

# Technological Intersubjectivity in Computer Supported Intercultural Collaboration

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## ABSTRACT

Technological intersubjectivity (TI) refers to a technology supported interactional relationship between two or more participants. The basic premise of this research project is that the structures and functions of technological intersubjectivity vary across cultures. To empirically evaluate this premise, an experimental study was conducted to investigate TI when participants from similar and different cultures appropriate affordances and relate to each other in a computer supported collaborative learning environment. Based on culture theory and empirical findings in cross-cultural psychology, several theoretical predictions were made about the cultural variation in the structures and functions of technological intersubjectivity during and after the experimental task of computer supported collaborative problem solving. Statistical results show a systemic variation in technological intersubjectivity along cultural dimensions. We discuss the findings and their implications for computer supported intercultural collaboration.

## ACM Classification Keywords

H.5.3 Group and Organization Interfaces: *Theory and models, Asynchronous interaction Collaborative computing, Evaluation/methodology*; H.1.2 User/Machine Systems: *Software Psychology*.

## Author Keywords

Affordance, apperception/perception/appropriation of affordances, comparative informatics, computer supported intercultural collaboration, culture, technological intersubjectivity.

## INTRODUCTION

*Computer supported intercultural collaboration* (CSIC) is an emerging research field that studies the iterative design,

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development, and evaluation of technologies that enhance and enrich effective intercultural communication and collaboration. Two interrelated aspects in computer-supported collaboration are designing for (i) interacting with computers and (ii) interacting with other persons. In computer supported intercultural collaboration (CSIC), technological intersubjectivity (TI) refers to a technology supported interactional social relationship between two or more participants from similar or different cultures. The basic premise of the research work reported here is that the structures and functions of technological intersubjectivity vary across cultures. Structures of TI refer to individual conceptions of self and kinds of organization in social relationships [18, 21]. Functions of TI refer to the interactional dynamics of a socio-technical situation [11, 13]. Strong empirical evidence exists documenting cultural differences in *cognition* [22], *communication* [14], *behavior* [17], and *interacting with computers* [37]. However, prior human-computer interaction (HCI) research has not adequately addressed cultural influences in computer supported collaboration. Below, we first briefly discuss intersubjectivity and interpret findings from the GLOBE study of 62 societies [17] as showing cultural variation in the structures and functions of intersubjectivity. Technological intersubjectivity is discussed next. An experimental study of the basic premise is described next followed by a report of the statistical results. We conclude this paper with a brief discussion of the empirical findings and implications for research and practice of CSIC.

## INTERSUBJECTIVITY

Intersubjectivity refers to communication and participation between two or more minds. It is the fabric of human social interactions [9]. Strong empirical evidence from social psychology [22], cultural sociology [10], cultural psychology [26], cross-cultural psychology [5, 21], cultural philosophy [18] and cultural anthropology [24] shows cultural variation in how humans socially relate to and interact with each other.

## GLOBE Cultural Dimensions Model

The GLOBE study of 62 societies formulated a model of nine cultural dimensions. Table 1 lists the nine cultural

dimensions of the GLOBE study and their respective definitions.

<i>Cultural Dimension</i>	<i>Definition</i>
Uncertainty Avoidance	“the extent to which members of an organization or society strive to avoid uncertainty by relying on established social norms, rituals, and bureaucratic practices” (p.11).
Power Distance	“the degree to which members of an organization or society expect and agree that power should be stratified and concentrated at higher levels of an organization or government” (p.12).
Collectivism I Institutional Collectivism	“the degree to which organizational and societal institutional practices encourage and reward collective distribution of resources and collective action” (p.12).
Collectivism II In-Group Collectivism	“the degree to which individuals express pride, loyalty, and cohesiveness in their organizations or families”(p.12).
Gender Egalitarianism	“the degree to which an organization or a society minimizes gender role differences while promoting gender equity and the equality of genders” (p.12).
Assertiveness	“the degree to which individuals in organizations or societies are assertive, confrontational, and aggressive in social relationships” (p.12).
Future Orientation	“the degree to which individuals in organizations or societies engage in future-oriented behaviors such as planning, investing in the future, and delaying individual or collective gratification” (p.12).
Performance Orientation	“the degree to which an organization or society encourages and rewards members for performance improvement and excellence” (p.13).
Humane Orientation	“the degree to which individuals in organizations or societies encourage and reward individuals for being fair, altruistic, generous, caring, and kind to others” (p.13).

