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CULTURAL AND REGIONAL PERSPECTIVES

The efficacy of an immersive 3D virtual versus 2D web environment in intercultural sensitivity acquisition

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Abstract Relatively few studies have empirically tested computer-based immersive virtual environments' efficacy in teaching or enhancing pro-social attitudes, such as intercultural sensitivity. This channel study experiment was conducted ($N = 159$) to compare what effects, if any, an immersive 3D virtual environment would have upon subjects' intercultural sensitivity, compared to a 2D web environment. Significant gains in intercultural sensitivity were found, with subjects exposed to the Second Life-based immersive virtual environment scoring higher than web-based subjects, both toward other cultures in general and toward Chinese culture in particular. An interaction effect for gender and channel was found, with males experiencing greater intercultural sensitivity outcomes than in a web environment. These empirical findings add to our theoretical understanding of channel effects and intercultural sensitivity. The results can guide cultural instructors or trainers toward the best platforms for content delivery to learners. These findings are

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worthy of future investigation to better understand their application in educational endeavors as well as in other fields.

Keywords 3D · Immersive virtual environment · Web · Intercultural sensitivity · Gender

Introduction

As individuals and communities become more interconnected by business, travel, and social media, one particularly important attribute for global citizens, including students, to acquire today is *intercultural sensitivity*, defined by Chen and Starosta (1998) as subjects' "active desire to motivate themselves to understand, appreciate, and accept differences among cultures" (p. 231). This study compares intercultural sensitivity outcomes for cultural content delivered in an immersive 3D virtual environment like Second Life to that of a more traditional web page. While much discussion and excitement have surrounded the emergence of multi-user virtual environments such as Second Life, few studies have empirically tested immersive virtual environments' efficacy in enhancing pro-social attitudes, such as intercultural sensitivity. This was the rationale for conducting the study and is its primary contribution. The results—particularly the evidence of the efficacy of immersive 3D environments—can guide cultural educators, instructors or trainers toward the best content delivery platforms for learners.

3D virtual environments in education

Virtual environments and games (e.g. Second Life®, Virtual Places®, World of Warcraft®) are known for their entertainment and social networking value. However, one of the fields that seems to have particularly embraced immersive 3D virtual environments is education. From teacher preparation in distance education (Hartley et al. 2015) to college freshmen orientation (Tüzün and Özdinç 2016) to serving as a social intervention tool for high-functioning autistic students (Chia and Li 2012; Stichter et al. 2014), to subjects including math (Bouta and Paraskeva 2013) and chemistry (Zhong and Liu 2014), 3D virtual environments have been welcomed by educators in an effort to identify best practices. Second Life, one of the most popular such environments, has been utilized in many university-level courses in particular. Some scholars (Pellas and Kazanidis 2014) have found that the collaborative climate this immersive 3D environment encourages and creates between students and instructors is one of its greatest educational benefits. The experiential framework provided by virtual immersive environments has also been highlighted as being among the educational benefits for medical students, including emergency training and telesurgical applications (Mantovani et al. 2003).

3D virtual environments: new routes to pro-social attitudes and behavior

In addition to the field of education, research has also begun to examine immersive virtual environments for their value in advancing health-related and pro-social objectives (Ahn et al. 2013; Butter et al. 2015; Deladisma et al. 2007; Fox and Bailenson 2009; Gillath et al. 2008; Hodges et al. 1995; Lane et al. 2013; Lee and Peng 2006; Lieberman 1997, 2006; Michael and Chen 2006; O'Brien and Levy 2008; Peng et al. 2010; Rosenberg et al. 2013;

Rothbaum et al. 1995; Schuemie et al. 2001; Slater et al. 2006; Stevens et al. 2006; Warburton 2009). For instance, Rosenberg et al. (2013) and Ahn et al. (2013) found that certain virtual immersive environment activities made participants more likely to engage in "helping behaviors" for others in the real world, such as courteously picking up dropped items for others (Rosenberg et al. 2013) or assisting those with color blindness (Ahn et al. 2013). Health behavior modeling is another pro-social behavior that has proven effective via virtual 3D environments; Fox and Bailenson's (2009) study found that persons exposed to a "virtual representation of self" engaged in significantly higher levels of exercise than those who were not. Ahn et al. (2013) stated that it is the heightened sense of realism provided by virtual immersive environments that aids "self-other merging," which enables the prosocial behaviors and desire to help.

Therapists are using virtual environments to treat various phobias (Gega et al. 2013; Hodges et al. 1995; Orman 2004; Rothbaum et al. 1995; Schuemie et al. 2001; Slater et al. 2006; Suied et al. 2013), medical students are using virtual environments as training aides for patient interaction (Deladisma et al. 2007; Stevens et al. 2006), and the U.S. military has been exploring the value of virtual environments to train soldiers as well as help them recover from war stress (Cain Miller 2009; Etengoff 2008; Vargas 2006). Educational communities have embraced virtual environments for efficiency reasons, but also for the multi-sensory, realistic learning environments they can provide (Romano and Brna 2001).

A small number of studies have begun to explore the efficacy of virtual environments in shifting cultural attitudes or increasing cultural knowledge. Among the contributions so far, Diehl and Prins (2008) found that persons who used Second Life enhanced their 'intercultural literacy,' making them more aware of other cultural practices and more open to various cultural perspectives, and aided cross-cultural relationships and encounters. Compassion and concern for others within a virtual space, as expressed toward virtual persons, was documented by Gillath et al. (2008), while another study has shown that participants are more willing to help others and take on particular roles in another culture after participating in a serious game, than those exposed to text-based messages (Peng et al. 2010). Lane et al. (2013) compared "declarative knowledge" outcomes, using both 2D and 3D interfaces for an intercultural communication scenario, however equivalent learning outcomes were found with no significant channel differences.

Empirical results in the scholarly literature regarding the statistical efficacy of immersive virtual environments upon cultural competence or intercultural sensitivity are not conclusive. However, there may be a connection. The very nature of many virtual environments permits simulated, perceived immersive 3D human interaction and interpersonal communications involving various non-verbal forms of communication known as "transformed social interaction," including eye contact (Bailenson et al. 2004, 2005). Bailenson et al. (2005) tested such interactions, including the "augmented gaze," in which a virtual character's eye gaze and head movement mirror that of the interactant, so that it feels like a real interaction. Lane (2009) offered a descriptive overview of immersive tools and technologies for learning or acquiring intercultural sensitivity using virtual immersive environments, including simulated interactions between military personnel and Afghani citizens, in which participants can learn about one another's customs, dress, language, gestures, and other intercultural differences, while learning how to interact. The "virtual reality" nature of such simulated scenarios would seem to suggest a simulated learning opportunity for intercultural sensitivity of all kinds, such as the simulation that is tested in the present study.

