple modalities are better than a single modality and which modality combination is better.

### **Multimodality and the Moderating Role of Visual Cues**

The cues-filtered-out theories (Walther, 2011) focus on the quantity more than the quality of modality cues. They assume a linear relationship between the number of modality cues and the level of sense of presence and effectiveness of communication. Following these theories, we posited that individuals would engage in more effective persuasion, would perceive a higher level of consensus, and would perceive less communication difficulty when they communicated via the medium with multiple modalities than they would via the one with a single modality. If we combined the existing audio-chat and text-chat conditions in Study 1 with additional visual cues, we should find better collaboration outcomes than what were shown in the first study. However, Whittaker and O'Conail (1997) suggest that more modalities do not necessarily associate with better outcomes. Adding more modalities might not always lead to a cumulative effect.

Text and audio are the two modalities that individuals relied on to negotiate with each other to make decisions in Study 1. In Study 2, we kept these two primary communication modalities and manipulated the presence and absence of a visual modality in addition. The visual modality was included as a moderator.

Compared to non-visual conditions, visual conditions could lead to a heightened sense of social presence. Walther, Slovacek, and Tidwell (2001) found in their study that in short-term, one-shot interactions, group members receiving visual information about their partners communicated more affection and enjoyed social interaction more than those who did not. However, Zhang (2006) found that visual cues from partners were not that powerful in team collaboration, especially when they did not directly correspond to the conveying of messages.

In intercultural virtual collaboration, the visual modality of the profile picture also conveys cues about the ethnicity of collaboration partners. These visual cues might induce thoughts about negative aspects of intercultural communication, such as different accents, varied usage words and phrases, and different value systems. However, it might also help to reduce potential surprise, to prepare individuals to deal with the frustration that might occur at the very beginning of the interaction, and to develop accommodation strategies to overcome communication difficulties, as predicted by CAT (Gallois et al.,

2005). Given the complexity of potential outcomes elicited by visual cues, we propose the following research question:

*RQ2. How would the presence or absence of visual modality moderate the influence of communication modality (audio chat or text chat) on short-term intercultural virtual collaboration?*

In Study 1, we proposed that dyad members might have developed communication accommodation strategies, such as linguistic adaptation, to address perceived language difference and communication problems. However, we did not include any method to track their conversation or analyze how they converged with each other linguistically. It is important to study how individuals overcome the impediments of communication technology with language adaptations (Walther, 2004). Thus, in Study 2, we recorded the conversations of dyad members and examined how they adopted linguistic accommodation strategies across different modalities and modality combinations. Because there is little existing research comparing linguistic accommodation across modalities, we propose the following research question rather than hypotheses:

*RQ3. How would different communication modalities (audio chat and text chat) and modality combinations differ from each other in the linguistic accommodation adopted in a short-term intercultural virtual collaboration?*

### **Study 2: Effects of Multimodality on Intercultural Virtual Collaboration**

Study 2 employed a 2 (communication modality: audio, text) x 2 (picture: without, with) within-subjects experiment to compare the effects of multiple modalities versus single modality ( $N = 30$ ). The average age of participants was 25.9, with 60% being female and 40% male. Half of them were Americans with English as their first language. The other half were native-born Chinese with Chinese as their first language. We followed the same criteria used in Study 1 to select Chinese and American participants. The majority of American participants were Caucasians (93.3%). Participants were randomly paired into 15 dyads with balanced gender combinations. Each dyad had one Chinese and one American member.

#### ***Stimuli***

Participants in Study 2 completed the same two survival tasks used in Study 1, one via audio chat and the other via text chat. The orders of modality condition and task type were counterbalanced. The only difference in stimuli between Study 1 and 2 was the added manipulation of the partner's profile picture.

Four profile pictures representing American and Chinese females and males were selected by the researchers in a pretest. The facial expression of the person in the picture was kept neutral for both female and male versions. They were wearing everyday clothes with no fashion accessories. The camera angles were kept the same.

