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Sociocultural Conventions in Avatar-Mediated Nonverbal Communication: A Cross-Cultural Analysis of Virtual Proxemics

Béatrice S. Hasler & Doron A. Friedman

We examined whether virtual worlds in which participants interact as avatars could be used as a novel instrument for cross-cultural and intercultural communication research. We explored differences between Asian and European cultures regarding their social spatial behavior (i.e., proxemics) in dyadic avatar interactions. Asian dyads interacted at larger distances than European dyads, which is consistent with the cross-cultural differences typically observed in face-to-face interactions. Mixed-culture dyads did not differ from the European dyads, indicating that Asians were more tolerant regarding the invasion of their personal (virtual) space. Since there is no culturally neutral physical environment, such intercultural interactions could not be studied in the physical world.

Keywords: Virtual Worlds; Avatars; Proxemics; Interpersonal Distance; Personal Space; Contact Cultures

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The space that people maintain around themselves and the distances at which they interact comprise an important part of nonverbal communication (NVC) in human face-to-face (FTF) interactions. Numerous studies have shown that cultures assign different meanings to space between people and use space differently (Altman & Chemers, 1984). The study of the social significance of space was initiated by Hall (1959, 1966) who termed it ''proxemics.'' Proxemics has been widely studied in social psychology resulting in hundreds of academic publications, mostly in the 1970s and 1980s (see Hayduk, 1978, 1983 for reviews). However, cross-cultural proxemics

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research has encountered several methodological challenges, which are addressed in the current paper.

We propose a novel instrument for studying cross-cultural and intercultural communication using avatar-based virtual worlds as simulations for human behavior in the physical world. We chose proxemics to demonstrate the potential of this novel methodological approach, as it constitutes a widely studied social behavior with known cultural variations. We evaluate the validity of this novel approach by testing whether sociocultural conventions in proxemics that are typically observed in dyadic FTF interactions are transferred into the virtual world. In addition to replicating findings on cross-cultural differences in proxemic behavior of single-culture dyads, we explore the proxemic patterns in mixed-culture dyads that emerge in avatar-mediated intercultural interactions. We discuss the advantages and limitations of this new approach based on the findings of a field study that has been conducted in a virtual world with participants from Asian and European cultures.

A Cross-Cultural View on Personal Space

People hold expectations regarding the nonverbal behaviors of others, which are learned and culturally driven (Neuliep, 2003). These expectations include preferences regarding interpersonal distances that are perceived to be appropriate in a given situation. Hall (1959) distinguished among four distance categories, measured as imaginary circles around a person: (1) intimate space: for touching; (2) personal space: for interaction among friends; (3) social space: for interactions among acquaintances; and (4) public space: for public interactions.

Personal space is of particular importance as it defines the minimum spatial area that individuals maintain around themselves, which is often described as a ''buffer zone'' surrounding a person (Dosey & Meisels, 1969; Horowitz, Duff, & Stratton, 1964). The term ''buffer zone'' implies a psychological need to protect our body from the intrusion of others (Hickson, Stacks, & Moore, 2004). Invasion of one's personal space often arouses discomfort and results in aversive reactions (Felipe & Sommer, 1966). Several theories have been proposed that explain the causes and consequences of personal space invasion (see Burgoon, Stern, & Dillman, 1995).

Causes and Consequences of Personal Space Invasion

Affiliative Conflict Theory, also known as Equilibrium Theory (Argyle & Dean, 1965; Coutts & Schneider, 1976) is based on individuals' needs for both affiliation and autonomy. Individuals balance these needs in interpersonal interactions by approach and avoidance behaviors. Violations of nonverbal expectations activate compensation mechanisms, such as changes in eye gaze, orientation, or movement. The invasion of one's personal space may be compensated by moving away in order to increase an interpersonal distance. In contrast, a distance that is perceived as too large may be compensated by moving closer to the other. Such approach-avoidance

compensations are likely to occur when interacting individuals have different expectations and preferences regarding interpersonal distances.

In contrast to Equilibrium Theory, which postulates a cognitive evaluation process, Discrepancy-Arousal Theory (Cappella & Greene, 1984) emphasizes the role of arousal and affect in the activation of compensation mechanisms in response to violations of expected nonverbal behavior. Discrepancy-Arousal Theory predicts that deviations from expected or preferred nonverbal behavior produce changes in arousal. Moderate arousal change is assumed to result in positive affect and elicit approach behaviors, while high arousal change would lead to negative affect and elicit avoidance behaviors.

Nonverbal Expectancy Violations Theory (Burgoon, 1976; Burgoon & Jones, 1976) extends the above theories by introducing a more diversified model of reactions toward the violation of expected nonverbal behaviors. The theory posits that people's reactions depend on their evaluation of the violator, the implicit message associated with the violation, and the evaluation of the act itself. Small deviations from an expected interpersonal distance may not be noticed, whereas large deviations in either direction (i.e., too close or too far) are likely to produce negative responses. In case of moderate deviations, attractive or rewarding violators may be evaluated positively, whereas violations committed by unattractive sources may lead to negative reactions.

Cross-Cultural Differences in Proxemics

Personal space expands or contracts in accordance with the characteristics of the interacting individuals (e.g., age, sex, race, culture, and personality), the relationship between them (e.g., level of acquaintanceship and group belonging), the characteristics of their interaction (e.g., topic and language), and the immediate physical environment (e.g., location and presence of others). These factors have been extensively studied under various conditions, but mainly in dyadic interactions (Hayduk, 1978, 1983).