In the classroom educational space, student participants focused on the cultural products or artifacts portrayed within a virtual class exercise within Second Life, and had strong

recall of these cultural products (O'Brien and Levy 2008). Students were also able to remember the similarities and differences between their own culture and the one to which they were exposed. A recent study (Butter et al. 2015) utilized the virtual learning environment Moodle to promote collaborative learning, but the research was not comparative by channel. This study answers a call for more empirically driven inquiry on intercultural sensitivity acquisition in immersive 3D virtual environments versus 2D web environments.

Second Life

Many virtual environments exist, but Second Life® has been described as the best known and most mature virtual world tool among educators (Warburton 2009). Operated by Linden Labs (Holtz 2007; Johnston 2007), it first appeared in 2003 and still boasts 900,000 active monthly users (from a high of 1.1 million), with "virtual payouts of $60 million in real-world money every year, and a virtual economy that has more than $500 million in GDP every year" (Weinberger 2015). Some virtual reality industry observers note that Second Life may have been a few years early, but are now closely watching the growing interest in virtual reality by industry giants including Facebook, HTC, and Sony (Weinberger 2015). In Second Life, users navigate fictional places with avatars, virtual representations of themselves. Second Life is considered a role playing environment and serves as a social networking space. Various industries have been experimenting with Second Life to ascertain its potential benefits. It has been popular among educators for its "relatively low cost of entry, the ability to create complex objects and environments, combined with the sophistication of its graphics and the rich immersive experience" (Warburton 2009, p. 418). In addition to the aforementioned (e.g. pro-social) applications being tested, could Second Life, a virtual environment, also teach users how to better relate to one another, specifically, how to become more interculturally sensitive?

Traditional web space

The study of immersive 3D virtual environments can be contrasted with the more traditional 2D website. A web page is a "document that can be displayed in a web browser," with a website being a "collection of webpages grouped together in various ways" (Mozilla Foundation 2016). Web pages can contain simple text, as well as multimedia features including audio, video, and images. Scripts are used to add interactivity to webpages (Mozilla Foundation 2016). Both 2D traditional websites and immersive 3D virtual environments can be used to disseminate information, including cultural information. By undertaking an experimental approach, this study sought to empirically address whether the immersive 3D virtual space can increase intercultural sensitivity, by comparing this delivery method to content delivered within a traditional web space. That is, can an immersive 3D virtual environment increase intercultural sensitivity with greater efficacy but with the same "ease of delivery" as a 2D web environment?

Intercultural sensitivity

Chen and Starosta (1996, 1998, 2000) described an "umbrella" concept of intercultural communication competence, which has three dimensions: intercultural sensitivity, cultural awareness, and intercultural adroitness. Intercultural sensitivity, they argued, was an affective concept, whereas intercultural awareness was cognitive, encompassing "the

understanding of culture conventions that affect how we think and behave" (Chen and Starosta 2000, p. 3) and that intercultural adroitness, the behavioral dimension, referred to "the ability to get the job done and attain communication goals in intercultural interactions" (Chen and Starosta 1996, p. 367). Thus, intercultural sensitivity is defined as the affective, measurable aspect of intercultural communication competence, and is the definition upon which Chen and Starosta (2000) developed their Intercultural Sensitivity Scale (ISS).

Through their own research, Chen and Starosta identified six attributes that they believe interculturally sensitive persons should possess, which include "self-esteem, self-monitoring, open-mindedness, empathy, interaction involvement, and suspending judgment" (2000, p. 5). Testing a related concept, Kobayashi (2010) found that the heterogeneity of persons in an online, virtual environment augments social tolerance toward persons in the virtual online environment, and that this, in turn, enhances social tolerance of others offline (in the physical world). Because there has been little empirical research on intercultural sensitivity as defined here and a lack of research testing how it may be affected by immersive 3D virtual environments, the present study plays an important role in advancing the literature in this area, particularly as it applies to digital media environments.

Channel effects

A comparative examination of 2D web and 3D immersive virtual environments is an exploration of channel effects. Previous research has identified significant differences in the efficacy of various media channels when delivering content. In terms of media delivery channel and knowledge retention (memory recognition and recall), new media have been shown to be superior to traditional media platforms (Bell et al. 2000; Kaupins 2002; Prathap and Ponnusamy 2009). Web videos proved to be a superior delivery platform for memory when compared to broadcast radio or television in a test of platforms for teaching methods (Kaupins 2002), though CD-ROM, games and other methods were still considered superior to web video. Online tutorials have been found to be more efficient and satisfying to learners than print-based materials when conveying information about appropriate care for a medical condition (Bell et al. 2000). In an earlier study, Edwardson et al. (1985) found that videotext—an early form of dynamic news presentation available via cable television systems (a "video newspaper" with crawls and frequent story updates that may have resembled an early web page)–produced better information gain (both recall and recognition) among viewers than television newscaster-presented stories. While previous scholars did not draw conclusions for the reasons behind greater efficacy of the internet, some (Bell et al. 2000; Peng 2008; Prathap and Ponnusamy 2009) opine that it is the internet's interactive opportunities that make it a helpful and, often, superior platform for users, as well as its relative "newness" compared to other media. One recent study using virtual environments seems to suggest that a 3D virtual environment can be more effective in teaching helpfulness or pro-social behaviors (Ahn et al. 2013).

The aforementioned studies did not test intercultural sensitivity, however the research clearly indicates that we can expect outcome variability based on media channel and many studies show that the multimedia Internet has performed better than traditional media platforms. Using a pre-test, post-test experimental design that compared baseline measures prior to stimulus exposure with post-exposure measures, this study sought to empirically address whether the 3D virtual space can increase intercultural sensitivity. Specifically, is an immersive 3D virtual environment more effective than a 2D web environment in delivering cultural information and in enhancing intercultural sensitivity?

