UNTANGLING CULTURAL INFLUENCES ON HUMAN COGNITION: INTEGRATING EVIDENCE ACROSS CULTURAL CONTEXTS AND METHODOLOGICAL APPROACHES

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Self-Construal Priming Affects Holistic Face Processing and Race Categorization, but Not Face Recognition

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Self-construal priming can affect an individual's cognitive processing. Participants who were primed with interdependent self-construal showed more holistic process bias than those who were primed with independent self-construal. The holistic processing of a face also differs across cultures. As such, the purpose of the present study was to explore whether the cultural differences in holistic face processing can be interpreted from the perspective of self-construal, as well as to investigate the relationship between self-construal and holistic face processing/face recognition/race categorization. In Experiment 1, participants were primed with control, interdependent, or independent self-construal, respectively, and then they completed a feature-space same-different task (Experiment 1A) or a composite face effect task (Experiment 1B). Results showed no priming effect in Experiment 1A, whereas independent self-construal priming resulted in less holistic processing in Experiment 1B. In Experiment 2, participants were primed with control, collective/interdependent, relational, or independent self-construal, respectively, and then they completed a Vanderbilt Holistic Face Processing Test and Cambridge Face Memory Test. Participants who were primed as independent showed greater congruency effect than the relational group. Self-construal priming had no effect on face recognition. In Experiment 3, we manipulated self-construal in the same way as that in Experiment 2 and monitored the eye movement of Chinese participants while they learned, recognized, and categorized their own-/other-race faces. Self-construal priming had no effect on face recognition. Compared with other groups, collective-/interdependent-self priming increased the fixation time of eyes and decreased the fixation time of nose in the race categorization task. These results indicated that the cultural differences in self-construal could not mirror the cultural differences in face processing in a simple way.

Keywords: self-construal priming, composite face effect, holistic processing, race, face recognition

INTRODUCTION

Cultural Difference in Self-Construal

Markus and Kitayama (1991) first proposed two kinds of self-construal: independent self and interdependent self. The following descriptions of these two kinds of self-construal are summarized from Markus and Kitayama (1991) and Singelis (1994). Independent self emphasizes the individual's uniqueness. People with such self-construal tend to separate themselves from the social background. When thinking about themselves, individuals with high independent self-construal will be more inclined to express their own abilities, traits, characteristics, or goals, rather than the feelings, thoughts, or actions of others. Interdependent self builds on relationships, identities, social status, and external expectations, emphasizing the connectedness and collectivity of individuals with others and their social relationships. Self-construal varies across cultures, being more independent in Western cultures and interdependent in Eastern cultures (Markus and Kitayama, 1991; Markus et al., 1996).

Some theories implicitly proposed further distinction between two levels of interdependent self: the relational self that derives from interpersonal relationships and interdependence with specific others, as well as the collective self that derive from membership in larger, more impersonal collectives, or social categories (see Brewer and Gardner, 1996; Brewer and Chen, 2007; for a review). In the tripartite model, the self comprises three levels of self-construal: individual, relational, and collective (Brewer and Gardner, 1996; Brewer and Chen, 2007; Tanti et al., 2008; Kashima et al., 2011; Sedikides et al., 2011; Lee et al., 2012). The individual self corresponds most closely to the independent self, as defined by Markus and Kitayama (1991). The relational self is at the interpersonal level and is the self-concept derived from connections and role relationships with significant others. The collective self is at the group level, which corresponds to the concept of social identity, as represented in social identity theory and self-categorization theory (Hogg and Abrams, 1988; Sedikides et al., 2011). Research has indeed indicated that relational self and collective self can be distinguished. For example, Oyserman et al.'s (2002) meta-analysis of individualism and collectivism showed that European Americans were not less collectivistic than Japanese or Koreans. When researchers use a sense of belonging to in-groups and seeking others' advice to assess collectivism, Americans rate themselves as relatively collective; when researchers use duty to in-group instead of these other ways of relating to assessing collectivism, Americans rate themselves as quite low in collectivism. They propose separating the assessment of feelings of belongingness and connectedness from the feelings of duty to the in-group. That is, they suggest assessing relationality separately from collectivism to better understand the difference between Americans and Japanese. Yuki's (2003) framework also posits that Americans have a stronger chronic tendency to emphasize categorical distinctions between in-groups and out-groups, whereas Japanese have a stronger chronic tendency to emphasize the structure of interrelationships within groups. Furthermore, evidence from neuroscience also suggests that relational self and collective self can be distinguished. For example, a functional magnetic resonance imaging (fMRI) study (Zheng et al., 2018) found that relational-self reference, compared with collective-self reference, generated stronger medial prefrontal cortex activity among Chinese participants.

Cultural Difference in Cognition

Nisbett et al. (2001) proposed that the Eastern cognitive system is holistic and that the cognitive systems of Western peoples are analytic. Holistic processing processes the overall message of things and tends to look at the targets and their context as a whole, focusing on the relationship between the two. Analytical processing, on the other hand, tends to process the local information of things and to separate those from their background (also see Ji and Yap, 2016 for a review). The holistic processing patterns of Asians involve a wider area of attention, whereas Westerners' analytical processing patterns involve relatively narrow but more focused attention areas (Nisbett et al., 2001). For instance, McKone et al. (2010) found that East Asians, relative to Caucasians, showed a strong global advantage in the Navon (1977) task. Even short-term cultural priming can affect people's eye movement: Japanese participants who watched the Japanese landscape, compared with the Japanese participants who viewed the American landscape pictures, viewed the culture-neutral images to be wider and less focused on the objects in the central area (Ueda and Komiya, 2012).

Cross-cultural studies on cognitive styles show that East Asians mainly show field dependence and that Westerners mainly show field independence (e.g., Ji et al., 2000; Kitayama et al., 2003). For example, compared with participants from individualistic cultures, participants from collectivistic cultures found it even more difficult to ignore the background information provided by the boxes, thus making more mistakes when adjusting the sticks in the rod-and-frame test (e.g., Ji et al., 2000) or in the framed-line test (Kitayama et al., 2003).

There are also cultural differences in facial holistic processing. Own-race faces are more likely to be recognized holistically, whereas other-race faces are more likely to be recognized featurally with a part-whole task (Tanaka et al., 2004). Davidoff et al. (2008) found that the Himba in north Namibian, compared to the Western observers, were more disrupted by the inversion of "Thatcherized" faces. Miyamoto et al. (2011) found that Japanese are more likely than Americans to use overall resemblance over feature-matching to identify a prototypic face, as well as that Japanese were more accurate than Americans in identifying the spatial configuration of features. Tardif et al. (2017) found that Chinese participants were tuned toward lower spatial frequencies than Canadians participants during the face recognition tasks, despite comparable low-level contrast sensitivity functions.

In addition to behavioral research, cross-cultural studies on eye movement also showed that Eastern and Western participants differ in their face processing. Eastern Asians fixed centrally on the nose region, whereas Western Caucasians primarily explored the eye and mouth regions (Blais et al., 2008; Kelly et al., 2010). Researches using the Spolight paradigm (Caldara et al., 2010) and the expanded Spotlight paradigm (Miellet et al., 2013) further confirmed that Eastern participants indeed collected more information from the nose area and that Western participants collected more information from the eyes and

mouth area. Rodger et al. (2010) found similar fixation patterns for inverted faces with an upright face.

As for cross-race faces, researchers found mixed results. Blais et al. (2008) found that Eastern participants collected more information from the nose area and that Western participants collected more information from the eyes and mouth area, no matter the race of the face during the learning, recognition, and race categorization tasks. Better performance for own-race faces than for other-race faces was observed for both Eastern and Western participants. However, Fu et al. (2012) found that Chinese participants adopt different visual strategies when looking at own-race and other-race faces: In the learning or recognition stage, Chinese participants pay more attention to the central areas (the nose and the mouth) of the own-race faces and on the eyes of the other-race faces. They did not observe an own-race bias in the face recognition task. Yi et al. (2015) further confirmed the above results with Chinese participants.

Self-Construal Priming and Cognition

Self-construal can be temporarily activated in a laboratory. Based on the classic dichotomy theory of self-construal (interdependent self and independent self) proposed by Markus and Kitayama (1991), three priming methods were commonly used to manipulate the self-construal. Two of them were developed by Trafimow et al. (1991). One is the instruction-priming task. They instructed participants to think about the differences between themselves and their family and friends for independent-self priming or to think about something they have in common with their family and friends for interdependent-self priming. The results showed that participants who received the independent self-priming indeed made more idiocentric responses and fewer group responses than participants who received interdependent self-priming in the self-attitude measure. The other is the story-reading task. The story is about a king asking a general, whom he attached great importance to, to recommend a soldier to aid the king. In the story of independent-self priming, the general recommends the soldiers based on the subsequent benefit related to himself, such as solidifying dominion and increasing prestige for himself. In the story of interdependent-self priming, the general recommends a member of his family based on the interest related to his family, such as showing his loyalty to his family and increasing the power and prestige of the family. The third method is the pronoun-circling task firstly developed by Brewer and Gardner (1996), modified by Gardner et al. (1999). In this method, participants were presented an essay and were asked to circle the pronouns (e.g., I, my, mine) communicating prime independent self or pronouns (e.g., we, our, ours) communicating prime interdependent self or control (e.g., it, mountain).

As mentioned above, the tripartite self-construal model is complementary to the dichotomy theory. Some researchers adopted a self-referential task that requires judgment of whether a trait can describe the self or others (e.g., a celebrity, mother, or father) or a group (e.g., Chinese) to activate individual self, relational self, and collective self, respectively (e.g., Mamat et al., 2014; Zheng et al., 2018). In corresponding pronoun-circling priming methods, the independent self is primed in the same way as that in the dichotomy model of self, whereas the methods to manipulate relational self and collective self are different from interdependent-self priming, mainly depending on the interpersonal contextual cues and pronouns used in the priming task. For example, Brewer and Gardner (1996) preliminary operationally distinguished the relational level of self-construal from the collective level of self-construal by using the pronoun-circling task. They instructed participants to read two stories and to circle "we, they, or it" in them. They manipulated the size of the group in these stories: one story is "A Trip to the City," which involves a small group of people, and the other is a story about attending and watching a football game at a large stadium, which involved a large group of people. Although both relational descriptions and collective descriptions were significantly or marginally significantly greater in the *we* prime than in the *it* prime or *they* prime, collective descriptions were clearly greater in the *we* prime condition, and this effect was particularly pronounced for the lager *we* context. Kashima et al. (2011) used a similar but different pronoun-circling task to prime the tripartite self-construal. The individual-self prime story used first-person singular pronouns only (*I, me, my*). The relational narrative told the story about "my parent and I," using first-person plural pronouns only (*we, us, our*). The collective narrative described a large group from the third-person perspective, using the third-person plural pronouns (*they, them, their*). The results showed that Asian's social self increased in the relational prime condition, whereas Australian's social self was prominent in the collective prime condition.

The pronoun-circling priming method has been used in a large body of studies and has been validated to affect cognitive processing, specifically the global/local preference (Kühnen and Oyserman, 2002; Lin et al., 2008; Lin and Han, 2009; Springer et al., 2012; Liu et al., 2015; Choi et al., 2016). For example, researchers found faster responses to the global than to the local targets in the Navon (1977) task (a global precedence effect) in participants exposed to the interdependent self-construal priming, but they found faster responses to the local than to the global targets (a local precedence effect) in participants with the independent self-construal priming (Kühnen and Oyserman, 2002; Lin and Han, 2009). This may be due to varied spatial attention by self-construal priming. The evidence is from participants who were primed with independent self-construal and who completed the local task with higher P1 than the global task; participants who were primed with interdependent self-construal completed the global task with higher P1 than the local task (Lin et al., 2008). P1 amplitude is modulated by spatial attention (Heinze et al., 1994; Martínez et al., 1999, 2001; Di Russo et al., 2003). Lin and Han (2009) found that the flanker compatibility effect was increased by the interdependent priming relative to the independent and control priming, indicating an increasing attention scope for interdependent priming. Liu et al. (2015) employed a focal-peripheral random-dot paradigm, and they also found that the attention scope is selectively modulated by self-construal priming. The interdependent self-construal resulted in the broadening of the attention scope, together with biased information processing in favor of the visual stimuli that share the same feature (e.g., color etc.), as the focally attended stimulus.

This modulation is mainly reflected by varying the degree of suppression on the processing of the incongruent contextual stimuli that do not share visual features with the focal object. Springer et al. (2012) used superimposed face-place stimuli, and they found that independency primed participants were less affected by distractors appearing in the presence of a target (i.e., smaller interference effect) than interdependently primed participants. Choi et al. (2016) found that participants attend more to the context changes in a change-blindness task following interdependent self-construal priming than following independent self-construal priming.

Present Study

Given the cultural differences in self-construal, the cultural difference in cognition, and the effect of self-construal priming on cognition, a reasonable question is whether the cultural difference in self-construal mirrors the cultural difference in cognition. The purpose of the present study was to tackle this issue by examining whether the cultural difference of self-construal mirrors the cultural difference in face processing.

To the best of our knowledge, only a few research (Sui and Han, 2007; Sui et al., 2013; Ng et al., 2015; Ramon et al., 2016) reported the research on self-construal and face processing. Ng et al. (2015) used the self-construal scale (Singelis, 1994) to measure participants' interdependence and to examine its correlation with old-new face recognition accuracy. They found that European Canadians with chronic interdependent-self performed greater recognition for own-race (White) but not for other-race (East Asian) faces, whereas for East Asians, higher interdependence predicted worse recognition for both own- and other-race faces. Ramon et al. (2016) recorded the eye movements of Western Caucasian and Eastern Asian observers after inter- and independent priming, whereas they performed an old/new recognition task for same- and other-race faces. They found that self-construal priming did not determine subjects' fixation patterns during the perceptual processing of faces, with Caucasians and Asians persistently deploying their culturally preferred visual sampling strategies. However, their results were inconsistent with those of Ng et al. (2015) and did not support the view that individual differences in self-construal account for the cultural differences in face processing. Other studies (Sui and Han, 2007; Sui et al., 2013) focused on self-face processing. Their results showed that dichotomy self-construal priming can modulate the neural responses when participants judge the orientations of own faces or familiar faces in the right middle frontal cortex (Sui and Han, 2007) and in the N2 component (Sui et al., 2013).

It should be noted that circling *we our* pronouns for priming interdependent self in Ramon et al. (2016) is actually meant to prime the collective self more than the relational self (Brewer and Gardner, 1996). Thus, whether relational priming takes effect on face recognition remains unknown. What's more, whether self-construal priming affects holistic face processing, and race categorization also remains unknown. Therefore, it is necessary to investigate whether tripartite self-construal priming influences face recognition, holistic face processing, and race categorization.

Generally, we used the pronoun-circling paradigm (Brewer and Gardner, 1996; Gardner et al., 1999) and the story-reading task (Trafimow et al., 1991) to manipulate self-construal. These two tasks were the two commonly used methods for priming self-construal (Oyserman and Lee, 2008). Some research (see Experiment 1 in Gardner et al., 1999) found no difference between their self-construal priming effect. However, a meta-analysis of Oyserman and Lee (2008) showed a larger priming effect size of story-reading task than that of pronoun-circling task. Given that the pronoun-circling task, compared with the story-reading task, was more popular, especially in research with Chinese participants (e.g., Sui and Han, 2007; Lin et al., 2008; Lin and Han, 2009; Sui et al., 2013; Liu et al., 2015) and was easier to prime tripartite self, we mainly used pronoun-circling task in the present study, and only used story-reading task in one experiment (Experiment 3A) to examine whether the results of pronoun-circling priming could be generalized with the story-reading priming.

As for the pronoun-circling task, we used the well-validated and popular pronoun-circling paradigm of the dichotomy self-construal model (e.g., Kühnen and Oyserman, 2002; Sui and Han, 2007; Lin et al., 2008; Lin and Han, 2009; Springer et al., 2012; Sui et al., 2013; Liu et al., 2015; Choi et al., 2016) in some experiments. Participants should read one story with plural pronouns (e.g., we, our) for interdependent-self priming, one with singular pronouns (e.g., I, my) for independent-self priming, and one with impersonal pronouns (e.g., it, its) in the control group. In some experiments, we used an adapted tripartite pronoun-circling paradigm based on previous studies (Brewer and Gardner, 1996; Kashima et al., 2011; Mamat et al., 2014; Zheng et al., 2018). Similarly, a story describing a trip was used. The pronoun-circling stories to prime independent self, collective/interdependent self, and the control condition were used in the same way as those in the dichotomy self-construal priming method. However, the story used to prime the relational self was written from the perspective of "my parents and I," involving only a small group of people, using the relational pronouns *my parents and/or I*.

In the present study, we first asked whether self-construal priming affects holistic face processing in Experiment 1 and Experiment 2. We used the featural-spacing change task (Mondloch et al., 2002; Miyamoto et al., 2011) in Experiment 1A, as well as the standard complete composite face task (e.g., Zhou et al., 2012; or see Richler and Gauthier, 2014 for a review) in Experiment 1B to examine holistic processing. Both Experiments 1A and 1B used the dichotomy pronoun-circling task to prime self-construal. Experiment 2 used a revised composite face task (Richler et al., 2014) to measure holistic processing and a tripartite pronoun-circling task to prime self-construal.

Previous studies have shown that after priming the independent self, the participants are more inclined to analytical processing, and after priming the interdependent self, they tend toward holistic processing (Kühnen and Oyserman, 2002; Lin and Han, 2009; Springer et al., 2012; Liu et al., 2015; Choi et al., 2016). Therefore, we hypothesized that Chinese participants who were primed with interdependent/collective or relational self, compared with those who were primed with

independent self, were more sensitive to configural features or were more likely to participate in holistic processing.

However, it should be noted that the definitions of holistic processing varied in different paradigms, and there was no correlation among these different types of holistic face processing, which implied that facial holistic processing may reflect distinct facial perceptual mechanisms (Wang et al., 2012; Rezlescu et al., 2017). Therefore, we adopted various paradigms of holistic face processing to examine which paradigm(s) is(are) sensitive to self-construal priming, and whether the effect of self-construal priming on holistic face processing could be generalized to various paradigms.

Second, we investigated whether self-construal priming affects face recognition. We used only own-race faces and used the Chinese version of the Cambridge Face Memory Test (CFMT-Chinese; McKone et al., 2012) to measure face recognition in Experiment 2, used own-race faces and other-race faces and used old-new face recognition task to measure face recognition in Experiment 3A and Experiment 3B, and recorded eye movement in Experiment 3B. Experiment 3A used an adapted Chinese version of the story-reading task (Trafimow et al., 1991) to prime self-construal. Experiment 3B adopted a tripartite pronoun-circling task to prime self-construal. Own-race faces are more likely to be recognized holistically, whereas other-race faces are more likely to be recognized featurally with a part-whole task (Tanaka et al., 2004; however, see Hayward et al., 2013 for a review for different results with other holistic tasks in Hayward et al., 2008; Wiese et al., 2009; Mondloch et al., 2010; Horry et al., 2015), and individual differences in holistic processing could predict face recognition (Richler et al., 2011; Wang et al., 2012; DeGutis et al., 2013; however, see different results in Konar et al., 2010; and mixed results in Rezlescu et al., 2017). Therefore, interdependent/collective or relational priming would be expected to increase own-race face recognition performance; independent priming would be expected to enhance other-race face recognition.

It should be noted that the measures of face recognition in those research also varied: four/ten-alternative forced choice identification task in some research (Konar et al., 2010; Richler et al., 2011), old-new face recognition task in some research (Wang et al., 2012), and the Cambridge Face Memory Test (Duchaine and Nakayama, 2006) in other research (Richler et al., 2011; DeGutis et al., 2013; Rezlescu et al., 2017). Therefore, we adopted various paradigms of face recognition to examine which paradigm(s) is(are) sensitive to self-construal priming, and whether the effect of self-construal priming on face recognition could be generalized to various paradigms.

In addition, Ng et al. (2015) found higher interdependence chronic self-construal predicted worse recognition for both own- and other-race faces for East Asians. What's more, self-construal priming did not determine subjects' fixation patterns during the perceptual processing of faces, with Caucasians and Asians persistently deploying their culturally preferred visual sampling strategies (Ramon et al., 2016). Therefore, we examine whether the results of Ramon et al. (2016) could be confirmed with Chinese participants.

Finally, we are interested in whether self-construal priming affects race categorization in behavior performance and eye movement in Experiment 3B. Race categorization is different from face recognition in that face recognition task showed an own-race advantage, while race categorization showed an other-race advantage (Levin, 2000; Ge et al., 2009). Blais et al. (2008) showed Caucasians and Asians persistently deploying their culturally preferred visual sampling strategies in the face learning, face recognition, and race categorization stages. It has been shown that self-construal priming did not influence the eye movement patterns during the face learning and face recognition stages (Ramon et al., 2016). However, whether self-construal priming affects race categorization remains unknown. According to Blais et al. (2008), we expect to observe different eye movement patterns for interdependent/collective or relational priming and for independent priming with the former similar with Asians' pattern and the latter similar with Caucasians' pattern. However, according to Ramon et al. (2016), it is also possible that self-construal priming would not affect race categorization, similar with the result of face learning and that of face recognition.

The current research has been approved by the Institutional Review Board of the Psychology Department of Sun Yat-sen University. Each participant in each experiment signed a consent form before taking part in the experiment.

EXPERIMENT 1: SELF-CONSTRUAL AND HOLISTIC FACE PROCESSING

In this experiment, we are interested in whether self-construal priming affects holistic face processing. We used the featural-spacing change task in Experiment 1A, as well as the standard complete composite face task in Experiment 1B to measure holistic processing. Both Experiments 1A and 1B used the dichotomy pronoun-circling task to prime self-construal.

If the cultural difference of self-construal mirrored the cultural difference in holistic face processing, the participants who were primed with interdependent/collective or relational self, compared with those who were primed with independent self, would be more likely to participate in holistic processing.

Experiment 1A: Space and Feature

Method

Participants

One hundred and nine students (Mean age = 18.84 years, SD = 1.21; 47 males, 62 females) of Sun Yat-sen University participated in this experiment for payment and were randomly assigned to three priming groups. Three subjects were excluded from the final analysis because they ran the wrong program that did not correspond to the priming group they were assigned to. The final data included 35 in the control group, 34 in the independent group, and 37 in the interdependent group.

Materials

Self-construal priming: We manipulated the self-construal level by employing the pronoun-circling task (Gardner et al., 1999). Because we used two tasks of face processing in the current experiment, we used two Chinese essays describing a trip in

the priming procedure. Each essay converted into three versions that contained independent (e.g., I, my), interdependent (e.g., we, our), and control (e.g., it, its) pronouns, with the same number of pronouns to circle.

Face stimuli: Four original Chinese faces (half male and half female) were used to generate four sets of spacing-change faces and featural-change faces. In all faces, the non-facial features such as hair, ears, and neck were removed, and the faces were generated into elliptical grayscale images of 284 × 396 pixels. As shown in **Figure 1,** each original face was generated into four images with changing facial spaces and four images with changing facial features. Following the previous study (Mondloch et al., 2002; Miyamoto et al., 2011), the four faces in the spacing set were created by moving the eyes in the original face down and up, shortening or widening them 4 mm (10 pixels), and moving the mouth down or up 2 mm (5 pixels) (moving eyes and mouth down; moving eyes and mouth up; moving the eyes closer together; moving the eyes farther apart). The four faces in the featural-changing set were created by replacing the eyes and mouth in the original face with the features of other same-sex faces. The replaced eyes and mouth are approximately equal in length with the eyes and mouth of the original face in order to maintain the original space position constant. In total, 36 images (4 original faces +32 generated faces) were created as stimuli.

Procedure

The experiment was programmed with E-prime1.1 and was run *via* a 23-inch computer with a resolution of 1,920 × 1,080 pixels. Throughout the experiment, the distance between the participants' eyes and the computer screen was about 50 cm.

Participants were randomly assigned to a priming group. The spacing and featural-face processing procedure followed that of the previous study (Mondloch et al., 2002; Miyamoto et al., 2011). Spacing-change trials and featural-change trials were blocked to encourage participants to use specific face-processing strategies. The order of the two blocks was balanced across participants.

In each block, the instructions informed the following: "These faces all look alike, but they are all different people. Two faces flash up fast on the screen successively several times. The task is to judge whether the two faces are the same or different as accurately and as quickly as possible." As an illustration, a Chinese male face and its four modified faces with spacing/featural change were presented on the screen. Then, participants were given eight practice trials: one same and one different trial for each face set. After that, participants read the printed priming stories and circled the pronouns. Then they completed 160 formal trials, with half being same trials and the other half being different trials.

In each practice trial, first there was a 600-ms inter-trial blank interval, and then the first face was displayed 360 ms, followed by a 100-ms blank, and then the second face was displayed until participants responded by pressing "1" (same) or "2" (difference), followed by a 1,500-ms feedback. The accuracy rate of practice trials should reach 60% to start the formal experiment.

In each formal trial, first there was a 600-ms inter-trial blank interval, and then the first face was displayed 200 ms at the center of the screen. After a 300-ms blank interval, the second face appeared until the participants' response.

Each face served as the first face as often as the second face, and each face was presented on the same trials as often as the different trials.

At the end of the experiment, participants were asked to complete a questionnaire to evaluate their attention to the information on the face during the experiment on a 7-point Likert scale from 1 (completely unnoticed) to 7 (completely noticed). The questionnaire contains gazing ratings of two types of information on the face: one is featural information such as nose, eyebrows, eyes, and mouth; and the other is integral information such as expression, overall impression, and configuration (Miyamoto et al., 2011).

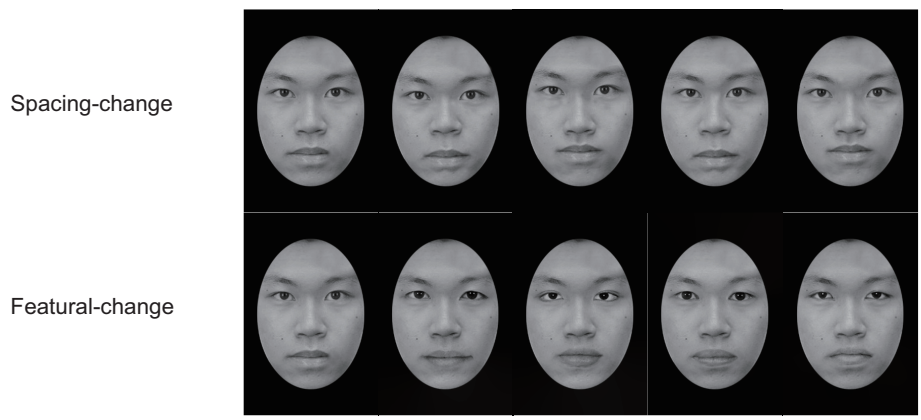

FIGURE 1 | Example of an original face (the left-most face in each row), his spacing-composite faces (top row), and his featural-composite faces (bottom row) used in Experiment 1A. These illustrated examples did not appear in the actual experiment. Written informed consent was obtained from the individual for the publication of this image.