As the expectations and preferences regarding proxemic behavior are based on sociocultural norms, it is not surprising that interpersonal distances have been found to vary greatly across cultures. Hall (1966) proposed a distinction between high-contact and low-contact cultures based on his observations on the manner in which cultural groups utilize space in different ways. High-contact cultures were described as highly sensory, wherein people interact at closer distances, and touch one another more frequently. In contrast, low-contact cultures were described as more reserved, and were more likely to display larger interpersonal distances. Most Arabic, Southern European, Latin American, and South American countries were typically classified as high-contact cultures, whereas Northern American, Northern European, and Western European countries were typically considered as moderate to low-contact cultures (Mehrabian, 1971; Patterson, 1983; Scheflen, 1972). Asian cultures, including virtually every Asian country, were most consistently described as low-contact cultures using the largest personal space

zones (Barnlund, 1975; Jones, 1994; McDaniel & Andersen, 1998; Sussman & Rosenfeld, 1982). More recent studies have shown that much of the Western world, including North America and Europe, were more likely to be moderate to high-contact cultures, especially compared to the extremely non-contact Asian cultures (Andersen & Wang, 2009). Cultural habits may have changed since Hall's (1966) original classification of low and high-contact cultures, possibly due to generational shifts or internationalization (Andersen, Hecht, Hoobler, & Smallwood, 2002; Knapp & Hall, 2006).

Although the contact classification has been widely used in cross-cultural communication research, we note that there are not only proxemics differences between cultures but also within cultures. Intra-cultural variations have been found between Latin American countries, which did not show all expected proxemic behaviors of high-contact cultures (Shuter, 1976). Variations in proxemics have also been found between European countries (Remland, Jones, & Brinkman, 1991; Remland, Jones, & Brinkman, 1995; Shuter, 1977). For example, Shuter's (1977) study showed that Germans, supposedly a low-contact culture, communicated more closely than expected. Further, it is important to note that studies in which subcultures were observed (e.g., Latin Americans in the United States), often failed to find the expected proxemic behaviors of the respective cultures (Forston & Larson, 1968; Jones, 1971).

Proxemics in Intercultural Interactions

Proxemics research on personal space and culture has mostly been concerned with *cross-cultural* comparisons of dyadic interactions between members of the *same* culture, while studies on *intercultural* interactions between members from *different* cultures are rare (Beaulieu, 2004). Levine, Park, and Kim (2007) argued that "the findings from cross-cultural communication research do not necessarily transfer automatically to predictions about intercultural communication" (p. 209). Just because members of one cultural group maintain larger interpersonal distances while they interact, this does not mean that they will also show larger distances when interacting with members of another cultural group. Levine et al. (2007) further stated:

> Although it is certainly informative to know cultural characteristics of members of one cultural group when predicting what might happen when the group members encounter/interact with members of another cultural group, there is no guarantee that cross-cultural communication differences will be fully exhibited in intercultural communication. (p. 209)

Some authors assume that mixed-culture dyads consisting of one member from a high-contact culture, and one member from a low-contact culture, would inevitably violate each other's expectation regarding appropriate interpersonal distances (Neuliep, 2003). Beaulieu (2004) hypothesized that such intercultural interactions are likely to lead to discomfort. The attempt by one of the counterparts to adjust his or her proximity in order to avoid discomfort, may in turn create an uncomfortable

situation for the other counterpart, who then tries to readjust the distance, and so forth. Beaulieu (2004, p. 797) speculated that "this mutual adaptation process could raise significant tension and misunderstanding between people" of different cultures. This assumption has received indirect support by Collett (1971), who trained English students in "Arab-like" nonverbal behavior, which included interacting at closer distances. The findings of this study indicated that Arab participants preferred to interact with English students who had been trained in Arabic norms of nonverbal behaviors over those who did not receive training. Similar results have been found in other studies regarding the relation of interpersonal attraction and culturally congruent versus incongruent nonverbal communication styles (Dew & Ward, 1993).

Challenges of Cross-Cultural and Intercultural Proxemics Research

Studying Personal Space in Intercultural Interactions

Several researchers have recognized the need for studying interactions between members of different cultures, and the consequences that arise from different sociocultural conventions regarding the use and perception of personal space (Altman, Rapoport, & Wohlwill, 1980; Beaulieu, 2004). However, there are several challenges associated with an intercultural approach to proxemics research. Most importantly, intercultural FTF meetings always take place in a specific cultural environment, which determines the sociocultural conventions that visitors are expected to follow. The majority of intercultural studies on nonverbal behavior have been conducted with participants who were residing in a foreign country (i.e., outside of their own cultural environment). Baldassare and Feller (1975) concluded based on their review of cultural differences in personal space that the spatial behavior of these participants has been influenced by proxemic patterns of their host culture. Therefore, caution is advised when generalizing from observations involving sojourners or participants with migration background (Altman et al., 1980).

Another issue in intercultural proxemics studies is concerned with the language in which the interactants communicate. According to Sussman and Rosenfeld (1982) language determines the social rules that are associated with it. They posited that language shifts would also result in changes of nonverbal behavior. Thus, communicating in a foreign language may lead to an adjustment to the sociocultural proxemics norms of the native speaker. The authors compared single-culture dyads consisting of Japanese, Venezuelan, and U.S. American students. They found that the Japanese participants had greater interpersonal distances (i.e., sat further apart) than Venezuelan participants when speaking their native languages, while Americans sat at an intermediate distance from one another. However, when speaking English (as a foreign language), neither the Japanese nor the Venezuelan dyads differed from the American dyads regarding their interpersonal distance. This finding indicates that interpersonal distances vary with language and that people are likely to adjust their

proxemic behavior to their interactant's sociocultural norms when speaking his/her language.