Conceptual framework and hypotheses

The conceptual framework of this study, then, proposes that the channel (i.e. 2D web versus 3D immersive virtual environment) used to communicate or disseminate cultural content plays a role in the acquisition or enhancement of intercultural sensitivity. Based on the preceding literature review's findings regarding new media and virtual environments on role-playing, empathy, and cultural sensitivity, we hypothesize that:

H1: Subjects exposed to the Second Life environment will have higher intercultural sensitivity *toward other cultures generally* than subjects exposed to the web environment.

H2: Subjects exposed to the Second Life environment will have higher intercultural sensitivity *toward the featured culture* than subjects exposed to the web environment.

The usage and rationale of Chinese culture as an exemplar will be explained in the "Method" section.

Gender effects

Previous literature has identified gender differences as they relate to memory, media selection, and media message evaluation (Grabe and Kamhawi 2006; Kamhawi and Grabe 2007, 2008; Knobloch-Westerwick and Alter 2006; Knobloch-Westerwick et al. 2006; Knobloch-Westerwick 2007), and so it is possible that gender (as self-identified) could also play a role in intercultural sensitivity outcomes. In one study, an e-magazine was most effective in delivering information about some farming technologies; females retained the most information when content was delivered over the Internet, followed by newspaper, television, and radio (Prathap and Ponnusamy 2009). Males were not tested in the study. Some recent research within the Second Life environment has focused on gender and social role theory, and found females used the virtual space more for communal purposes (communicating and socializing with others, virtual shopping) and males spent more time in "agentic" activities such as building, owning, or working their virtual property (Guadagno et al. 2011). The present study contributes to this initial knowledge base, adding a new layer of understanding about channel and gender effects as they pertain to emerging media platforms such as virtual environments. As more consumers spend time on such platforms and these media offerings proliferate, it is important to study the effects of such media. Based on the above, it would seem likely that gender effects would exist in a virtual immersive 3D environment where richer human interaction can occur. Specifically, since females tend to use virtual spaces more for communal purposes, they may score more highly than males in terms of intercultural sensitivity in a virtual environment; the immersive nature of the environment lends itself to connecting with others.

Intercultural sensitivity and gender

Within research areas exploring intercultural sensitivity and related concepts such as cultural empathy and cultural competence, studies have found females to be more receptive, empathetic, or sensitive than males (Kamhawi and Grabe 2008; Constantine 2000; Cowan and Khatchadourian 2003; Cundiff and Komarraju 2008; Cundiff et al. 2009; Holm et al. 2009; Nieto and Booth 2010; Wang et al. 2003). Also, scholars have found females to be more drawn to interpersonal topics when consuming media content, whereas males tend to be drawn to topics of achievement and performance (Knobloch-Westerwick et al. 2006;

Knobloch-Westerwick and Alter 2006). This aligns with the aforementioned work (Guadagno et al. 2011) documenting how males tended to be involved in more "agentic" activities in virtual environments rather than for communal purposes, as females were. So it may not be that virtual environments are of greater or lesser benefit or efficacy for one gender, but that the genders simply utilize virtual environments and their traits differently. Due to the literature indicating females' tendency to display greater sensitivity and empathy toward others, it seems likely that gender (as self-identified) may also play a role in intercultural sensitivity outcomes. We hypothesize that:

H3: Females will experience greater intercultural sensitivity effects *toward other cultures generally* than males.

H4: Females will experience greater intercultural sensitivity effects *toward the featured culture* than males.

Finally, while previous research has identified gender differences in media use and selection, and channel effects toward newer media generally, we pose a research question in order to learn what relationship, if any, gender and channel may have in this study of virtual and web spaces. Given the different uses of virtual environments by gender (Guadagno et al. 2011) and due to mixed outcomes heretofore in this area, we pose this research question:

RQ: Is there an interaction effect between gender and channel?

Method

The study employed a 2 (Channel) × 2 (Gender) × 3 (Time) mixed factorial design. Channel and Gender were between-subjects factors and Time was a within-subjects factor. Level of expertise with virtual environments was applied as a covariate, in case a participant's competency or familiarity in maneuvering within virtual environments played a role on outcomes. Previous studies have, in fact, shown that video gamers have greater spatial learning capabilities than non-gamers (Greenfield et al. 1994; Feng et al. 2007; Green and Bavelier 2003), or have found an association between playing video games and increased cognitive performance (Castel et al. 2005; Boot et al. 2008; Colzato et al. 2013; Oei and Patterson 2013). The two tested media channels were Second Life and web, while gender levels were female and male.[1] Three points in time were tested: pre-test (prior to stimulus exposure), immediate post-test (directly following exposure), and delayed post-test (administered two weeks later). The pre-test measure ensured that there was a baseline measure for intercultural sensitivity prior to stimulus exposure. The two-week period between immediate post-test and delayed post-test was determined as a duration long enough to sufficiently capture decay in stimulus effects, but soon enough for efficiency in data collection. The dependent variable was intercultural sensitivity, defined earlier by Chen and Starosta (2000), and was measured using a modified version of Chen and Starosta's Intercultural Sensitivity Scale (Coffey et al. 2013). This modified version is detailed under Procedures. Applying a randomized-blocks research design, subjects were randomly assigned to a channel for testing, either the web or Second Life version. Prior to

[1] On an administered demographic questionnaire, participants self-identified as male or female.

conducting the full experiment, a pilot test ($N = 34$) was performed to pretest stimuli and measures, which were affirmed.

To summarize, this study sought to address the following overarching research questions. What difference exists, if any, between a 2D web and 3D immersive virtual environment on intercultural sensitivity outcomes? Are there positive outcomes toward other cultures generally? Are there positive outcomes for a specific, featured culture (when used as the stimulus)? The following summary outlines the hypotheses and research question addressed in the study.

Summary of hypotheses and research questions

Before detailing the experimental stimuli and procedures, the hypotheses and research question are recapped below.

H1: Subjects exposed to the Second Life environment will have higher intercultural sensitivity *toward other cultures generally* than subjects exposed to the web environment.

H2: Subjects exposed to the Second Life environment will have higher intercultural sensitivity *toward the featured culture* than subjects exposed to the web environment.

H3: Females will experience greater intercultural sensitivity effects *toward other cultures generally* than males.

H4: Females will experience greater intercultural sensitivity effects *toward the featured culture* than males.

RQ: Is there an interaction effect between gender and channel?