### **Procedure**

The procedure of Study 2 was the same as Study 1. The only difference was the presence or absence of a profile picture. Participants were told that their partners were given the opportunity to display a profile picture of their own if they would like to. However, they may choose not to do so. We carefully matched the gender of the person in the picture with the gender of the dyad member who was using that profile. Each dyad was only exposed to the partner's picture for one of the two tasks. The order of presence and absence of the picture was counterbalanced. In Study 2, the conversation between dyad members was recorded. The conversation completed via audio chat was recorded in an MP3 and transcribed after the experiment. The conversation via text chat was automatically saved by Google Talk and was exported as the chat log.

### **Measures**

*Persuasion.* Following Setlock, Fussell, and Neuwirth (2004), persuasion was operationalized as the difference between a participant's pre- and post-discussion rankings. The score for the degree of being persuaded was measured by summing the absolute values of the difference between his or her ranking and the ranking the dyad agreed upon after discussion ( $M = 7.77$ ,  $SD = 4.77$ ).

*Perceived consensus.* Six items measured on a 7-point scale ranging from strongly disagree to strongly agree, adapted from Convertino, Zhang, Asti, Rosson, and Mohammed (2007) and Mohammed and Ringseis (2001), measured perceived consensus ( $M = 5.62$ ,  $SD = .82$ ,  $\alpha = .70$ ). Examples included "I agreed with many of the points made by my partner," "My partner was willing to compromise on making decisions," "I adjusted my viewpoint on some of the issues to incorporate the views of my partner," and others.

*Perceived communication difficulty.* We adopted the same five items (Sellen, 1992; Daly-Jones et al., 1998) used in Study 1 to measure perceived communication difficulty on the same 7-point scale ( $M = 1.85$ ,  $SD = .77$ ,  $\alpha = .83$ ).

*Perceived language difference.* Different from the single item used in Study 1, in Study 2, we adopted three semantic differential items—local/alien, different/similar, and strange/native—measured on a 7-point scale (Cargile, Maeda, Rodriguez, & Rich, 2008) to indicate perceived language difference ( $M = 3.14$ ,  $SD = 1.51$ ,  $\alpha = .74$ ).

*Linguistic characteristics.* We analyzed the scripts of conversations between dyad members using the text-analysis software Linguistic Inquiry and Word Count (LIWC), extracting words into eight categories: total words, self-references, negative affective processes, positive affective processes, articles, social words, cognitive words, and big words. LIWC calculates the percentage of words in the text that match each of these language categories. According to the LIWC manual (Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007), examples of positive emotion words are love, nice, and sweet. Examples of negative emotion words are hurt, ugly, and nasty. Social words refer to all words that are not first-person singular personal pronouns and to verbs that suggest human interaction such as *talk* and *share*. Cognitive

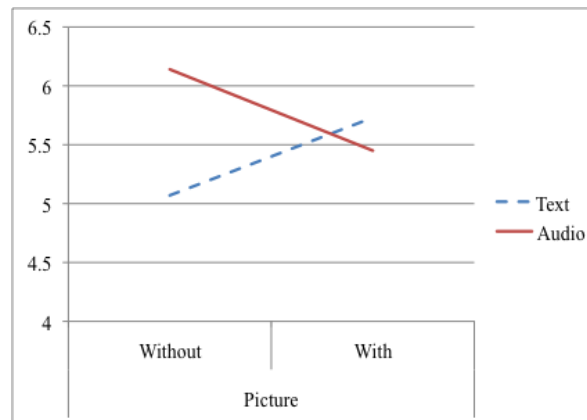
words are those that express qualities such as insight, causation, discrepancy, tentativeness, and certainty. Researchers coded the emoticons used in text-chat scripts and then added these codes to the result generated by LIWC, because LIWC does not recognize these symbols.

### Results

In Study 2, we used the mixed-model analysis of variance to examine the individual and combinatory effects of modalities on variables from the questionnaire, with communication modality (text or audio) and picture (without or with) as fixed factors. We used intraclass correlation to explore whether dyad members adopted similar linguistic features. Since the members of each dyad were distinguishable by nationality, we followed Kenny, Kashy, and Cook (2006) to use partial correlation controlling for nationality to determine the intraclass correlation coefficients ( $r$ ) for each linguistic feature.