Results and Discussion

The analysis of the questionnaire of gazing ratings showed no significant effect (*p*s > 0.35).

Miyamoto et al. (2011) showed that Japanese are more likely than Americans to use overall resemblance over feature-matching to identify a prototypic face, as well as that Japanese were more accurate than Americans in identifying the spatial configuration of features. Therefore, if the cultural difference of self-construal mirrors the cultural difference in face processing, the participants who were primed with interdependent/collective or relational self, compared with those who were primed with independent self, would be more sensitive to spacing-change.

Sensitivity d' [Z(Hit)-Z(False Alarm)] of each participant was submitted to a 3 (priming: control, interdependent, independent) × 2 (feature type: featural, spacing), mixed-design ANOVA. Four participants' d' was below two standard deviations from the mean in either the featural task or the spacing task, so their data were discarded. Results (see **Figure 2**) showed a significant main effect on the feature type, $F(1, 99) = 38.94$, $p < 0.001$, $\eta_p^2 = 0.28$, with better performance for featural change than for spacing change. The main effect of priming and its interaction with feature type did not reach significance, *p*s > 0.19, indicating that self-construal priming did not affect participants' sensitivity to spacing change or featural change.

The analysis of response time on the correct trials showed no significant effect (*p*s > 0.37), further confirmed that self-construal priming did not affect participants' sensitivity to spacing change or featural change (**Figure 2**).

Experiment 1B: Standard Composite Effect

Method

Participants

Twenty-nine Sun Yat-sen students (mean age = 19.93 years, SD = 1.71; 16 males, 13 females) participated in this experiment for payment. All participants were with normal or corrected normal vision.

Materials

Self-construal priming: In this experiment, the self-construal levels were manipulated within the subjects. Same as Experiment 1A, we also used the pronoun-circling task (Gardner et al., 1999), but we asked the participants to circle the neutral words (e.g., mountain, see Liu et al., 2015) here instead of impersonal pronouns (e.g., it, its) in the control condition.

Face stimuli: Eight Chinese male faces were used to generate stimuli by removing the hair, ear, neck, and other non-facial features from facial images and were processed into grayscale images of 180 × 240 pixels.

Procedure

The experiment was programmed by E-prime1.1 software. The stimuli were presented on a 21-inch computer screen with a resolution of 1,024 × 768 pixels.

The composite face task consists of a training block and three formal blocks. The training block consisted of eight practice trials with feedbacks, and then participants were required to complete the pronoun-circling task before each formal block. The inter-block intervals lasted 1 min. The order of three priming tasks was counterbalanced across participants.

The trial procedure of the composite face task followed that of Zhou et al. (2012). In each trial, a 200-ms fixation was displayed at the center of the screen, followed by a 250-ms blank screen. The first composite face (the learn face in **Figure 3**) was displayed for 200 ms, followed by a 500-ms blank screen, and the second composite face (the test face in **Figure 3**) was displayed for 2,000 ms or until participants responded. Participants were required to determine whether the tops of the two composite faces were the same or different as quickly and accurately as possible. Half of the trials were the same correct response, and the other half were the different correct response. In congruent trials, the tops and bottoms were both the same or different; in incongruent trials, the tops were the same and the bottoms were different, or vice versa. Each formal block consisted of four conditions (alignment × congruence) with 32 trials in each condition, totaling 128 trials.

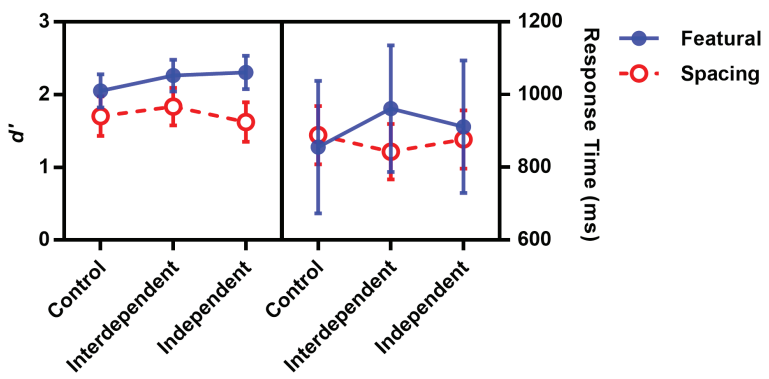

FIGURE 2 | Mean sensitivity and correct response time as a function of priming and feature change type in Experiment 1A. The error bar included here and elsewhere refers to a 95% confidence interval.

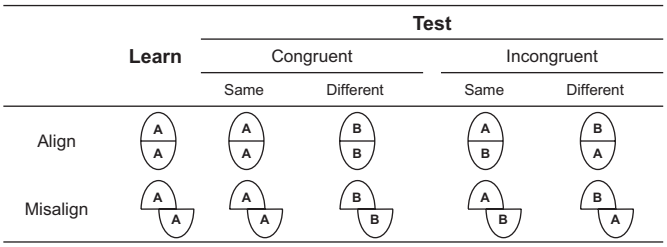

FIGURE 3 | Illustration of the standard composite task in Experiment 1B. Participants' task was to determine whether the tops of the learn- and test-composite face were the same or different. In the congruent trials, the tops and bottoms were both the same or different; in incongruent trials, the tops were the same and the bottoms were different, or vice versa.

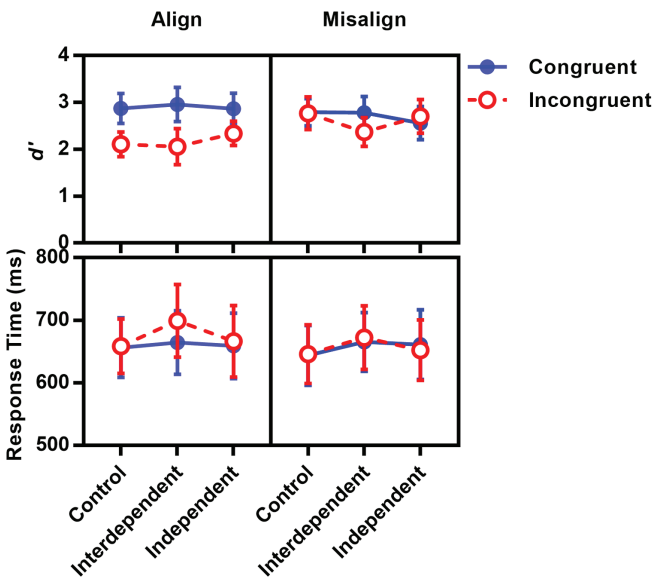

FIGURE 4 | Mean sensitivity and correct response time as a function of priming, congruency, and alignment in Experiment 1B.

Results and Discussion

Two participants' data were discarded because their accuracies were below two standard deviations from the mean (mean = 0.85, SD = 0.06).

Sensitivity d' (see **Figure 4**) of each participant was submitted to a 3 (priming: control, interdependent, independent) × 2 (congruency: congruent, incongruent) × 2 (alignment: aligned, misaligned) repeated ANOVA. If the cultural difference of self-construal mirrored the cultural difference in face processing, the participants who were primed with interdependent/collective or relational self, compared with those who were primed with independent self, would show more holistic face processing (i.e., larger alignment × congruence effect).

There was a significant main effect in congruency [$F(1, 26) = 27.88$, $p < 0.001$, $\eta_p^2 = 0.52$] and a trend toward an alignment effect [$F(1, 26) = 2.92$, $p = 0.10$, $\eta_p^2 = 0.10$]. Their interaction reached significance, $F(1, 26) = 18.48$, $p < 0.001$, $\eta_p^2 = 0.42$, indicating a holistic face processing. Further simple effect analysis showed that when the top half and the bottom half of a face were aligned, the bottom half indeed impacts the processing of the top half, with a better performance in congruent condition than that in incongruent condition, $p < 0.001$. In the misaligned condition, however, no difference between congruence and incongruence was observed, $p = 0.32$.

Importantly, a significant interaction between priming and congruency was observed, $F(2, 52) = 3.33$, $p = 0.04$, $\eta_p^2 = 0.11$. A simple effect test showed no congruency effect for the independent condition ($p = 0.90$), whereas it showed a congruency effect for the control condition ($p < 0.01$) and interdependent condition ($p < 0.001$). Other main effects or interactions did not reach significance ($ps > 0.30$).

Although priming did not affect congruency × alignment holistic processing, priming influenced the congruency effect with the same pattern mirroring the cultural difference in holistic processing.

The correct mean response time (see **Figure 4**) of each participant was submitted to a 3 × 2 × 2 repeated ANOVA. There was a marginal significant main effect of congruency [$F(1, 26) = 3.07$, $p = 0.09$, $\eta_p^2 = 0.11$] and alignment [$F(1, 26) = 3.52$, $p = 0.07$, $\eta_p^2 = 0.12$]. Their interaction reached significance, $F(1, 26) = 5.67$, $p = 0.03$, $\eta_p^2 = 0.18$. Importantly,

we observed a significant interaction between priming and congruency, $F(1, 26) = 3.44$, $p = 0.04$, $\eta_p^2 = 0.12$. A simple effect test showed no congruency effect for the control condition ($p = 0.75$) and independent condition ($p = 0.90$), whereas it showed a congruency effect for the interdependent condition ($p = 0.005$). Other main effects or interactions did not reach significance ($ps > 0.35$).

Similar to the result of d', the result of the response time showed that priming could influence the congruency effect. However, compared with the control condition, the interdependent priming only affects response speed, so as to enlarge the congruency effect, whereas the independent priming only affects sensitivity, so as to shrink the congruency effect.

EXPERIMENT 2: SELF-CONSTRUAL, REVISED COMPOSITE EFFECT, AND FACE RECOGNITION

Given that there is low reliability (around 0.2) for the standard composite face task (DeGutis et al., 2013; Ross et al., 2015), Richler et al. (2014) proposed the Vanderbilt holistic face processing test (VHFPT) as a revised composite effect task. VHFPT has good reliability, around 0.4–0.7 (Richler et al., 2014; Wang et al., 2016). In addition, according to the tripartite model of self-construal (Brewer and Gardner, 1996), self-construction can be subdivided into independent/individual self, relational self, and collective self. Therefore, in this experiment, we used VHFPF to measure holistic face processing and used the pronoun-circling task to prime the independent, relational, and collective selves to examine whether the self-construal priming effect on holistic face processing could be generalized. We were also interested in whether self-construal priming would affect face recognition.

Own-race faces are more likely to be recognized holistically, whereas other-race faces are more likely to be recognized featurally (Tanaka et al., 2004), Chinese participants were tuned toward lower spatial frequencies than Canadians participants during the face recognition tasks (Tardif et al., 2017), and individual differences in holistic processing could predict face recognition (Richler et al., 2011; Wang et al., 2012; DeGutis et al., 2013). Therefore, if the cultural difference in self-construal mirrored the cultural difference in face holistic processing and face recognition, the participants who were primed with interdependent/collective or relational self, compared with those who were primed with independent self, would show more holistic face processing and better face recognition performance.

Method

Participants

Eighty-six undergraduates (mean age = 19.66 years, SD = 1.25; 39 males, 47 females) of Sun Yat-sen University participated in the study. All participants had normal or corrected normal vision and were randomly assigned to four groups (about 21 or 22 participants in each group).

Materials

Self-construal priming: Based on the tripartite self-construal model (Brewer and Gardner, 1996), we used an adapted pronoun-circling task to prime independent, relational, and collective selves. The collective-self priming method was the same as that used for interdependent-self priming in Experiment 1. The relational self was manipulated by reading the story with pronouns of *my parents and me, parents,* or *me* and circling those pronouns in it. Independent-self priming and control conditions were identical to those in Experiment 1A.

Faces in VHFPT: Six female Chinese celebrity faces obtained from the Internet and 216 unfamiliar Chinese faces (108 males and 108 females) were used as stimuli. They were converted to 86 × 120 pixels grayscale images. The celebrity-face set was used for practice. The unfamiliar faces were grouped into 36 sets of six same-sex faces. Within each set, three faces were used to generate the target parts, and the other three faces were used to generate the distractor parts. Each set of faces was combined into 3 alignments (aligned, misaligned, and scrambled) × 2 congruencies (congruent or incongruent) for a total of six trials per set (see **Figure 5**). Unfamiliar face sets were randomly assigned to nine target part conditions (see **Figure 6**): top and bottom third (86 × 40 pixels); top half and bottom half (86 × 60 pixels); top and bottom two-thirds (86 × 80 pixels); and eyes, nose, and mouth (86 × 23 pixels). The target parts in the learning and test phases were marked with a red line with a width of two pixels. The top portions of targets were cropped to remove hair to avoid salient non-face cues. Each target part condition contained two female sets and two male sets.

Each target face was the correct answer for one alignment condition pair (congruent and incongruent trials) and served as a foil in the other two alignment conditions. The composite face in the learning phase was created by pairing one of the three target parts and distractor parts in one set. The same composite face was used for congruent and incongruent trials within each alignment condition. In the test phase, three composite faces (correct response, foil 1, and foil 2) were displayed simultaneously. In congruent trials, the target part of the correct-response face was paired with the same distractor part of the composite face in the learning phase. The other two foil faces were composited with the remaining two target and distractor parts. In incongruent trials, the target part of the correct-response face was paired with the distractor part of foil 1, and the learning composite distractor part was paired with the target part of foil 1. The second foil face in congruent trials was the same as that in incongruent trials.

In misaligned condition, the target and distractor parts were aligned in study composites and were misaligned in test composites. The extent of misalignment of the two parts was constant in the experiment at 20.5 pixels to the right of the interfering part. In scrambled condition, the distractor parts were degraded using the random image structure evolution algorithm proposed by Sadr and Sinha (2004) and refer to the 65% picture distortion rate used in Richler et al.'s study (2014).

Face recognition: We used the Chinese version of the Cambridge face memory test (CFMT-Chinese; McKone et al., 2012) to measure face recognition. The procedure of CFMT-Chinese

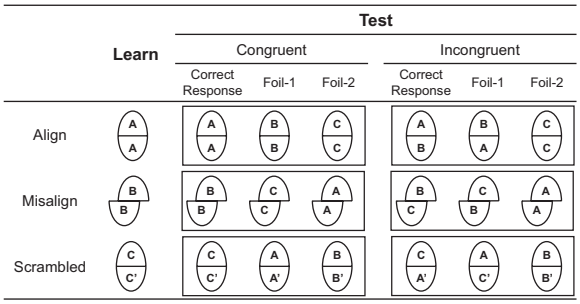

FIGURE 5 | Illustration of six trials in the revised composite task in Experiment 2. Participants' task was to select one composite face with the same target parts (here, the target is the top half) as that of learning composite face from three test composite faces (each rectangle above). Apostrophes indicate that distractor parts of the composite faces (bottom parts in this figure) have been phase-scrambled.

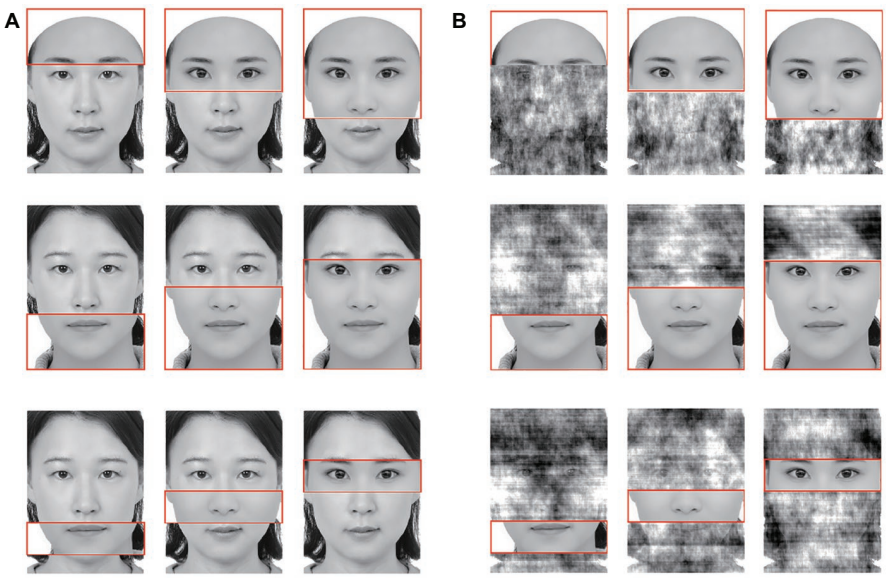

FIGURE 6 | Examples of nine different kinds of target parts in alignment condition **(A)** and scramble condition **(B)** of the VHFPT in Experiment 2. In all trials, target parts were identified by a 2-pixel wide red line box. These illustrated examples did not appear in the actual experiment. Written informed consents were obtained from the two individuals for the publication of these images.

followed the same procedure of the CFMT (Duchaine and Nakayama, 2006). The Chinese male face stimuli were developed in the same way as those in CFMT.

Procedure

The VHFPT, running with E-prime 1.1 software, and CFMT-Chinese, running with MATLAB software, were displayed on a monitor with a resolution of 1,024 × 768 pixels. The distance between the participants and the screen was 65 cm.

Participants were randomly assigned to one of four priming groups. Each group accepted one type of self-construal priming with the pronoun-circling priming task. Participants then immediately completed the VHFPT (Richler et al., 2014), followed by the CFMT-Chinese (McKone et al., 2012).

Vanderbilt holistic face processing test (VHFPT): In each trial, one composite face (the learn face in **Figure 5,** target part was outlined in red as shown in **Figure 6**) was presented for 1,000 ms, followed by a 500-ms mask. Then, a set of three test faces (the test faces in **Figure 5,** target parts were outlined in red) appeared until participants made a response. The masked pictures were black and white random dots and were of the same size as the composite faces (86 × 120 pixels). The task was to judge which of the three composite faces contained the same target part as the study composite. The response keys (J, K, and L) appeared below each test image. The position of correct faces was randomized.

Trials were blocked by target parts. The order of nine blocks was randomized among participants. Each block started with six practice trials generated by the celebrity face set, followed by 24 formal trials generated by four face sets. In order to ensure that at least two trials separated trials generated from the same face set, trials were presented in preset random

order. The VHFPT contains 270 trials (54 practice trials and 216 formal trials).

Cambridge face memory test (CFMT-Chinese): The CFMT-Chinese (McKone et al., 2012) was presented using the standard procedure in Duchaine and Nakayama (2006), consisting of four phases (practice, same images, novel images, and novel images with noise). The practice phase familiarizes participants with the procedure used in the "same images" phase by presenting carton faces in the same fashion that target faces will be presented. In the "same images" phase (18 trials), there were six different male faces presented from three viewpoints each (a left 1/3 profile, a frontal view and a right 1/3 profile). In each trial, a face was displayed for 3 s, then three test items consisting of one target face and two distractor faces were presented. Participants were instructed to choose the individual who they were just shown. In this phase, the target face in study and test are the same image. In the subsequent "novel images" phase, six target faces with a frontal view were displayed for 20 s. Then, 30 trials of three-alternative forced-choice test items were displayed in a fixed random order. Participants were asked to select one of the six target faces from three test faces. The target images in the test items were novel images that varied in pose, lighting, or both. The procedure in the "novel images with noise" phase was similar, except that there were 24 trials in this phase, and the test faces were all novel images with Gaussian noise.

Results and Discussion

Four participants' accuracies were below two standard deviations from the mean (Mean = 0.86, SD = 0.06), so their data were discarded.

Compared to traditional face composite effect tasks that measure the holistic processing effect of faces by the interaction effect of congruency (congruent or incongruent) × alignment (aligned or misaligned), VHFPT adds a new set of scramble conditions. The holistic processing effect in the present experiment was measured as the congruency (congruent or incongruent) × alignment (aligned, misaligned, or scrambled) interaction.

Self-Construal Priming and the Holistic Processing Effect

The accuracies of the remaining participants were submitted to a 4 (priming: control, collective/interdependent, relational, independent) × 2 (congruency: congruent, incongruent) × 3 (alignment: align, misalign, scramble) mixed-design repeated measure ANOVA. The results (see **Figure 7**) showed a significant main effect of congruency, $F(1,78) = 115.84$, $p < 0.001$, $\eta_p^2 = 0.60$, and its interaction with alignment, $F(2,156) = 24.84$, $p < 0.001$, $\eta_p^2 = 0.24$. Importantly, these effects were modulated by priming. Both the interaction of congruency and priming [$F(3,78) = 3.06$, $p = 0.03$, $\eta_p^2 = 0.11$] and the three-way interaction [$F(6,156) = 2.69$, $p = 0.02$, $\eta_p^2 = 0.09$] reached statistical significance. Other main effects or interactions were not observed ($ps > 0.14$).

Separate analysis for each priming group showed significant main effects of congruency for all groups ($ps < 0.01$). Significant congruency × alignment interactions were observed for all groups ($ps < 0.02$) except the control group ($p = 0.16$).

To compare the congruency effect of each priming group, we calculated the size of congruency effect (control: 0.05, relational: 0.03, collective/interdependent: 0.06, independent: 0.08) and submitted it to a one-way ANOVA. Bonferroni's *post hoc* tests showed that only the independent group and

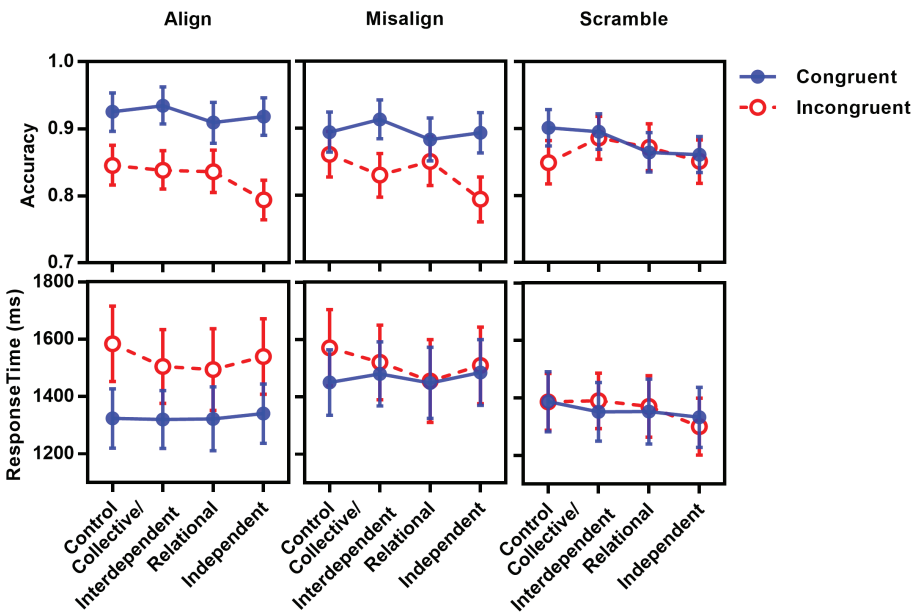

FIGURE 7 | Accuracy (top panel) and correct response time (bottom panel) as functions of priming, congruency, and alignment in Experiment 2.

the relational group showed significant differences, with a larger congruency effect for the independent group than that of the relational group ($p < 0.03$); the differences between other groups did not reach significance ($ps > 0.29$). That is, although we replicated the result that the congruency effect was modulated by priming in Experiment 1B, the priming pattern was different from that of Experiment 1B. The larger congruency effect in independent priming than in relational priming is inconsistent with the cultural difference in holistic processing.

To examine whether the three-way interaction of priming × congruency × alignment was due to null congruency × alignment interaction for the control group, we did a 3 (priming: collective/interdependent, relational, independent) × 2 (congruency: congruent, incongruent) × 3 (alignment: align, misalign, scramble) mixed-design repeated measure ANOVA. The three-way interaction of priming × congruency × alignment did not reach statistical significance, $F(4,124) = 0.48$, $p = 0.75$, $\eta_p^2 = 0.02$.

The 4 × 2 × 3 mixed-design repeated measure ANOVA of the correct response time of each participant showed a significant main effect of congruency; $F(1,78) = 49.51$, $p < 0.001$, $\eta_p^2 = 0.39$; alignment, $F(2,156) = 37.21$, $p < 0.001$, $\eta_p^2 = 0.32$; and their interaction, $F(2,156) = 41.83$, $p < 0.001$, $\eta_p^2 = 0.35$. No other main effect or interaction was observed ($ps > 0.23$). Differently from Experiment 1B, priming did not affect the congruency effect in RT.

Self-Construal Priming and Face Recognition

Two participants' data were discarded because their CMFT performance was beyond two deviations of the mean. The CMFT percentage was submitted to a one-way ANOVA. The results showed no effect of self-construal priming on CMFT performance, $F(3,84) = 1.31$, $p = 0.28$, $\eta_p^2 = 0.05$. This result also indicated that self-construal had no effect on face recognition, consistent with Ramon et al. (2016), inconsistent with Ng et al. (2015). The null effect of self-construal on face recognition may be due to a not strong enough priming effect of pronoun-circling task. Therefore, we further examined the effect of self-construal on face recognition with story-reading task in Experiment 3.

The Pearson correlation analysis showed that the accuracy of CFMT was not correlated with the holistic processing effect neither in accuracy nor in RT no matter take scramble as baseline or misalign as baseline, $ps > 0.26$, consistent with some research (Konar et al., 2010) while inconsistent with others (Richler et al., 2011; Wang et al., 2012; DeGutis et al., 2013).

EXPERIMENT 3: SELF-CONSTRUAL AND OWN-RACE BIAS

Although Experiment 2 did not show self-construal priming effect on face recognition, the purpose of Experiment 3 was to investigate whether the result could be replicated with story-reading priming task (Experiment 3A), whether the result could be generalized to other race face recognition and race categorization task (Experiment 3A and 3B), and how self-construal would affect the eye movement during face learning, face recognition, and race categorization (Experiment 3B).

Experiment 3A: Self-Construal, Own-Race Bias

Method

One hundred and three students of Sun Yat-sen University (mean age = 18.65, SD = 0.79; 41 males, 62 females) participated in this experiment. All participants had normal or corrected normal vision and were randomly assigned to three groups. Each group received one type of self-construal priming and then completed a face recognition task immediately. The face recognition task was programmed with E-prime1.1 and done on a computer with a resolution of 1,280 × 768 pixels.

Self-construal priming: In this experiment, we manipulated the self-construal level using the story-reading task in Trafimow et al. (1991). Because all participants are Chinese, we changed the backgrounds and names of the characters in those stories into Chinese style. In the control condition, no priming was done.

Face recognition task: The own-race faces were 20 faces photographed by our lab [some of them used in Zhou et al. (2015) and the other-race faces were 20 Caucasian faces by Minear and Park (2004)], 10 female faces and 10 male faces. We removed the non-facial features such as hair, ears, and necks, and generated the faces into elliptical grayscale images of 120 × 170 pixels.