**Table 1: GLOBE Study’s Nine Cultural Dimensions**

In the GLOBE study, respondents from the USA score lower on power distance, uncertainty avoidance, institutional collectivism, and in-group collectivism, but higher on assertiveness compared to respondents from East-Asian countries like China, Taiwan, South Korea and

Japan. We interpret the GLOBE empirical findings as indicative of cross-cultural variation in the structures and functions of intersubjectivity. In different cultures, people relate to each other differently and have different social and task expectations. Note that the GLOBE study’s cultural dimensions model is based on face-to-face interactions. As far as we know, there is no systematic empirical work on applying the GLOBE dimensions model to the design and evaluation of collaborative systems in general. In this research project, we were interested in empirically evaluating the structural functionalism of the cultural dimensions documented by the GLOBE study on computer supported intercultural collaboration. In particular, we focus on the GLOBE dimensions of power distance, in-group collectivism and institutional collectivism.

### **TECHNOLOGICAL INTERSUBJECTIVITY**

Human beings are not only functional communicators but also hermeneutic actors. In technological intersubjectivity, technology mediation can sometimes (but not necessarily always) appear transparent like in Clarke’s third law of technology [8]. Technological intersubjectivity is an emergent resulting from psychological-phenomenological nexus of the electronic self–other social relationship. We offer the following definition of technological intersubjectivity.

#### **Definition of Technological Intersubjectivity**

*Technological intersubjectivity (TI) refers to a technology supported interactional relationship between two or more participants. TI forms from a dynamic interplay between the technological relationship of participants with artifacts and their social relationship with others.*

Information and commutation technologies (ICT) and the Internet have changed our social relations with others and objects in fundamental ways that transcend technology mediation (by making mediation transparent). Our psychological perception of and phenomenal relation with others is changed fundamentally by the advances in information and communication technologies and social software. Our interactions with others and objects are informed by the logic of technology.

From a functional perspective, intersubjectivity in the psychological sense doesn’t require two or more persons to have the same or similar subjective experience. Put differently, having a collective phenomenal experience is not a necessary condition for intersubjectivity in the psychological sense. In psychological intersubjectivity, the other human being is always an object of our attention and an object in our awareness. We observe the other person for communicative cues relevant to the ongoing interaction [11, 13]. Unlike intersubjectivity in the phenomenological sense, there is no requirement for an emphatic relationship with the other person. However, in technological intersubjectivity, there is a dynamic interplay between these psychological and phenomenological aspects. In

technological intersubjectivity, information processing entailed by computational support can enhance the communicative possibilities and communion potentials of two or more human beings. Computer supported intercultural collaboration systems have potentials for both psychological and phenomenological intersubjective experiences without the requirement that interacting persons be co-present in the same place and/or interact at the same time. In the next section we consider relevant notions from the humanities, information, computer and social sciences.

## RELATED CONCEPTS

### Presence

In their review of the concept of presence in technology settings, Lombard and Ditton[20], identified six interrelated concepts of presence as *social richness; realism; transportation; immersion; social actor within medium; and medium as social actor*. Also related is the notion of “connected presence” [19]. TI inherits from these conceptions of presence but extends the notion of presence in two ways. First, TI is offered as a “theoretical object” to help inform the design and implementation of new forms of associations in HCI, AI and human-robot interactions. Second, TI also focuses on the phenomenal experiential aspects of being together.

### Information Subject

Mark Poster’s work on the relationship between technology and subjectivity from a critical theory and media studies perspective has posited the postmodern individual agent as an “information subject” [23]. TI differs from Poster’s notion by virtue of being a technology design oriented relational construct.

### Time-Space Compression

David Harvey has articulated the notion of “time-space compression” [16] as a condition of human existence in the postmodern era. With the advent of information and communication technologies (ICT); social networking websites like Orkut, My Space and Face Book; content sharing websites like Flickr and youtube; virtual worlds like Second Life and WoW, there is a “time-space-being compression”. It is not just that the physical world has shrunk across time and space due to transportation technologies, it is also that intersubjective distances with friends, family, significant others and familiar strangers have compressed due to social technologies.

### Networked Individualism

Manuel Castell’s [7] notion of “networked individualism” is also related to TI. The differences are in the scope and extent of the two notions. Networked individualism is situated in a broader Critical theory approach to Internet while TI is situated in the philosophy of mind. Networked individualism is oriented towards macro level phenomena over extended periods of time in contrast to TI as an

emergent phenomenon in locally social interactions. Networked individualism has a latent current of technological determinism while interactional determinism might be a possible critique of TI.