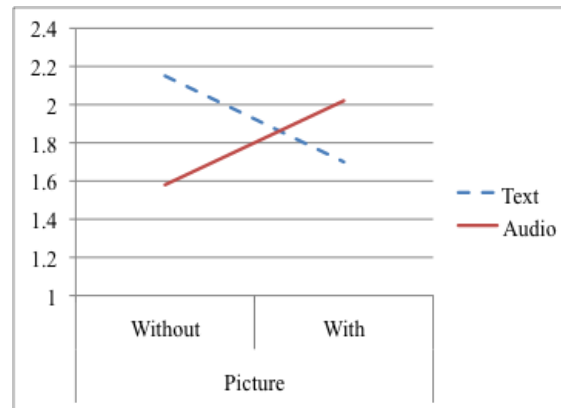
*Persuasion.* There was only a main effect of communication modality (text or audio) on persuasion,  $F(1, 27) = 9.27, p < .01$ , but not any other effect. Audio chat led to more persuasion ( $M = 9.20, SE = .83$ ) than text chat ( $M = 6.28, SE = .83$ ), which supports H8.

*Perceived consensus.* There was a significant main effect of modality,  $F(1, 27) = 8.56, p < .01$ , on perceived consensus such that audio chat led to more perceived consensus ( $M = 5.79, SE = .14$ ) than text chat ( $M = 5.40, SE = .14$ ), which supports H9. There was also a significant interaction effect of communication modality and picture,  $F(1, 27) = 8.14, p < .01$  (Figure 2). Audio chat led to more perceived consensus when there was not a picture than when there was one, whereas text chat led to more perceived consensus when there was a picture than when there was not one.



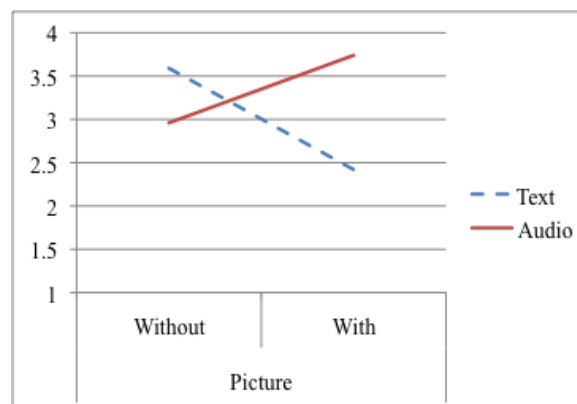
**Figure 2. Interaction effect of modality and picture on perceived consensus.**

*Perceived communication difficulty.* For perceived communication difficulty, we discovered only a significant interaction effect of communication modality and picture,  $F(1, 27) = 4.99, p < .05$  (Figure 3), but not any other effect. Audio chat led to more perceived communication difficulty when there was a picture than when there was not one, whereas text chat led to more perceived communication difficulty when there was not a picture than when there was one.



**Figure 3. Interaction effect of modality and picture on perceived communication difficulty.**

*Perceived language difference.* For perceived language difference, we found only a significant interaction effect of communication modality and picture, but not any other effect,  $F(1, 27) = 7.12, p < .05$  (Figure 4). Audio chat led to more perceived language difference when there was a picture than when there was not one, whereas text chat led to more perceived language difference when there was not a picture than when there was one.



**Figure 4. Interaction effect of modality and picture on perceived language difference.**

*Accommodation in linguistic features.* Based on the correlation coefficients shown in Table 1, dyad members were similar to each other for *total words* used in all four conditions. They converged more for text chat with picture than for text chat without picture. They also converged more for audio chat without picture than for audio chat with picture. For *self-reference words*, dyad members converged for text chat ( $r = .60$ , 95% CI: .31, .79) but not for audio chat in general. Within the two text-chat conditions, dyad members significantly converged in the text-chat-with-picture condition but not in the text-chat-without-picture condition. With regard to affective processes, dyad members converged in using *positive emotion words* in the text-chat-with-picture and audio-chat-with-picture conditions but not in other conditions. For *negative emotion words*, they significantly converged only in the text-chat-without-picture condition and not in other conditions. For the use of *articles*, dyad members converged only in the text-chat-without-picture condition. There was no significant correlation between dyad members for the other categories of linguistics characteristics.