The stimuli

The four topics were: (1) Chinese teahouses, (2) Chinese city squares and government buildings, (3) Chinese business office settings, and (4) Chinese city parks and streets (see Fig. 1). The visual and cultural content of each scenario was developed after extensive

Fig. 1 Sample Second Life stimulus. The Chinese Parks scenario as seen in the Second China environment. Bots are performing tai chi

consultation with Chinese cultural experts, to ensure that the virtual architecture, props, and bots' appearance and dress were culturally accurate for ecological validity.[2] Each scenario delivered aural and visual cultural information. As an example, the Chinese business office scenario was developed based on critical information from western visitors to China. Information regarding punctuality and gift giving, Chinese landscape paintings, seating arrangements, Chinese tea drinking, and expressions of seniority and respect was presented (see Appendix). All scenarios followed the model of supplying cultural information "just in time." The four Chinese topics were created in each of the two channels carefully preserving the elements that each channel offers its user.

3D immersive virtual environment stimulus

Second China is an immersive 3D virtual environment or "island" within Second Life created by language, Chinese culture, and aesthetic modeling and computing experts (Fishwick et al. 2008; Henderson et al. 2008). The environment was designed to resemble a modern Chinese city with streets, buildings, and "bots"—"programmed" avatars–scattered throughout the city (see Fig. 1). Users can "visit" the virtual island and walk through the city, explore its parks and buildings, etc. As users explore the island, they are able to click on objects of cultural significance to access detailed information about the object and its cultural significance.

In order to configure this virtual environment for experimentation, adaptations were made to the Second Life version of Second China to produce a "testing version." Among these adaptations were the addition of red, blinking dots on various objects within each testing location (scenario) on the island, which were used as visual cues to help participants navigate; and the addition of audio instructions and navigational directions. In addition, an equal number of unique "bots"—programmed avatars—were created and placed within each scenario as guides, to greet and lead the participant through each topical scenario. The four scenarios all presented similar navigation and interaction experiences, and varied only by subject matter and content.

2D web environment stimulus

Web-based stimuli of the four topical scenarios were also created (see Fig. 2) to maintain the integrity of the visuals and maintain as many similarities as possible to the virtual environment, but it was necessary to remove the immersive third dimension and transfer the content to two dimensions. A website was created with the same topical information from the four scenarios. Instead of navigating through the virtual scenario with an avatar, a narrated slideshow presentation was produced for each using still photos from the scenarios. A Chinese instrumental music track was added, as well as an audio narration of the cultural information. Participants were directed to navigate to the webpage and go back to a home page when the presentation was over. This audiovisual web stimulus was constructed in a way to maintain the integrity of the content and presentation and to be externally valid for presentation via the web using photos and audio while removing the

[2] The decision to use China as the exemplar was made in large part due to the many observable cultural differences with the Western world, which provide sufficient distinctions for experimental testing and aided content and stimuli development for testing intercultural sensitivity outcomes. China's economic and cultural influences upon the Western world make this choice increasingly relevant. Future experiments may wish to test other cultural stimuli.

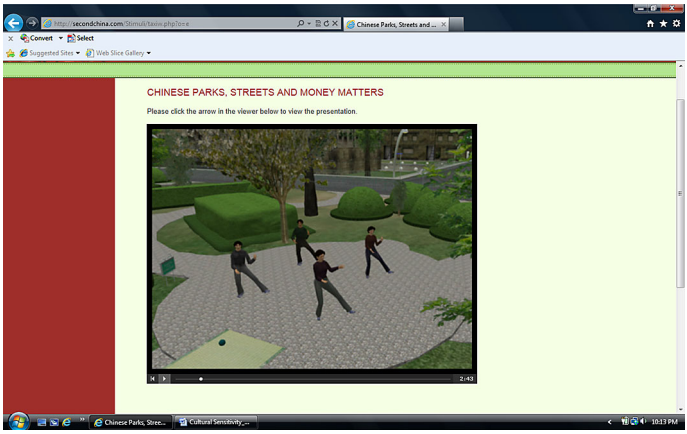

Fig. 2 Sample web stimulus. The Chinese Parks scenario as seen in the narrated slideshow within the web environment

immersive element, a model also used by Peng et al. (2010) in their presentation mode study.

Participants

Undergraduate students ($N = 159$) were recruited from a variety of disciplines at a large public university in the southern United States. Students who met the criteria for participation were offered either extra credit or 20 U.S. dollars as an incentive to participate. Participants were almost equally divided by self-identified gender ($N = 80$ male; $M = 79$ female) and channel ($N = 79$ Second Life treatment, $N = 80$ web treatment). Eighty-five were categorized as experts in online virtual environments, while 74 were categorized as non-experts. The participants' mean age was 20.3 years (Median = 20.0, $SD = 1.8$). In terms of race, 66.7% self-identified as White, 15.1% as Black or African American, 8.8% as Asian, 6.3% as "other race," 1.3% as Native Hawaiian or other Pacific Islander, and 0.6% as American Indian or Alaska Native. The majority (88%) of participants were non-Hispanic, while 12% self-identified as Latino or Hispanic.

Procedures

The experiment involved two sessions. The primary session lasted 1.5–2 h and involved the exposure to stimuli and data collection, and the secondary session, which was conducted two weeks later and lasted about 30 min, was used for administering a delayed measure post-test. The experiment was held in a research lab, in which there were individual carrels with desktop computers (24-inch screens), as well as several laptops. A maximum of two subjects ran simultaneously, and both subjects were administered the same stimulus type (web or Second Life) during a given session. Utilizing a randomized block design, subjects were randomly assigned to a condition.[3] The carrels blocked

[3] In addition to the randomized assignment of conditions, the study was approved by a university IRB and no concerns were raised with the design, ethical or otherwise, thus we feel confident that ethical research practices were followed here.

subjects' view of other computer screens, and each subject's audio reception was facilitated through the use of headphones. The web and Second Life groups received stimuli from computers with identical specifications and screen sizes. Once the participant(s) arrived, they were given the informed consent and after signatures were provided they were given a questionnaire to measure their experience with other cultures. Students who had considerable experience with cultures other than their own, had lived or traveled extensively abroad, or who had experience or substantial knowledge about China or Chinese culture, were excused from the study. Fewer than 15 students were excused for this reason.