Our conception of interaction is not merely about Human Computer Interaction (HCI) – i.e., *interacting with technology* – it is also about technological intersubjectivity (TI) – i.e., *interacting with people and information*. In summary, our objective is to offer TI as a rich construct to conduct a theory-based empirical study of technology supported/mediated human social interactions and relations with a specific focus on computer supported intercultural collaboration.

## METHODOLOGY

We designed an experimental study that introduced a variation in the cultural background of individuals by assigning participants from a nation-state based ethnically stratified random sampling frame, but kept invariant the technological interface and the interactional setting. Briefly, the experimental study investigated how pairs of participants from similar and different cultures (American-American, American-Chinese, and Chinese-Chinese) related to each other and formed impressions of each other in a quasi-asynchronous computer supported collaborative learning environment. We verified through a demographic questionnaire that the collaborative dyad were not friends, family, or significant others. Our objective was to empirically observe and evaluate the development of technological intersubjectivity.

### Research Questions

Four separate lines of empirical research have demonstrated that culture influences: (1) *social behavior* [17], (2) *communication* [14], (3) *cognitive processes* [22], and (4) *interacting with computers* [37]. These four lines of empirical research were integrated into a methodological framework (Figure 1) to answer two research questions. The first research question asked “*to what extent does culture influence the appropriation of socio-technical affordances?*” The second research question asked “*to what extent does culture influence technological intersubjectivity?*”

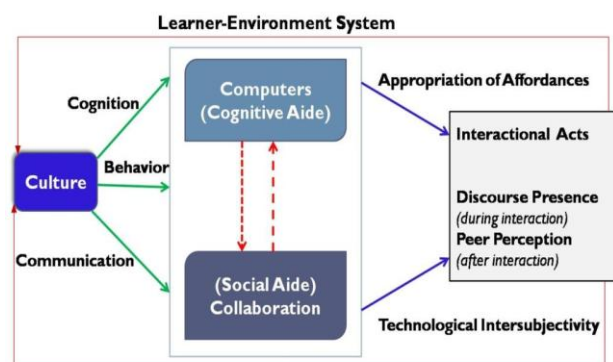


Figure 1: Methodological Framework

An experimental study was designed and conducted to answer these two research questions [36]. The second research question is the focus of this paper. Seven theoretical predictions were generated from prior empirical evidence [14, 17, 22] warranting the claim that structures and functions of technological intersubjectivity might vary across cultures. The theoretical predictions about technological intersubjectivity are presented after the discussion of the experimental study topics and software in the materials section. In the next five subsections experimental design, materials, research hypotheses, sampling and procedure are discussed briefly.

### Experimental Design

The experimental study design consisted of three independent groups of dyads from similar and different cultures (American, Chinese) doing collaborative problem solving in a knowledge mapping learning environment (described below). The three experimental conditions were the Chinese-Chinese *intra*-cultural condition, the American-American, *intra*-cultural condition and the Chinese-American *inter*-cultural condition.

In all three experimental conditions the dyads were given the same experimental task (described below). All the dyads interacted in the same software environment after reading the same instructions, software tutorial and demonstration. Construct validity was addressed by using existing instruments with high validity and reliability [4, 17, 27, 29].

### Materials

#### Software

The software environment used in this study was originally constructed in support of a research program on how representational affordances influence and are appropriated by collaborating dyads [31]. We chose to use a configuration of this environment that offered a diversity of resources for interaction, so that there would be sufficient degrees of freedom to allow cultural influences to be manifest.

Figure 2 displays a captioned screenshot of the environment used in the experimental study. It has an “information viewer” in which materials relevant to the problem are displayed. This information viewer functions as a simple web browser, but the presentation of materials is constrained as discussed in the next section. The environment has a shared workspace or “information organizer” in which participants can share, organize, and discuss information they gather from the problem materials as well as their own interpretations and other ideas. The “discussion” tool below the “information viewer” enables participants to discuss their ideas in a threaded discussion format.

The “information organizer” workspace includes tools derived from Belvedere [33] for constructing knowledge objects under a simple typology relevant to the experimental task of identifying the cause of a phenomenon (e.g. a disease), including data (green rectangles, for empirical information) and hypotheses (pink rectangles, for postulated causes or other ideas). There are also *linking* tools for constructing consistency (“for”) and inconsistency (“against”) relations between other objects, visualized as green links labeled “+” and red links labeled “-“ respectively. “Unspecified” objects and “unknown” links provide for flexibility. Finally, an *embedded note* object supports a simple linear (unthreaded) discussion that appears similar to a chat tool; except that a note is interactionally asynchronous and one can embed multiple notes in the knowledge map and link them like any other object. In the “threaded discussion” section of the environment (see Figure 2) participants can embed *references* to knowledge map objects in the threaded discussion messages by selecting the relevant one or more graph object while composing the message. The references show up as small icons in the message. When the reader selects the icon, the corresponding object in the knowledge map is highlighted, indicating the intended referent. The lower-left corner of Figure 2 shows I3P1 appropriating the affordances for referencing a knowledge map object (yellow outlined hypothesis node in the bottom-right of Figure 2).