**Table 1. Correlation Between Dyad Members by Different Conditions.**

|                         | Text with Picture |             | Text without Picture |              | Audio with Picture |             | Audio without Picture |             |
|-------------------------|-------------------|-------------|----------------------|--------------|--------------------|-------------|-----------------------|-------------|
|                         | <i>r</i>          | 95% C. I.   | <i>r</i>             | 95% C. I.    | <i>r</i>           | 95% C. I.   | <i>r</i>              | 95% C. I.   |
| <b>LIWC Categories</b>  |                   |             |                      |              |                    |             |                       |             |
| <i>Total words</i>      | .76*              | (.41, .92)  | .62*                 | (.16, .86)   | .69*               | (.27, .89)  | .82*                  | (.53, .94)  |
| <i>Self-reference</i>   | .71*              | (.31, .90)  | .47                  | (-.06, .79)  | .17                | (-.37, .63) | .37                   | (-.18, .74) |
| <i>Positive emotion</i> | .68*              | (.26, .88)  | .50                  | (-.02, .81)  | .70*               | (.29, .89)  | -.11                  | (-.59, .43) |
| <i>Negative emotion</i> | .45               | (-.08, .78) | .71*                 | (.31, .90)   | .09                | (-.44, .58) | .14                   | (-.40, .61) |
| <i>Articles</i>         | .08               | (-.45, .57) | .54*                 | (.04, .82)   | .34                | (-.21, .73) | -.37                  | (-.74, .18) |
| <i>Cognitive words</i>  | .49               | (-.03, .80) | .28                  | (-.27, .69)  | .05                | (-.47, .55) | -.29                  | (-.70, .26) |
| <i>Social words</i>     | .39               | (-.15, .75) | .47                  | (-.06, .79)  | .01                | (-.50, .52) | .05                   | (-.47, .55) |
| <i>Big words</i>        | .02               | (-.50, .53) | .51                  | (-.003, .81) | .39                | (-.15, .75) | .18                   | (-.37, .63) |

Note: Correlation coefficients with "\*" are significant because their 95% confidence intervals do not include "0."

### Summary and Discussion for Study 2

Study 2 explores how visual cues given by a partner's profile picture moderated the effects of primary communication modalities of text chat and audio chat. Audio chat was found more conducive to persuasion and perceived consensus than text chat. Since persuasion was measured as the absolute difference between pre-discussion individual rankings and the post-discussion dyad rankings, this finding could also be interpreted as showing that individuals were more affected by negotiation when using audio chat than text chat. This finding provides further support to the assumption that dyad members deemed collaboration to be interpersonal rather than intergroup in the current context. Given that audio chat allows cues of language difference to seep through faster than text chat does, dyad members were able to adopt appropriate accommodations contributing to group cohesion more quickly.

The visual modality served as a moderator for the effect of the primary communication modality on perceived communication difficulty and perceived consensus. The effect patterns on these variables were very consistent, such that text chat led to more desirable results with visual cues, whereas audio chat led to more desirable results without visual cues. This finding cannot be fully explained by either SIDE (Lea & Spears, 1992) or CAT (Giles & Ogay, 2007). Following SIDE, we predicted that more cues for identity difference would accentuate the perception of intergroup communication, leading to negative collaboration outcomes. However, this was only the case for audio conditions and not for text conditions. On the other hand, if dyad members considered the collaboration to be interpersonal communication, following CAT (Giles & Ogay, 2007), more cues would lead to more adaptation and more positive outcomes. But this did not hold true for the audio-chat-with-picture condition.