The first intercultural sensitivity questionnaire (pre-test) was then administered. Following this, experimental instructions were read aloud to participants and they could begin the experiment. In the Second Life stimulus cases, a few additional steps occurred, in which respondents were allowed to select one of six avatar types based on gender and skin color, pre-designed for testing purposes. This enabled the participants to choose their own identity, to make the experience as lifelike as possible, and to enable the user to identify with his or her avatar. All testing avatars featured similar clothing types, a simple white t-shirt and blue jeans. The Second Life participants also participated in a navigational tutorial to introduce them to Second Life and learn how to interact within the environment and move their avatar. Once this was complete, they participated in an "acclimation scenario" similar in duration to the four used in testing, but which was used to acclimate them to the virtual environment, the audio and visual instructions, and to provide practice in manipulating controls for the avatar. This was included to provide an equalized starting point for all participants.[4] Once the four scenarios of the stimulus were completed (whether web or Second Life), participants were asked to sit at another desk to complete a demographic questionnaire. They were then administered the immediate post-test for intercultural sensitivity. An appointment was set for two weeks later, on which date the participant(s) returned for a delayed measure post-test of intercultural sensitivity. The delayed post-test was conducted in a separate room of the same building.

Measures

Intercultural sensitivity

The dependent variable, intercultural sensitivity, was measured using an adapted version of Chen and Starosta's (2000) ISS, which was selected as the measurement tool due to its reported validity and reliability in subsequent studies (Dong et al. 2008; Fritz et al. 2001; Peng et al. 2005; Peng 2006). Two studies did not find the same level of reliability and their authors have suggested additional testing, particularly when using non-Western population samples (Fritz et al. 2005; Tamam 2010). However, our pilot test ($N = 34$) affirmed the scale's five-factor structure and reliability. We proceeded with the scale's use based on this result and on previous studies that documented its reliability, particularly with Western samples such as this study's. Five dimensions make up the ISS and are defined below, along with a sample question measuring each dimension. Each dimension's abbreviation, for purposes of this study, is also listed:

[4] Such an acclimation or "practice" procedure is common in experiments to make sure users have a "test run." It is also common when introducing users to new technologies. For example, Second Life recommends its users all begin at "Orientation Island," a practice setting where users can learn how to navigate their avatars and familiarize themselves with basic commands and communications used within the environment before entering other places within Second Life.

Interaction Engagement (eng) An individual's "feeling of participation in intercultural communication" (Chen and Starosta 2000, p. 6).

Sample question (eng) I am open-minded to people from different cultures.

Interaction Enjoyment (enj) The individual's evaluation of how positive or negative he/she feels when communicating with people from other cultures (p. 7).

Sample question (enj) I get upset easily when interacting with people from different cultures.

Interaction Confidence (conf) How confident an individual is in an intercultural setting (p. 7).

Sample question (conf) I am pretty comfortable interacting with people from other cultures.

Respect for Cultural Differences (rcd) An individual's evaluation of his/her tolerance to another's culture and opinion or how he/she orients to that culture (p. 7).

Sample question (rcd) I respect the traditions and customs of other cultures.

Interaction Attentiveness (att) Concerned with the individual's willingness to exert "effort to understand what is going on in intercultural interaction" (p. 7).

Sample question (att) I try to learn as much as possible from people of other cultures when I'm with them.

While Chen and Starosta's (2000) scale addressed intercultural sensitivity in general (something we sought to do in this study), we also wanted to know how intercultural sensitivity toward a specific culture might be affected by the stimuli. Toward this end, the ISS was modified, so that a parallel set of questions was developed that dealt specifically with feelings toward Chinese culture and people. For example, a sample parallel question based on the item above for "respect for cultural differences" was: "*I respect the traditions and customs of the Chinese culture*." Foil questions were also added, in an effort to mask the China-specific questions (e.g. "I believe that most Americans are well-informed about the world around them."). For length considerations, three items from each of Chen and Starosta's five identified dimensions were used in the modified scale; excluded items were determined based on inter-item correlations. In terms of final instruments, then, each of the modified versions contained 15 items testing intercultural sensitivity generally (toward "other cultures," with three items per dimension), 15 testing intercultural sensitivity toward China, and 15 foils. Questionnaire items were mixed, so that the general, China-specific, and foil questions were not grouped together or in a particular order. Then, two versions of the same questionnaire were developed (A and B) to minimize order effects. Items that were reverse coded in Chen and Starosta's original scale were also reverse-coded in this study.

Scale reliability

Cronbach's α tests confirmed the reliability of these modified ISS scales. In each case, α ranged from 0.76–0.86 for ISS_General, and 0.79–0.85 for ISS_China. When calculated together as a single scale (as administered in the questionnaires in our study), α ranged from 0.91–0.92. Cronbach's α scores that are 0.70 or above are considered acceptable, with

0.60 considered a lower limit for exploratory research (Hair et al. 1998). All scale scores, then, including the new scale evaluating intercultural sensitivity toward Chinese people and culture, can be considered reliable. Cronbach's α were calculated for each of the five dimensions as well, and were found to be as follows for General Intercultural Sensitivity: interaction engagement (0.88), interaction enjoyment (0.97), interaction confidence (0.82), respect for cultural differences (0.63), and interaction attentiveness (0.94). Cronbach's α results for the individual dimensions on Intercultural Sensitivity toward Chinese culture were: interaction engagement (0.88), interaction enjoyment (0.96), interaction confidence (0.89), respect for cultural differences (0.77), and interaction attentiveness (0.83).

Subject expertise level (co-variate)

To measure participant expertise level (covariate), subjects were asked about their self-reported level of experience with virtual environments, multi-user virtual environments (MUVEs) and role playing games (RPGs). For purposes of this study, non-experts were defined as persons who (1) had no experience with Second Life; or (2) no experience using other virtual environments (including massively multiplayer online role-playing games such as *World of Warcraft*®); or (3) spent less than 1 hour weekly playing massively multiplayer online role-playing games or in an online virtual environment (which could include Second Life or the *World of Warcraft* game), and (4) spent one hour or less weekly playing video games of any kind. All other participants were operationally defined as "experts." Thus, expertise was a dichotomous variable. The categorization was based on respondents' own reporting of the extensiveness or intensiveness of play in these virtual environments; respondents own responses thus served as guidelines for developing expertise categories in the study. This is similar to two other self-reported measurements of expertise in scholarly work that utilized hours (de Castell et al. 2015) or frequency of game play (Jäncke and Klimmt 2011). Another study utilized a three-item scale incorporating self-reported frequency of game play, level of difficulty of the game, and perceived gaming skills (Kazakova et al. 2014).