The face recognition task consisted of two blocks, one for own-race faces and the other for other-race faces. The order of the two blocks was counterbalanced across participants. Each block consisted of a learning stage and a recognition stage. In the learning stage, 10 faces were randomly presented in turn. Each picture was presented at the center of the screen for 3,000 ms after a 500-ms fixation. Then, participants would relearn the 10 faces in the same order. Participants were asked to try to remember those faces. In the following stage of recognition, 20 pictures were randomly presented on the screen one by one. Half of the face pictures were from the learning stage and half were new faces. Participants were asked to judge as accurately as possible whether each face picture had been shown in the learning stage, pressing the "F" key for "old face" and the "J" key for "new face."

Results and Discussion

Five participants' data were discarded because their mean accuracy was beyond two standard deviations of the mean.

Sensitivity d' were submitted to a 3 (priming: control, interdependent, independent) × 2 (facial race: own-race, other-race) mixed-design repeated measures ANOVA. If the cultural difference of self-construal mirrored the cultural difference of face recognition, an interdependent/collective priming would be expected to increase own-race face recognition, and independent priming would increase other-race face recognition.

Neither main effect nor interaction of d' reached statistical significance ($ps > 0.13$).

Analysis of hit rates also showed no significant effect ($ps > 0.25$).

However, analysis of false alarms showed an own-race bias effect, $F(1,95) = 16.20$, $p < 0.001$, $\eta_p^2 = 0.15$. The main effect of priming and its interaction did not reach statistical significance ($ps > 0.50$).

These results indicated no priming effect of self-construal on face recognition, consistent with the results of Experiment 2 and Ramon et al. (2016), inconsistent with Ng et al. (2015).

Experiment 3B: Self-Construal, ORB, Race Categorization, and Eye Movement

Method

Participants

Eighty-three students from Sun Yat-sen University (mean age = 19.8 years, SD = 1.59; 35 males, 48 females) participated in the experiment and were randomly assigned to four groups (22/21/20/20 for independent, relational, collective, and control groups). Three participants' data were discarded because of failed calibration. Only 80 participants' data were used for analysis.

Materials

Self-construal priming: We used the same pronoun-circling priming task as in Experiment 2 to manipulate self-construal level.

Face stimuli: A total of 40 face images (20 female faces and 20 male faces) with neutral expressions were used, including 20 Caucasian face images and 20 Chinese face pictures used in the eye movement research of Yi et al. (2015). The images were 500 × 700 pixels (11.3 × 15.8 cm) in size, viewed at a distance of 60 cm, displayed on a 17-inch screen with a resolution of 1,280 × 1,024 pixels.

In order to reduce the influence of irrelevant variables and to measure eye movements accurately (see Yi et al., 2015), the face images were standardized by removing the non-facial features and generating elliptical grayscale images with uniform brightness and luminance. In addition, in order to better detect the number of fixation points in the area of interest (AOI: eyes, nose, and mouth; see **Figure 8**), the AOIs of different faces were adjusted to be substantially the same position.

Eye tracking: Eye movements were recorded at a sampling rate of 1,000 Hz with the Eyelink 1000 eye tracker (SR Research), which has an average accuracy of down to 0.15° (0.25–0.5° typical), a spatial resolution of 0.01° RMS, and a gaze tracking range of 60° horizontally and 40° vertically (see EyeLink 1000 User Manual for details). Participants' binocular movements were tracked and analyzed.

Procedure

The experiment was programmed and run *via* SR Research Experiment Builder software. At the beginning of the formal experiment, a 9-point randomized calibration of eye fixation was conducted. If the participant failed to complete the calibration after four attempts, he or she did not undergo the formal experiment. The calibration was then validated and repeated when necessary until the optimal calibration criterion was reached.

The following face recognition task mainly followed the procedure of Blais et al. (2008). First, participants completed a traditional face recognition task for own-race faces and other-race faces. The order of the two race blocks was counterbalanced across participants. The face recognition task was identical with that used in Experiment 3A, except that each picture was presented for 5,000 ms in the learning phase. Next, the participants completed a race categorization task. Forty faces were randomly presented at the center of the screen one by one until participants responded. Participants were required to indicate the race of the presented face and to use their dominant hands to press 1 for "Chinese" or 2 for "Caucasian." To guarantee the self-construal priming effect, participants had to complete a pronoun-circling priming task at the beginning of the own/other face recognition task and race categorization task.

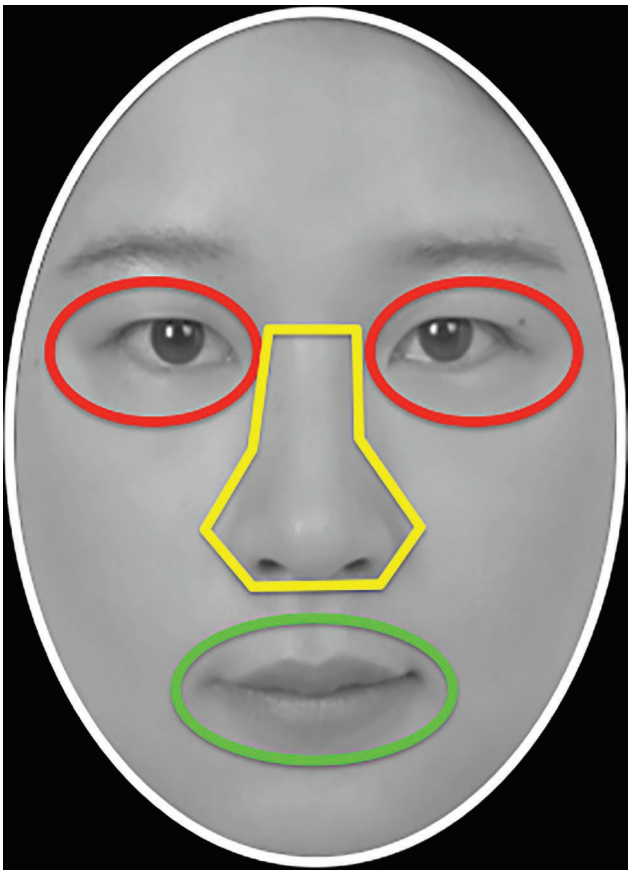

FIGURE 8 | An example of face stimuli with area of interest (AOI) used in Experiment 3B. Written informed consents were obtained from the two individuals for the publication of these images. This illustrated example did not appear in the actual experiment. Written informed consent was obtained from the individual for the publication of the image.

Results and Discussion

Own-Race Bias

If the cultural difference of self-construal mirrored the cultural difference of face recognition, an interdependent/collective or relational priming would be expected to increase own-race face recognition, and independent priming would increase other-race face recognition.

Sensitivity d' was submitted to a 4 (priming: control, collective, interdependent, independent) × 2 (face race: own-race, other-race) mixed-design repeated measures ANOVA. Neither main effect nor interaction reached statistical significance ($ps > 0.26$; see **Figure 9**).

Analysis of hit rates and false alarms also showed no significant effect (*p*s > 0.15).

The results showed no own-race bias, consistent with Fu et al. (2012) and Yi et al. (2015). Normalized face photos may contribute to the null race effect (Yi et al., 2015). We used another set of face stimuli and another priming in Experiment 3A and obtained an own-race bias in FA, also supporting this explanation.

Both Experiments 3A and 3B found no priming effect on own-race/other-race face recognition, consistent with Experiment 2 and Ramon et al. (2016).

Eye Movement: Fixation Proportion

Because participants might scan the face with different total fixation durations under different conditions, in order to examine whether self-construal conditions had a differential influence on fixation patterns on the major facial features, we calculated the proportional fixation duration for each individual AOI area (i.e., eyes, nose, and mouth). Proportional fixation duration was calculated by dividing the total fixation duration within each AOI area by the total fixation duration within the whole face area (see **Figure 10** for the proportional fixation duration in each condition).

If the cultural difference of self-construal mirrored the cultural difference of eye movement during face learning, face recognition, and race categorization, an interdependent/collective or relational priming would be expected to increase fixations on nose, while independent priming would increase fixations on eyes.

Face learning stage: Proportional fixation duration was submitted to a priming (control, collective/interdependent, relational, independent) × face race (own, other) × AOI (eyes, nose, mouth) mixed-design repeated measure ANOVA. The main effect of AOI was observed, $F(2,152) = 49.04$, $p < 0.001$, $\eta_p^2 = 0.39$, with the greatest duration of time gazing at eyes (21.7%), then noses (16.4%), and least for mouths (7.6%), *p*s < 0.05. A marginally significant main effect of priming was observed, $F(3,76) = 2.66$, $p = 0.05$, $\eta_p^2 = 0.10$, with no difference among control, relational, and collective groups, *p*s > 0.41. These three groups tended to spend less amount of time on eyes, nose, and mouth than independent group, *p*s < 0.06. Other main effects or interactions did not reach statistical significance, *p*s > 0.15.

Face recognition stage: Similar results were observed in the recognition task. The main effect of AOI was observed, $F(2,152) = 27.63$, $p < 0.001$, $\eta_p^2 = 0.27$, with roughly equal proportions for eyes (14.8%) and noses (16.0%; $p = 0.44$), and least for mouths (6.6%), *p*s < 0.001. Other main effects or interactions did not reach statistical significance, *p*s > 0.12.

Race categorization stage: The main effect of AOI was observed, $F(2,152) = 29.62$, $p < 0.001$, $\eta_p^2 = 0.28$, with roughly equal proportions for eyes (14.5%) and noses (16.1%; $p = 0.39$), and least for mouths (4.7%), *p*s < 0.001. Importantly, the interaction of AOI with priming was observed, $F(6,152) = 2.90$, $p = 0.01$, $\eta_p^2 = 0.10$. A simple effect test for eyes showed greater proportional fixation duration for the collective group than the control group ($p = 0.03$) and independent group ($p = 0.002$), and more for

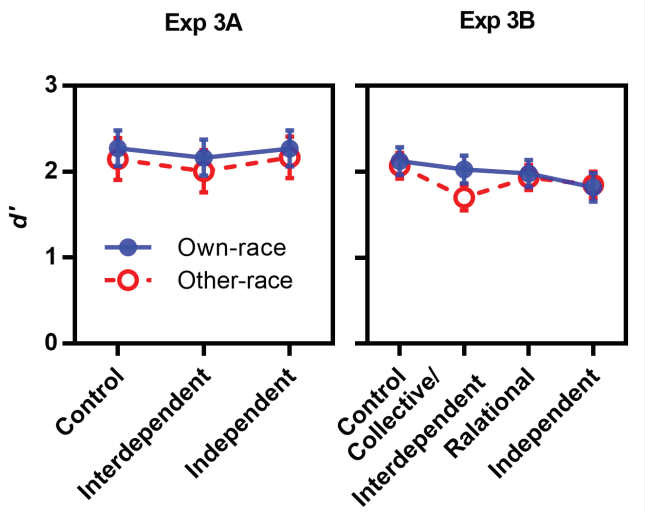

FIGURE 9 | Sensitivity as a function of priming and face race in Experiments 3A and 3B.

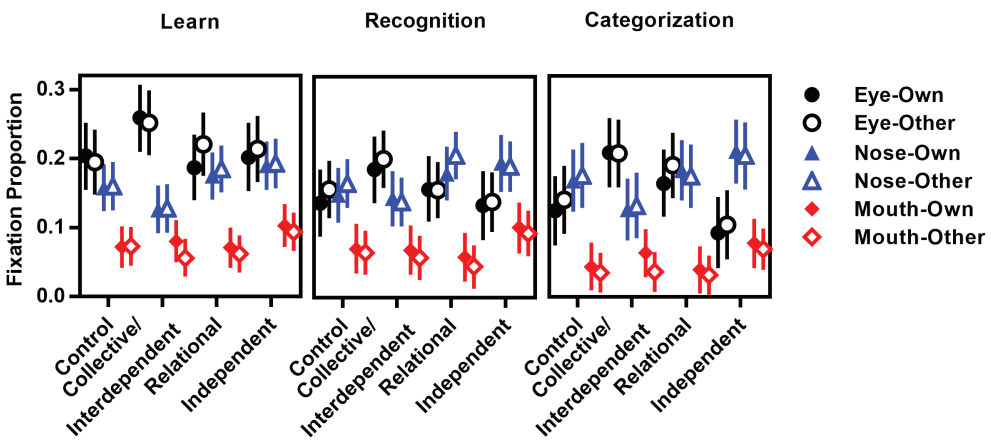

FIGURE 10 | Proportional fixation duration as a function of priming, AOI and race in learning, recognition, and categorization stages in Experiment 3B.

the relational group than for the independent group ($p = 0.025$). However, for noses, the fixation duration percentage for the independent group is higher than that of the collective group ($p = 0.017$). Only a tendency was observed for the mouth, with greater fixation duration percentage for the independent group than for the relational group ($p = 0.091$).

During the race categorization stage, AOI interacted with face race, $F(2,152) = 6.21$, $p = 0.003$, $\eta_p^2 = 0.08$. A simple effect test showed that, both for own-race faces and other-face faces, proportional fixation durations on eyes and noses were longer than for mouths ($ps < 0.001$, no difference between eyes and nose, $ps > 0.24$). However, Chinese participants looked longer at other-race eyes than own-race eyes ($p = 0.024$), less at other-race mouths than own-race mouths ($p < 0.001$), and equally at noses ($p = 0.95$).

Other main effects or interactions did not reach statistical significance, $ps > 0.34$.

In sum, we did not replicate the interaction of AOI and face race during the learning and recognition stages as in Fu et al. (2012) and Yi et al. (2015). This discrepancy may be due to the priming manipulation in our experiment.

We did not observe the priming effect on eye movement during learning or recognition stages, consistent with Ramon et al. (2016). Interestingly, we found this effect during race categorization. We will address detailed discussion in the general discussion section.

GENERAL DISCUSSION

Self-Construal Priming and Holistic Face Processing

Previous studies have shown that after priming the independent self, the participants are more inclined to analytical processing, and after priming the interdependent self, they tend toward holistic processing (Kühnen and Oyserman, 2002; Lin and Han, 2009; Springer et al., 2012; Liu et al., 2015; Choi et al., 2016). Therefore, we expected to observe increasing holistic processing for interdependent or collective priming and decreasing holistic processing after independent priming.

Our results showed that whether self-construal priming affects holistic face processing depends on the type of holistic processing. That is, the results varied by paradigm. No such priming effect was observed in Experiment 1A with the featural-spacing paradigm. Although the priming effect was observed with the composite paradigm, the patterns were different when using a standard composite paradigm in Experiment 1B and the revised composite paradigm in Experiment 2. Although no priming effect on congruency × alignment holistic processing in Experiment 1B was observed, priming can modulate the congruency effect. As expected, compared with control priming, interdependent priming increased the congruency effect, while independent priming decreased the congruency effect. Experiment 2 also showed a modulation of priming on the congruency effect. However, compared with control priming, no change was observed for any priming, but a larger congruency effect was observed for independent priming than for relational priming, inconsistent with cultural differences in holistic processing.

The inconsistent results of Experiments 1A, 1B, and 2 may come from the different definitions of holistic processing within these different paradigms. It has been shown that composite effects did not correlate with either the part-whole effect (Wang et al., 2012; Rezlescu et al., 2017) or the inversion effect (Rezlescu et al., 2017), which implies that facial holistic processing may reflect distinct facial perceptual mechanisms (Wang et al., 2012; Rezlescu et al., 2017). The standard composite holistic processing used in the present study reflects a tendency to integrate the internal features of a face as a gestalt (Maurer et al., 2002), indexes failure of selective attention to target a facial half while ignoring the other half (Richler et al., 2014), or is only sensitive to objects' shape information (Zhao et al., 2016a,b). Space-feature holistic processing in our study indexes people's sensitivity to spatial distances among facial features (Maurer et al., 2002). Therefore, it is very possible that the nature of the standard composite holistic processing used in Experiment 1A, the nature of the space-feature holistic processing used in Experiment 1B, and that of revised composite holistic processing used in Experiment 2 are different and have different sensitivities to self-construal priming.

Similarly, the inconsistent results of the present study and previous object processing research (Kühnen and Oyserman, 2002; Lin and Han, 2009; Springer et al., 2012; Liu et al., 2015; Choi et al., 2016) may also come from the different definitions of holistic processing with these different paradigms. For example, Davidoff et al. (2008) found that Namibians showed significant local processing preferences compared to the British in the Navon perception test. However, in the task of face perception, Namibians have shown a greater face inversion holistic processing effect than the British, indicating that Namibian local processing preferences were not generalized to face-processing tasks. Dale and Arnell (2013) found no relationship among standard Navon task (Navon, 1977) performance, hierarchical shapes in a forced choice task (Kimchi and Palmer, 1982), and superimposed high- and low-pass spatial frequency faces in a forced-choice task (Deruelle et al., 2008). Caparos et al. (2013) proposed that local and global perceptual biases must be distinguished from local and global selective attention. Caparos et al. adopted Navon-like hierarchical figures and asked Namibian subjects who exhibited greater local processing bias than British subjects when making subjective similarity matches regarding hierarchical figures (e.g., Davidoff et al., 2008; Caparos et al., 2012) and British subjects to identify local/global figures while ignoring global/local figures. The authors found that Namibians not only demonstrated a better ability to select local information, but also a better ability to select global information than British subjects.

Self-Construal Priming and Face Recognition

Present results showed that self-construal priming did not affect own-race face recognition (Experiments 2, 3A, and 3B) or other-race face recognition (Experiments 3A and 3B), consistent with Ramon et al. (2016) and inconsistent with Ng et al. (2015). This discrepancy may be explained by two types of self-construal: chronic self-construal and situational self-construal.

Chronic self-construal refers to a stable personal trait that is mainly influenced by the cultural background and inflexible across varied situations (Markus and Kitayama, 1991). Unlike chronic self-construal, situational self-construal refers to a dominant self-concept according to the immediate situation and is easily activated by priming tasks. A chronically interdependent individual will appear to be independent under certain circumstances and vice versa.

Ng et al. (2015) used the interdependence subscale of the self-construction scale (SCS; Singelis, 1994) to measure the interdependence of European Canadian and East Asian participants. The interdependent orientation that they measured was chronic; whereas, in our study and in Ramon et al. (2016), self-construal was manipulated by priming and was therefore situational. Unlike holistic face processing in Experiments 1A, 1B, and 2 or face orientation processing in Sui and her colleagues' research (e.g., Sui and Han, 2007; Sui et al., 2013), which could be modulated by situational self-construal, face recognition might be a stable and chronic ability that cannot be situationally affected.

One limitation of the present study is that we did not investigate how the chronic tendency of self-construal of Chinese participants affects their face processing, especially face recognition. Further research with Chinese participants is needed to examine the relationship between chronic self-construal and face processing, especially face recognition, to examine whether the result of Ng et al. (2015) could be replicated.

Self-Construal Priming and Race Categorization

Based on the cross-cultural studies on eye movement that showed Eastern Asians fixed centrally on the nose region, while Western Caucasians primarily explored the eye and mouth regions during race categorization (e.g., Blais et al., 2008), we expected to find a greater fixation proportion on eyes for the independent priming group and greater nose fixation proportion for the interdependent or collective priming groups. However, we found a self-construal priming effect on eye movements during race categorization. Specifically, for eyes, a greater fixation proportion was noted for the collective group than for the control group, and greater for the interdependent group than for the independent group. However, for the nose, a greater fixation proportion was observed for the independent than for the collective group. Only a tendency was observed for mouths, with greater fixation proportion for the independent group than for the interdependent group. These results are inconsistent with our prediction.

The results of relational self-construal and collective/interdependent self-construal have some similarities, which are different from the results of independent self-construal. The relational self and the collective/interdependent self are more inclined to engage with others. Holland et al. (2004) found that self-construal activation automatically influences interpersonal behavior as reflected in the actual distance between the self and others. Therefore, it is no surprise that relational priming or collective priming showed more eye fixation and less nose fixation than independent priming, given that these people were more inclined to interact with others and more inclined to eye contact; after independent priming, people are less likely to make eye contact with others.

Conclusion and Limitation

In summary, our study adopted several face recognition paradigms, several holistic face processing paradigms, and several self-construal priming tasks to investigate the effects of self-construal priming on face recognition, holistic face processing, and race categorization. The results showed that self-construal priming had no effect on face recognition, but had varied influence on holistic face processing depending on the holistic processing paradigm and had an effect on race categorization in eye movement. These results indicated that cultural differences in self-construal could not simply mirror cultural differences in face processing.

We are confident of these results since several experiments in the present study have obtained consistent results, which were also consistent with previous studies (e.g., Ramon et al., 2016). However, the present study could not rule out the possibility that the null results in the present study were due to not enough power to test the not strong enough priming effect on face processing. For example, from **Figures 2, 9,** and **10**, we can observe some weak although not significant effect of self-construal priming on face processing. Present study only took an initial step to investigate the effect of self-construal priming on holistic face processing, face recognition, and race categorization. Future studies are encouraged to adopt more participants, more powerful priming task (e.g., story-reading task), and more sensitive measurement (e.g., using eye movement to measure priming effect on holistic face processing) to examine and extend present findings.

DATA AVAILABILITY

All datasets generated for this study are included in the manuscript and/or the supplementary files.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of "protection of human participants, Institutional Review Board of Department of Psychology at Sun Yat-sen University" with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the Institutional Review Board of Department of Psychology at Sun Yat-sen University.

AUTHOR CONTRIBUTIONS

GZ developed the concept. GZ and XLi developed the design of the whole experimental work. CF and XLia developed the design of the Experiment 3B. XLi, XLia, CF, and GZ

actively participated in the implementation of the experimental tasks, data collection, and data analyses in the experiments. All authors contributed to writing and reviewing the manuscript and approved the final version of the manuscript.

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Residential Mobility Decreases Neural Responses to Social Norm Violation

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Social norms are essential, but they vary across cultures and societies. With the internationalization of human society, population mobility has greatly increased, especially in developing countries, which can have an impact on people's psychological states and behaviors and result in sociocultural change. The current research used three studies to examine the hypothesis that residential mobility plays a crucial role in the perception of social norm violations. Study 1 used an association test and found that residential mobility was correlated with the perception of both weak and strong social norm violations in females. Study 2 combined electroencephalography and found a negative differential N400 between weak social norm violations and appropriate behavior between residentially mobile and stable mindsets, suggesting that residential mobility modulates individuals' detection of social norm-violating behavior. Study 3 revealed that residential mobility does not have a similar effect on semantic violations, which indicates that the effect of residential mobility does not occur in non-social norm violations. Our findings provide insight into how and why individuals' detection of social norm-violating behaviors varies according to the dynamic development of society. As residential mobility continues to increase worldwide, especially in developing countries, more attention should be paid to the concomitant impact during the course of sociocultural change to build a better strategy for cultural specific social governance.

Keywords: residential mobility, social norm violations, event-related potential, mobility, EEG

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INTRODUCTION

In recent decades, countless people have moved to new cities or countries for better jobs or education. Schools and colleges provide students with opportunities for exchange, and corporations offer employees chances to work in other cities. Thus far, residential mobility has been relatively high in North America (Castles et al., 2013). Because of the rapid economic development in Asia and cooperation among countries, residential mobility in this region is expected to increase (Czaika and De Haas, 2014; International Organization for Migration, 2015). Africa, which is described in the literature as an emigrant location, also shows an increased trend in residential mobility because African countries have increased their attractiveness (Jonsson, 2009). Thus, residential mobility appears to be increasing worldwide. The World Migration Report (International Organization for Migration, 2015) revealed that there are currently more than 232 million international migrants

and 740 million internal migrants. Moreover, an additional 2.5 billion people are expected to move to urban areas in Asia and Africa.

Nevertheless, residential mobility is associated with several problems. For example, residentially mobile areas have higher crime rates than stable cities (Sampson et al., 1997). However, an extended study conducted by Cohen (1998) revealed that residential mobility was not necessarily related to increased violence, and the association was dependent on the acquiescent culture shared by the community. In communities that valued a culture of honor, less stable regions were related to decreased argument-related homicide but were associated with increased felony-related homicide compared to more stable regions (Cohen, 1998). To extend these research areas, we investigated how residential mobility influences social norm violations that are not formally sanctioned.

Residential mobility is defined as the frequency with which people change residences. At the individual level, this concept refers to the number of residential moves that a person experiences during a specific period or moves that are expected in the future (Oishi, 2010). Although residential moves can be exciting, they can lead to short- and long-term psychological, cognitive and behavioral consequences (Oishi and Talhelm, 2012). For example, high residential mobility may induce anxiety and foster familiarity seeking (Oishi et al., 2012). People who move frequently are motivated to expand social networks because of loneliness (Oishi et al., 2013), and they are more likely to help strangers than are people who are residentially stable (Lun et al., 2012). One primary difference between stable and mobile individuals is the state of their social relationships. Frequent movers tend to have a social network with few responsibilities, whereas those who are residentially stable tend to have stable friendships with obligations and duties (Ho et al., 2006; Oishi, 2010). In stable societies, social ties are deep and friends are obliged to help each other in times of need; occasionally, excessive costs are associated with helping. Thus, in a residentially stable context, people must be cautious of friends and ensure that they are trustworthy. In stable societies, when friends are ill-behaved, people may impose punishments to deter inappropriate behavior. Indeed, research has found that East Asians are more likely to punish inappropriate behavior than North Americans are (Wang and Leung, 2010). Compared with people in mobile societies, people in stable societies may have stronger sensitivities to norm violations to ensure that their friends are trustworthy and avoid punishments associated with deviant behavior. Thus, we hypothesized that residential mobility would decrease the detection of social norm violations.

A norm can be a pattern of action that provides mutual understanding for solving problems or encourages individuals to behave pro-socially when conflicts in self-interest and joint gain arise (Hechter and Opp, 2001). As such, norms are essential for upholding social order. According to Hechter and Opp (2001), social norms refer to standards for behavior in a given situation. Compared with legal rules, social norms are not supported by formal sanctions but are publicly shared. Previous research has found that the perception of social norm-violating behaviors (i.e., the extent to which people can detect social norm-violating behaviors) varies across cultures and societies (Mu et al., 2015). The N400, an event-related potential (ERP) with a negative deflection at approximately 400 ms, is a neural index of the detection of unexpected anomalous stimuli and affective and social incongruent information (Ceballos et al., 2005; Goto et al., 2010). The N400 evoked by a social norm violation task has been found to be more negative in Chinese people than in Americans (Mu et al., 2015). Even at national, regional and state levels, diverse sensitivities to social norm violations are observed (Harrington and Gelfand, 2014).