Cross-Cultural Comparisons of Personal Space

Cross-cultural proxemics research has typically been conducted in laboratory experiments and observational field studies. While experiments are likely to create an artificial setting, field observations have often been criticized for their limited measurement accuracy (Hayduk, 1983). An important concern for valid cross-cultural comparisons is the establishment of equivalent conditions for the observation of culture-specific proxemics in the respective cultural environments. It is nearly impossible to create equivalent settings and to control for variations in the physical environment. Variations in environmental conditions are even more difficult to control in field studies in which naturally occurring interactions are observed. Potentially confounding variables, including attributes of participants' appearance (e.g., attractiveness), are another issue to be considered. Projective techniques have been suggested as a method to circumvent the difficulty of controlling environmental conditions and appearance-related attributes of the interacting individuals. In projective proxemics studies, participants are required to manipulate miniature figures, silhouettes, dolls, or paper and pencil drawings. In contrast to observing human interactions and collecting physical (real-sized) proxemics measures, projective techniques require mental projection from the interpersonal distance that participants predict they would adopt in an equivalent social interaction in the physical world. Hayduk (1978, 1983) concluded based on his reviews of proxemics studies that projective techniques provide unreliable measures. He found only low correlations with physical measures, and the scaled distances often failed to correspond closely to physical-world distances.

We propose a new method for studying interactions between and within different cultural groups. We use proxemics as a starting point to explore the potential of virtual worlds as a research tool for cross-cultural and intercultural communication. Specifically, we evaluate whether studying proxemics in virtual worlds may help to overcome the challenges associated with both cross-cultural and intercultural proxemics research in physical environments.

Virtual Worlds as Proxemics Research Tools

Virtual worlds enable participants from all over the world to interact in real-time in a shared three-dimensional virtual environment. Participants are provided with an avatar (i.e., a graphical representation of themselves) that "grounds" them in the virtual world. This avatar serves several purposes: it conveys one's virtual identity (which may be totally different from one's physical identity), and visualizes a participant's chosen position in relation to objects and other avatars in the virtual environment. In addition to verbal communication via text and voice chat, participants are provided with means of NVC by moving their avatar's body, and

performing gestures, postures, and facial expressions through their avatar. Due to the similarity between avatar-mediated and FTF communication regarding the concepts of embodiment and social interaction capabilities, several researchers proposed the use of virtual worlds as a research tool to study human social behavior (Bainbridge, 2007; Williams, 2010).[1]

Advantages of Virtual Worlds for Cross-Cultural Proxemics Research

Studying avatar behavior in virtual worlds has clear advantages over observations of human social behavior in the physical world. Collecting observational data on social behavior in the physical world often requires invasive and expensive methods, such as placement of sensors or cameras at various locations, or involvement of human confederates and observers. In contrast, virtual worlds make it possible to collect large amounts of data on avatar-mediated social interactions in an extremely precise and automated way (Friedman, Steed, & Slater, 2007; Penumarthy & Boerner, 2006). Participants' behavior can be tracked unobtrusively by the system, which does not interfere with the social interaction under investigation.

Like in any other online communication medium, participation in virtual world interactions is not restricted to any particular physical location. While large-scale intercultural communication studies are difficult to administer in physical settings, virtual worlds make it possible to bring a large number of participants from different countries together at a low cost. Participants typically remain within their authentic cultural environment (unless they reside in a foreign country) while interacting with others as avatars in a shared virtual space, which constitutes a major advantage for studying intercultural interactions.

Observations of FTF interactions are always conducted in a specific cultural environment, which determines the sociocultural norms. In contrast, virtual worlds make it possible to design the environment in a culturally neutral way; for example, by removing cultural artifacts in buildings or landscapes. This provides a unique opportunity to study the impact of people's cultural background on their proxemic behavior in a standardized, culture-free environment, which would not be possible in the physical world. Alternatively, the virtual environment can be designed in culture-specific (or culture-stereotypical) ways in order to test the impact of the immediate environment on social interaction processes in different cultural groups.

In addition to changes of the environment, participants' representation in the virtual world can be manipulated by changing their avatar appearance (e.g., gender, age, race, height and weight). This provides interesting opportunities for experimental research. We can hold certain characteristics constant that differentiate people in the real world from one another (e.g., attractiveness), or create culture-free avatars by removing visual signs of ethnicity or race. Studies conducted under such standardized appearance conditions allow for unbiased description and evaluation of nonverbal behaviors across cultures (Bente, Senokozlieva, Pennig, Al-Issa, & Fischer, 2008). Alternatively, we can manipulate appearance-related variables by creating avatars that reveal culture-stereotypical characteristics, which may match or

mismatch participants' cultural identity. The impact of transformed self-representations in virtual environments has already been tested under various conditions (Yee & Bailenson, 2007; Yee, Bailenson, & Ducheneaut, 2009). Avatars have also been used to investigate racial bias in social interactions; for instance, in studies on virtual prejudice (Dotsch & Wigboldus, 2008) and embodied perspective-taking (Groom, Bailenson, & Nass, 2009).