Data analysis

Analyses were performed to identify gains made in (a) intercultural sensitivity in general and (b) intercultural sensitivity toward Chinese culture. Repeated measures analysis of variance (ANOVA) and analysis of covariance (ANCOVA) procedures were performed in SPSS, using participant expertise level as a covariate. Normality and sphericity assumptions were met, however the covariate (expertise) was not significantly related to the independent variables, $F(1, 154) = 3.450$, $p < 0.065$. Because the homogeneity of covariance assumption was not met for the China-specific tests, an ANOVA was used in place of ANCOVA for that particular set of analyses. The significance level for hypothesis testing was set at $\alpha = 0.05$.

Results

Subjects experienced improvement in their intercultural sensitivity, both toward other cultures in general and toward Chinese culture in particular.

Channel effects

Hypothesis one stated that subjects exposed to the Second Life environment would have higher intercultural sensitivity *in general* than subjects exposed to the web environment. H1 was supported. After adjustment by the covariate of subject expertise, there was a main effect for channel, such that subjects exposed to the Second Life environment displayed significantly higher intercultural sensitivity ($M = 18.49$, $SE = 0.288$) *toward other cultures in general* (and not to one specific culture) than subjects exposed to the web environment ($M = 17.67$, $SE = 0.286$), $F(1, 154) = 4.11$, $p = 0.044$, $\eta_p^2 = 0.026$, observed power = 0.522. Thus, a channel effect was found, and the Second Life environment appeared to produce greater intercultural sensitivity than the web environment for this group of participants. Post-hoc paired comparison tests with Bonferroni adjustment indicated this effect was statistically significant from the pre-test to immediate post-test interval, with an intercultural sensitivity gain of 0.74 ($p < 0.0001$), as well as pre-test to delayed post-test, two weeks later (mean gain in ISS of 0.48, $p < 0.0001$). Despite some loss in intercultural sensitivity between the immediate and delayed post-tests (−0.26, $p = 0.014$), subjects still experienced a net gain in intercultural sensitivity after two weeks (mean gain of 0.48, $p < 0.0001$).

Hypothesis two stated that subjects exposed to the Second Life environment would have higher intercultural sensitivity *toward Chinese culture* than subjects exposed to the web environment. H2 was also supported. A channel effect was found, in which subjects exposed to the immersive 3D virtual (Second Life) environment displayed statistically significant higher intercultural sensitivity toward *Chinese culture* ($M = 17.65$, $SE = 0.290$) than subjects exposed to the web environment ($M = 16.63$, $SE = 0.288$), $F(1, 155) = 6.279$, $p = 0.013$, $\eta_p^2 = 0.039$, observed power = 0.702, applying the Bonferroni post hoc adjustment for multiple comparisons. Paired sample t tests revealed a significant increase in intercultural sensitivity toward Chinese culture immediately following stimulus exposure ($M = 0.80$, $SD = 1.47$), $t(6.86) = p < 0.0001$, and also two weeks later ($M = 0.83$, $SD = 1.49$), $t(7.02) = p < 0.0001$.[5] There was no significant gain or loss between the immediate and delayed measures two weeks later, suggesting that the intercultural sensitivity gains toward China did not diminish over time and had a "staying effect." The Second Life stimulus, Second China, appeared to produce greater intercultural sensitivity toward Chinese culture than the web.

Gender effects

Due to scholarly research indicating that females tend to have greater intercultural sensitivity and awareness and receptivity toward others, hypothesis three stated that females would experience greater intercultural sensitivity toward other cultures *in general* than males. H3 was not supported. There was no main effect for gender, $F(1, 154) = 0.067$, $p = 0.796$, $\eta_p^2 = 0.000$, observed power = 0.058. We also hypothesized that females would experience greater intercultural sensitivity *toward Chinese culture* than males would (H4). H4 was not supported. A gender effect was found, however it was in the opposite direction. Males displayed significantly higher intercultural sensitivity toward Chinese

[5] It should be noted that independent sample t tests comparing intercultural sensitivity mean scores between channels (Web and Second Life) at the pre-test level revealed no significant differences, providing a good baseline condition for the testing that followed. This baseline condition held both for intercultural sensitivity "toward other cultures in general" and toward "Chinese culture specifically."

culture ($M = 17.63$, $SE = 0.288$) than females ($M = 16.65$, $SE = 0.290$), $F(1, 155) = 5.70$, $p = 0.018$, $\eta_p^2 = 0.035$, observed power = 0.660, applying the Bonferroni post hoc adjustment for multiple comparisons.

Finally, due to some previous findings on gender differences and media channel, we asked one research question: whether there was any interaction effect between gender and channel. An interaction effect was found for channel and gender pertaining to intercultural sensitivity in general, $F(1, 154) = 3.93$, $p = 0.049$, $\eta_p^2 = 0.025$, observed power = 0.504. Males exposed to the Second Life environment scored higher in intercultural sensitivity ($M = 18.98$, $SE = 0.405$) than females ($M = 18.01$, $SE = 0.410$), after adjustment by the covariate of participants' expertise. In the web environment, females ($M = 18.04$, $SE = 0.425$) scored higher on intercultural sensitivity than males ($M = 17.29$, $SE = 0.438$), after the covariate adjustment (see Fig. 3). However, post hoc independent t tests indicated that there was no statistically significant difference between males' and females' intercultural sensitivity scores in Second Life for any of the three points in time ($t = 1.903$, $p = 0.061$ pre-test, $t = 1.585$, $p = 0.117$ immediate; $t = 1.264$, $p = 0.210$ delayed), or in the web ($t = -0.731$, $p = 0.467$ pre-test; $t = 0.070$, $p = 0.944$ immediate, $t = -0.366$, $p = 0.715$ delayed), therefore this observed interaction effect was not driven by gender.[6] Rather, the interaction effect was driven by the media channel effect noted earlier. The post hoc testing revealed that significant differences occurred for males in their own intercultural sensitivity outcomes when in Second Life, compared to the web ($t = 2.277$, $p = 0.026$ pre-test; $t = 0.300$, $p = 0.076$ immediate[7]; $t = 0.950$, $p = 0.023$ delayed). However, females' own intercultural sensitivity outcomes did not significantly differ between channels at any of the three points in time ($t = -0.208$, $p = 0.836$ pre-test; $t = 0.328$, $p = 0.744$ immediate; $t = 0.728$, $p = 0.469$ delayed).