#### Awareness of Artifacts and Activity

The software supports mutual awareness of participants’ *artifacts*. All knowledge map nodes and threaded discussion messages show the name of the creator. The mutual awareness features of *artifacts* and of *activity* are shown in Figure 2 (see uncompressed version in additional files). In Figure 2, the I3P1’s screen name of “Teri” (screen name selected by participant) appears on the title bar of the application window and on knowledge map nodes and message created by I3P1. Similarly, I3P2’s screen name of “Sue” appears on artifacts created by her. Artifacts marked with a solid red triangle in the top right corner are from I3P2 and are unopened by I3P1. The yellow circle on the threaded discussion message of I3P1 in the lower left

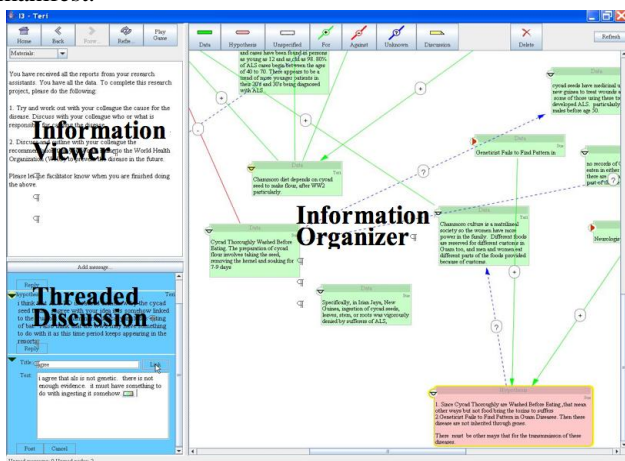


Figure 2: Screenshot from an experimental session

region of Figure 2 indicates artifacts created by “Teri” (I3P1) but not read by the study partner, “Sue” (I3P2). Thus, each participant is provided with cues identifying new artifacts from the study partner as well as which of their artifacts are not yet read by their partner.

#### *Protocol for Workspace Updates*

To simulate asynchronous online interactions, the actions of each participant in the shared workspace were not displayed immediately in the other participant’s workspace. As a person worked, the actions of that person were sent to the other participant’s client application, but were queued rather than displayed. Participants were given a new report (discussion forthcoming) after playing the game of Tetris™. Tetris™ was chosen as it presents a different sensory-motor perceptual task than the primary experimental task of reasoning about conflicting evidence (described below), and simulates taking a break from study [31]. After the game of Tetris™, all of the currently queued actions on that client were displayed. Conflicts that might arise when both participants edited the same object were resolved through operational transformations [30]. The delayed updating protocol simulates one aspect of the experience of asynchronous computer supported collaboration: a participant sees what one’s partner has done upon returning to a workspace after a period of time. It excludes the possibility of synchronous conversation in which one participant posts a message in the workspace and receives an immediate reply.

#### *Alternates for Action*

The software environment provides multiple alternatives for action. Participants have multiple ways of sharing the information presented to them (threaded discussion, embedded notes, and knowledge-map). Participants can discuss the task at hand or any other topic of interest using the threaded discussion tool to the bottom-left of the knowledge map or the embedded notes tool within the knowledge-map. Participants can also use the knowledge-map objects to interact. Participants can refer to artifacts by deictic referencing (this, that, etc...) or use the cross-referencing feature of the threaded discussion. Participants can externalize the perceived relations between their concepts by creating evidential relation links between objects in the knowledge-map, by spatial arrangement such as proximity and clustering, or by mentioning these relations in discussion.

The research strategy was to provide participants with a feature rich collaborative environment with multiple alternates for action. By incorporating systematic variation in the assignment of participants to the collaborative dyad based on their cultural background and gender, the experimental design strategy was to observe and evaluate systemic differences in how participants used the tools and resources of the technology (appropriation of affordances) and interacted with each other (TI).

#### *Topics*

The study required participants to identify the cause of a disease on the island of Guam. This disease has been under investigation for over 60 years, in part because it shares symptoms with Alzheimer’s and Parkinson’s diseases. Only recently have investigators converged on both a plausible disease agent (a neurotoxic amino acid in the seed of the Cycad tree) and the vector for introduction of that agent into people (native Guamians’ consumption of fruit bats that eat the seed). Over the years numerous hypotheses have been proposed and a diversity of evidence of varying types and quality explored. The unlikelihood of prior exposure to the problem, multiple plausible hypotheses, contradicting information, ambiguous data and high interpretation make this a good experimental study task for measuring cultural effects on appropriation of affordances.