In summary, virtual worlds provide several advantages for the study of sociocultural conventions in proxemics, including: (1) similar concepts of embodiment in a shared three-dimensional environment, (2) spatial navigation and orientation, (3) precise measurement of position changes over time, (4) unobtrusive measurement that does not interfere with the social interaction, (5) option to create a culturally neutral meeting location, (6) possibility to control for confounding appearance-related variables, (7) possibility of conducting observational field studies on naturally occurring social interactions, and (8) use of experimental manipulations (e.g., transformed appearance and environments) in controlled laboratory settings that go beyond the possibilities of FTF interactions in the physical world. Moreover, since millions of people spend large amounts of time in virtual worlds, and virtual worlds are expected to play an even larger role in intercultural communication in the future, this medium has become of interest in itself.

Limitations of Virtual Worlds for Cross-Cultural Proxemics Research

Despite similar concepts of embodiment, NVC in virtual worlds is very different from NVC in the physical world. NVC is considered as an automated process in FTF interactions, and interpersonal distances are regulated unconsciously (Hample, 1987; Knapp, 1980). Most virtual worlds provide a set of gestures, postures, and facial expressions that participants can perform through keyboard commands or by selecting the respective nonverbal behavior from a menu. While nonverbal behaviors contain many nuances and subtleties in FTF communication, virtual worlds typically offer only a limited, predefined set of nonverbal behaviors. NVC displayed by avatars (at least in currently available virtual world technologies) has no relation to the participant's actual nonverbal behavior since it is based on automatically programmed models. It is therefore not surprising that such gestures and facial expressions are relatively rarely used in avatar-mediated interactions (Boellstorff, 2008). However, people often use their virtual bodies as a means of NVC by volitional movement and placement of their avatar in the virtual environment. While moving in the physical world is very different from navigation in a virtual world, we still note that this movement is voluntary, yet the psychological processes are not necessarily conscious. In this sense navigation in a virtual world is similar to movement in the physical world. Nevertheless, we need to keep in mind that avatars do not display the full range of nonverbal behaviors as humans do in FTF communication, and that the mechanics of spatial movement are not the same.

This leads us to the fundamental question of how valid observations of virtual world proxemics are, and whether they can be generalized to social interactions in the physical world. If virtual worlds were to be used as a reliable and valid tool in cross-cultural communication research, we need to determine the extent to which people behave in the same way in virtual worlds as they would behave in an equivalent physical-world situation. Williams (2010) called for the establishment of "mapping principles" between virtual and physical world behavior. Mapping refers to the question as to whether social behaviors in virtual environments are "real"; that is, to what extent human behaviors occur in virtual spaces in the same way as they occur in real, physical spaces. As Williams (2010) pointed out, the mapping assumption cannot be taken as a given but must be established by investigating the conditions under which human behaviors map between the virtual and the physical world. One way to establish such a mapping is to replicate well-known physical-world phenomena of social behavior in the virtual world, something that has already been attempted in the field of proxemics.

Initial Findings on Virtual Proxemics

There is some initial evidence that social proxemics norms that apply in the physical world are transferred into virtual environments. Several studies using immersive Virtual Reality (VR) systems provided evidence that users treat social space very naturally, attending to the gaze of avatars and watching their body language (Sanchez-Vives & Slater, 2005). VR studies consistently showed that avatars respected others' personal space (Bailenson, Blascovich, Beall & Loomis, 2001). Likewise, it has been found in desktop-based virtual worlds that avatars typically face others they are communicating with and respect their personal space (Becker & Mark, 2002; Boellstorff, 2008; Friedman et al., 2007; Jeffrey & Mark, 1998; Yee, Bailenson, Urbanek, Chang, & Merget, 2007). Even experienced users, who know that avatar proximity and facing direction is neither necessary nor sufficient to enable communication, adopt socially aware spatial behaviors.

Friedman et al. (2007) used software bots in an automated experiment in the virtual world *Second Life* that invaded other avatars' personal space. They found that avatars that were closely approached by the bot moved away from it. However, while some found that participants reacted to invasions of personal (virtual) space with verbal expressions of discomfort (Becker & Mark, 2002), others did not register such affective reactions (Nassiri, Powell, & Moore, 2005).

Most of the proxemics studies conducted in virtual environments have been concerned with gender effects (Nassiri et al., 2005; Yee et al., 2007). Gender is also one of the most extensively studied factors that influence proxemics in the physical world (Hayduk, 1978, 1983). When comparing male-male (MM), female-female (FF), and opposite-sex (MF) dyads, proxemics has often been found to follow a FF < MF < MM rule; with female dyads interacting at closer distances than

mixed-gender dyads, and male dyads showing the largest interpersonal distances (Aiello & Jones, 1971; Brady & Walker, 1978; Evans & Howard, 1973).

There is no clear evidence for a gender effect in virtual proxemics. Yee et al. (2007) found that the impact of avatar gender on proxemics in virtual worlds followed the FF < MM rule, which partly replicates typical gender effects on proxemics in the physical world. However, mixed-gender dyads showed the closest distances between their avatars, which contradicts the FF < FM < MM rule of physical-world proxemics. It is important to note that participants' actual gender was unknown in their study. Proxemics studies conducted in VR settings in which actual gender and avatar gender were congruent also showed gender effects that contradict findings of physical proxemics studies (Bailenson et al., 2001; Blascovich et al., 2002).