In other words, while females' intercultural sensitivity after exposure to cultural information on Second Life did not significantly differ from their intercultural sensitivity when presented the same information on the web, males' intercultural sensitivity levels did, and were driven by the channel effect found earlier. Males had higher intercultural sensitivity when cultural information came from the immersive 3D virtual environment and lower intercultural sensitivity outcomes when the information was presented via the 2D web environment. No interaction effect was found between channel and gender for the Chinese culture specifically, $F(1, 155) = 0.817$, $p = 0.367$, $\eta_p^2 = 0.005$, observed power = 0.146.

Discussion

Channel (e.g. Second Life, web) is a significant factor when it comes to increasing intercultural sensitivity among subjects, and thus should be heavily considered by those instructing or training in the area of intercultural communications or distributing cultural content to audiences. The interaction of gender and channel also revealed that the immersive 3D virtual environment seems to be especially powerful for males in increasing

[6] As further explanation for the non-significant difference between males' and females' intercultural sensitivity scores at all three points in time, there were different starting mean scores. Thus, males still revealed significant increases in their own Second Life outcomes (when comparing to their own starting levels of intercultural sensitivity). See Fig. 3.

[7] The immediate post-test result was non-significant for males, but the other two points in time had significantly higher scores for Second Life compared to the web.

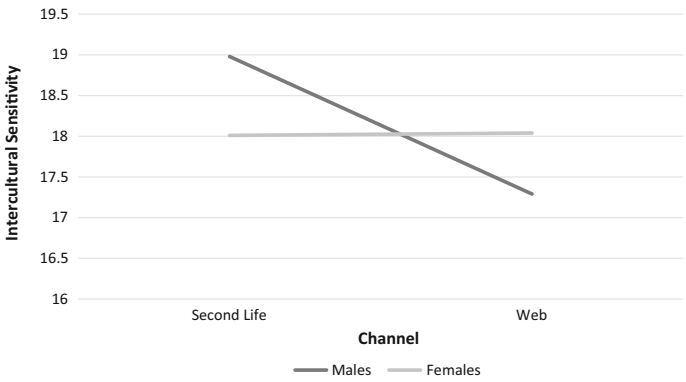

Fig. 3 Interaction of gender and channel on intercultural sensitivity in general

their intercultural sensitivity outcomes. Intercultural sensitivity outcomes—toward other cultures in general and toward specific cultures as well—seem to be affected by media channel choice. While exposure to the cultural stimuli did increase intercultural sensitivity in both channels, we did see enhanced outcomes overall for understanding "the other" in our world, particularly when leveraging 3D immersive environments. The more we know about a culture or people group, the less likely we are to fear them and the more successful we may be in building a relationship with them. The more immersed we are within that culture, the stronger this effect because we are "in" the group versus just being a passive bystander, i.e. the idea of "self-other merging" (Ahn et al. 2013). It is hoped that the superior benefits of the immersive 3D channel would be used for good and not for harm, however one study that compared 2D and 3D gaming environments found that participants who played 3D immersive violent video games experienced a greater sense of presence that amplified their state of anger, compared to those who did not play violently (Lull and Bushman 2016). This current work seems to only illustrate the amplification effect of presence in 3D gameplay, regardless of content; future studies could explore whether there is equal impact of the 3D environment in violent gaming compared to 2D gaming stimuli.

The current study's findings have relevance and implications for persons selecting media and communication distribution channels for conveying cultural content to their constituents, whether international business personnel, students, or general audiences. The immersive 3D virtual environment was found to be more effective than a traditional 2D webpage environment for enhancing intercultural sensitivity in this study, whether toward other cultures in general or toward Chinese culture specifically. Moreover, results indicated these gains in intercultural sensitivity persisted for some time (two weeks). This evidence of "staying power" is important to trainers and educators concerned with intercultural sensitivity retention. Future studies should test intercultural sensitivity gains over longer time periods, to better understand the potential for long-term intercultural sensitivity acquisition.

One possible explanation for why the 3D virtual channel was significantly more effective than the web environment is its life-like, immersive nature. Virtual reality, as the name of this technology suggests, feels "real," so it is almost like interacting with other persons. Intercultural sensitivity would be more likely to be gained when interacting with other real people, and this may be the next closest experience. While actual face-to-face interactions are ideal for education of this type, it may not always be possible due to the

nature of the student's circumstances or work (e.g. soldiers sent to the field, diplomats quickly sent to a foreign region).

An unexpected interaction effect between media channel and gender was found for intercultural sensitivity toward other cultures in general, in which males experienced significantly higher scores in Second Life compared to the web, whereas females did not experience a significant change in their own intercultural sensitivity outcomes between channels.[8] In this sense, the result is consistent with literature noting males' receptivity to visual stimuli (see e.g. Lim and Reeves 2009, gender effect for avatar choice and point-of-view), as well as interaction and navigation opportunities (Lawton 1994; Pazzaglia and Cornoldi 1999). The result suggests that providers of cultural content must bear in mind the nature of their audiences before selecting the appropriate channel for disseminating content. This study's findings suggest that, while 3D immersive environments can be more effective than 2D environments in producing intercultural sensitivity, the 3D virtual environment may be especially effective for males. More testing is recommended to further investigate this conclusion.

Theoretical contributions

While channel effects research is not new, few if any studies have explored the comparative effects of 2D web versus immersive 3D media platforms for delivering content. This study's findings update our knowledge in this area, demonstrating that immersive 3D media platforms play a superior role in aiding intercultural sensitivity acquisition. This form of learning is increasingly valuable in the globalized communities of today's society and classrooms. The need to be interculturally sensitive, and to understand how to best enhance this trait in learners, can be served well by immersive 3D content delivery. These results add strength to previous work exploring the pro-social value of virtual environments. In addition, it extends the work of Diehl and Prins (2008) who found that persons who used Second Life enhanced their 'intercultural literacy,' and Gillath et al. (2008), who documented compassion and concern for virtual others within a virtual space. Overall, there had been a dearth of empirical testing in these areas, and this study provided needed empirical validation of a 3D virtual environment's effects upon intercultural sensitivity acquisition.