As the largest developing country, China has witnessed considerable internal labor mobility in the last two decades, accompanied by the implementation of the reform and opening-up policy (Fan, 2003). The traditional Chinese family inherited the intrafamily labor division in which men take the responsibility for working outside the home and women stay at home and raise the offspring. The development of the market economy pushed a great amount of laborers from rural areas into cities and towns to pursue higher pay and better education, which caused an impact on the structure of traditional families and a major transition in the social role of females. According to the investigation of the National Statistics Bureau, the number of female domestic immigrants grew rapidly around 2000, even more rapidly than the growth of male immigrants (National Bureau of Statistics of China, 2005). This great transformation in social roles can cause enormous challenges for female immigrants during the process of social change (Tuccio and Wahba, 2018). A previous study on the gendered division of labor during the transition period in China revealed that the impact of gender stereotypes and underrepresentation in patriarchal society undermined the status of the majority of rural women (Fan, 2003). Female immigrants worldwide seem to be faced with more challenge than male immigrants with regard to their occupational and educational mobility and are reported to have a higher risk of suffering from mental health problems (Fisher and Hood, 1988; Magdol, 2002; Haynie et al., 2006). Women have been found to be more likely to seek help from the others (i.e., professionals or friends) and to be more emotionally interrelated than men when faced with difficulties in life (Ashton and Fuehrer, 1993; Jordan and Revenson, 1999; Addis and Mahalik, 2003; Bosco et al., 2019). As a result, they might be more flexible in adjusting to the changing environment. Nevertheless, limited research has been conducted to investigate how residential mobility impacts the psychological status and social perception of this underrepresented group specifically during the process of social change.

We hypothesized that residential mobility would decrease the detection of social norm violations and that this influence would mainly exist in women due to the demanding adaptation to the change of environment. To test these hypotheses, we conducted three studies with mixed methods, including surveys, behavioral manipulations and neuroscientific approaches (electroencephalography, EEG). In Study 1, we conducted an online survey with a homogenous sample with a predetermined sample size to investigate the association between historical residential mobility and the perception of social norm violations, which was measured by the task developed by Mu et al. (2015).

Based on the gendered findings of Study 1, we conducted two separate laboratory EEG experiments to further uncover the neural mechanism of the influence of residential mobility on perceptions of social norm violations (Study 2) and found that the effect was exerted mainly on social norm violations but not on general semantic violations (Study 3).

MATERIALS AND METHODS

Study 1

A total of 175 participants (86 males, 89 females, M_{age} = 22.99 years, SD = 5.19) were recruited at Sun Yat-sen University. Each participant received 20 yuan in compensation. This sample size allowed us to detect the residential mobility effect with a medium effect size (r = 0.30, alpha = 0.05, power = 0.80, number of predictors = 6) and the gender-dependent mobility effect with a medium effect size (r = 0.30 vs. 0.10, alpha = 0.05, power = 0.80, allocation ratio = 1) using linear multiple regression (estimated with G*Power software, Faul et al., 2007). Informed consent was obtained from all participants before the experiments were started in all studies. All studies were approved by the ethics committee of the Department of Psychology at Sun Yat-sen University.

The participants were asked to complete an online survey. Subjective socioeconomic status (SES) was measured with McArthur's Self-Anchoring Scale, which was previously used to link subjective SES with social norm violations (Mu et al., 2015). After reporting background information, the participants were asked to list all the cities or towns to which they had moved and their age when they moved. Cumulative moving times served as the participants' residential mobility scores. Then, the participants completed a norm violation rating task. The social norm violation rating task contained three types of items (appropriate, weakly social norm violating, and strongly social norm violating) that were adapted from Mu et al. (2015). Each type included eight items, and each item described a behavior in a certain situation. The participants rated the appropriateness of the norm violation items on a scale from 1 (*strongly inappropriate*) to 7 (*strongly appropriate*). In these studies, we report all measures, manipulations and exclusions.

Study 2

Forty-two female students (M_{age} = 19.24 years, SD = 1.65, age range: 18–26 years) were recruited from Sun Yat-sen University. All participants were right-handed and had normal or corrected-to-normal vision. Each participant received 50 yuan in compensation.

Prior to the EEG session, the participants completed a survey that included demographic information. The participants were randomly assigned to one of two conditions consistent with the work of Oishi et al. (2013): residential mobility vs. residential stability. The participants in the mobile condition were asked to imagine that they were offered a job that they had always wanted, but it required living in a different city every other year. The participants in the stable condition were asked to imagine obtaining the same dream job, but it required them to remain in the same city for 10 years. Both groups were instructed to write relevant content in 10 min.

Two independent experts read the written responses to the residential mobility/stability manipulation items and rated the concern for relationships with family and friends as well as the overall concern on a 5-point scale (1 = *not at all*, 5 = *extremely*). These two experts also counted words or phrases that were related to loneliness (e.g., isolated, lonely, alone) and decreased social networks. Agreement on the concern scores and word-counting was adequate (rs > 0.80). Bonferroni correction was used for multiple comparisons during the *post hoc* comparison.

After the residential mobility manipulation, the participants were asked to imagine the situation that was described in the manipulation and complete a norm violation rating task. In the EEG session, we used a social norm violation task that was based on Mu et al. (2015) (see **Figure 1**). Thirty-four behaviors (e.g., clapping hands) were presented for three types of situations: appropriate (e.g., at a symphony concert), weakly inappropriate (e.g., in the hotel lobby), and strongly inappropriate (e.g., at a funeral). The participants were asked to judge whether a certain behavior was appropriate in a given situation. For each situation, there were 34 types of behavior. Among the 34 behaviors, 10 were randomly chosen and presented twice. Thus, each situation contained 44 trials. A total of 132 trial (44 behaviors × 3 situations) (**Supplementary Tables S7, S8**) were randomly assigned across four runs, with each run lasting 4 min. In each run, the participants were instructed to imagine the situation in the opening question and complete the following task. Each trial began with a fixation of 500–1500 ms. Then, the first sentence describing a situation was presented (e.g., Elle is at a symphony concert) for 1500 ms. After a 100-ms fixation, the second sentence that depicted a behavior (e.g., she is clapping her hands) was separated into two 400 ms screens. For example, "she is" was presented for 400 ms followed by a fixation of 100 ms, followed by "clapping hands" presented for 400 ms. After an 800-ms fixation, a response screen was shown for 3 s (at a viewing distance of 80 cm), during which the participants judged the appropriateness of the behavior from 1 (*very inappropriate*) to 4 (*very appropriate*) using the index and middle fingers of both hands on a keyboard. We targeted the ERPs elicited by the screen that presented the behaviors (e.g., clapping hands, screen with a red frame in **Figure 1**). The entire procedure is depicted in the **Supplementary Figure S1**. The response buttons were counterbalanced across subjects.

We collected continuous EEG signals using 64 scalp electrodes based on the 10–20 system of the NeuroScan system. The vertical electro-oculogram (VEOG) was recorded from two electrodes located above and below the left eye. The horizontal electro-oculogram (HEOG) was recorded from two electrodes placed 1.5 cm lateral to the left and right external canthi. EEG was amplified (bandpass 0.05–100 Hz) and digitized at a sampling rate of 500 Hz. All data were re-referenced offline to an average mastoid reference and filtered with a 30-Hz low pass. The ERPs in each condition were averaged separately, with an epoch beginning 200 ms prior to the stimulus onset and continuing for 1200 ms. Trials that were contaminated by eye movements and muscle potentials exceeding ±50 μV at HEOG, VEOG,

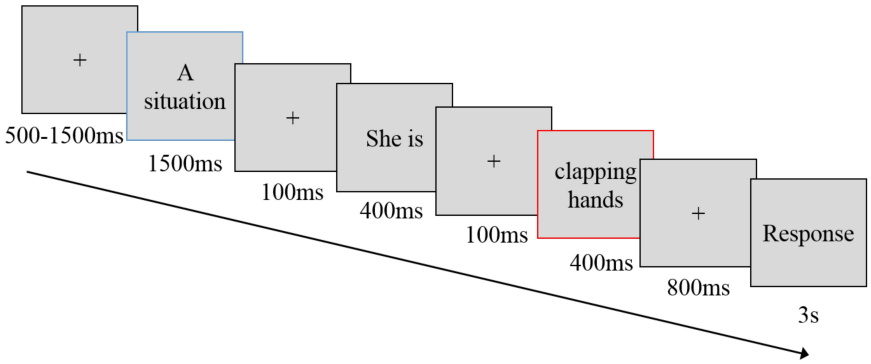

FIGURE 1 | The social norm violation task. Each trial began with a fixation of 500–1500 ms. Then, the first sentence describing a situation was presented (e.g., Elle is at a symphony concert.) for 1500 ms. After a 100-ms fixation, the second sentence depicting a behavior (e.g., she is clapping her hands) was separated into two 400-ms screens with a fixation of 100 ms. After an 800-ms fixation, a response screen was shown for 3 s during which the participants judged the appropriateness of the behavior from 1 (*very inappropriate*) to 4 (*very appropriate*) using their index and middle fingers on both hands on a keyboard, at an 80-cm viewing distance. ERP components were generated in a screen with a red frame.

FP1, FPZ and FP2 were excluded from the calculation of the average. The mean of the acceptable trial rate for participants was 82.3% ± 9.3%. The data for each participant were averaged for each situation. The mean amplitude of the N400 component was calculated via electrodes selected from the central-parietal (Cz, C1, C2, CPz, CP1, CP2) regions at the 250- to 450-ms time window (peaking at approximately 350 ms), similar to a previous study in which the N400 was evoked (Fisher et al., 2010; Kutas and Federmeier, 2011) (**Figure 2**). Voltage topography was used to estimate potential sources of neural responses to violation.

Study 3

To test whether residential mobility may have an impact on non-social violations, we conducted Study 3 as a control study. Forty female students (M_{age} = 19.27 years, *SD* = 1.72, age range: 18–26 years) were recruited from Sun Yat-sen University. All of the participants were right-handed and had normal or corrected-to-normal vision. Each participant received 50 yuan in compensation.

Prior to the EEG session, the materials and procedures were consistent with those described above for Study 2. The EEG session adopted a semantic violation task based on an established paradigm (see **Figure 3**). In the semantic violation task, several semantically correct or incorrect sentences were presented, and the participants were asked to judge whether these sentences were right or wrong. Ninety subject-verb-object segmented sentences, including 45 semantically correct and 45 incorrect sentences, were randomly assigned to three runs. Each run lasted 4 min (**Supplementary Tables S9, S10**). In each run, the participants were instructed to imagine the situation in the opening question and complete the task, which was followed by 30 trials, with 15 trials for each semantic condition. Each trial started with a fixation of 550–1000 ms. Then, short phrases segmented from the sentence were shown for 400 ms each, with a 100-ms fixation between the two short phrases. After the entire sentence was presented, an 800-ms fixation was followed by a 3-s response screen (at a viewing distance of 80 cm), during which the participants judged the correctness of the sentence using the index fingers of both hands on a keyboard. We targeted the ERPs elicited by the screen that presented the objects (e.g., 小麦(wheat), screen with a red frame in **Figure 3**) after the behavior (e.g., 痛骂 (cursed)). The entire procedure is depicted in the **Supplementary Figure S2**. The response buttons were counterbalanced across subjects.

EEG data collection and analysis were the same as those described for Study 2, except that trials containing incorrect responses were excluded before filtering, and the data for each participant were averaged for the two semantic conditions (correct vs. incorrect). The mean of the acceptable trials for the participants was 80.7% ± 10.5%.

RESULTS

Study 1

We utilized the statistical software SPSS 22.0 to analyze all the data for all the studies. Study 1 obtained the participants' historical residential mobility data and used a social norm violation rating task to test the relationship between historical residential mobility and perceptions of social norm-violating behavior. The social norm violation rating task was adapted from Mu et al. (2015) and included three types of behavior sorted by the participants' subjective rating: appropriate, weakly social norm-violating (WSN), and strongly social norm-violating (SSN) behavior. We calculated the scores for WSN and SSN behavior using the original rating scores for these two types of behaviors minus the original appropriate behavior score. The same calculation methods were used consistently in the following studies. Means, standard deviations, and the correlation matrix of all variables are shown in **Supplementary Tables S1–S3**.

A regression analysis showed that historical residential mobility was significantly associated with the WSN rating scores (WSN: β = 0.17, p = 0.029) but marginally significantly associated with the SSN rating scores (SSN: β = 0.15, p = 0.051,

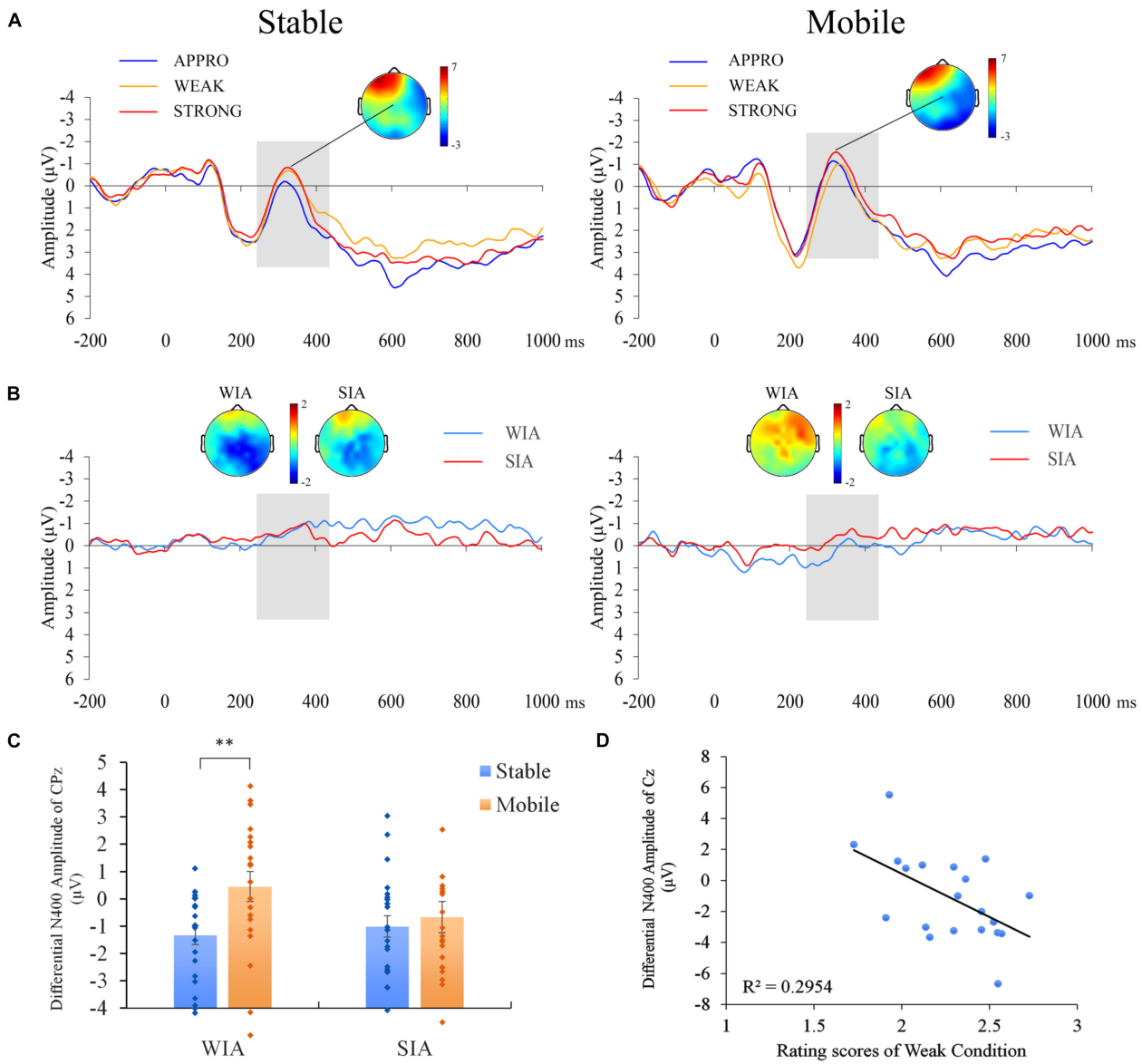

FIGURE 2 | Event-related potential (ERP) results for social norm violations. **(A)** Grand average ERPs for the original appropriate, weak, and strong conditions in the stable residential and mobile residential conditions in the central region. The topography shows the distribution of the N400 effect in the strong condition at 250–450 ms for the stable residential and mobile residential conditions. **(B)** Differential ERPs for the contrast between the weak and appropriate conditions (WIA) and the contrast between the strong and appropriate conditions (SIA) for the stable and mobile conditions. The topographies show the distribution of the differential N400 (WIA and SIA) for the stable and mobile conditions at 250–450 ms. **(C)** Bar chart illustrating the contrast of the N400 effects for WIA and SIA at the central-parietal region (CPz was chosen as a representative electrode) for the 250–450 ms time window. The error bars represent the standard errors. **(D)** Correlation between the differential amplitude to contrast the strong vs. weak conditions in the 250–450 ms time window with subjective rating scores from the weak condition during EEG processing (higher scores correspond to more appropriate behaviors). $^{**}p < 0.01$. Bonferroni corrected for multiple comparisons.

Table 1). We tested whether gender moderated the relationship between mobility and norm violations, and the results indicated that this relationship was significant for WSN ($\beta = 0.17$, $p = 0.023$, **Supplementary Table S4**). Next, we employed separate regression analysis for the two gender groups (**Supplementary Figure S1**). For females, higher residential mobility corresponded to a weaker perception of WSN ($\beta = 0.32$, $p = 0.002$, **Table 2**) and SSN ($\beta = 0.25$, $p = 0.020$). Residential mobility was not related to norm violations for males (WSN: $\beta = -0.05$, $p = 0.674$; SSN: $\beta = 0.05$, $p = 0.691$). There was no gender difference in the history of residential mobility (male: 1.40 ± 0.82, female: 1.34 ± 0.85, $t = 0.46$, $p = 0.645$). These results were consistent after controlling for age, location (urban/rural), annual income and subjective SES.

We also calculated the weighted residential mobility based on administrative division. We gave different weights to the scores of residential mobility according to the administrative division.

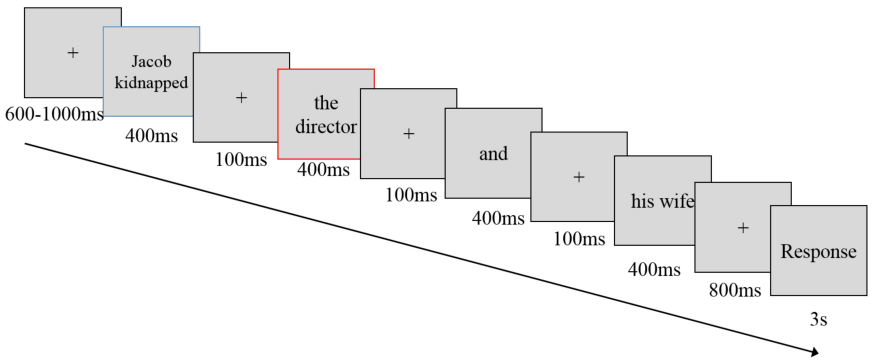

FIGURE 3 | The semantic violation task. Each trial began with a fixation of 550–1000 ms. Then, short phrases segmented from the sentence were shown for 400 ms each, with a 100-ms fixation between two short phrases. After the whole sentence was presented, an 800-ms fixation was shown, followed by a 3-s response screen during which participants judged the correctness of the sentence using their index fingers on both hands on a keyboard, at viewing distance of 80 cm. ERP components were generated in a screen with a red frame.

TABLE 1 | Coefficients from regression analysis in Study 1.

		WSN			SSN		
		β	*t*	*p*	β	*t*	*p*
Model 1	Historical mobility	0.17*	2.20	0.029	0.14	1.97	0.051
Model 2	Historical mobility	0.16*	2.09	0.038	0.12	1.52	0.131
	Gender	−0.15*	−2.00	0.047	−0.06	−0.75	0.454
	Age	0.03	0.33	0.744	0.21**	2.75	0.007
	Urban-rural	0.02	0.30	0.762	0.05	0.64	0.523
	Income	−0.11	−1.42	0.157	−0.11	−1.42	0.157
	SES	0.09	1.10	0.272	0.12	1.50	0.135

*WSN, the redefined weakly inappropriate condition (original weakly inappropriate - appropriate); SSN, the redefined strongly inappropriate condition (original strongly inappropriate – appropriate). Males were coded as "0," and females were coded as "1". Males were set to be the baseline of the analysis. *p < 0.05; **p < 0.01.*

TABLE 2 | Coefficients from regression analyses performed separately for females and males in Study 1.

			WSN			SSN		
		Model	β	*t*	*p*	β	*t*	*p*
Females	1	Historical mobility	0.32**	3.14	0.002	0.25*	2.37	0.020
	2	Historical mobility	0.32**	2.95	0.004	0.21	1.93	0.058
		Age	−0.13	−1.16	0.249	0.07	0.64	0.524
		Urban-rural	0.02	0.18	0.860	0.13	1.16	0.249
		Income	0.02	0.21	0.835	0.06	0.53	0.599
		SES	0.02	0.22	0.826	−0.01	−0.08	0.939
Males	3	Historical mobility	−0.05	−0.42	0.674	0.04	0.40	0.691
	4	Historical mobility	−0.04	−0.38	0.708	0.03	0.26	0.794
		Age	0.17	1.50	0.137	0.31**	2.88	0.005
		Urban-rural	0.01	0.05	0.962	−0.04	−0.33	0.739
		Income	−0.23*	−2.03	0.046	−0.26*	−2.39	0.019
		SES	0.13	1.17	0.245	0.22*	2.09	0.040

*WSN, the redefined weakly inappropriate condition (original weakly inappropriate – appropriate); SSN, the redefined strongly inappropriate condition (original strongly inappropriate - appropriate). Males were coded as "0," and females were coded as "1". Males were set to be the baseline of the analysis. *p < 0.05; **p < 0.01.*

Specifically, migrations between cities within provinces were given a weight of 1, and migrations between provinces within the same part of China (i.e., southern/northern China) were given a weight of 2, and migrations between parts of China or between nations were given a weight of 3. Finally, we calculated the total scores of these three types of migrations as the weighted history of residential mobility. With this measure, we found consistent results indicating that a history of residential mobility was

significantly correlated with WSN and SSN in females (r = 0.319 and 0.247, p = 0.002 and 0.02) but not in males (r = −0.014 and −0.004, p = 0.974 and 0.691, **Supplementary Figure S1**).

Study 2

Although the decrease in subjectively appropriate ratings for social norm violations in the residentially mobile context of the behavioral experiment could be explained by a decrease in perceptions of social norm violations, the pattern we found could also result from comparable perception but higher tolerance toward social norm violations. Whether this effect is due to a decrease in detection requires further evidence. Study 2 used the electroencephalography (EEG) technique to investigate the underlying neural mechanisms of residential mobility on social norm violations by examining the N400, the neural marker for detecting social norm violations. If the N400 in the two mobility conditions differs, then the detection of social norm violations is influenced by residential mobility. Because significant interactions were observed between residential mobility and social norm violations for females in Study 1, we focused on females in Study 2. Based on the gendered findings of Study 1, we focused on females in the present study.

For the N400 component elicited by the target screen depicting the behaviors, differential ERPs for the contrasts between the weakly inappropriate (WI)/strongly inappropriate (SI) conditions and the appropriate condition were used to perform the analyses (WIA and SIA, respectively). We performed a 2 × 2 (residential mobility [mobile, stable] × norm [WIA, SIA]) repeated-measures ANOVA for the central and parietal regions. A significant main effect was observed for residential mobility (F(1,40) = 4.66, p = 0.037, η_p^2 = 0.10). The main effect for norms was not significant (F(1,40) = 0.69, p = 0.412, η_p^2 = 0.02; detailed results for each electrode are provided in **Supplementary Table S6**. A significant interaction was observed between residential mobility and norms in the central and parietal regions (F(1,40) = 6.23, p = 0.017, η_p^2 = 0.14). *Post hoc* analyses revealed that differential ERPs for the WIA were significantly more negative in the stable condition than in the mobile condition (t(40) = −3.13, p = 0.003), and significant effects were not observed between the two residential mobility conditions for the differential ERPs for the SIA (t(40) = −0.55, p = 0.583), which indicated that residential mobility may decrease perceptions of weak violations (see **Figure 2**).

To explore the relationship between the participants' subjective ratings (**Supplementary Table S5**) and neural responses to the WI condition, we performed a correlation analysis. The results showed that the differential amplitudes between the SI and WI conditions (SIWI) were negatively related to the subjective ratings for weak violations in the mobile condition (r = −0.56, p = 0.011). This association was not detected for the residentially stable condition (r = 0.27, p = 0.226). Hierarchical regression analyses further confirmed that residential mobility moderated the relation between the weak violation rating scores and the differential ERPs for SIWI in the central and parietal regions (β = −0.403, p = 0.004).

Study 3

To test whether residential mobility may have an impact on non-social violations, we conducted Study 3 in which a semantic violation task (Mu et al., 2015) was used.

In this study, participants were randomly assigned to either the residential mobility or stability conditions and completed a sematic violation task. The accuracy rates for all participants for the semantic violation task were higher than 80%. For the N400 amplitude, we employed a 2 × 2 (residential mobility [mobile, stable] × semantic violation [correct, incorrect]) repeated-measures ANOVA. A more negative N400 was elicited in the semantically incorrect condition than in the correct condition (F(1,38) = 9.73, p = 0.003, η_p^2 = 0.20, see **Figure 4**), and a main effect was not observed for residential mobility and the interaction between residential mobility and violation (residential mobility: F(1,38) = 0.40, p = 0.529, η_p^2 = 0.01; interaction: F(1,38) = 1.96, p = 0.170, η_p^2 = 0.05).

DISCUSSION

Our research examined the relationship between historical residential mobility and social norm violations. In addition, we manipulated residential mobility and found that it influenced neural responses to social norm violations.

Residential Mobility and Social Norm Violations in Females

Our results showed that historical residential mobility was correlated with decreased detection of both weak and strong social norm-violating behaviors among females in Study 1. After priming with residential mobility, the neural component of social norm violation was subdued in the context in which the violation was weak. The findings of the present study suggest that the perception of social norms is flexible in females, which might contribute to their coping with a changing environment. Previous studies on gendered vulnerabilities to climate change revealed that females are most vulnerable among vulnerable groups to extreme climatic situations due to their underrepresentation in the distribution of social resources (Ferdous and Mallick, 2018; Goodrich et al., 2019). Similar situations occur during the course of mobility, especially in the context of traditional Chinese culture, such as the traditional gendered norms of women staying at home and inequity in obtaining opportunities for education (Fan, 2003). Additionally, previous research has found that underrepresented minority groups are more other-oriented, and at public scientific institutions, research microcultures act as socialization contexts for underrepresented science students and are integrated into their personal science norms (Thoman et al., 2017). In summary, due to their inadequate power to exert a strong influence on the surrounding environment, women might adopt new social norms that are formulated within a more diverse group, and this impact is apparent at the stage of detection. However, insufficient research has been conducted to investigate how the psychological and social status of female teenagers changes during the process of residential mobility, which is a worthwhile topic for future studies.