We are not aware of any empirical studies that investigated cross-cultural differences in virtual proxemics or patterns of virtual proxemic behavior in intercultural interactions. Despite some initial evidence for the transfer of social proxemics norms from the physical into the virtual world, it is still unclear whether proxemics patterns would be similar to those of FTF interactions when people of different cultures interact as avatars in a virtual world. In order to fill this gap, we conducted a field study in which we observed naturally occurring avatar interactions between students from Asian and European universities in a virtual world. We examined inter-avatar distances (IAD) in dyadic interactions, including single-culture dyads, which either consisted of two Asian students or two European students, as well as mixed-culture dyads consisting of one Asian and one European student. The study focused on three main research questions.

Following William's (2010) mapping approach, our first research question is concerned with whether or not differences between Asian and European cultures regarding interpersonal distances can also be found in avatar-mediated interactions in a virtual world. If Europeans had lower personal space requirements in a virtual world and preferred closer IADs than Asians, we hypothesized that Asian avatar dyads would interact at larger distances than European avatar dyads: IAD (Asian) > IAD (European).

The second research question is concerned with mixed-culture dyads, and explores which sociocultural proxemics norms dominate in a culture-free virtual environment. Assuming support for Hypothesis 1, we expected that mixed-culture dyads would interact at an intermediate IAD, resulting in the following pattern: IAD (Asian) > IAD (mixed) > IAD (European). However, depending on the language in which the mixed-culture dyads communicate, this pattern would shift according to the cultural proxemics norms of either the Asian or European culture. If the mixed-culture dyads were to communicate in English, we expected them to approximate the Western proxemics norms, resulting in: IAD (mixed) = IAD (European). This second assumption is based on earlier findings on the influence of language on proxemics (Sussman & Rosenfeld, 1982).

The third research question explores the consequences of personal space invasion in mixed-culture dyads. As this is the first study on cross-cultural differences in virtual proxemics, the size of personal space zones that participants of different

cultural groups are likely to maintain around their avatars is unknown. However, we can assume that the shorter the IAD, the more likely this distance would be perceived as a violation of personal space requirements. We expected that participants' reactions to the invasion of their personal virtual space would be reflected in the duration for which mixed-culture dyads remained at their closest IAD. Thus, the shorter the IAD, the less time mixed-culture dyads were expected to remain at that distance.

Method

Participants and Procedure

Participants were 139 students (114 men and 25 women) from different East Asian and European universities who volunteered to take part in a research project in the context of a global lecture series called The ShanghAI Lectures[2] (Hasler, 2011). They were graduate, post-graduate, and PhD students majoring in Computer Science and Engineering, between the ages of 19 and 39 years ($M = 24.58$, $SD = 3.44$). Seventy students were East Asians (59 Chinese, four South Korean, four Japanese, one Mongolian, one Cambodian, and one Vietnamese), and 69 students were from Western and Eastern Europe (38 Swiss, 23 German, two Austrian, one Czech, one Estonian, one Hungarian, one Romanian, one Serbian, and one Polish).

Upon registration for the ShanghAI Lectures, the students were requested to choose an avatar name and to create a profile page on the course website that included basic demographic information, such as sex, age, and nationality. Online registration also contained an informed consent form with information about the research conducted within the context of the ShanghAI Lectures. The students were then assigned to multicultural virtual teams of four to five members, in which they worked together on bi-weekly group exercises in a virtual world over the course of a semester. We selected all dyadic avatar interactions that occurred between the Asian and European students in this collaborative virtual world. We only considered the dyads that communicated via text chat while no other avatars were around. This selection resulted in a total number of 107 dyads with three different culture compositions: 31 Asian dyads, 41 European dyads, and 35 mixed-culture dyads.

Materials and Measures

Collaboration tasks. Some of the group exercises were designed as collaboration tasks in a virtual world, which was developed based on the *Open Wonderland* (OWL)[3] toolkit (version 0.5). These in-world group exercises mainly required two-dimensional application sharing tools, such as Web browsers, video-players, PDF viewers, text editors, and whiteboards, which could be inserted for collaborative use at any position in the virtual world. Thus, the in-world collaboration tools did not place any spatial restrictions on the avatars' position or movement in the virtual world during task completion.

Virtual world design. The virtual world consisted of a large public meeting area surrounded by team rooms. In order to avoid performance issues, a low-polygon design was chosen and no additional 3D objects, such as tables or chairs, were placed in the virtual world. Thus, the avatars' navigation was not influenced by any obstacles in the virtual world. The starting position was identical for each avatar, and its coordinates could not be changed by the participants. They were automatically placed in the public area in the middle of the virtual world after they logged in. From this starting position, they could freely navigate within the virtual world using the arrow keys of their keyboard.

In-world communication tools. Text chat and voice communication were enabled, and a (rather limited) set of gestures and postures could be selected from a menu. Compared to other virtual worlds, such as *Second Life*, the OWL chat system had no spatial restrictions. The avatars could exchange text messages from any location within the virtual world, that is, regardless of the distance between them. However, voice communication required the proximity of avatars. The volume increased the closer two avatars were placed to one another, and decreased the further they walked apart. Therefore, we only considered dyads that communicated via text chat.

Avatar appearance. Each participant started with a default non-anthropomorphic avatar, which did not convey any culture-specific attributes, as shown in Figure 1. OWL offered basic avatar customization options. Participants could choose a human-like male or female avatar, and make (relatively limited) changes of skin color, hair style and color, eye color, dress, and accessories. However, customized avatars were not stored on the server. If participants changed their browser settings or logged in from another computer, they were again assigned to the default avatar. This may have been the reason why the students were represented by the default avatar in 89% of all recorded interactions in the virtual world. We removed all dyads in which at least one of the dyad members was represented by a customized avatar.