All experimental study materials were in English. All participants began with a mission statement that provided the problem description and task information. Four mission statements corresponding to the four participant assignment configurations (Chinese vs. American x P1 vs. P2) were administered accordingly. Evidence was distributed across participants in a hidden profile design [28] that required participants to share evidence in order to expose the weakness of some proposed causes (e.g., genetics, minerals in the drinking water) as well as to construct the more complex explanation involving bats and cycad seeds. Identification of this hypothesis involves making connections across reports given to the two participants over time and considering and rejecting other explanations. The study task and task materials are designed to highlight the social division of cognitive labor. The experimental study encouraged participants to interact with each other by including the following reinforcing task instruction on each report (set of 4 articles): “*Please share and discuss this information with you colleague. Please play the game to receive the next report from your research assistant.*” The next section discusses several research hypotheses generated from the theory of culture and empirical findings in cross-cultural psychology.

#### **Research Hypotheses**

Research Hypothesis 1 (RH1): *Chinese participants will copy+paste from source materials more than Anglo-American to directly quote statements of scientific experts in the experimental materials.* This hypothesis was generated based on the GLOBE cultural dimension of power distance [17]. Power distance refers to “the degree to which members of an organization or society expect and agree that power should be stratified and concentrated at higher levels of an organization or government” [17, p.12]. Participants from the relatively high power distance Chinese culture might have higher respect for scientific authorities and experts. Therefore they might prefer to directly quote from the materials (arguments from authority). On the other hand, Anglo-American participants

come from relatively lower power distance cultures. Hence, they might be more inclined to interpret / paraphrase the claims of scientific experts compared to direct quotation.

Research Hypothesis 2 (RH2): *Anglo-American participants will make more individual (self-directed) contributions to the study partner than the Chinese participants.* This hypothesis was generated from the GLOBE cultural dimensions of in-group and institutional collectivism [17]. In-Group collectivism refers to “the degree to which organizational and societal institutional practices encourage and reward collective distribution of resources and collective action” [17, p. 12]. Institutional collectivism refers to “the degree to which organizational and societal institutional practices encourage and reward collective distribution of resources and collective action” [17, p. 12]. Based on the cultural dimensions differences discussed above, variance was predicted in the degree to which a participant marks her/his individual contribution with one's own name (e.g. putting a name in the subject line of a message); or manipulate study partner's contributions; or invite the study partner to edit or otherwise manipulate one's contributions. Differences were also predicted between Chinese participants and Anglo-American participants in whether the study partner is addressed as an individual or contributions are simply offered to the shared space rather than the person.

Research Hypothesis 3 (RH3): *Chinese participants will make more collective contributions than Anglo-American participants.* This hypotheses was also generated from the GLOBE cultural dimensions [17] of in-group and institutional collectivism (see discussion in RH2 above).

Research Hypothesis 4 (RH4): *Chinese participants will have more social presence than the Anglo-American participants in the collaborative discourse.* This hypothesis was based on the GLOBE cultural dimensions of in-group and institutional collectivism [17] and the concept of social presence [25] in the asynchronous learning networks literature. “Social presence is defined as the ability of learners to project themselves socially and affectively into a community of inquiry” [25]. Since Chinese participants belong to a collectivistic culture, it was predicted that they would exhibit greater social presence in the collaborative discourse.

Research Hypothesis 5 (RH5): *Anglo-American participants will have more cognitive presence than Chinese participants in the collaborative discourse.* This hypothesis was based on the GLOBE cultural dimensions of in-group and institutional collectivism [17] and the concept of cognitive presence [12] in the asynchronous learning networks literature. “Cognitive presence is defined as the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry” [12]. Since Anglo-American participants belong to an individualistic culture, they might

exhibit greater cognitive presence in the collaborative discourse.

Research Hypothesis 6 (RH6): *Chinese participants will have more teaching presence than Anglo-American participants in the collaborative discourse.* This hypothesis was generated from the GLOBE cultural dimensions of in-group and institutional collectivism [17] and the concept of teaching presence [3] in asynchronous learning networks. Teaching presence is the “the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes” [3]. Since Chinese participants belong to a collectivistic and high power distance culture, they might exhibit greater teaching presence in the collaborative discourse.