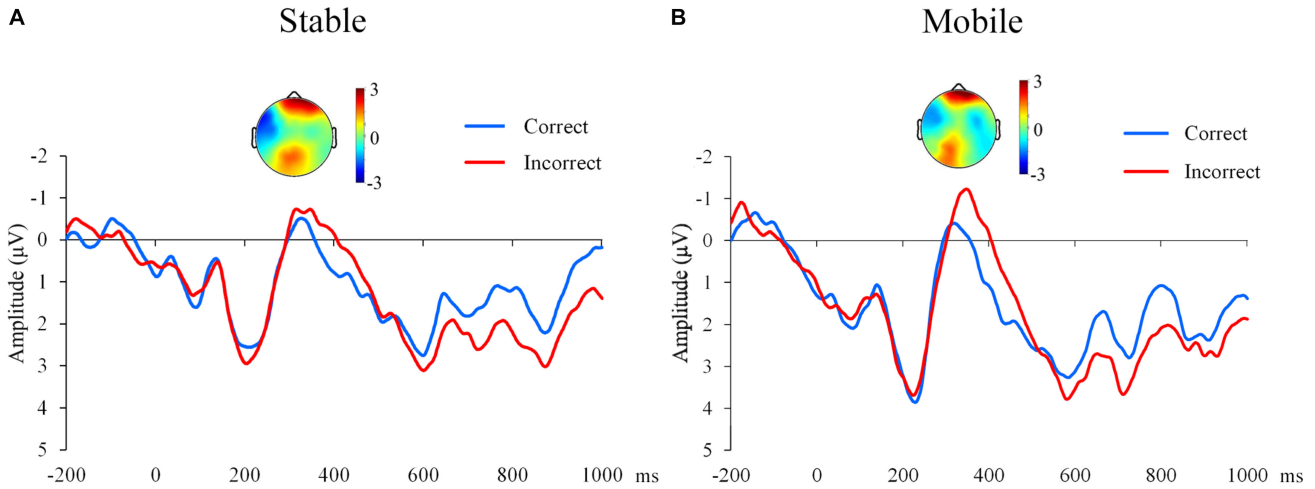

FIGURE 4 | Event-related potential (ERP) results for semantic violations. **(A)** Grand average ERPs for the semantically correct and incorrect conditions for the stable residential condition in the central region. The topography shows the distribution of the N400 effect for the incorrect condition at 250–450 ms in the stable residential condition. **(B)** Grand average ERPs for the semantically correct and incorrect conditions in the mobile residential condition in the central region. The topography shows the distribution of the N400 effect for the incorrect condition at 250–450 ms in the mobile residential condition.

Nevertheless, we did not find significant associations between residential mobility and perceptions of strong social norm-violating behavior among females in Study 2. This may be because the effect for strong violations was not as strong as that for weak violations and may not have been detected in the current sample size with 80% power. We assumed that strong social norm violations have some overlap with moral norm violations, whereas weak social norm violations do not. Moral norms are internalized, and regardless of the circumstances, behavior that violates moral norms is wrong (Bicchieri and Muldoon, 2014). As such, perceptions of moral norm violations should be inflexible. With regard to social norms, people can establish an association between a situation and a normative behavior, and these associations can strengthen such that normative behavior occurs automatically when a situation is depicted (Aarts and Dijksterhuis, 2003). In such circumstances, if a behavior transgresses a norm, the behavior is a strong violation that can be easily detected. On the other hand, moral norm violations hurt others physically (Royzman et al., 2009) as well as emotionally (Bicchieri, 2005). Some SSN behaviors, such as "laughing out loud at a funeral," can emotionally harm the offended. Thus, perceptions of strong social norm violations may be less dependent on social context than weak social norm violations. The effect of residential mobility on perceptions of strong social norm-violating behaviors requires further examination.

Neural Mechanism Underlying the Residential Mobility Effect on Social Norm Violations

At the neural level, WI behavior evoked more negative differential N400s in the stable residential condition than in the mobile residential condition in females, whereas no differences for strong social norm violations were observed in either residential mobility condition. In previous research, N400 effects were observed for social inconsistencies, such as stereotypes (White et al., 2009) and affective incongruities (Goto et al., 2013; Fong et al., 2014), as well as non-social incongruities, including semantic violations (Proverbio and Riva, 2009) and the Stroop test (Rebai et al., 1997). In our study, the N400 results may have reflected the detection of social norm violations, as indicated by the inconsistencies between an expected and an observed behavior in a given situation. Furthermore, the negative correlation between the differential ERPs for the SI and WI conditions and the subjective rating of weak violations in the mobile condition indicate that mobility weakened the detection of weak social norm violations. These results sufficiently suggest that the detection of social norm violations is affected by mobility. If mobility only affected people's tolerance, they could still detect inappropriate behaviors; thus, top-down regulation would lead them to make appropriate ratings. However, according to our findings, the detection of weakly violating behaviors was modified in the mobile residential condition. Thus, the reason why mobility increases the subjective ratings of weak violations at the behavioral level is that mobility reduces people's perception of weak violation situations rather than that mobility increases their tolerance to weak violation situations.

Our ERP findings from Study 2 and our behavioral data from Study 1 consistently suggest that residential mobility decreases the detection of weak social norm violations. It should also be noted that residential mobility influences external behaviors as well as psychological processes at the neurobiological level. Previous research has shown that diversified experiences lead to cognitive flexibility and norm violations (Ritter et al., 2012). Individuals who are in residentially mobile contexts may become involved in diverse contexts and may be exposed to unusual issues

or situations. As a result, they may become more cognitively flexible with social norm violations, meaning that they may become less sensitive to these violations. Notably, residential mobility did not influence the detection of semantic violations, as shown in Study 3, indicating that the impact of residential mobility on the detection of social norm violations follows a specific pattern.

Theoretical Implications and Future Directions

Social changes have an impact on individuals through mixed approaches, and individuals respond differently based on both the micro and macro culture they encounter. The findings of the present study suggest that studying the effect of residential mobility on social cognition would allow gender differences to be taken into account. Changes in social cognition and social status might be passed to the next generation by interaction among family members (McGinn et al., 2018; Tuccio and Wahba, 2018). Females play a significant role in influencing the values and perspectives of children due to their responsibility to teach and raise the next generations, especially in the context of traditional Chinese culture (King and Bond, 1985). More studies could be conducted to investigate how the impact of residential mobility on females' social cognition is transmitted and passed on intergenerationally.

Psychological consequences may lead to behavioral changes. Although the reduced perception of social norm violations might help women adapt to changing environments and blend in, it may also lead to a "side effect," such as an increase in counter-normative behaviors. Studies have shown that low moral sensitivity is related to increased antisocial behavior (Blair, 1997; Thornberg and Jungert, 2013). At the neural level, the dorsal and ventral prefrontal cortex, the amygdala and the angular gyrus are activated during moral judgment tasks and represent some of the primary areas in which antisocial individuals are functionally or structurally impaired, suggesting that behaving antisocially is partially caused by impairments in the moral judgment-related regions of the brain (Raine and Yang, 2006). In other words, failing to perceive a behavior as a moral violation because of brain impairment may lead to antisocial behavior. Our studies found that residential mobility influences the perception of social norm violations at the psychological level. Future research should examine whether decreased sensitivity to social norms due to mobility causes social norm-violating behaviors.

Importantly, the psyche and social ecology are mutual, and this mutual constitution is the nexus of socioecological psychology (Oishi and Graham, 2010). Our research found that residential mobility decreased an individual's detection of social norm violations, which may lead to social norm-violating behavior. Social norm violators in a residentially stable context may encounter harsh punishments and may not be able to maintain their face, which may encourage more frequent moves. In this case, social norm violations may contribute to higher residential mobility in a society.

Another issue that warrants attention is the dynamic influence of residential mobility on individual judgments of norm violations, specifically in societies that have been developing at a rapid pace (e.g., China). The frequency of residential mobility coded in the present study takes into account the mobile range (i.e., moving within provinces or moving across provinces), and the results remain consistent. It is worth investigating in the future whether mobility of a broader range (e.g., international or cross-cultural mobility) would influence the perception of social norm violation differently. During the globalization era, the consequences of residential mobility warrant further examination. This area of research may assist in resolving certain questions in human society.

DATA AVAILABILITY STATEMENT

The datasets underlying the findings described and used to reach the conclusions of the manuscript are included in the **Supplementary Material**. Other data in this project is also available on request to the corresponding author for qualified researchers.

ETHICS STATEMENT

All participants gave written informed consent, and the study was approved by the Department of Psychology of Sun Yat-sen University Ethics Committee.

AUTHOR CONTRIBUTIONS

QK and SL designed the research. QK, YZ, and YX conducted the experiments. QK, ZK, and SL analyzed the data. QK, ZK, MY, LH, and SL wrote the manuscript. All authors commented on the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2019.02654/full#supplementary-material

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Social Cognition 2.0: Toward Mechanistic Theorizing

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Social cognition emerged in the 1970s and 80s as an attempt to answer social-psychological questions by adopting experimental techniques and theoretical concepts from cognitive psychology. Recently, cognitive psychologists began to build complementary bridges between cognitive and social psychology by showing increasing interest in the cognitive implications of social situations. Here, we take a closer look at the remaining obstacles to join cognitive and social perspectives on human behavior. Using conformity as an example, we attempt to demonstrate that the social-cognition approach has been successful in adopting cognitive concepts and experimental methods, but is still lagging behind with respect to (1) mechanistic theorizing, as it often engages in merely describing phenomena in terms of reasons rather than explaining it in terms of causes and (2) reflecting the sociohistorical context of the phenomenon under investigation. As we try to show, developing mechanistic theories for social phenomena, including the effects of individual differences and their sociohistorical dependencies, is not only possible but necessary to eliminate the boundaries between cognitive and social accounts of human behavior.

Keywords: conformity, theory of event coding, adaptive behavior, social cognition, mechanistic theorizing

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Social cognition, a "field of psychology concerned with the mental processes through which we preceive, think about, and act toward other people and in response to situational factors" (Amodio, 2019), emerged in the 1970s and 80s, as a result of adopting experimental techniques and theoretical concepts from cognitive psychology. In contrast to more sociological or behavioristic approaches, the social cognition approach tries to understand social thought and behavior from an individualistic perspective that considers the way information about social events is processed, stored, and used. This emphasis on individuals has been criticized (e.g., Taylor and Brown, 1979), and we do not intend to claim that the social cognition is the best or only way to understand social behavior. And yet, the social-cognition approach does provide an interesting and stimulating interface between cognitive and social research and theorizing, which is particularly important as the increasing interest of social psychologists in cognitive processes has recently been echoed by an increasing interest of cognitive psychologists in social situations and the cognitive implications thereof (Hommel, 2006).

This interest was fueled by surprising observations that what cognitive psychologists considered well-established, almost hard-wired cognitive effects can be strongly affected by the real or even imagined presence of other people. Take the notorious Simon effect (Simon, 1969), which indicates that speeded responses to stimuli are faster and more accurate if the stimulus spatially corresponds to the location of the response, even if stimulus location is irrelevant to the task. The classic effect has been replicated hundreds, perhaps thousands of times across

different variations of the basic design, the stimuli, and the responses (e.g., Hommel, 2011). It is commonly attributed to response conflict, the idea being that, when stimulus and response do not correspond, the intentional response conflicts with the response that is automatically triggered by the stimulus location, which in turn may lead to an error or a delay that reflects resolution of the conflict (e.g., Kornblum et al., 1990). If so, one would expect that the effect disappears if the participant responds with only one key to only one of the stimuli, rendering the task a "go-nogo task," because in this case the correct response can already be prepared long before the stimulus appears. This is indeed what studies have shown (Hommel, 1996). However, if such a go-nogo version of the task is performed in the presence of another person who operates the other key to respond to the other stimulus (see **Figure 1**), the effect comes back—the so-called Joint Simon effect (JSE; Sebanz et al., 2003).

The discovery of the JSE has been considered to show that people automatically co-represent other people and their tasks and to demonstrate "the fundamental social nature of perception and action" (Knoblich and Sebanz, 2006). While more recent findings have challenged the assumption of automatic co-representation (Dolk et al., 2014) and speculations about "social nature" do not seem to contribute much to understanding the underlying mechanisms, the observation of the JSE and related phenomena demonstrate that even the most basic cognitive effects are not immune to the social environment and the real or imagined presence of others. This in turn renders any clear-cut separation between cognitive and social psychology or phenomena questionable (Hommel, 2006)—irrespective of whether one assumes that all social behavior is actually cognitive in nature or whether one prefers the opposite perspective. However, the increasing methodological overlap between the cognitive and social sciences notwithstanding, integrating insights from both fields still faces considerable challenges. In the following, we highlight two of them: non-mechanistic theorizing about social effects and insufficient attention for the historicity and cultural boundedness of social phenomena. We will discuss both issues in the context of social conformity, by drawing on some, partly rather unexpected recent findings from our lab.

NON-MECHANISTIC THEORIZING

Conforming behavior has always been an interesting social phenomenon attracting the attention of many social psychologists in all times. In his most famous, but at the same time most controversial study, Asch (1951) demonstrated that people easily change their opinion when confronted with deviating opinions of others. His participants were to choose the one out of three visual lines that would match a reference line in length. Even though the correct response was obvious, participants were strongly affected by deviating judgments of other participants, who in fact were all confederates, and followed the group's opinion even when it was incorrect. Asch himself initially expected participants to choose the correct response irrespective of the group's opinion, so the actual results surprised him as much as the entire scientific community at that time.

How can we explain this kind of behavior? Social-psychological accounts have claimed that conformity effects reflect the belief in the superior knowledge of the group (Asch, 1951) and suggested that people conform to the group's norms and values because they want to be accepted by it (e.g., Kelman, 1958). While we do not doubt the validity of these claims, they remain descriptive and do not amount to a truly mechanistic explanation. Social-psychological "explanations" refer to the possible reasons of conformity behavior rather than to the actual causes, and thus favor the personal level of explanation over the more appropriate functional or systems level. If we are to understand social behavior by referring to and analyzing the information-processing operations underlying it, explanations should be restricted to this functional/systems level of description rather

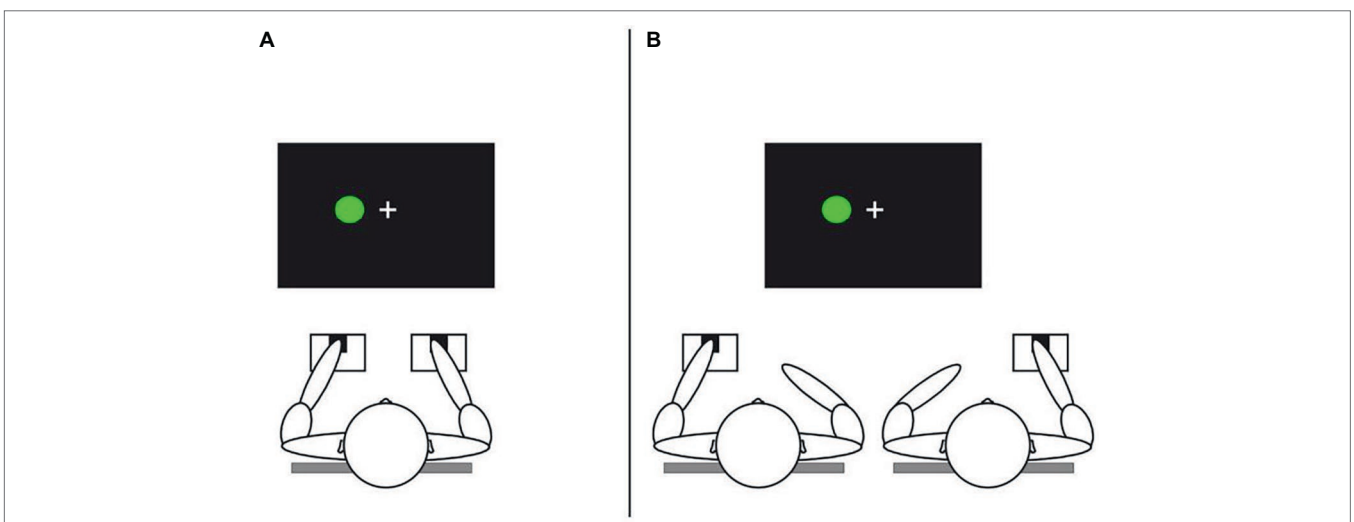

FIGURE 1 | Schematic representation of standard Simon task **(A)** and joint Simon tasks **(B)** (Ruissen and de Bruijn, 2016).

than to the personal level at which the to-be-explained phenomenon is defined. Failing to do so is likely to result in re-describing the phenomenon in pseudo-explanatory terminology, rather than revealing the actual mechanistic underpinnings (Hommel, 2019). Neuroscientific "explanations," in turn, have merely demonstrated that conformity behavior goes along with neural activity that has also been shown to go along with other (e.g., conflict-inducing) behavior that is similar to conformity behavior. For example, in the study of Klucharev et al. (2009), results demonstrated that when individual judgments differed from those of the group, activity in the medial prefrontal cortex (an area generally known to be involved in the processing of conflict) increased, while activity in the nucleus accumbens, an area associated with the expectation of reward, decreased. Again, we do not doubt the validity and importance of these observations, but they hardly provide a mechanistic principle that would really explain the phenomenon.

We conclude that the social cognition approach was successful in bringing into play cognitive methodological techniques and cognitive theoretical concepts, but it did not yet make the decisive step of engaging in truly mechanistic theorizing. In order to do so, social cognition approaches would not only need to include cognitive concepts in the explanation of phenomena but also to delineate exactly how the interaction of cognitive operations causally generates the phenomena. A truly mechanistic approach needs to look for a cognitive theory that goes beyond re-describing or provide personal reasons to produce effects like conformity by providing a mechanism that allows researchers to systematically predict such behavior under various conditions.

To become more explicit with respect to the needed level theorizing and to provide a concrete example case, we refer to a recent attempt of ours (Kim and Hommel, 2015) to explain key characteristics of conformity by using basic principles of the Theory of Event Coding (TEC), a general theory of the interactions between human perception and action (Hommel et al., 2001). We would like to emphasize that our goal is not to defend our particular approach at this point, but will use it only as an example for the degree of theoretical detail and specificity that we think is needed for the next generation of social cognition approaches—Social Cognition 2.0 (a term we borrow from Amodio, 2019) that is. We also admit that our approach does not account for all available conformity-related observations. In the original Asch (1951) experiments, participants carried out their judgments in the presence of confederates. This introduces motives of justification and self-presentation, as obvious from self-reports showing that some participants knew that the answer of the group was wrong but they apparently did not dare to give a deviant answer. Later, approaches have focused more on the after-effects of information about majority opinions and judgments of a relevant reference group, such as in the studies described below (i.e., changes of one's judgment of a given object or issue to make it more compatible with a majority vote), and it is only these kinds of after-effects we will be addressing in the following.

Our account of the impact of majority judgments on the future behavior of participants was motivated by TECs claim that both produced and perceived events (i.e., action plans and perceptual representations) are coded in terms of their features and in a common format (Hommel et al., 2001; Hommel, 2009), and that it does not differentiate between representing "me/self" and "others" (Hommel, 2018). Accordingly, actions performed by the individual him/herself and the actions performed by someone else should be coded in comparable ways (Hommel et al., 2009)—even though one commonly has more (e.g., proprioceptive, anticipatory, and historical) information about one's own action (Hommel, 2018). Given TECs further assumption that co-activated event codes tend to be bound into event files (Hommel, 2004), experiencing a (self- or other-performed) action should lead to a binding of action-related feature codes to codes representing the perceptual context (i.e., the stimuli inducing the action, the object on which it is carried out, and the situation in which that happens). Event files operate according to a pattern-completion logic, so that the retrieval or stimulus-induced reactivation of one code spreads to the other components (Kühn et al., 2011).

Given these assumptions, we reasoned, conformity-related changes in judgment might thus have nothing to do with group wisdom or group norms but rather reflect a mix-up of event files reflecting one's own action history and event files reflecting the actions of others. If, say, an individual reacts to a stimulus line by judging it to be 2 cm long, she would store an event file that integrates perceptual codes of the stimulus features and the response "2 cm." Perceiving nine other people reacting to the same stimulus by judging it to be 3 cm long would lead to the storage of nine event files that integrate stimulus features with the response "3 cm." Even if event files coding one's own action might enjoy more attention or stronger weighting, encountering the stimulus on another occasion would still tend to retrieve 10 event files with most of them suggesting another than the correct response. Given the notorious strong impact of (memories of) past responses on present performance (Lewin, 1922a,b), what looks like conformity may simply be the failure to properly discriminate between one's own (correct) response and the (incorrect) response(s) of one's co-actor(s).

To test this possibility, Kim and Hommel (2015) adopted the experimental design of recent conformity studies (Klucharev et al., 2009; Shestakova et al., 2012) and had participants rate 220 pictures of female faces for attractiveness on a scale 1–8. After their own evaluation, participants were presented with what they were led to believe was the rating of the same face by other students of their university—an important reference group. After a short break, participants were asked to rate the same faces again. Replicating previous studies, we found significant changes in the ratings into the direction of the rating of a reference group: higher scores if a reference group found the face more attractive and lower scores if they found it less attractive. Importantly, we included a second group of participants that was also presented with other ratings after having rated each face themselves, but the cover story did not mention any possible reference group. Rather, participants were told that the numbers were randomly chosen and function as distractors to make the task more difficult. Given our

theoretical background, we expected that the mere exposure to an alternative "response" (even in the absence of any social indication of it) would result in an adjustment of participants' rating behavior in the second rating session. Indeed, even in the absence of any social cover story, participants demonstrated "conformity" by adjusting their second rating into the direction of the presented number (Kim and Hommel, 2015).

We hasten to add that this observation must not be taken as unequivocal evidence for the validity of our theoretical background. As argued by Ihmels and Ache (2018) and partly confirmed by Kim and Hommel (2018), the paradigm used by Kim and Hommel (2015) and previous researchers is sensitive to regression-to-the-mean effects, which implies that the effect that Kim and Hommel (2015) were able to extend to non-social conditions was actually not a real conformity effect. What we do want to emphasize, however, is that we consider our approach the first truly mechanistic account of conformity behavior which allows for much more specific predictions than the previously suggested descriptive accounts.

AHISTORICAL THEORIZING

A major objection against the application of cognitive theories to social phenomena may be based on the fact that cognitive approaches address processes that rely on millions of years of biological evolution while social phenomena can change even within the lifespan of one generation. This problem was voiced by Gergen (1973), who argued that laws and principles of social interaction vary over time, so that "theories of social behavior are primarily reflections of contemporary history". If so, phenomena we observe today may become weaker tomorrow and even cease to exist the year after, sometimes due to that reporting and discussing a phenomenon might work back and speed up eliminating the phenomenon; e.g., studying and discussing obedience to authority may reduce the likelihood of finding obedience in citizens.

A related aspect of social behavior is its cultural variability. Similar social situations can evoke different behavioral responses in members of different cultures, historical traditions, and religions, different gender roles, even different emotional reactions, and different neural responses (Han and Ma, 2014) to life events like death or childbirth. This suggests that culture has a strong impact on basic cognitive aspects of human brain functioning. Indeed, a number of seminal studies by Nisbett and colleagues, who have strongly revived the interest in cultural factors, found that people growing up in East Asian cultures such as China and Japan tend to develop more holistic thinking styles, whereas people brought up in Western cultures like Australia and the USA tend to develop analytic thinking styles, with severe consequences for the way global and local information is processed (e.g., Nisbett et al., 2001). Along the same lines, members of collectivistic (e.g., Catholicism or Buddhism) and individualistic (e.g., neo-Calvinism) religions show profound differences in cognitive-control styles (Hommel and Colzato, 2017).

Take again conformity as an example. After Asch's famous experiment (Asch, 1951), many replications of the study followed exploring which factors contributed to the main effect, such as the obviousness of the correct response, group size, or gender composition of the group (e.g., Larsen, 1990; Bond, 2005). But not all replications were successful. In fact, effect sizes decreased systematically over decades and even tended to disappear in the most recent studies (Bond and Smith, 1996), which according to Perrin and Spencer (1981) suggests that Asch's study was a "child of its time" by reflecting the high level of social obedience of 1950s in the USA that disappeared as a consequence of the rise of individualistic values. And yet, successful replications of the Asch's observations are still reported even in the Western World in the last two decades of the 20th century (e.g., Vlaander and Rooijen, 1985; Abrams et al., 1990). Could this be a sign that Gergen was correct in claiming that social phenomena cannot be studied in the lab?

We would like to argue that, on the contrary, Gergen's challenge calls for more mechanistic theorizing based on systematic laboratory research. Historical processes and the dynamics of social phenomena they imply do not stand in the way of more rigorous theorizing but rather provide useful constraints for building theories that embrace historical processes and make them part of the modeling process. Hence, we need mechanistic models that can explain exactly how historical changes impact cognitive processing and the phenomenon under investigation. For example, Hommel and Colzato (2017) have suggested that differential emphasis on commonalities versus distinctions between events and individuals in collectivistic and individualistic cultures provide selective social feedback for the development of a more integrative or a more discriminative cognitive processing style, which eventually establishes a corresponding default bias. A more integrative bias would increase, and a more focused bias would reduce the amount of social information considered in a decision, which in the latter case would reduce and eventually eliminate phenomena that rely on the processing of social information, such as conformity. If so, conformity effects should be easier to find in more collectivistic societies.

To test this prediction, Kim et al. (2019, submitted) created a novel paradigm for testing conformity effects that avoids methodological problems like regression-to-the-mean effects. Participants saw 110 pairs of pictures (plants and flowers) and chose the one they liked more. As in previous studies, participants were then confronted with the opinion of "others" before they were tested again to see whether deviating opinions of "others" changed their judgment (see **Figure 2**). To compare collectivistic and individualistic cultures, we tested participants in the Netherlands, a country in the top-5 Hofstede's Individualism/Collectivism Scale (Hofstede et al., 2010, with 80 out of 100 Individualism points), and China (20 Individualism points), which despite a visible trend toward individualization has remained much more collectivistic in comparison (Van de Vliert et al., 2013). We found a significant main effect of conformity in the Chinese but not in the Dutch sample, suggesting that the Dutch students were ignoring the social information. This suggests that conformity behavior is not hardwired but emerges from an interaction between cultural biases and situational salience of social information. Rigorous mechanistic theorizing can capture both of these factors and

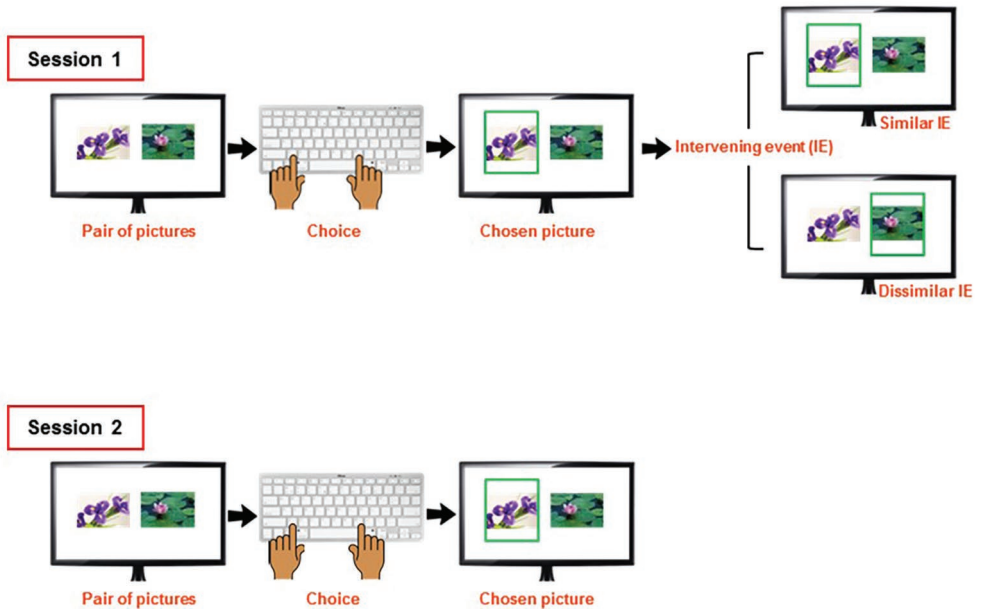

FIGURE 2 | Schematic representation of the sequence of events occurring on each trial of the conformity task of Study 2.

make specific and increasingly precise predictions that are open to laboratory testing.