Figure 1 Two Default Avatars Interacting in Wonderland at a Distance of Approximately One (Virtual) Meter.

Thus, the current study only considered the cases in which the default avatar was used by both dyad members.

Avatar names. The students were required to choose a user name when they registered for the lectures. This user name appeared on their profile page on the course website as well as in the chat and above their avatar's head in the virtual world. Information about participants' culture was immediately available and visually salient through the choice of their culture-specific avatar names. For example, Asian students used avatar names like ''zhaoyue,'' ''huanghe,'' ''luoyantai,'' or ''akiaisys.'' European students named their avatars ''Mike,'' ''Felix,'' ''henry,'' or ''claudia.'' We can further assume that dyads that consisted of students who were assigned to the same team knew their team members' nationality. Non-member dyads were also likely to know their interactants' nationality, either by asking them where they were from or looking up their profile pages on the course website, which were searchable by avatar names.

Tracking of in-world behavior. A behavioral tracking system was implemented in OWL, which registered changes in avatar appearance, recorded public and private text messages, and tracked avatar locomotion (i.e., changes in position, rotation, velocity, and view angles) (Hasler, 2010). Avatar behaviors in OWL were tracked in an event-based manner. Hence, any change in an avatar's position was logged. The spatial tracking data and the recorded chat messages were matched based on time stamps.

Inter-avatar distance measures. The distances between dyad members were calculated based on the horizontal coordinates of each dyad member's position, thus neglecting possible height differences. Figure 1 shows two avatars interacting in OWL at an IAD of approximately one (virtual) meter. We adopt the practice introduced by Hall (1959, 1966) to analyze the minimum distance throughout a dyadic interaction. Minimum distances have been commonly used by proxemics researchers to investigate the minimal comfort zone in which dyads remain over the course of their interaction, and have also been used in previous proxemics studies in VR settings (Bailenson et al., 2001, Bailenson, Blascovich, Beall, & Loomis, 2003).

In order to determine the minimum inter-avatar distance (IAD_{min}) in each dyad, we only considered the distances at the times when they exchanged text messages, and ignored any movement in-between messages. We expected that students were aware of their avatar's position during chat interactions in the virtual world as they had to direct their attention to the screen when sending and receiving messages. Thus, there is a high probability that the IADs at the times when they exchanged messages were voluntarily chosen. This method reduces the risk of mistakenly analyzing minimum distances that may have occurred randomly or involuntarily; for example, when two avatars walked into each other by mistake or when they logged in at the same time and were forced by the system to be placed at the same starting position (i.e., at zero distance).

Results

Exploration of Potentially Confounding Variables

Gender and team membership. As gender and group belonging have been found to influence proxemics in the physical world (Hayduk, 1983), we examined whether these variables were confounded with the dyads' culture. The majority of the dyads consisted of two male students (73 male dyads, 17 female dyads, and 17 mixed-gender dyads), and students who were assigned to the same team (61 team member dyads and 46 non-member dyads). Pearson Chi-square tests showed that the culture pairs did not significantly differ regarding their gender composition, $\chi^2(4) = 7.14$, $p > .05$, nor team membership, $\chi^2(2) = 3.08$, $p > .05$.

Conversational factors. Acquaintanceship has also been found to influence proxemics in the physical world (Hayduk, 1983). The intensity of a dyadic interaction is assumed to be related to the acquaintanceship of the interacting individuals, taking the possibilities into account that (a) those who already had previous contact may also communicate longer in the current interaction, and (b) the longer they interact, the better they might get to know each other. Therefore, we tested whether the culture pairs differed regarding their interaction intensity as measured by the duration of their current interaction and the number of messages exchanged. The dyad members exchanged between two to 224 messages ($M = 36.19$, $SD = 41.66$), and interacted between one minute to 3.64 hours ($M = 37.68$ min, $SD = 46.52$ min). One-way ANOVA tests showed that the culture pairs did not significantly differ regarding the duration of their interaction, $F(2, 104) = .76$, $p > .05$, or the number of messages exchanged, $F(2, 104) = .62$, $p > .05$.

As language has also been found to influence proxemics (Sussman & Rosenfeld, 1982), we checked in which language the different types of culture dyads communicated. All mixed-culture dyads communicated in English. The European dyads either communicated in English ($n = 22$) or German ($n = 19$). The Asian dyads either communicated in Chinese ($n = 11$) or English ($n = 20$).

Minimum Inter-avatar Distances

Distribution of minimum distances. A Kolmogorov-Smirnov test revealed that the IAD_{min} values over all dyads did not follow a normal distribution, but were heavily left-tailed, $Z = 2.79$, $p < .001$. We performed log-transformations on IAD_{min} in order to normalize the data for statistical analysis (i.e., using parametric tests). We refrain from reporting means but use the median as a more representative indicator of central tendency of skewed distributions. Figure 2 shows the IAD_{min} distribution of the Asian dyads ($Mdn = 8.43$ m), the European dyads ($Mdn = 2.28$ m), and the mixed-culture dyads ($Mdn = 3.39$ m).