Research Hypothesis 7 (RH7): *Peer ratings will diverge from self ratings the most in the intercultural group compared to the intracultural groups.* The second aspect of research question R2 is operationalized as an empirical evaluation of the contact hypothesis [1]. The contact hypothesis states that when the preconditions of equal status, superordinate goal and institutional support are met, contact between different groups will create a productive inter-group encounter and lead to positive inter-group relationships [6]. The contact hypothesis is considered one the most important findings of social psychology [2].

Equal status was operationalized as equal payment of US \$75 per person, equal social role in the experiment, and by recruiting from the same academic level (graduate students). The same superordinate goal of discovering the cause of a public health problem was provided to both of the participants. Participants not only make a World Health Organization (WHO) report but also are informed of an award of US \$200 for the best performing team. Institutional support was equally provided by giving the participants the same set of computer tools in the same laboratory. In the pre-investigative session, each participant rated himself/herself on the Portrait Values Questionnaire (PVQ) [27]. In the post-investigative session, each participant rated their collaborative partner on the same scale (with modified instructions). This change in the directionality of assessment allows for an analysis of correlation between each participant's self-report of his/her own individual values and the report of the perceived individual values of the collaborative other.

## **Participants**

### *Sampling*

Participant recruitment drew from the graduate student population at the University of Hawai'i at Mānoa. Participant stipends were US\$75. There is a tendency in cross-cultural computer mediated communication research to use cultural models bounded by modern nation-states. Nation-state boundaries are not tantamount to culture, but nationality-based sampling frames are a methodologically

convenient way to categorize participants provided that cultural differences are assessed on validated instruments. To address the possible mismatch of nation-state boundaries and cultural identity, previously validated instruments were used for assessing cultural differences. The Portrait Values Questionnaire (PVQ) [27] was used to assess cultural values at the individual level. The GLOBE instrument [17] was used to assess cultural dimensions at the group level.

#### *Assignment*

Participants were randomly assigned to either the intra- or the inter- cultural profiles and the same or different gender profiles. Excluding 6 pilot studies, a total of 33 experimental sessions involving 66 pairs of participants were conducted. Data from 3 experimental sessions was discarded due to issues of a missing screen recording, a software crash and a disqualification. There were 10 pairs of participants for each of the three treatment groups: Chinese-Chinese intracultural; American-American intracultural, and American-Chinese intercultural groups. All the three conditions were gender-balanced because gender can substantially influence social interaction [32]. Each treatment group included 3 female-female, 3 male-male and 4 female-male dyads.

#### **Instruments**

The different instruments used for the measurement of the constructs are discussed below.

#### *Demographic Questionnaire*

A demographic questionnaire [36] collected participants' prior knowledge about the study problem, familiarity with each other, with online learning environments, with usability evaluation studies as well as data about age, gender, ethnic background, duration of stay in the USA, and duration of stay in the state of Withheld. All participants were requested to make a self-report of their cumulative grade point average (CGPA). Participants signed a release form for obtaining official records of their CGPA and graduate record examination (GRE). Chinese participants authorized release of their test of English as a foreign language (TOEFL) scores [36].

#### *Self-Perception: Portrait Value Questionnaire (PVQ)*

The 40-item version of the PVQ instrument [36] recommended for intercultural contexts (Schwartz, S. H, personal communication) was administered. The PVQ scale measured cultural values at the individual level. Cronbach's "alpha measures of internal consistency range from .37 to .79 for the PVQ (median, .55)" [27, p. 532]. Gender specific versions of the self perception PVQ scale were administered.

#### *GLOBE Cultural Dimensions Instrument*

The GLOBE instrument [17] was used to measure cultural values at the group level [36]. Section 1 and Section 3 of

the original GLOBE instrument were administered. Section 1 of the GLOBE instrument measures a responder's perceptions of their society ("Section 1 — The way things are in your society"). Section 3 of the GLOBE instrument measures a responder's preferences for their society ("Section 3 — The way things generally should be in your society"). According to the "Guidelines for the Use of GLOBE Culture and Leadership Scales", "the construct validity of the culture scales was confirmed by examining the correlations between the GLOBE scales with independent sources (e.g., Hofstede's culture dimensions, Schwartz's value scales, World Values Survey, and unobtrusive measures)" [17]. Phrasing of "this country" has been changed to "my home society" to remove possible ambiguity for Chinese graduate students (who might rate State, USA instead of the society they grew up in).

#### *Individual Essays*

An individually written essay was administered following the collaborative science problem solving exercise [36]. Essay writing instructions were identical for all participants. The instructions asked the participants to state the hypotheses they considered. They were also asked whether and how their hypotheses and conclusions differed from those of their study partners.