CONCLUSIONS

Lewin (1952) claimed that nothing is as practical as a good theory, and we claim that this holds in particular for the understanding of social phenomena. While the social-cognition approach has been successful in adopting cognitive concepts and experimental methods, it is still lagging behind with respect to mechanistic theorizing and still way too often engages in merely describing phenomena in terms of reasons rather than explaining it in terms of causes. As we tried to show here, developing mechanistic theories for social phenomena is possible (see also Pfister et al., 2019, for a mechanistic account of rule-breaking), and there is no reason to shy away from using these theories to also account for the impact of historical development, cultural and individual variability, and environmental dynamics. In other words, the time is ripe for Social Cognition 2.0.

AUTHOR CONTRIBUTIONS

Both authors contributed to the development of the article concept and they both approved the final version of the manuscript. DK drafted the manuscript and BH provided critical revisions.

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What Early Sapiens Cognition Can Teach Us: Untangling Cultural Influences on Human Cognition Across Time

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Evidence of cultural influences on cognition is accumulating, but untangling these cultural influences from one another or from non-cultural influences has remained a challenging task. As between-group differences are neither a *sufficient* nor a *necessary* indicator of cultural impact, cross-cultural comparisons in isolation are unable to furnish any cogent conclusions. This shortfall can be compensated by taking a diachronic perspective that focuses on the role of culture for the emergence and evolution of our cognitive abilities. Three strategies for reconstructing early human cognition are presented: the *chaîne opératoire* approach and its extension to brain-imaging studies, large-scale extrapolations, and phylogenetic comparative methods. While these strategies are reliant on our understanding of present-day cognition, they conversely also have the potential to advance this understanding in fundamental ways.

Keywords: cognition, culture, evolution, early humans, *chaîne opératoire*, cross-cultural comparisons, phylogenetic comparative methods

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INVESTIGATING THE ROLE OF CULTURE FOR COGNITION

Human cognition is profoundly shaped by culture. This is perhaps more evident for some domains than for others, but striking examples abound: orientation in and referencing to space and time (Levinson, 2003; Haun et al., 2011; Bender and Beller, 2014b), reasoning about the biological world (Medin and Atran, 2004; Bang et al., 2007; Ojalehto et al., 2017a,b), accounting for cause–effect relations (Choi et al., 1999; Bender and Beller, 2019), or representations of numbers (Beller and Bender, 2008; Bender and Beller, 2012, 2014a; Núñez, 2017), not to mention the way in which we conceptualize social relationships (Fiske, 1992; Lillard, 1998) and ourselves within them (Markus and Kitayama, 1991). As much as they are rendered possible by endowed capacities, all of these cognitive abilities, activities, and achievements are also predicated on culture, be it by way of culturally accumulated and transmitted knowledge, culture-specific concepts and framework theories, cultural tools, conventions, and practices, or simply by the fact that we are a cultural species (Tomasello et al., 2005; Henrich, 2016; Heyes, 2018; Bender, 2019).

Limitations of Cross-Cultural Studies

Despite increasing evidence for the existence of cultural influences on cognition, untangling them from one another or from non-cultural influences has remained a challenging task. One obvious, and increasingly popular, strategy is cross-cultural comparison. Such studies do help us to detect diversity in cognitive phenomena, but they do not reveal the extent to which this diversity is brought

about by culture. For instance, ethnolinguistic groups differ regarding which frame of reference they habitually adopt for representing spatial relations. Whether, however, these differences are due to linguistic availabilities, to cultural preferences, or to environmental affordances and constraints is subject to ongoing debate (overviews in Majid et al., 2004; Bohnemeyer et al., 2014).

While such differences are interesting in any case, in that they attest to cognitive diversity, for us to be willing to accept them as *cultural* differences, we would want them to involve at least two types of social processes: one for generating the pattern (such as transmission) and one for stabilizing it (such as mutual coercion). After all, the hallmarks of culture are learning, sharing, and some extent of normativity (Brumann, 1999; Gatewood, 2012; de Munck and Bennardo, 2019). As a minimum standard, therefore, cross-cultural studies would have to be complemented and bolstered by in-depth ethnographic investigations of where these group-specific patterns originate, how they spread, and how they are maintained (for a rare example of this combination, see Dasen and Mishra, 2010). Another strategy for teasing apart influences of culture from other factors is triangulation: comparing one group with two others that differ from the former on distinct dimensions, one regarding culture, the other regarding, say, environmental experience (Medin and Atran, 2004).

In addition to not being *sufficient* as indicators of cultural influences, between-group differences are not *necessary* either. Theory of mind, for instance, is the ability for mental reasoning, which humans typically acquire long before adulthood. It may thus seem to be a textbook example of an ability with which humans are endowed. Still, its development benefits from, if not relies on, social interaction and cultural practices, including a focus on mental states and the use of mentalistic language (Ruffman et al., 2002; Pyers and Senghas, 2009; overview in Träuble et al., 2013; Slaughter and Perez-Zapata, 2014). As a consequence of culture's pivotal role in the development of this ability, all human populations – unlike any other species – become so attuned to reasoning about others' minds that they cannot help but also ascribe some form of mental reasoning to species that, for all we know, most likely lack this ability (Povinelli and Vonk, 2003). That is, culture impacts on cognition not only as a means of diversification, but also, and profoundly so, as a driving force in cognitive evolution and development. Yet, if asserting whether between-group differences in cognitive behavior are caused by culture is already challenging, then asserting an influence of culture in those instances in which it does not even produce any differences poses seemingly insurmountable obstacles.

In short, cross-cultural comparisons are a valuable scientific tool for the investigation of cognitive diversification, but in isolation they fall short of furnishing any cogent conclusions: While they allow us to detect differences, they do not allow us to infer an impact of culture from the presence of such differences, or indeed to infer a lack of impact from their absence. Crucially, cross-cultural comparisons remain largely silent on the scaffolding role of culture – a shortfall that can be compensated by adopting an evolutionary perspective on how aspects of specifically human cognition emerged.

The Potential of an Evolutionary Perspective

Assessing the role of culture for early human cognition is important both on ontological and epistemic grounds: It is a subject worthy of investigation in its own right, but it is also an essential qualification in all attempts to reconstruct past cognition.

Several hundred thousand years ago, early *Homo sapiens* learned to control fire, invented complex tools such as bow-and-arrow sets, and began to use abstract symbols and language (Henshilwood et al., 2002, 2018; Wadley, 2013; Backwell et al., 2018). Even in hindsight, these achievements strike us as truly impressive, yet what made them possible has remained one of the most tantalizing questions of human evolution. Among paleoscientists, there is increasing consensus that most, if not all, important innovations made by *Homo sapiens* were brought about by evolutionary mechanisms in which culture was the major driving force (for more details and examples, see Colagè and d'Errico, 2018; Bender, 2019; Sterelny, 2019). One such mechanism is the cultural transmission and accumulation of knowledge, ideas, and inventions, which generates the "ratchet effect" so characteristic of human culture (Tennie et al., 2009; Henrich, 2016). It is attested to, for instance, in numerical cognition, in which a concept, once understood, paves the way for further elaboration (Miller and Paredes, 1996). Existing cultural achievements may also be co-opted for new cognitive purposes, a mechanism that is called cultural exaptation and has been detailed for number notations (d'Errico et al., 2017; d'Errico and Colagè, 2018). Even brain anatomy and gene pool are impacted by culture, through mechanisms such as cultural neural reuse and gene-culture coevolution: the former by recycling cortical maps, as in the case of literacy (Dehaene and Cohen, 2007; d'Errico and Colagè, 2018), the latter by exerting pressure on gene selection (Boyd and Richerson, 1988; Laland et al., 2010). Our language abilities, for instance, are linked to genetic mutations that are present in the human line, but not in other primates. While, according to a standard scenario of pure natural selection, language use would have been "switched on" in individuals possessing the mutation, gene-culture co-evolution opens up a more convincing, alternative scenario: that some form of language use was already part of the cultural environment, in which the mutation could then confer a selective advantage (Fisher and Marcus, 2006; Fisher and Ridley, 2013).

In short, culture helped us to develop cognitive capacities (such as language), cognitive tools (such as writing), and cognitive skills (such as calculation). Investigating the mechanisms that sparked off and shaped these capacities, tools, and skills is therefore essential, as it will enable us to illuminate the instrumental role of culture.

RECONSTRUCTING EARLY HUMAN COGNITION

When trying to delineate the impact of culture on the emergence, evolution, and molding of what makes human cognition unique, we face a major challenge. Other than the material remains of

humans and the material output of their activities, the cognitive skill set and knowledge available to our ancestors have left no direct traces in the archeological record and therefore have to be inferred. Three such approaches from a wide range of disciplines are detailed below: reconstructing the cognitive underpinnings of past activities, large-scale extrapolation of cognitive abilities, and retracing the cultural evolution of cognitive systems.

Reconstructing Cognition Involved in "Past Activities"

The approach generally adopted in cognitive archeology is a kind of reverse engineering. Taking the material remains of an artifact as a starting point, the implicated *chaîne opératoire* is then deployed to reconstruct the steps required for its production, ranging from acquisition of the raw material to manufacturing and subsequent use. It then goes from the behavioral components involved in these processing steps back further to infer the cognitive and social endowment indispensable for production, such as working memory capacity or focus of attention (Sellet, 1993; Haidle, 2010, 2014).

Lombard and Haidle (2012) elaborated this type of analysis for the production of bow-and-arrow sets, which date back to at least the Middle Stone Age in Sub-Saharan Africa (Backwell et al., 2018). This complementary tool set, in which the extraordinary efficiency of the components only unfolds when they are used jointly, was a major technological advancement, linked to an increase in cognitive and behavioral flexibility. Its invention required the craftsperson to conceive of a novel idea, for which several unrelated elements needed to be detached from their distinct context and combined to form something entirely new. This ability to assemble objects and actions in a modular manner is considered as a major breakthrough in problem-solving and creativity (Lombard and Haidle, 2012).

Such reconstructions of the cognitive, behavioral, and social components necessary for the production of prehistoric tools are increasingly complemented by neuroscientific methods (Stout and Chaminade, 2007). To identify the neural substrates involved in past activities such as flint-knapping, the brain activation of present-day participants is measured while they engage in mental imagery of these activities. This helped researchers to ascertain, for instance, that more advanced tool-making requires more efficient visuomotor coordination and hierarchical action organization, and points to a shared basis of tool-making and language (Stout et al., 2008). More recently, Mellet et al. (2019) adopted a similar strategy to investigate symbol processing. They found that prehistoric engravings are perceived by present-day participants as organized and meaningful representations, which suggests a symbolic function also for those who created them.

These reconstructive approaches all share the assumption that our human ancestors possessed an almost identical genome, similar brain structures, and hence basically the same cognitive capacities as do contemporary humans. While this assumption is plausible, the inference that early sapiens cognition can therefore be simply extrapolated from today's cognition is more contestable. This inference is valid only to the extent that it takes into account the changes brought about by cultural evolution and ensuing cognitive diversification.

Reconstructing "Past Cognition" by Extrapolation

When attempting to extrapolate from present-day cognition to past cognition, two major challenges need to be tackled: One is to delineate basic aspects from all of those that are generated by mechanisms of cultural evolution, and the other is to delineate universal aspects from all of those that are shaped by culture. These two tasks require different approaches.

The delineation of *basic* aspects of cognition is aided by insights from a wide range of disciplines including evolutionary anthropology and paleoanthropology, archeology, comparative psychology, and language evolution. This research helps to identify the set of social and cognitive skills that is uniquely human (Haun et al., 2010; Tomasello and Herrmann, 2010), the evolutionary mechanisms that enabled them, such as cumulative culture and cultural exaptation (Tennie et al., 2009; Colagè and d'Errico, 2018; Heyes, 2018), and characteristics of those processes and constraints that continue to shape cognitive tools and skills (Christiansen and Chater, 2008; Lupyan and Dale, 2016). The classic example of a cultural innovation with a profound impact on cognition is literacy. Learning to read and write not only facilitates the accumulation and transmission of knowledge on a grand new scale (Huettig and Mishra, 2014; Morin et al., 2018), but also rewires the individual brain (Dehaene and Cohen, 2007). When extrapolating to past cognition, we therefore need to discount the neural and cognitive changes brought about by cultural innovations such as literacy and, more generally, we need a more exhaustive overview of the range of changes to be taken into account.

For delineating *universal* aspects of cognition, large-scale cross-cultural studies are an important step (e.g., Majid et al., 2004, 2015; Henrich et al., 2005, 2010a; Bohnemeyer et al., 2014). For the case of language, such studies have found substantial diversity on almost every level of linguistic organization (Evans and Levinson, 2009; Dunn et al., 2011). The universals that could be established so far seem to be confined to aspects of usage such as turn-taking and repair (Dingemanse et al., 2015; Levinson, 2016). A better understanding of what is really shared by present-day humans, however, is a prerequisite for any attempt to extrapolate our models and assumptions to early sapiens cognition.

Yet, as noted before, the identification of diversity can only be the first in a series of steps, and needs to be enriched by deep ethnographic understanding. When combining cross-cultural studies with investigations into cognitive development and across species (Liebal and Haun, 2018), we are able to more accurately assess the proportions of cultural diversity and convergence that are due to hereditary predispositions compared to those transformed by cultural influences (Haun et al., 2006). An even more comprehensive combination of approaches was tested recently for causal cognition (Bender and Beller, 2019): Research across species, back into prehistory, and on cognitive development was surveyed to identify those aspects of causal cognition that are specific to humans rather than shared by other primates, and research across cultures and languages was surveyed to identify both commonalities and differences. One specifically human feature is the pivotal

role of causally relevant knowledge, most of which is culturally accumulated and transmitted. As a consequence, causal cognition in humans is shaped by culture in two ways: It is diverse across cultural traditions, and it is molded more generally by the distinct characteristics of human sociality, modes of teaching, and language.

Reconstructing "Past Cognition" From Present Diversity

While the previously mentioned strategies try to take cultural evolution and diversity into account on inferential grounds, the third approach, originating from evolutionary biology and anthropology, capitalizes precisely on present-day diversity, as reflected, for instance, in conceptual systems. In principle, diversity in such systems is understood to be an outcome of evolutionary processes, either due to random changes or to systematic transformations. With the help of phylogenetic comparative methods, evolution can therefore be "re-run" in order to gauge the relative proportions of these sources. The same approach also allows one to infer past states of such systems, to assess their transformations, and to retrace co-evolution between system properties and other factors (Mace and Holden, 2005; Levinson and Gray, 2012).

Let us illustrate its explanatory power for systems of kinship terminology (Jordan, 2013). Given the clear and strong biological underpinnings of kin relations, the degree of diversity exhibited by kinship systems is astonishing – and still by no means unlimited (Levinson, 2012). Differences occur particularly in the extent to which features such as generation, gender, relative age, or connecting relatives are relevant for classification. Some systems, for instance, collate cousins with brothers and sisters, while others distinguish between same- and opposite-sex cousins of same- or opposite -sex parents (rendering some of them prohibited and some desired marriage partners). Harnessing phylogenetic comparative methods has helped to identify the semantic distinctions made in a kinship system, or the settlement patterns based thereupon, in ancestral populations and to assess how these have changed over time (Jordan et al., 2009; Jordan, 2011). The same methods can also be deployed to test hypotheses regarding cognitive constraints on a system's complexity. For the case of kinship systems, several constraining factors have been identified, among them general communicative principles that balance informativeness and simplicity, language-specifics such as descent from a joint ancestor language, and the social practices linked to the kinship systems (Kemp and Regier, 2012; Rácz et al., 2019).

In a nutshell, the modeling of evolutionary trajectories enables us to ascertain the primal states of cognitive systems and to reconstruct the conditions under which such states are likely to change. This renders it a powerful tool for reconstructing past cognition from present-day diversity, specifically in those domains for which rich phylogenetic language trees are available.

CONCLUSION

The strategies presented here are an important step toward the reconstruction of early sapiens cognition, but their true potential is greater. While each of these strategies is reliant on our understanding of present-day cognition, they also substantially advance this understanding, including an appreciation of how cognition is influenced by culture. More concretely, they help to delineate those aspects of cognition that are widely shared and universal, and allow us to assess more general constraints on diversity. They help to illuminate the conditions under which aspects of cognition emerged, evolved, and changed, as well as the time scales in which this happened. By retracing evolutionary trajectories, they help to identify components with which a cognitive skill or tool may have co-evolved. And by identifying these driving forces in cognitive evolution, finally, they also raise our awareness of the extent to which these factors continue to impact on cognition.

Since its emergence, cognitive science has been strongly committed to the assumption that cognition basically works in the same way across all human populations (Flanagan, 1991) – a view still popular in wide parts of cognitive psychology. The insight that variability in cognition may indeed be greater than long assumed is slowly gaining ground (Bender et al., 2015; Bender, 2019). An accumulation of empirical findings (e.g., Levinson, 2003; Medin and Atran, 2004; Bender and Beller, 2016) and methodological criticism from within the cognitive sciences (Arnett, 2008; Henrich et al., 2010b) has helped to promote an attitude change. But the research field still has a long way to go from acknowledging the existence of cognitive diversity to accepting the profound impacts of culture, or to be able to untangle the processes involved. The position championed here is that real progress in this regard will depend on combining different perspectives in an interdisciplinary effort to investigate cognition across both cultures and time. We have a lot to learn from today's cognitive diversity for the evolution of human cognition, but we have equally much to learn from our ancestors for today's cognition.

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The author confirms being the sole contributor of this work and has approved it for publication.

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BRIEF RESEARCH REPORT
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Cultural Differences in Visual Contents in Picture Books

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Previous studies investigating cultural differences in attention and perception have shown that individuals from Western countries (e. g., the U.S.) perceive more analytically whereas individuals from East Asian countries (e.g., Japan) perceive more holistically (e.g., Nisbett and Miyamoto, 2005). These differences have been shown in children as young as 3 years old (Kuwabara and Smith, 2016). To reflect cultural influences on cognition, specifically on attention and perception, this study investigated potential differences in the visual environment. In this study, we focused on one of such visual environments that young children are exposed to regularly and influence other domains of development, picture books (Horst and Houston-Price, 2015). Thirty seven U.S. picture books and 37 Japanese picture books were coded for visual contents—how visually crowded—by computer software from the National Institute of Health (NIH) and human coders. Results show that the U.S. picture books are more visually crowded than the Japanese books by the software, but contained more objects than the Japanese books as expected, which reflect well with the cultural differences in attention observed in young children in previous studies. However, the results differed based on the target ages of the books. The implication of the current study is discussed as a reflection of the mutual constitution between culture and psyche.

Keywords: cross-cultural, visual environment, children, picture books, infant/toddler, preschool

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Cultural influences can be observed in how our minds work and process information and how the differences in the environment might trigger or facilitate those differences in our minds (Markus and Hamedani, 2007). Both of these processes in mind and environment must be studied systematically if we would like to untangle the cultural influences on human cognition. Cultural differences in our cognition, specifically in attention and perception have been documented in a wide variety of tasks, such as visual recognition tasks (e.g., Masuda and Nisbett, 2001; Kitayama et al., 2003), including eye-tracking method (e.g., Chua et al., 2005; Kelly et al., 2010) and brain imaging (e.g., Hedden et al., 2008; Masuda et al., 2014). Accumulating evidence suggests individuals in Western cultures tend to focus on individual and most salient elements of a scene (analytic attention) while individuals in East Asian cultures tend to focus on the relationship among objects in a scene (holistic attention) (see Nisbett and Miyamoto, 2005 for review). For example, when shown a mundane scene of fish in an aquarium, adults from Western cultures were more likely to look at and remember the focal object, whereas adults from East Asian cultures were more likely to fixate on and remember multiple elements in the scene and their relation to each other (Masuda and Nisbett, 2001). Although the number of cross-cultural studies on attentional differences in young children is yet limited, the findings that children developing in East Asian cultures are more sensitive to relations among objects in scenes than are children in Western cultures, the trend similar to adults, have been observed as young as 3 years of age

(Duffy et al., 2009; Kuwabara and Smith, 2012, 2016; Moriguchi et al., 2012; Imada et al., 2013; Senzaki et al., 2014). The research investigating the cultural influences in attention has focused mainly on how our minds process information (in our minds differences). As pointed out by Morling and Lamoreaux (2008), if we truly want to understand the cultural influences on cognition, it is important to understand how environmental factors facilitate such cultural differences in our minds from such a young age.

Some studies have suggested and investigated how differences in visual environments we encounter daily might influence our attention (Miyamoto et al., 2006). For example, Miyamoto et al. (2006) found the U.S. street scenes are visually simpler (e.g., less crowded, a smaller number of objects) than Japanese street scenes (e.g., more crowded, a greater number of objects). Cultural products that we encounter daily also incorporate cultural values (Morling and Lamoreaux, 2008), such that the meta-analysis of previous studies of cultural products have shown the products from the Western societies included more independent values (e.g., uniqueness) whereas the products from the Eastern societies included more interdependent values (e.g., relationships). Cultural products reflect not only those cultural values, but also reflect the attentional differences observed in each culture, such as websites (Wang et al., 2012) and arts (Masuda et al., 2008) follow the similar trend—the U.S. products were visually less crowded than Japanese products. For example, the U.S. comic books framed scenes by focusing on individual characters whereas Japanese comic books framed scenes by highlighting the relationship between the characters and scenes (Cohn et al., 2012). For children, the textbooks used in elementary schools show a similar trend—the U.S. textbooks included a fewer number of characters than the Japanese textbooks (Imada, 2012). All of these trends suggest the visual environment that we encounter daily might encourage the cultural differences observed in attention and perception. Specifically, having less crowded visual environment which is commonly seen in the U.S. might encourage analytic attention because it might be easier to focus on focal objects in scenes whereas having more crowded visual environment which is commonly seen in Japan might encourage holistic attention, which might benefit the processing of the environment where objects are scattered around. A previous study (Miyamoto et al., 2006) has shown priming participants with the crowded visual scenes (e.g., Japanese street scenes) made participants (from both the U.S. and Japan) attend more holistically than priming participants with the less crowded visual scenes (e.g., the U.S. street scenes), suggesting the visual environment that we encounter daily might influence how we process information visually.

However, most studies investigating the cultural differences in visual environments focused on the visual environments that adults and older children (e.g., elementary school) encounter and few studies, if any, focused on the visual environment that young children encounter. Given cultural differences in attention have been observed as young as 3 years of age (Kuwabara and Smith, 2016), visual environments that might encourage these differences in such a young age should be a priority in untangling how visual environments might interact with attentional differences. Therefore, for this study, we focused on one of such visual environments that young children encounter often, picture books, to see whether cultural differences in visual contents, specifically, visual crowdedness, could be observed. We chose the picture book because the activities related to the picture book (e.g., looking at the picture book) is a very common activity that children often enjoy (Horst and Houston-Price, 2015). Research has also shown picture books help children's development of language (e.g., Bus et al., 1995), socio-emotional understanding (e.g., Adrian et al., 2005), and memory (e.g., Cornell et al., 1988). Picture books are also cultural products that represent culture and cultural values. For example, Yannicopoulou (2013) found the aesthetics and drawings in the book shows how different cultures see beauty, understand what good and bad are. The picture books have also shown to portray the cultural differences in ideal emotional states. For example, Tsai et al. (2007) have found the U.S. picture books contained more arousing emotions (e.g., excited) and activities (e.g., splashing and jumping in the pool) than the Taiwanese books did. In the current study, we analyzed the visual contents of the U.S. and Japanese picture books for young children to see whether visual contents follow a similar trend found in previous studies that might encourage the attentional differences observed in young children and adults. We focused on the visual contents of illustration, rather than the wording of picture books because young children spent most of the time on the illustration than the wording of the picture books (An et al., 2017). Based on Miyamoto et al. (2006), if the visual environment influences the differences in attention, the picture books from the U.S. would be less visually crowded than Japanese picture books. We also explored the potential differences in visual content based on the target age of books (targeting infant and toddlers and targeting preschoolers) to see how early visual content in the picture books might follow the similar trend found in previous studies to support the attentional differences observed in young children and adults. For picture books targeting preschoolers, we expected the U.S. picture books would be less visually crowded than the Japanese picture books following the similar trends observed in previous studies (e.g., Miyamoto et al., 2006) because cultural differences in attention have been observed as early as age three. Due to the lack of research with infants and toddlers on attentional differences, we did not have a specific hypothesis for picture books targeting infants and toddlers.

METHODS

Sampling Books

One of the challenges of cultural studies, especially dealing with media, is the selection and inclusion criteria of samples (Livingstone, 2003). Sampling books that are representative of each country using the same inclusion criteria that are not culturally biased posed a challenge for our current study. For our research purpose, we wanted to select books that are accessible and available to many children in each country using the same criteria. We used the same criteria—the list of recommended books by librarians—as an indicator that these books might be available and accessible to many children in each country. For

each country, we used five libraries (the New York public library, Berkeley public library, County of Los Angeles public library, Fairfield public library, and Monroe County public library for the U.S.; Fukuoka prefectural library, Shimane prefectural library, Kyoto city library, Yokohama city library, and Ehime prefectural library for Japan) that posted the list of recommended books for children on their websites. From the list, books that were recommended by at least two library websites were included for this study. Books written and illustrated by foreign nationals were excluded from the selection due to the purpose of research. One book from Japan was excluded from coding and analysis because the book included mostly texts with very few images. Thirty six books (13 infant/toddler books and 23 preschool books) from the U.S. and 37 books (14 infant/toddler books and 23 preschool books) from Japan were included for this study (see **Appendix A** for the list of books). For this study, we coded each image segment on each page. The image segment was defined by the illustration on each page. For example, if the page included multiple-segmented illustrations divided by texts or the main character showing up in two separate illustrations on the page, each of those segments was counted as an image segment and coded separately from the other image segments on the page (see **Figure 1** for an example). The total number of image segments coded was 780 for the U.S. books and 504 for the Japanese books. This difference is due to the number of pages books had. On average, the U.S. books had 21.17 pages (ranging between 10 and 57 pages) and the Japanese books had 16.83 pages (ranging between 11 and 26 pages). We focused on the visual contents of illustration rather than the wording of each image segment as similar to the previous study (Tsai et al., 2007) because young children spent most of the time on the illustration than the wording of the picture books (An et al., 2017). The target ages listed by the library were used for Japanese books. For the U.S. books, libraries did not agree on the target ages of books or some libraries did not list the target ages of books. Therefore, the target ages list in the scholastic website (the world's largest publisher and distributor of children's books—https://www.scholastic.com) was used for the U.S. books.