Differences between culture-pairs. A one-way ANOVA with culture pairs as the independent variable and log-transformed IAD_{min} as the dependent variable was statistically significant, $F(2, 104) = 8.49$, $p < .001$, $\eta_p^2 = .14$. Post-hoc tests revealed

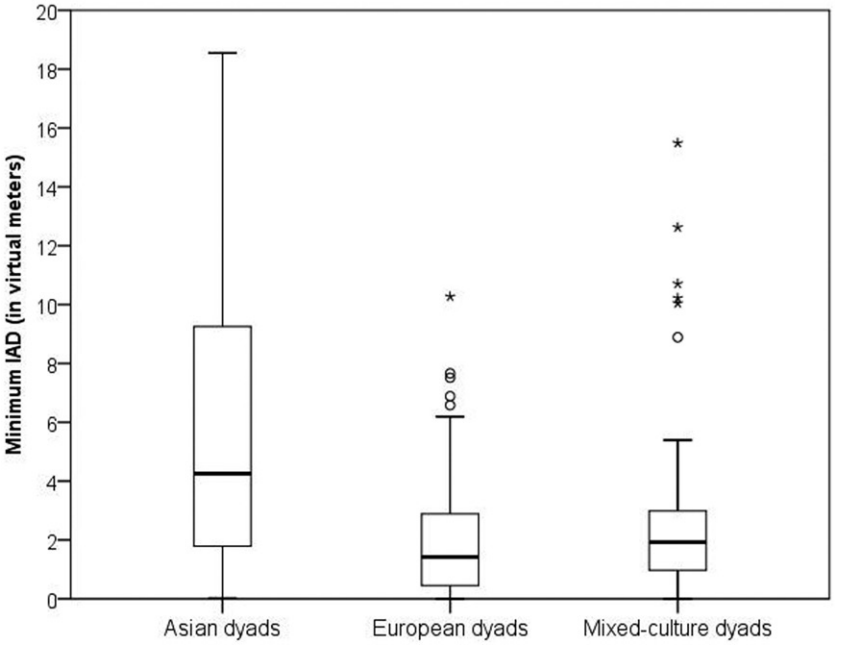

Figure 2 Distribution of Minimum Inter-avatar Distances in Asian Dyads, European Dyads, and Mixed-Culture Dyads.

that the IAD_{min} of the Asian dyads was significantly larger than the IAD_{min} of both the European dyads and the mixed-culture dyads. The mixed-culture dyads did not significantly differ from the European dyads regarding their IAD_{min}.

Distances and duration. A one-way ANOVA showed that the Asian dyads ($M = 1.41$ min, $SD = 2.24$ min), European dyads ($M = 3.06$ min, $SD = 4.68$ min), and mixed-culture dyads ($M = 2.38$ min, $SD = 4.96$ min) did not significantly differ regarding the duration for which they remained at their IAD_{min}, $F(2, 104) = 1.34$, $p > .05$. However, a positive correlation was found for the mixed-culture dyads between IAD_{min} and the duration of IAD_{min}, $r = .37$, $p = .01$. Thus, the shorter their IAD_{min} was, the shorter was the duration for which they remained at that distance. No significant correlation between IAD_{min} and duration of IAD_{min} was found for the Asian dyads, $r = .004$, $p > .05$, or the European dyads, $r = .04$, $p > .05$.

Interaction language. A one-way ANOVA with interaction language as the independent variable and log-transformed IAD_{min} as the dependent variable was not statistically significant, $F(2, 104) = 1.48$, $p > .05$. No statistically significant difference was found regarding IAD_{min} between Asian dyads that communicated in English ($Mdn = 4.67$ m) and those who communicated in Chinese ($Mdn = 2.90$ m), $t(29) = .84$, $p > .05$. The European dyads that communicated in English ($Mdn = 1.42$ m) also did not differ from those who communicated in German ($Mdn = 1.18$ m) regarding their IAD_{min}, $t(39) = .38$, $p > .05$.

Discussion

Assuming that people behave according to the same social rules in physical and virtual environments, it would be possible to generalize from observations in virtual worlds to social behavior in the physical world, and vice versa (Williams, 2010). Thus, the use of virtual worlds as proxemics research tools requires that the mapping between proxemic behavior in virtual worlds and the physical world is successful. We studied naturally occurring avatar interactions in single-culture dyads in order to test whether participants' sociocultural proxemics norms are transferred into the virtual world. We compared the minimal interaction distance in avatar dyads consisting of two Asian students with avatar dyads consisting of two European students. Asian dyads maintained larger personal space zones as indicated by larger IAD_{min} than European dyads. This finding is consistent with Hall's (1966) notion of low/high-contact cultures. According to Hall, Asians as typical representatives of low-contact cultures interact at greater distances than Europeans who are considered a moderate to high-contact culture. Thus, the mapping of cross-cultural proxemics patterns between avatar-mediated interactions in virtual worlds and FTF interactions in the physical world can be considered successful.

We further hypothesized that mixed-culture dyads consisting of one European and one Asian student would interact at an intermediate distance compared to the respective single-culture dyads. However, considering previous findings in intercultural interactions, we expected that the language in which the dyad members communicate would influence their proxemic behavior according to the sociocultural conventions associated with the respective language (Sussman & Rosenfeld, 1982). Indeed, we found that mixed-culture dyads did not significantly differ from the European dyads regarding their minimal interaction distance. Since all mixed-culture dyads communicated in English, the finding that the pattern of their proxemic behavior shifted toward the Western proxemics norms supports the second assumption. If language was the main factor that determines proxemic behavior, we would also expect Asian dyads communicating in English to interact at closer distances than Asian dyads communicating in Chinese. However, we failed to find statistical evidence for this assumption.