#### *Peer-Perception: Portrait Value Questionnaire (PVQ)*

The second immediate post-test was the administration of the Portrait Value Questionnaire (PVQ) [27] instrument with a reversal of the direction of assessment [36]. This time instead of assessing themselves, participants assessed their partners.

#### *Acculturation: SL-ASIA Questionnaire*

The experimental study recruited Chinese graduate students at a university in the USA. Acculturation occurs when members of one culture live in another culture. Acculturation becomes another variable in cross-cultural research. This can be controlled by measuring the acculturation level of the participants belonging to the minority immigrant culture [34]. Participants with high level of acculturation can be used as members of the majority host culture or not included in the study [34]. This research project used the Suinn-Lew Asian Self Identity Acculturation (SL- ASIA) scale [29] to measure the acculturation levels of the Chinese participants [36]. This instrument is designed for Asian-Americans. Suinn et al. [29] reported an internal-consistency estimate of .91 for the SL-ASIA instrument.

#### *Intercultural Sensitivity: Intercultural Sensitivity Instrument*

Intercultural sensitivity is a vital skill for intercultural collaborations [4]. The SL-ASIA scale provided a measure of Chinese participants' assimilation to USA. The intercultural sensitivity instrument (ICSI) [4] was used to measure the American participants' self-assessment of intercultural sensitivity [36]. Bhawuk and Brislin (1992)

report that “the ICSI was validated in conjunction with intercultural experts at the East-West Center with an international sample (n=93)” (p. 423). “China” substituted for “Japan” in the original ICSI instrument for this experiment.. Prior testing determined that Part 3 of ICSI was irrelevant and thus not used.

#### *User Satisfaction: QUIS Questionnaire*

The QUIS 7.0 questionnaire [15] was administered to collect the participants subjective perceptions and preferences of the learning environment [36]. The QUIS has high reliability (Cronbach’s alpha = 0.95 and high construct validity (alpha = 0.86) [15]. The QUIS instrument also measured participants’ subjective satisfaction with the instructions and the software tutorial besides various systems measures.

#### **Procedure**

Approval for use of human subjects was sought and granted. Two students participated in each session. Experimental sessions lasted about 3.5 hours on average. Informed consent [36].was obtained from all participants for both the pilot studies and the experimental studies. After signing the informed consent forms, participants completed a demographic questionnaire. They were then given a CGPA/GRE/TOEFL score release form, the Self-Perception PVQ [27] and the GLOBE instrument [17]. Participants were next trained to use the software. After the software demonstration, the two participants were led back to their respective workstations in two different rooms to begin work on the study task. Participants had up to 90 minutes to work on the information available for this problem. The update protocol described in [31] was used to synchronize the workspaces of the two participants. At the conclusion of the investigative session, each participant had up to 30 minutes to write an individual essay. The essay focused on the hypotheses that were considered, the evidence for and against these hypotheses, and the conclusion reached. The software environment remained available to each participant during the essay writing, but the participants were requested not to engage in any further communication. After each participant had finished writing the individual essay, the other-perception PVQ instrument [27], and the QUIS instrument [15] were administered. The SL-ASIA instrument [29] was used to measure acculturation of Chinese participants. The ICSI instrument [4] was used to measure inter-cultural sensitivity of American participants. This concluded the experiment.

#### **RESULTS**

The data generated were then analyzed at four levels of culture, gender, dyadic culture and dyadic gender.

#### **Demographics**

There was no significant difference in age at any of the four levels of analysis. As expected, American participants spent significantly more time in the USA than the Chinese

participants. On the other hand, the time spent by the participants in Hawai’i with respect to culture and gender was not statistically significant. This was done as control for context effects. There were no significant differences at any of the four levels of analysis for prior experience with experimental studies, prior knowledge about the experimental task, and partner familiarity. Further, results for the Learning section of the QUIS instrument showed no significant difference on the ease of learning the software usability measure at any of the four levels of analysis. Results for the Tutorial section of the QUIS instrument showed no significant difference for participants’ subjective evaluation of the software demo and experimental instructions at any of the four levels of analysis. Therefore, experimenter bias and “demand characteristics” are ruled out as confounding factors.

#### **Culture Measures**

Portrait Values Questionnaire (PVQ) [27] was used to measure culture at the individual level. The GLOBE instrument [17] was used to measure culture at the group level. Similarly, significant differences resulted on both sections of the GLOBE instrument as well as the PVQ instrument [35]. Significant differences observed on the GLOBE instrument correlated with those observed on the PVQ instrument. None of the Chinese participants had high acculturation scores and none of the American participants scored lower on intercultural sensitivity. In summary, even though a nation state based stratified random sampling frame was employed; systemic variation between the two participant groups was documented and not stereotypically assumed.