Limitations and future research

While the methodological novelty of creating and testing an immersive 3D virtual space is a major contribution of this study, some limitations are worth noting. The nature of virtual environments differs, thus the results for this Second Life-based environment may not necessarily hold for other types of 3D spaces. For instance, some 3D spaces' interfaces enable users to "rotate" or "scale" objects within the space, which can then provide multiple perspective images as stimuli. Still other 3D spaces permit the user to assume the role or perspective of a camera moving through an environment, perhaps in combination with the rotating capabilities. More testing of virtual 3D environments is needed to better understand which types of environments and interfaces produce which types of effects. A

[8] It is important to note that both females and males gained in intercultural sensitivity following exposure to the cultural stimuli according to gender-specific pre-test and post-test scores, in both the 2D web and 3D virtual environments. However, the focus of the study has been on comparative differences by channel and by gender.

slightly larger sample would also have been ideal in this study ($N = 180$ rather than $N = 159$), and may have produced additional or stronger effects.

The testing of other cultural stimuli is also recommended to further inform the efficacy of virtual environments upon intercultural sensitivity. Having a tool to aid cultural understanding can be useful in facilitating communication and bridging gaps between cultures, particularly as it may prevent the propagation of cultural stereotypes in today's media and society (Bratanova and Kashima 2014; Hunzaker 2014; Mandel 2001; Ramasubramanian 2007; Savukynas 2003). In addition, while it is unknown how participant race and ethnicity affected outcomes, if at all, this would be a valuable area for future exploration. More testing of gender is also recommended to further understand and establish its effects within 3D environments, given the range of gender results in previous studies.

Conclusion

This study has advanced our theoretical understanding of the efficacy of immersive 3D virtual environments upon cultural attitudes, and has strengthened the research knowledge base indicating that new, emerging media platforms may be superior media channels for certain content delivery and audience reception. Specifically, channel makes a significant difference in intercultural sensitivity outcomes, and virtual environments can be an effective way of doing so, both for enhancing intercultural sensitivity in general and toward one culture specifically. However, the interaction result between gender and channel for intercultural sensitivity toward other cultures generally, suggests the intended audience of the cultural messages should be considered before delivering such content. Specifically, males experienced significantly greater outcomes within an immersive virtual (3D) space and may be effectively and uniquely reached using this environment. The study's findings have filled a gap not only within channel study research, but have enhanced the knowledge base on intercultural sensitivity, the efficacy and value of immersive 3D virtual environments, and gender research.

The results have practical implications for education in the areas of international relations and diplomacy, racial and ethnic relations, and societal attitudes toward those who we perceive as culturally distinct from ourselves. In the classroom itself, immersive 3D environments may help students of varied cultural backgrounds understand one another better and aid classroom discussion and dynamics, in addition to serving as a foundation for interculturally relevant curricular exercises. For instance, lessons in history, current events, sociology or social studies lend themselves to exercises built using immersive virtual environments, particularly for male students.

Intercultural education and training is a field unto itself; programs are widespread and are often undertaken by international business personnel, governmental entities, and other fields (Brislin et al. 1986; Devita 2000; Jain 2013; Landis and Bhagat 1996; Mausehund et al. 1995; Schreiber 1996; Seidel 1981; Stephan and Stephan 2013). Future training applications using Second China and other virtual environment training (using other cultures and nations) could potentially be installed on students', soldiers', diplomats' or business persons' computers or mobile phones for intercultural sensitivity training prior to departure to another country (and could continue while in the country using the mobile device). Interactive scenarios similar to those presented in Second China would then familiarize individuals on specific customs and ways of life and prepare them for what to

expect, sensitizing them to the new cultural environment for better chances of success during their intercultural interactions.

Identifying new virtual tools, such as Second China, that can effectively "move the needle" toward enhancing intercultural sensitivity, should be considered encouraging news in a time when news headlines suggest a lack of intercultural awareness and understanding. In education and training, there is always an interest in identifying the best delivery platform for instruction and learning. The study's channel results suggest promise for the immersive 3D delivery platform, especially for those interested in reaching male learners. It would seem that males may be significantly affected by messages delivered in an interactive and navigable virtual space, including immersive 3D spaces. While this study focused only on intercultural sensitivity outcomes, future studies may wish to further explore the roles of gender and channel upon other outcomes using other types of content delivered in an interactive virtual environment. Additional testing is also recommended within other cultures to better understand the extent of these findings' generalizability in other contexts.

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Compliance with ethical standards

Conflict of interest The authors declare that there are no conflicts of interest.

Research involving human participants and/or animals The authors affirm that human participants provided informed consent prior to participation in this study.

Appendix: Sample of cultural content presented in stimuli—recorded text from Second China business scenario

When attending a Chinese business meeting, one should arrive 5 min early. Guests are greeted by the host's representative and shown to a meeting room. Gifts are common in business and particular attention should be paid to gift selection. Appropriate gifts include items which symbolize the giver's culture like traditional art or books of photographs. Fine cognacs and pens are also good choices. Gifts to be avoided are clocks, umbrellas, white flowers, and green hats.

For the Chinese, landscape painting represented the universal longing to commune with nature. Chinese depictions of nature were seldom mere representations of the external world but also self-expression and criticism toward the society at the time. Daoism may have contributed to the rise of landscape painting due to its emphasis on how minor human presence is in the greater cosmos.

Seniority is very important in Chinese business contexts and is illustrated in a number of ways. In a Chinese meeting room, the principal guest and host usually sit at the middle of the table with the guest facing the door. Low-ranking guests sit toward the ends of the table. When giving out business cards or other business materials, one should start with the most senior people rather than with those sitting closest to you.

The most common refreshment served at a Chinese business meeting is tea. It is usually served boiling hot. In a formal business situation, there is no need to drink more than a couple of sips of tea. If you do drink more, it will be refilled periodically. If you have the opportunity to pour tea for someone, it will be interpreted as a gesture of respect. In a business environment, the pouring of tea is usually performed by a subordinate.

In modern settings, long tables in the center of meeting rooms may be decorated with flags of the visiting party's country. In addition, one may encounter fresh fruit or bottled water on tables in meeting rooms. Fresh flowers can also be found in some modern conference rooms in China. White flowers are not usually found because white is a funeral color in Chinese culture. Flowers of bright colors like red are preferred.

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