Thus, we can exclude that English language was the reason for an approximation of interaction distances toward Western proxemics norms in mixed-culture dyads. This leaves us with the conclusion that Asians were more tolerant regarding the violation of their personal virtual space when interacting in mixed-culture dyads than Europeans. This interpretation seems plausible since personal space violations do not have the same consequences in the virtual world as in the physical world because there is no potential harm to our (physical) bodies. Although virtual space invasions may activate cognitive evaluation processes, as predicted by Nonverbal Expectancy Violations Theory (Burgoon, 1976), it seems less likely that they would provoke a high level of physiological arousal, which would be necessary according to Discrepancy-Arousal Theory (Cappella & Greene, 1984) for compensation responses to occur.

Nevertheless, our results showed that the shorter the minimal interaction distance in mixed-culture dyads was, the less time the dyad members remained at that distance. This correlation was found for the mixed-culture dyads, but not for either of the single-culture dyads. This finding indicates that the proxemics expectations of Asians may have indeed been violated, and that some compensation did occur; that is, changing the avatar's position quickly after the act of personal space invasion. However, it is important to note that not all minimal interaction distances may have comprised an invasion of personal space. Further research is required in order to determine the actual size of personal virtual space zones for different cultural groups. Only then we can further investigate the consequences of personal space violations in avatar-mediated intercultural encounters; for instance, what compensation mechanisms would be activated after which distance, or how the violation of nonverbal expectations influences interpersonal attraction, perceived (dis)similarity, mutual understanding or the (actual or perceived) effectiveness of the communication process. Physiological measurements, such as heart rate or skin conductance, would provide more insights into affective reactions to personal space invasion in virtual worlds, and the consequences that emerge from different arousal levels.

Despite the statistically significant cross-cultural differences that have been found in the current study between high and low-contact cultures relating to their inter-avatar distance, future research is advised to study virtual proxemics in more homogeneous samples. Our sample consisted of participants from different countries that were a priori assigned to Asian low-contact cultures versus European high-contact cultures. As previous research has shown, it is likely that there are proxemics variations between different European countries (Remland et al., 1991, 1995; Shuter, 1977), as well as between different Latin American countries (Shuter, 1976), and may also be found across Asian countries. While earlier proxemics research in FTF settings mostly relied on single measures (e.g., minimum distances), virtual worlds make it possible to measure distance changes in avatar interactions continuously in a very accurate and unobtrusive way. Further research that makes use of virtual worlds as a tool for cross-cultural proxemics studies should take advantage of these novel measurement techniques in order to study the dynamic nature of proxemic behavior.

Our analysis of virtual proxemics was based on interactions between identical, non-anthropomorphic avatars, which did not convey any culture-specific characteristics. However, information about participants' cultural background was visually salient through their choice of culture-specific avatar names. It has yet to be investigated how customized avatar appearance, that is, using human-like avatars that convey information about participants' race or ethnicity, which may match or mismatch their actual identity, would influence their proxemic behavior in a virtual world. Furthermore, the dyadic avatar interactions in the current study took place in a culturally neutral virtual world. Further research is required to understand whether virtual environments that are designed in a culture-specific way would "dictate" the sociocultural norms to which people from different cultural groups adhere. Future studies may also include participants' perceptions in order to evaluate whether a virtual space is perceived as culture-free or culture-specific. This

manipulation check would be required in order to support the claim that ''object-free'' spaces can indeed be considered as ''culture-free.''

While current virtual world technologies still have limitations to the expression of nonverbal behaviors (i.e., gestures, postures, and facial expressions), new generations of virtual worlds based on natural human-avatar interfaces are beginning to emerge. These novel interfaces use body and face tracking techniques, which enable participants to control the nonverbal behaviors of their avatar in a more natural and intuitive way—or more precisely, not ''control'' it at all; thus, removing the conscious effort that is required to perform nonverbal behaviors in current virtual world interfaces. As avatars become more nonverbally expressive (Ventrella, 2011), the study of cultural differences in other types of avatar-mediated NVC will also be of great importance, such as body postures, gestures, and facial expressions. According to the spectrum hypothesis proposed by Friedman, Karniel, and Lavie-Dinur (2009), the more immersive the environments and the more natural avatar-mediated interactions become, the better will be the mapping from FTF behavior to virtual behavior. We may eventually reach a stage in which avatar-mediated interactions in virtual environments will be an exact simulation of FTF interactions in physical environments.

Conclusions

Research on cross-cultural differences and intercultural interactions in virtual worlds is still at an early stage. It is of high theoretical and practical importance to study social behavior in virtual worlds since millions of people are spending time in these virtual spaces and their behavior has ''real'' consequences (e.g., economy). It is therefore urgent to understand where the mapping to physical-world behavior breaks and why. Such research will practically inform us on how to construct improved interfaces, which preserve more of the social nuances of interactions in the physical world. Theoretically, such research may provide us with new insights about the way humans adapt to new types of mediated social experiences. Hence, the findings of the current study are not only relevant to the field of cross-cultural NVC, but also have implications for the design of culturally sensitive virtual environments (Hasler, 2011). We need to advance our understanding of cross-cultural differences in the use and perception of virtual spaces and how they need to be designed in order to effectively support cross-cultural trainings, intercultural team collaboration, or conflict resolution between different cultural groups.

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Notes

[1] Similar claims have been formulated for more immersive virtual reality systems using head-mounted displays as potential social science research tools (Blascovich et al., 2002; Loomis, Blascovich, & Beall, 1999; McCall & Blascovich, 2009). The focus of the current paper, however, lies on desktop-based multi-user virtual worlds, which differ from virtual reality environments in several ways. For example, they do not involve actual physical movement of participants.

[2] http://shanghailectures.org

[3] http://openwonderland.org

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