Coding

Previous studies have used different measures to determine the visual crowdedness of images. A previous study (e.g., Miyamoto et al., 2006) has used the computer software, NIH ImageJ program (Rasband, 2018), and counted the number of particles as a measure of the visual crowdedness whereas another study (e.g., Senzaki et al., 2014) used the number of objects as a measure of the visual crowdedness. Therefore, we used both of these measures as an indicator of the visual crowdedness—one by the computer software and the other by human coders.

For the first measure, the NIH ImageJ program (Rasband, 2018) was used to measure the visual crowdedness of images on a Macintosh computer. The "analyze particles" command, which counts the number of particles in each image, was used. A particle is defined as any area of the image with a closed boundary. For example, each line of the dinosaur's shirt was counted as a particle in **Figure 1**. The minimum particle size was set at 100 pixels based on Miyamoto et al. (2006). Each image segment was converted to black and white with an 8-bit to meet the requirement of the program (see **Figure 1** for an example image after conversion). Because we focused on the illustration, the text of each image segment was excluded from the analysis.

For the second measure, two human coders also coded 68 books out of 73 books (93%). These coders counted the number of objects in each image segment on a page. A namable object was defined as having a clear division from other objects. If the object or animal had an atypical feature (e.g., a t-shirt on the dinosaur in **Figure 1**) or variable numbers of features (e.g., number of windows in the house), those features were counted as separate

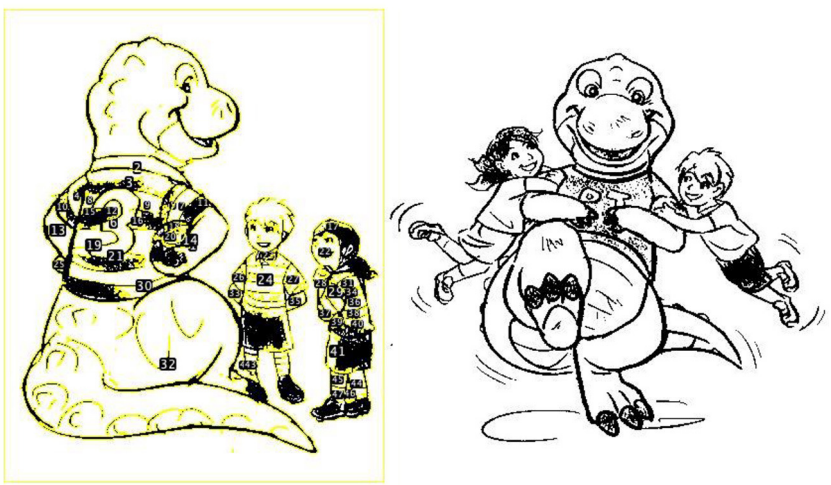

FIGURE 1 | The example illustration processed by the ImageJ. The example illustration is not a part of any picture books we coded, but the illustration, "Do dinosaurs play rugby?" by Stevie Mahardhika (licensed under CC BY-NC 4.0) from the Creative Commons was used as an example due to the copyrights of picture books. The image was processed to meet the requirements of the computer program, ImageJ. The example included two image segments that would be coded separately by the ImageJ and the human coders. The yellow lines highlight the particles coded by the ImageJ with the number on each particle.

objects. The overlapping particles (e.g., trees in a forest) without any clear boundary was counted as one object. Similar to particle counting by the ImageJ program, coders counted objects in each image segment on the page. Twelve books out of 73 total books (16%) were coded by both coders for reliability. The reliability of the coders was very high (Cronbach's alpha = 0.98). In **Figure 1**, the shirt that was counted as many particles by the ImageJ was counted as one object by the human coder. Therefore, the number of objects counted by human coders was much smaller than the number of particles counted by the ImageJ.

Analysis Plan

To test whether the visual contents of the U.S. and Japanese picture books for young children follow the similar trend found in previous studies, we ran ANOVA with the number of particles counted by the ImageJ and the number of objects counted by the human coders as dependent variables and the country as the independent variable. Based on Miyamoto et al. (2006), our expected results were that picture books from the U.S. would include a smaller number of particles and a smaller number of objects than Japanese picture books.

To explore the potential differences in visual content based on the target age of books, the number of particles counted by the ImageJ and the number of objects counted by the human coders were entered as the dependent variables in 2 (country—the U.S. and Japan) × 2 (age—infant/toddler books and preschool books) ANOVA. Our expected results were preschool books from the U.S. would include a smaller number of particles and a smaller number of objects than Japanese picture books. For infant/toddler books, due to a lack of research with infants and toddlers on attentional differences, we did not have a specific hypothesis.

RESULTS

Particle counts per an image segment was entered as a dependent variable in ANOVA by country (the U.S. and Japan), which shows the U.S. picture books (M = 124.05, SD = 139.59) contained significantly more particles than Japanese picture books (M = 107.06, SD = 135.06), $F(1, 1282) = 4.65$, $p < 0.05$. The number of object count per an image segment was entered as a dependent variable in ANOVA by country (the U.S. and Japan), which shows the U.S. picture books (M = 20.07, SD = 29.44) contained significantly less number of objects than Japanese picture books (M = 26.64, SD = 47.08), $F(1, 1127) = 9.71$, $p < 0.01$.

To see whether the target age of picture books influence the visual crowdedness, particle counts per an image segment was entered as a dependent variable in 2 (country—the U.S. and Japan) × 2 (age—infant/toddler books and preschool books) ANOVA. This yielded significant interaction between country × age, $F(1, 1280) = 59.13$, $p < 0.01$ (see **Figure 2A**). For infant and toddler books, the U.S. books (M = 161.32, SD = 139.93) contained significantly more particles than Japanese books (M = 56.29, SD = 72.47), $F(1, 395) = 76.28$, $p < 0.01$. For preschool books, the U.S. books (M = 107.78, SD = 136.41) contained significantly fewer particles than Japanese books (M = 130.67, SD = 150.19), $F(1, 885) = 5.48$, $p < 0.05$. Infant and toddler books (M = 161.32, SD = 139.93) contained significantly more particles than preschool books (M = 107.78, SD = 136.41) in the U.S., $F(1, 778) = 25.03$, $p < 0.01$, whereas infant and toddler books (M = 56.29, SD = 72.47) contained significantly fewer particles than preschool books (M = 130.67, SD = 150.19) in Japan, $F(1, 502) = 35.38$, $p < 0.01$. The number of object counts per an image segment was also entered as a dependent variable in 2 (country—the U.S. and Japan) × 2 (age—infant/toddler books and preschool books) ANOVA, which yield significant interaction between country x age, $F(1, 1125) = 33.21$, $p < 0.01$ (see **Figure 2B**). For infant and toddler books, the U.S. books (M = 21.56, SD = 33.10) contained significantly more objects than Japanese books (M = 12.40, SD = 25.13), $F(1, 336) = 10.63$, $p < 0.01$. For preschool books, the U.S. books (M = 19.47, SD = 27.83) contained significantly less number of objects than Japanese books (M = 35.58, SD = 54.85), $F(1, 789) = 33.44$, $p < 0.01$. Infant and toddler books (M = 21.56, SD = 33.10) and preschool books (M = 19.47,

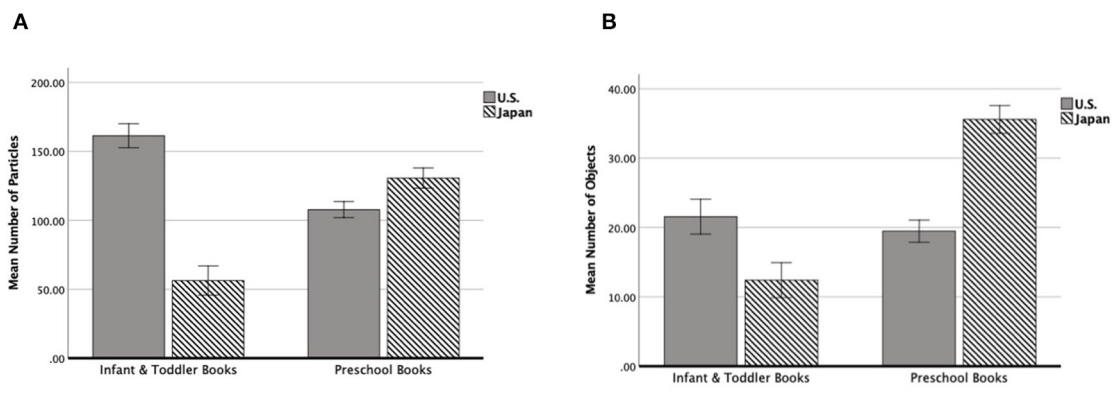

FIGURE 2 | The bar graph of the average number of particles counted by the ImageJ **(A)** and the average number of objects counted by the human coders **(B)**. The x-axis shows the books targeting different age groups (infant/toddler and preschool) and the y-axis shows the mean number counted by each coding method. The gray bars are for the U.S. picture books and the striped bars are for Japanese picture books. The error bars were set as +/– 1 SE.

$SD = 27.83$) did not differ in the number of objects in the U.S., $F(1, 762) = 0.79$, $p > 0.05$, whereas infant and toddler books ($M = 12.40$, $SD = 25.13$) contained significantly less number of objects than preschool books ($M = 35.58$, $SD = 54.85$) in Japan, $F(1, 563) = 34.38$, $p < 0.01$.

To see whether the visual crowdedness coded by the ImageJ and the number of objects counted by human coders have any relationship, the mean number of particles was correlated with the mean number of objects, which yield significant correlation, $r = 0.42$, $p < 0.01$.

DISCUSSION

This study investigated the visual environment of young children to see whether there are cultural differences in what young children were exposed to. Specifically, we compared one of such visual environments, picture books in the U.S. and Japan. Based on previous studies, we predicted Japanese picture books would be visually more crowded than the U.S. books. Two coding methods we used in this study as a measure of visual crowdedness, the number of particles counted by ImageJ and the number of objects counted by the human coders correlated significantly, suggesting these two measures used in previous studies are related and both of them combined might be a good indicator of visual crowdedness. Although these two measures are related, the results show the different trend between the number of particles and the number of objects. As we expected, we found the U.S. books were less visually crowded than the Japanese books according to the number of objects coded by the human coders. However, the U.S. books were more visually crowded by including more particles than Japanese books by the ImageJ. This difference might be due to how we process holistic/global structure and analytic/local structure of scenes. Although we used two codings of the visual crowdedness based on previous studies, based on the previous studies of the visual development have shown human process the holistic/global structure (e.g., t-shirt) earlier and more predominant than the analytic/local structure of the visual scene (e.g., each line of the t-shirt), suggesting the number of objects might be a better measure than the particle measures (e.g., Kimchi, 1992; Johnson, 2010). This difference might also be due to the potential differences in how objects are emphasized in each country. Previous studies found objects, especially namable objects, were considered an important part of development in young children in the U.S., but not so for Japanese children (e.g., Gopnik and Choi, 1990; Fernald and Morikawa, 1993). Therefore, having less namable objects in the books might make it easier for U.S. children to pay attention to objects which are important in the U.S. society, but not necessarily so for Japanese children. For example, when looking at the videos of human actions, 24-month-old infants from the U.S. looked longer at the objects whereas infants from China looked longer to the actions (Waxman et al., 2016), suggesting it would be possible that the visual environment influences on cognition might start with objects.

For the number of objects, the results also showed no significant difference in the number of objects between infant and toddler books and preschool books in the U.S. This result might be due to that the U.S. books might not have clearer target ages as seen by libraries did not agree on the target ages of books whereas Japanese libraries agreed. If this was the case, the comparison should be all the U.S. books (because the target ages are not clear) and preschool books in Japan. With this analysis, we found U.S. books ($M = 20.07$, $SD = 29.44$) still contained significantly less number of objects than Japanese preschool books ($M = 35.58$, $SD = 54.85$), $F(1, 1109) = 37.38$, $p < 0.01$.

The results show the visual crowdedness of picture books varied based on the target age of the books. For picture books targeting infants and toddlers, the U.S. books contained a greater number of particles and a greater number of objects than Japanese picture books, which made the U.S. books more visually crowded than Japanese books. This is somewhat surprising given our expectations that Japanese books would be more visually crowded than the U.S. books. As expected, Japanese preschool books contained more particles and more objects than U.S. books, which made Japanese preschool books more visually crowded than U.S. books. The results suggest by preschool age, the visual contents of the picture books follow a very similar trend with other visual environments studied previously—the U.S. environment being simpler than the Japanese environment. The results also pose the possibility that the change in the visual crowdedness—the decrease in the visual crowdedness in the U.S. books from infant and toddler books to preschool books and the increase in the visual crowdedness in Japanese books from infant and toddler books to preschool books—might provide needed opportunities for comparison, which has a central role in other cognitive domains, such as categorization, memory, and similarity judgments (e.g., Gentner and Medina, 1998). Therefore, the change in visual crowdedness, which provides a comparison process, might be necessary for attention and perception to be attuned to visual environment differences.

Although we have created a new database of books to be used for cultural comparison in future studies, the number of books included in this study based on the inclusion criterion that is not culturally biased was small that might need to be expanded in the future. Also, besides the cultural differences in visual contents of picture books which we found, the visual environments that young children encounter are not limited to picture books. Studying other visual environments that young children are regularly exposed to would be a vital next step to further our understanding of these visual environments influences on cognition. Despite these limitations, the current finding reflects the similar trends found in the current literature on attention and perception, indicating visual environments that young children are exposed to regularly might influence the cultural differences in attention even in young children. Previous studies have found the direct link between visual environment and people's behaviors (e.g., Miyamoto et al., 2006; Tsai et al., 2007). For example, Tsai et al. (2007) found priming children with an exciting story made those children choose the exciting activity over calm activity. Therefore, future studies could use picture books as primes to see whether the visual contents of picture books could act as a direct influence on cultural differences in attention. The finding from infants and toddler

books also provides the potential new line of research, suggesting young infant and toddlers might not show the expected cultural differences in attention based solely on picture books, but needs multiple visual environments differences to influence their attentional systems. Because the book reading is a shared activity between adult and child, it would also be interesting to see how adults read books to children might differ based on the visual contents of books (e.g., one with fewer objects vs. one with more objects). Because previous research has shown picture books help children's development, such as language (e.g., Bus et al., 1995), socio-emotional understanding (e.g., Adrian et al., 2005), and memory (e.g., Cornell et al., 1988), how the differences in visual content might influence these development domains would be other future interests. Further, because the picture books contain both the images and wording, it would be interesting to see how the visual properties might be related to the wording of the image.

We understand the environment (e.g., physical, social, visual) and our mind interacts and constructs cultural differences (Shweder et al., 2006). For example, the ways humans create these cultural products might be influenced by the minds of creators, which in return influences other minds. However, as pointed out by Morling and Lamoreaux (2008), the research fields have focused on the differences in our minds over the environmental differences. Therefore, the systematic analysis of the environment would give us insight into how our minds interact with the environment differently. In this study, we explored the potential cultural differences in such an environment for young children as a first step into untangling the interaction between culture and our minds.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

AUTHOR CONTRIBUTIONS

MK contributed to all aspects of this research, the conception of the idea, designing, data coding, analysis, and drafting the article. JA and DA contributed to the conception of the idea, designing, data coding, and drafting the article.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.00304/full#supplementary-material

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The Own-Race Bias for Face Recognition in a Multiracial Society

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The own-race bias (ORB) is a reliable phenomenon across cultural and racial groups where unfamiliar faces from other races are usually remembered more poorly than own-race faces (Meissner and Brigham, 2001). By adopting a yes–no recognition paradigm, we found that ORB was pronounced across race groups (Malaysian–Malay, Malaysian–Chinese, Malaysian–Indian, and Western–Caucasian) when faces were presented with only internal features (Experiment 1), implying that growing up in a profoundly multiracial society does not necessarily eliminate ORB. Using a procedure identical to Experiment 1, we observed a significantly greater increment in recognition performance for other-race faces than for own-race faces when the external features (e.g. facial contour and hairline) were presented along with the internal features (Experiment 2)—this abolished ORB. Contrary to assumptions based on the contact hypothesis, participants' self-reported amount of interracial contact on a social contact questionnaire did not significantly predict the magnitude of ORB. Overall, our findings suggest that the level of exposure to other-race faces accounts for only a small part of ORB. In addition, the present results also support the notion that different neural mechanisms may be involved in processing own- and other-race faces, with internal features of own-race faces being processed more effectively, whereas external features dominate representations of other-race faces.

Keywords: other-race effect, own-race bias, multiracial, face recognition, cross-cultural

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INTRODUCTION

The human face conveys a range of important social information, including race. Despite the proficiency with which facial information can be processed, face recognition accuracy is easily affected by race. We use the word "race" in preference to "ethnicity" throughout this article because this is the terminology used in academic, governmental, and common parlance to refer to the different community groups in Malaysia. The own-race bias (ORB; also known as the other-race effect and cross-race effect) refers to the phenomenon by which own-race faces are better recognized than faces of another race (e.g. Meissner and Brigham, 2001; Sporer, 2001; Wright et al., 2003; Walker and Hewstone, 2006a; Goldinger et al., 2009). Own-race bias has been extensively researched and is found consistently across different cultures and races, including individuals with Caucasian, African, and Asian ancestry (see Meissner and Brigham, 2001, for a meta-analytic review) and in both adults (Tanaka and Pierce, 2009; Caharel et al., 2011) and children (Anzures et al., 2014) as young as 3-month-old infants (Kelly et al., 2005; Hayden et al., 2007;

Kelly et al., 2007). One early explanation for ORB was based on the hypothesis that there may be inherent physical differences in facial features between races that make discrimination easier within some races than others. However, there is no evidence to suggest on the basis of either anthropometric or behavioral data that faces from one race are physically more homogenous than faces from other races (e.g. Goldstein and Chance, 1978; Walker and Tanaka, 2003; Walker and Hewstone, 2006b).

Another common explanation for ORB appeals to the quantity of experience people have with own-race faces versus other-race faces, which is known as the contact hypothesis. According to the contact hypothesis, the amount of contact that an individual has with another race is positively correlated with the recognition accuracy for faces of that race. Wright et al. (2003) investigated ORB and interracial contact in the United Kingdom and South Africa. They employed a classic old/new recognition task in which participants were presented with 30 faces (15 African, 15 Caucasian) during the learning phase. Subsequently, they were presented with 60 faces (30 previously seen, 30 new) and were asked to indicate whether they had seen each face during the recognition phase. As predicted, ORB was observed for Caucasian participants (from the United Kingdom and South Africa), but intriguingly, African participants (from South Africa) also recognized Caucasian faces marginally better than African faces. The authors then attributed the reversal of ORB observed in African participants to the fact that their African participants were university students who had been more highly exposed to Caucasian people than most of the local South African population. Interestingly, they also discovered that African participants' self-reported interracial contact with Caucasian people positively correlated with their recognition accuracy for Caucasian faces. Similar results were observed in a study by Fioravanti-bastos et al. (2014), which involved Caucasian and Japanese children 5 to 7 years and 9 to 11 years old born and living in Brazil. It was demonstrated that Brazilian–Japanese children did not show ORB when tested with Caucasian and Japanese faces, whereas Brazilian–Caucasian children in both age groups demonstrated ORB. Taken together, these findings suggest that the poorer recognition of other-race faces may be rooted in the amount of contact the observer has had with people of other races. The contact effect is often explained in terms of the perceptual expertise account, which proposes that more frequent interaction with own- than with other-race individuals results in richer and more differentiated cognitive representations of own-race faces [see reviews by Meissner and Brigham (2001) and Sporer (2001)], leading to greater expertise in processing and more accurate recognition of own-race faces compared to other-race faces. Although contact effects are not always evident in standard face recognition tasks, there is considerable evidence to support the hypothesis that individuating experience with own- and other-race faces contributes to ORB (Chiroro and Valentine, 1995; Kelly et al., 2007; Zhao et al., 2014). The critical role of differential experience in ORB is supported by developmental studies. Not only does ORB emerge in Caucasian and Chinese infants as young as 6 months old, but also 3-month-olds (but not newborns) even demonstrate a preference for own-race faces over other-race faces (Kelly et al., 2005, 2008; Bar-Haim et al., 2006) and discriminate between (Sangrigoli et al., 2005) own-race faces more than other-race faces. By employing a standard face recognition task, de Heering et al. (2010) found that East Asian children between 6 and 14 years of age who were adopted by European families at 2 to 26 months of age did not present a significant recognition advantage for Asian over Caucasian faces. In a similar study, Sangrigoli et al. (2005) demonstrated that Korean adults who were raised in Korea before being adopted when aged between 4 and 9 years by European Caucasian families presented a reversed ORB—they recognized Caucasian faces more accurately than Korean faces. These findings support the assumption that the face processing system is shaped by the interaction with the environment and thus can be profoundly altered by experience during early childhood.

To date, the issue regarding the role of lifetime interracial exposure in modulating ORB remains unresolved and deserves further investigation. It is worth noting that the perceptual experience hypothesis has not yet been fully explored for multiracial populations. The majority (approximately 88%) of research on ORB employed white or black populations, with only a few studies employing other races (Meissner and Brigham, 2001). In the past two decades, a growing body of research has addressed ORB in East Asian populations (e.g. Kelly et al., 2005; Goldinger et al., 2009; Wu et al., 2012). Yet, these findings may not necessarily apply to other racial groups because the social environment for individuals from a multiracial country can be more complex and vary drastically in comparison to that of individuals from a monoracial society. In this study, we focus on a key question: Does extensive exposure to faces of multiple races over a long period of time, which is not possible in a laboratory setting, augment one's ability to recognize other-race faces?

To the best of our knowledge, studies investigating ORB in multiracial social settings are scarce (Goodman et al., 2007; Fioravanti-bastos et al., 2014; Su et al., 2017) and have produced inconsistent results. Goodman et al. (2007) demonstrated that South Africans who grew up and lived in a highly multiethnic (African–Caucasian) society did not evince a smaller ORB than did Norwegians from a predominantly Caucasian population. However, a few studies on individuals from multiracial societies have garnered some empirical support for the perceptual experience hypothesis, showing that ORB is reduced in multiracial populations, where other-race faces are frequently seen and individuated (e.g. Wright et al., 2003; Tan et al., 2012; Su et al., 2017).

Malaysia as a Multiracial Country

Malaysia is a Southeast Asian country, but its racial composition is highly diverse, serving as a prime example of a multiracial society. Its population, which comprises racial groups of Malay (50.4%), Chinese (23.7%), Indian (7.1%), indigenous Bumiputra groups (11%), and others (7.8%; including Africans and Western–Caucasians) (Department of Statistics Malaysia, 2018), is far more racially diverse than the famously homogeneous societies of Japan and South Korea, or even those of Taiwan (with its split between indigenous Taiwanese and mainlanders) or Singapore (which has the same major race groups as Malaysia but is >75% Chinese). The high degree of racial diversity in

TABLE 1 | Ethnic fractionalization index (EFI) of selected countries from Yeoh (2001). Higher scores represent greater racial diversity.

Country	EFI
India	0.876
Canada	0.714
Malaysia	0.694
Singapore	0.479
United States	0.395
United Kingdom	0.325
Taiwan, Republic of China	0.274
Australia	0.096
Japan	0.079
Republic of Korea	0.002

Malaysia is also indicated by the Ethnic Fractionalization Index, an index that measures the racial (phenotypical), linguistic, and religious cleavages in society (**Table 1**; Yeoh, 2001). This index is based on the probability that a randomly selected pair of individuals in a society will belong to different groups [Rae and Taylor (1970); as cited in Nagaraj et al. (2015)]. The inflow of Chinese and Indian immigrant workers into Malaysia during the British colonial era led to the emergence of a multiracial characteristic of the population, with diverse religions, culture, language, and customs. The population is also highly influenced by Western culture, having been under British rule until 1957 (Kawangit et al., 2012). Considering its unique multiracial characteristics, Malaysia provides an interesting environment for face recognition research and a rich field area for studying ORB in the context of high interracial contact among the different race groups.

Three recent studies have highlighted the unique cultural and racial diversity in Malaysia and how this can have a direct influence on face processing ability of own- and other-race faces in children (Su et al., 2017) and young adults (Tan et al., 2012; Estudillo et al., 2019). Su et al. (2017) reported that Malaysian–Chinese children tested with four races of faces (Chinese, Malay, African, and Caucasian) showed reduced recognition of African faces, but similar recognition accuracy for Chinese, Malay, and Caucasian faces. In another study, Tan et al. (2012) reported that Malaysian–Chinese young adults performed equally well at recognizing East Asian and Western–Caucasian faces, but less well at recognizing African faces, which are not typically encountered in Malaysia. In contrast, Estudillo et al. (2019) found that Malaysians (Chinese, Malay, Indian) recognized Chinese faces equally well compared to the normative data derived from Mainland-Chinese population (Mckone et al., 2017) but showed a clear ORB for Caucasian faces. In the latter two studies, however, only Malaysian samples were involved, and conclusions were drawn without including Western–Caucasians as a comparison group.

It is also important to note that the face stimuli used in Tan et al. (2012) study were presented with the distinctive external cues (e.g. hair, ears), and those in Su et al. (2017) were presented with hairline information. Numerous studies have shown that the hair and hairline may provide high diagnostic value for unfamiliar face recognition (Ellis et al., 1979; Kramer et al., 2017). Thus, it is entirely possible that the participants based their judgment on these external diagnostic cues to achieve a generally high recognition performance across face races. We address this question through Experiment 2, which examined the relative contributions of internal and external features to own- and other-race face recognition.