We suspect this nonlinear effect of modality is attributable to the limited perceptual bandwidth that individuals have for managing the impression of partners while completing the task. The complexity of the task itself demands a lot of cognitive resources for deliberation (Nowak et al., 2004). Multiple modalities conveying more nonverbal cues might facilitate the discussion of complex issues, as predicted by the cues-filtered-out theories (Walther, 2011). However, the cues about identity difference that seeped through multimodality may also elicit non-task-related thoughts that also consume mental resources. For example, the expectations one partner forms about the other from the profile picture prior to the interaction could lead the first partner to choose communication strategies beforehand that persist throughout the entire communication. The leaner communication modality of text chat is less likely to introduce cues about identity difference in addition to the profile picture; thus, individuals are better able to focus on the task itself. In contrast, the richer modality of audio chat could have introduced further cues of identity differences between collaborators during discussion in addition to the ones conveyed by picture. These differences may or may not be consistent with collaborators' pre-interaction impression. Collaborators thus need to make internal adjustments to ameliorate the pre-interaction impressions of their partners (Walther, Deandrea, & Tong, 2010). This internal adjustment also consumes cognitive resources and may even reduce the mental capacity available for task completion by limiting the perceptual bandwidth. The resultant cognitive overload reduces the efficiency and effectiveness of negotiation. This could explain why text worked better with a picture while audio worked better without a picture.

The accommodation analysis found that members of a dyad converge in total words for both audio chat and text chat regardless of visual cues. However, they adopted different linguistic features to accommodate each other in different text conditions. In the text-with-picture condition, they converged in using words showing self-reference and positive emotions. In the text-without-picture condition, they converged in using a similar numbers of articles and words showing negative emotions. These findings suggest that if the members of a dyad were able to develop appropriate accommodation strategies based on prior expectations of the interaction partner, the leaner modality would not always lead to negative outcomes.



### Conclusions

In this article, we reported two experiments that explored the effects of modalities and modality combinations in intercultural virtual collaboration. The contributions of this study to the existing literature are summarized as follows: Unlike most studies on virtual collaboration, which have compared CMC collaboration to face-to-face collaboration, the current studies explored how different CMC tools differ in their capacities to affect virtual collaboration. In addition, one single medium may include multiple modalities, such as audio and visuals. Different from some of the studies that only compared media without separating the effects of different modalities and modality combinations (Setlock et al., 2004; Yoo & Alavi, 2001), this study first compared the effects of two single modalities, text chat and audio chat, and then explored how modality combinations (audio plus visual, text plus visual) differ from one another and whether these combinations were better than single modalities in intercultural virtual collaboration. In general, although we found that audio chat led to better collaboration outcomes than text chat when it was the only modality used in collaboration, we did not find a linear relationship between the number of modalities and favorable collaboration outcomes. Multimodality is not necessarily better than single modality in intercultural virtual collaboration.

More important, this study contributes to the existing literature on intercultural collaboration by showing that although dyad members noticed their identity differences, this perception did not have a detrimental effect on sociometric outcomes of collaboration, such as task satisfaction and perceived consensus. This is different from what SIDE (Spears et al., 2002) predicts—that leaner media with fewer social cues leads to better group cohesion and better collaboration outcomes by de-emphasizing individual identity and enhancing group identity. The current findings reveal that despite the noticed identity differences, intercultural virtual dyad members were able to adapt to each other by treating the communication as interpersonal rather than intergroup. This adaptation in language particularly served to shorten the social distance between dyad members belonging to different social categories prior to the interaction, as predicted by CAT (Gallois et al., 2005). We confirmed this accommodation by examining collaborators' conversation through dyadic analysis that addresses the issue of interdependence of data (Kenny et al., 2006). This methodological approach also serves as a new way to identify linguistic accommodation between individuals.

The current study focused on examining the short-term intercultural virtual collaboration. However, given enough time, information about social category membership may seep through text-based CMC as it does through audio-based CMC (Anderson et al., 2010). It is possible that in long-term intercultural virtual collaboration, audio and text would not differ from each other greatly in the resultant perception of identity difference. Future studies might consider exploring how long-term intercultural virtual collaboration is affected by different modalities. In addition, the content analysis on conversation between dyad members did not take the direction of convergence into consideration. It only revealed whether the convergence happened and for which word category. Future research could include more in-depth content analysis by figuring out who converges to whom and examining linguistics features other than word categories.

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