#### **Hypotheses Testing**

##### *Research Hypothesis 1 (RH1)*

Video analysis of the screen recordings of participant sessions was done to obtain the counts for copy+pasting of direct quotes from scientific experts in the experimental materials. No statistically significant differences were found at any of the four levels of analysis.

##### *Research Hypothesis 2 (RH2)*

Counts for *individual/collective contributions* were obtained from the software logs of participant sessions. On average, Anglo-American participants made significantly more individual contributions compared to the Chinese participants of this experimental study ( $F(1,56) = 10.06, p=0.002$ ).

##### *Research Hypothesis 3 (RH3)*

Marginally significant differences were found for collective contributions ( $F(1,56) = 3.703, p=0.06$ ). However, the results were opposite to the theoretical prediction made.

##### *Research Hypothesis 4 (RH4)*

Cognitive presence was greater for Anglo-American participants compared to the Chinese participants of this experimental study, the main effect for culture was marginally significant ( $F(1,56)=3.09, p=0.08$ ).

#### *Research Hypothesis 5 (RH5)*

Even though, on average, social presence was greater for Chinese participants this experimental study, the difference was not statistically significant.

#### *Research Hypothesis 6 (RH6)*

No significant differences were observed for teaching presence.

#### *Research Hypothesis 7 (RH7)*

Out of the ten PVQ values, in the *inter-cultural* conditions, significant differences were observed in the difference of self-perception and other-perception on only two PVQ values (Universalism and Security). This implies that participants did not make radically opposite attributions of individual values to their study partners.

## **DISCUSSION**

Even though, on average, Chinese participants did more copy+paste compared to the Anglo-American participants of this experimental study, no significant differences were found to support hypothesis 1. This result corresponds with the empirical findings on the Power measure of the PVQ scale and the Power Distance GLOBE dimension (no statistically significant differences but Chinese participants scored higher than Anglo-American participants). Given the cross-cultural differences in learning and teaching, we think that the power distance dimension should be systematically explored in future studies of computer supported collaborative learning [36, see pp. 37-39].

As predicted in hypothesis 2, Anglo-American participants made significantly more individual contributions at the culture level of analysis. However, the results for hypothesis 3 on collective contributions are opposite to the theoretical prediction made. Taken together, these findings have implications for collaborative task structures and collaborative learning environments. The preference for and/or the prevalence of a particular contribution mode might affect the ultimate quality of the desired outcomes. On the contrary, the contribution mode might merely be an instrumental means for interaction [35]. An individual contribution mode might signify cognitive engagement at the individual level whereas a collective contribution mode might indicate a socio-cognitive engagement at the group level. The open empirical question here is about the efficacy and effectiveness of computer-supported collaboration. Future research should help clarify these issues.

For hypotheses 7, a failure to reject Allport's Contact Hypothesis [1] was reached as the statistical results do not suggest a bias in the perception of the others in the *inter-*

cultural collaboration condition. Therefore, in online learning settings, in accordance with Allport's contact hypothesis [1], if equal status, equal institutional support and a superordinate goal are provided, this experimental study results suggest that *inter-cultural* encounters might leave create no less favorable impressions of others than *intra-cultural* encounters. The current transformation of the internet emphasizing a participatory mode of interaction is creates many possibilities opportunities for intercultural collaboration. Addressing Amichai-Hamburger and McKenna's [2] call for reconsidering the contact hypothesis with traditional groups [6] in internet interactions is a first step in realizing the tremendous promise of technology supported research and practice of cross-cultural collaboration, learning and training.

Mixed results were obtained for hypotheses 4, 5, and 6 related to social, cognitive and teaching presence in the collaborative discourse. It might be that the very notion of embeddedness can be differentiated across cognitive and social realms. Prior research summarized in [37] strongly supports the argument that there exists systemic cross-cultural variation in embeddedness across the cognitive, realm. The question of how technology influences these distinct senses of cognitive embeddedness and social embeddedness remains to be explored. This might have implications for not only CSIC design but also for the design of social software.

The results raise some questions about the nature of interaction and intersubjectivity in technology supported collaborative settings. Could asynchronous and non-located activities ever be as collaborative as synchronous and located tasks? Moreover, is the presence of a prior intersubjective awareness and familiarity with others a prerequisite for collaborative interactions? In other words, is effective technological intersubjectivity for collaboration predicated upon prior phenomenological intersubjectivity?

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