The External Features and ORB

The majority of previous research on ORB has focused on the recognition of internal features and used standard face stimuli without hair (e.g. McKone et al., 2007), likely because the internal features (i.e. eyes, nose, and mouth) have been shown to be the most significant features for face recognition, whereas external features (e.g. hairstyle and facial hair) are features that can be easily changed and therefore are potentially unreliable cues to identity. Previous studies found that the recognition and matching of unfamiliar faces rely heavily on external features (Ellis et al., 1979; Young et al., 1985; O'Donnell and Bruce, 2001), whereas familiar faces can be easily recognized and discriminated one from another based on internal features (Ellis et al., 1979; Henderson et al., 2005; Sporer and Horry, 2011; but see Toseeb et al., 2014; Toseeb et al., 2012). Some authors have argued that perceptual expertise is required to successfully encode internal face features (Megreya and Bindemann, 2009; Megreya et al., 2012; Wang et al., 2015), with developmental studies finding that adult-like processing of internal features is not achieved until between 10 and 15 years of age (Campbell et al., 1999; Want et al., 2003; but see Bonner et al., 2004).

Although there has been extensive research on the contributions of external features to face memory (Ellis et al., 1979; Jarudi and Sinha, 2003; Toseeb et al., 2012), relatively little is known about to what extent the presence/absence of external features affects ORB. This is an important consideration because the exclusion of external features may produce findings that are inconsistent with other studies using face images with external features, rendering interpretation of any differences found difficult. To our knowledge, only one study has directly tested its effect on own- and other-race recognition accuracy. Sporer and Horry (2011) tested German and Turkish participants' recognition performance for faces from four ethnic groups: African–American, Caucasian–American, Caucasian–German, and Turkish, with the presence or absence of external features being manipulated. In the classic yes–no recognition task, both groups of participants were least accurate at recognizing African–American faces, the race group to which they would have had least exposure. The authors also reported that removing external features at encoding reduced recognition accuracy for other-race faces but not for own-race faces. However, further inspection of their data revealed that none of the significant interaction terms actually involved participant ethnicity, and the advantage for encoding the whole face over just the internal features occurred only in African–American and Turkish faces. Hence, it remains unclear how this effect may vary depending on participants' perceptual experience with own-race versus other-race faces. In this article, we describe two experiments addressing two related questions: (1) Do participants from

a multiracial country show a similar magnitude of ORB to participants from a more homogenous country? This is a test of the exposure hypothesis and is addressed in both experiments. (2) Does the inclusion/exclusion of external facial features from the stimuli influence the magnitude of ORB? This is a test of the hypothesis that participants depend more on external features for other-race than for own-race facial recognition and is addressed by comparing the results of Experiments 1 and 2.

EXPERIMENT 1

The first experiment tested for the presence of ORB among the three main Malaysian race groups, who grew up in a highly multiracial society: Malaysian–Chinese, Malaysian–Malay, Malaysian–Indian, and a Western–Caucasian comparison group. We examined the effects of interracial contact, based on theories of ORB that attribute it to a lack of perceptual experience with other-race people. To examine whether increased other-race contact reduces cross-race differences in recognition performance, a social contact questionnaire was also used in this study to measure participants' quantity and quality of contact with other-race people. Because of high levels of exposure to several different racial groups within their social environment, Malaysians are likely to possess discrimination abilities for multiple racial categories, especially for the faces from their own nation (e.g. Malay, Chinese, and Indian faces). We reasoned that Malaysian participants (Chinese, Malay, Indian) with sufficient multiracial experience would develop a broadly tuned face representation, such that they may show comparable recognition for all races of faces and therefore not display the traditional ORB. On the other hand, Western–Caucasian participants from a less racially diverse population are likely to show ORB—with superior performance on own-race Caucasian faces and poorer performance on other-race faces (Chinese, Malay, and Indian) with which they have less experience.

Methods

Participants

Sample size was determined in advance based on previous studies that obtained a strong ORB in Malaysian–Chinese children (Su et al., 2017) and young adults (Tan et al., 2012), by using the same old/new recognition paradigm. An *a priori* power analysis was performed to determine the sample size needed to find a medium-effect size with $\alpha = 0.05$ and power of $\beta = 0.8$. A total of 23 participants per group were needed to detect a medium-effect size, and a total of 16 participants per group were needed to detect a large effect size. A majority of prior studies included fewer than 25 participants per group. In Experiment 1, participants consisted of 94 young adults: 26 Malaysian–Chinese [10 males; mean age = 20.23 years (SD = 2.14)], 23 Malaysian–Malays [10 males; mean age = 19.70 (SD = 1.15) years], 22 Malaysian–Indians [11 males; mean age = 22.50 (SD = 4.35), years], and 23 Caucasians [13 males; mean age = 22.26 (SD = 3.93) years]. All Malaysian participants were university students who had not lived outside of Malaysia for more than 2 years [mean = 3.56 (SD = 5.63) months]. Caucasian participants were British exchange students who had not resided in Malaysia for more than 11/2 years [mean = 3.95 (SD = 3.42) months]. All participants had normal or corrected-to-normal vision. They gave informed consent to participate in the study, which was approved by the ethics committee of the School of Psychology at the University of Nottingham Malaysia. Each of them received either course credit or were paid RM 5 (approximately the price of a simple lunch on campus) for their participation in the study.

Design

The yes–no recognition task followed a 4 (face race: Chinese, Malay, Indian, and Caucasian; within-subjects) × 4 (participant race: Chinese, Malay, Indian, and Caucasian; between-subjects) mixed design. The dependent variable was the recognition sensitivity d'.

Apparatus and Materials

Face Stimuli

Photographs of 18 Chinese, 18 Malay, 18 Indian, and 18 Caucasian (half were male, half were female; different individuals to the participants completing the perceptual task) participants were taken under controlled lighting conditions, with all camera settings held constant. For each individual, two photographs were taken: one smiling and one with a neutral expression. Participants gave informed consent in writing for their images to be used in studies conducted by the researchers. Stimuli were randomly chosen to create three sets of 48 faces (12 for each face race). The original facial images were resized to 370 × 470 pixels (16-bit color depth), corresponding to a visual angle of 8.75° horizontally and 11.22° vertically at a viewing distance of 63 cm. To eliminate any confounding variations between different types of stimuli, Gaussian (radius = 3 pixels) and pixelate filters (cell size = 2 squares) in Adobe Photoshop CS6 were applied to the Caucasian facial images as an attempt to normalize the image resolution/quality. All face images were also aligned on the eyes' position and cropped around the face in a standard oval to exclude salient cues such as ears and hairstyle. **Figure 1** shows some examples of face stimuli used in Experiment 1. The stimuli were presented on a 17-inch thin-film transistor monitor with a screen resolution of 1280 × 1024 pixels. Tobii Studio experimental software was used to control the stimulus presentation.

Social Contact Questionnaire

The questionnaire used in this study contained 15 statements (answered once for each race group), which sought to assess quality (the first 10 items) and quantity (the last five items) of contact with individuals from the three main racial groups in Malaysia (i.e. Malay, Chinese, and Indian) and with Caucasian people. The social contact questionnaire used in this study was identical to the one used by Toseeb et al. (2012), which was a modified version of the one employed by Walker and Hewstone (2007). The questionnaire had the same items for own race and each of the other races (**Appendix A**). Participants rated each statement using a five-point scale, with 1 meaning "very strongly disagree" and 5 meaning "very strongly agree."

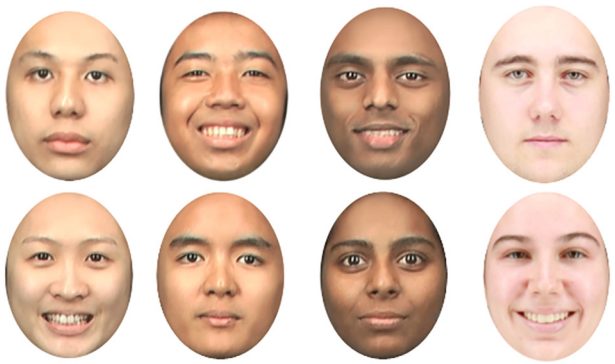

FIGURE 1 | Examples of cropped stimuli with happy and neutral expressions used in Experiment 1. Each column shows a male (top) and a female (bottom) face for each race group (left to right, Malaysian–Chinese, Malaysian–Malay, Malaysian–Indian, and Western–Caucasian). The individuals depicted in this figure gave written informed consent to the publication of their images.

Procedure

Participants were first presented with eight practice trials that were identical to the rest of the experiment except that fewer faces (two for each face race; four targets and four distractors) were used to familiarize them with the task. The facial images shown in the practice phase were not used in the main experiment. The main experiment followed immediately after the practice and involved two parts: the learning and the recognition phase. In the learning phase, participants viewed 32 faces (eight Malaysian–Malay, eight Malaysian–Chinese, eight Malaysian–Indian, and eight Western–Caucasian; four males and four females for each race), one at a time. Each face was presented randomly in one of the four quadrants of the screen against a white background for 5 s, preceded by a central fixation cross with an interstimulus interval of 1 s. Participants were asked to remember as many of the faces as possible. To prevent them from using simple image matching strategies, half of the study set of each race showed a smiling expression, and the other half showed a neutral expression. For target faces, if the neutral expression was presented in the learning phase, the smiling expression was then presented in the recognition phase and vice versa.

Upon completion of the learning task, participants were given a 3-min distracter task in which they were required to complete the social contact questionnaire. In the recognition phase, participants were presented with 32 faces (including the 16 targets seen in the learning phase and 16 distractors not seen before) one at a time for 5 s each. For target faces, the facial expression changed between the study and test phases (i.e. randomized into learning and test phases) to avoid a trivial image matching strategy. The target and distractor faces were counterbalanced across participants. After viewing each face, participants were asked if they had seen the face before and chose one of the three following options: (1) yes, (2) no, or (3) yes, I definitely know this person in real life. Participants selected "yes" if they thought the face was learned (i.e. old) and "no" if they thought the face had not been presented in the learning phase (i.e. new). Furthermore, they had the option to choose an additional answer, "Yes, I definitely know this person in real life," if they were familiar with any of the faces outside the experimental setting; for example, the individual in the stimulus was a friend of theirs or they were course mates. None of them reported knowing more than three faces from the stimulus set in real life. Individual trials with the third answer were excluded (<10% of all trials) from statistical analyses. There was no time limit for making responses via mouse clicks.

Data Analysis

Recognition Sensitivity

Data from the recognition phase were sorted into four conditions for Malaysian–Chinese, Malaysian–Malay, Malaysian–Indian, and Caucasian faces: hits (correctly identified learned faces), misses (learned faces wrongly classified as new), correct rejections (new faces correctly identified as new), and false alarms (new faces wrongly classified as learned). To obtain an unbiased (e.g. strategy free) measure of people's face recognition performance, a signal detection measure of sensitivity (d') was used as the index of recognition performance (i.e. discrimination ability). To overcome infinite values of d' in the case where hit rate or false alarm rate is equal to 1.0, the Snodgrass and Corwin (1988) correction factor was applied by using the following formulas:

$$\text{Hit rate} = \frac{\text{number of hits} + 0.5}{\text{total number of trials with signal present} + 1}$$

$$\text{False alarm rate} = \frac{\text{number of false alarms} + 0.5}{\text{total number of trials with signal absent} + 1}$$

Participants' corrected hit and false alarm rates from the face recognition task were combined into d' scores, where d' is equal to z score for hit rates (Z_H) minus z score for false-alarm rates (Z_{FA}) (Macmillan and Creelman, 1991). A higher d' score represents more sensitivity to a signal, whereas a score that approaches 0 represents less sensitivity.

Results

Recognition Sensitivity

To obtain an unbiased (e.g. strategy free) measure of people's face recognition performance, recognition sensitivity d' was examined. A 4 (race of observer) × 4 (race of face) mixed factorial analysis of variance (ANOVA) on d' showed no significant main effect of race of observer, $F_{3,90} = 1.18$, $p = 0.32$, $\eta_p^2 = 0.04$. There was a highly significant interaction between race of observer and race of face, $F_{9,270} = 5.45$, $p < 0.001$, $\eta_p^2 = 0.15$ (**Figure 2**). Simple main effect analyses for the significant interaction revealed better recognition performance to own-race faces (as shown by higher d' values) than to other-race faces (except for Indian faces) in Chinese, Malay, and Caucasian participants, whereas ORB was not prominent in Indian participants. In Chinese participants, there was a sensitivity advantage for recognizing own-race faces over Malay

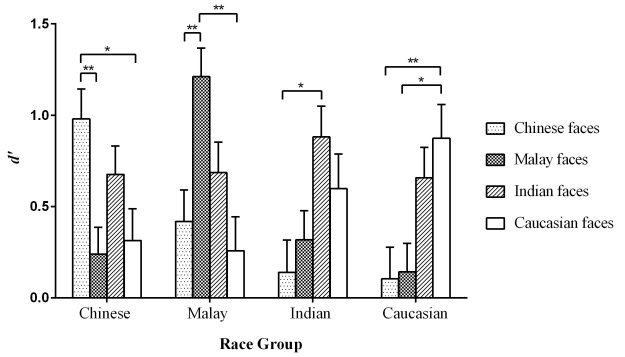

FIGURE 2 | Recognition accuracy of Chinese, Malay, Indian, and Caucasian participants for own- and other-race faces in the face recognition task. Error bars represent standard errors of the mean (**$p < 0.01$, *$p < 0.05$).

($p = 0.005$) and Caucasian ($p = 0.03$) faces. Malay participants showed a significant ORB for Malay versus both Chinese and Caucasian faces ($p = 0.005$ and $p = 0.002$). Indian participants were significantly more sensitive to own-race faces only when compared to Chinese faces ($p = 0.04$), whereas other comparisons were non-significant but in the predicted directions. Caucasian participants were more sensitive to own-race faces than to Chinese ($p = 0.01$) and Malay faces ($p = 0.03$). In general, an own-race recognition advantage was detected for many, but not all, pairs of races.

A paired-sample t test showed no significant difference in the recognition accuracy of participants, $t_{91} = 0.53$, standard error of the mean = 0.09, $p = 0.60$, if they were shown the smiling or neutral expression of each face in the learning versus recognition phase.

Social Contact Questionnaire Responses

Amount and quality of contact were assessed using an identical version of a social contact questionnaire used by Toseeb et al. (2012). Mean scores were calculated by taking the average for each participant on both measures of quantity and quality of contact with own- and other-race groups (**Table 2**). Internal consistency (Cronbach's α) was examined separately for each measure, showing a high internal reliability (α = 0.85, quantity of contact; α = 0.96, quality of contact). Two mixed factorial ANOVAs (DV = quality or quantity of contact) revealed strong interactions between race of participant, $F_{2.75,247.51} = 27.31$, $p < 0.001$, and race of face, $F_{3,270} = 22.04$, $p < 0.001$. Pairwise comparisons (Bonferroni corrected) showed that all races of participants had significantly greater amount and quality of contact with own-race than other-race people (all $p < 0.01$), except for Indian participants, who reported similar quality (but not quantity) of contact with Chinese and Malay people as with Indian people (all $p > 0.34$), implying that Indians (minority group) generally had more opportunity for other-race contact with Malay and Chinese people (majority groups).

To reduce the possible issues of subjectivity and response bias in the self-reported data, we computed the relative scores for both

TABLE 2 | Means and standard errors (in parentheses) of the level of social contact (1 = no or low degree of interaction; 5 = high degree of interaction) with own- and other-race individuals reported by Chinese, Malay, Indian, and Caucasian participants.

	Chinese participants			Malay participants			Indian participants			Caucasian participants		
	Quality of contact	Quantity of contact	Total contact	Quality of contact	Quantity of contact	Total contact	Quality of contact	Quantity of contact	Total contact	Quality of contact	Quantity of contact	Total contact
Chinese people	4.55 (0.09)	4.62 (0.07)	4.60 (0.07)	3.24 (0.17)	3.10 (0.14)	3.15 (0.14)	3.28 (0.21)	3.34 (0.15)	3.32 (0.16)	2.27 (0.24)	2.34 (0.16)	2.32 (0.18)
Malay people	2.48 (0.20)	2.50 (0.16)	2.49 (0.17)	4.43 (0.15)	4.60 (0.08)	4.54 (0.10)	2.96 (0.26)	2.84 (0.20)	2.88 (0.21)	1.94 (0.20)	2.03 (0.15)	2.00 (0.16)
Indian people	2.50 (0.20)	2.34 (0.15)	2.39 (0.16)	2.70 (0.23)	2.42 (0.15)	2.51 (0.17)	4.02 (0.13)	3.98 (0.12)	3.99 (0.11)	2.26 (0.21)	2.43 (0.19)	2.37 (0.19)
Caucasian people	1.82 (0.16)	1.86 (0.11)	1.85 (0.12)	1.75 (0.17)	2.16 (0.10)	2.02 (0.11)	1.94 (0.25)	1.96 (0.16)	1.96 (0.18)	4.17 (0.17)	4.35 (0.17)	4.29 (0.15)

quantity and quality of contact with other-race people for each race group using the following calculations:

$$\text{Relative quality of contact with people of target race} = \text{quality of contact with people of target race} - \text{quality of contact with own} - \text{raracce people}$$

$$\text{Relative quantity of contact with people of target race} = \text{quantity of contact with people of target race} - \text{quantity of contact with own} - \text{race people}$$

In addition, to control for individual differences in face recognition ability, we calculated the size of ORB in recognition memory for each participant by subtracting d' scores for target-race faces from d' scores for own-race faces. Pearson correlations were calculated between own-race recognition advantage and relative scores. Based on the contact hypotheses, we anticipated that individuals who reported higher levels of interracial contact would show a smaller ORB in comparison to those who reported less interracial contact. Negative correlations between these two measures were expected. However, Pearson correlation analyses revealed that all correlations failed to surpass the Bonferroni-corrected α of 0.002 (0.05/24), two-tailed, and a few were even in the opposite-to-predicted direction (**Table 3**). This suggests that both self-reported quantity and quality of contact with other-race individuals did not consistently predict how well other-race faces would be recognized.

TABLE 3 | Correlations between relative contact scores and own-race recognition advantage (d′ scores for own-race faces - d′ scores for other-race faces) for Chinese, Malay, Indian, and Caucasian participants.

Race of participants	Relative quantity of contact with Chinese	Relative quality of contact with Chinese	Relative quantity of contact with Malays	Relative quality of contact with Malays	Relative quantity of contact with Indians	Relative quality of contact with Indians	Relative quantity of contact with Caucasians	Relative quality of contact with Caucasians
Chinese	–	–	$r = 0.45$, $p = 0.02$	$r = 0.04$, $p = 0.84$	$r = 0.16$, $p = 0.45$	$r = -0.06$, $p = 0.78$	$r = -0.07$, $p = 0.72$	$r = -0.13$, $p = 0.54$
Malay	$r = -0.18$, $p = 0.41$	$r = 0.09$, $p = 0.69$	–	–	$r = -0.24$, $p = 0.26$	$r = -0.47$, $p = 0.02$	$r = -0.17$, $p = 0.45$	$r = -0.21$, $p = 0.34$
Indian	$r = 0.30$, $p = 0.18$	$r = 0.40$, $p = 0.07$	$r = 0.57$, $p = 0.006$	$r = -0.07$, $p = 0.75$	–	–	$r = -0.20$, $p = 0.37$	$r = -0.08$, $p = 0.72$
Caucasian	$r = -0.18$, $p = 0.41$	$r = -0.03$, $p = 0.90$	$r = -0.28$, $p = 0.20$	$r = -0.24$, $p = 0.26$	$r = 0.10$, $p = 0.64$	$r = 0.06$, $p = 0.80$	–	–

Shaded cells indicate significant correlation r values (at α = 0.05) before Bonferroni corrections.

Discussion

The current study is the first to investigate ORB among four different race groups: Malaysian–Chinese, Malaysian–Malay, Malaysian–Indian, and Western–Caucasian, who had differential exposure to other races in a racially diverse country. One explanation offered for ORB suggests that processing of facial information can be improved through contact with others. We reasoned that if this generalized version of the contact hypothesis were true, Malaysian groups from a multiracial population would be able to develop a facial representation that was broadly tuned to optimally encode individuating facial information from different races, such that they might exhibit a reduced ORB relative to the Western–Caucasian participants. However, our results do not support this hypothesis.

Own-race bias was found in all race groups: when presented with face images containing only internal features, Malaysian participants (Chinese Malay, Indian) showed a recognition deficit for other-race faces. Chinese participants recognized Malay and Caucasian faces significantly more poorly than own-race faces. Broadly similar to Chinese participants, Malay participants exhibited an ORB in favor of own-race faces, showing higher ability to recognize own-race faces compared to Caucasian and

Chinese faces. Caucasian participants were found to be better at recognizing own-race faces than Chinese and Malay faces. Own-race bias was less pronounced in Indian participants compared to other groups, with significant recognition deficit only for Chinese faces, and non-significant differences in the predicted directions for other-race faces.

It should be noted that regardless of race group participants recognized Indian faces fairly well, possibly due to greater distinctiveness of the Indian face set. To test this possibility, we conducted a follow-up study where the facial distinctiveness of the stimulus sets was measured based on the mean subjective ratings obtained not only from same-race raters, but also from other-race raters (**Supplementary Table 1**). The results revealed that the Indian faces selected in the present study were more distinctive from one another than the other three races of faces. This might have hindered a shift toward significantly lower level of recognition performance for Indian faces than for own-race faces in Chinese, Malay, and Caucasian participants. Thus, any result derived from the Indian faces should be interpreted with caution.

Our findings differ from the previous two studies conducted in a Malaysian population (Tan et al., 2012; Su et al., 2017). Su et al. (2017) found that Malaysian–Chinese children tested with four races of faces (Chinese, Malay, African, and Caucasian) showed reduced recognition of African faces, but similar recognition accuracy for Chinese, Malay, and Caucasian faces. This study differed from the current study in a number of ways: first, it used children (5- and 6-year-olds and 13- and 14-year- olds) rather than adults; second, the number of faces to remember and the number of distractor faces were smaller; third, the stimuli included parts of the external facial features (the outline of the face and hairline). The relative easiness of the task renders these findings not directly comparable with our young adult samples. In another study, Tan et al. (2012) found that Malaysian–Chinese young adults performed equally well at recognizing East Asian and Western–Caucasian faces. However, the stimuli included the external features (e.g. hair, facial contour) of the face, which have been shown to be relied on more during other-race face recognition (Sporer and Horry, 2011). Experiment 2 was therefore conducted to examine the role of external features in ORB.

EXPERIMENT 2

In Experiment 1, participants showed an ORB when only information about the internal features was available. The exclusion of external features from the cropped facial stimuli could have somehow increased the difficulty of the recognition task (Ellis et al., 1979; Jarudi and Sinha, 2003; but see Toseeb et al., 2012), strengthening ORB effects. In Experiment 2, we further examined whether and, if so, to what extent the presence of external features reduces ORB in face memory, including both Malaysian and Caucasian samples. In this experiment, we replicated Experiment 1 using the identical procedure but different stimulus type. Rather than faces cropped to the internal features using egg-shaped masks, face images including the external features were presented. Given that external features are useful for recognizing and matching unfamiliar faces (Ellis et al., 1979; Endo et al., 1984; Young et al., 1985; O'Donnell and Bruce, 2001), we predicted that adding the external features would improve recognition accuracy. Previous research has shown that participants are less efficient at processing configural relationships between internal facial features of other-race faces than own-race faces (e.g. Rhodes et al., 2009). This could lead to a reliance on processing of external facial features of other-race faces. Hence, we hypothesized that the presence of external features would substantially enhance participants' performance for other-race faces more than for own-race faces, reducing ORB compared to Experiment 1.

Methods

Participants

A separate group of undergraduate students participated in this experiment. There were 23 Malaysian–Chinese [13 males; mean age = 21.52 (SD = 3.76) years], 23 Malaysian–Malays [10 males; mean age = 19.74 (SD = 3.76) years], 25 Malaysian–Indians [12 males; mean age = 20.92 (SD = 5.60) years], and 20 Western–Caucasians [10 males; mean age = 23.05 (SD = 4.39) years]. All had normal or corrected-to-normal vision. All participants gave informed consent to participate in the study. *A priori* power analysis showed that, for all of the within-between interaction terms that directly related to our hypotheses, this sample size gave sufficient power to detect medium-effect sizes of $\eta_p^2 < 0.06$, with $\alpha = 0.05$, and power $(1 - \beta) = 0.80$.

Materials

We employed the same set of stimuli as in Experiment 1, but presented with the external features and hair being retained. Other aspects of the stimuli were identical to Experiment 1. Examples of stimuli are shown in **Figure 3**.

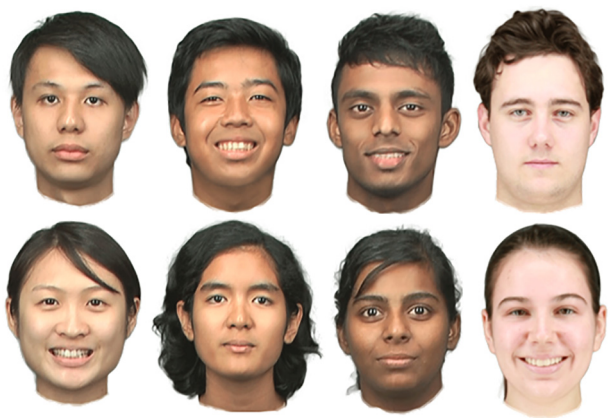

FIGURE 3 | Examples of whole-face stimuli with smiling and neutral expressions used in Experiment 2. Each column shows a male and a female face for each race group (Malaysian–Chinese, Malaysian–Malay, Malaysian–Indian, and Western–Caucasian, respectively). The individuals depicted in this figure gave written informed consent to the publication of their images.

Procedure

Experiment 2 followed the same procedure as Experiment 1. In both experiments, participants performed a yes–no recognition task for four face races: Malaysian–Chinese, Malaysian–Malay, Malaysian–Indian, and Western–Caucasian.

Results

Recognition Sensitivity

A 4 (race of face: Malay, Chinese, Indian, or Caucasian) × 4 (race of observer: Malay, Chinese, Indian, or Caucasian) mixed factorial ANOVA revealed that d' scores did not differ significantly between races of faces, $F_{2.55,222.06} = 0.87$, $p = 0.46$, $\eta_p^2 = 0.01$, Greenhouse–Geisser corrected, as well as between races of observers, $F_{3,87} = 1.95$, $p = 0.13$, $\eta_p^2 = 0.05$. The interaction between race of face and race of observer also did not reach significance, $F_{9,261} = 1.57$, $p = 0.12$, $\eta_p^2 = 0.06$, indicating the absence of ORB among different race groups.

Does Performance Improve in the Whole Face Condition?

In Experiment 2, participants performed equally well at recognizing own- and other-race faces, suggesting that their recognition performance was influenced by the inclusion of external features. Next, we conducted additional analyses on the d' scores to explore whether the magnitude of ORB (i.e. the recognition performance for own- and other-race faces) significantly differed between the egg-shaped (Experiment 1) and full-face (Experiment 2) conditions. A 2 (face type: egg-shaped vs. whole) × 4 (race of observer: Chinese, Malay, Indian, and Caucasian) × 4 (face race: Chinese, Malay, Indian, and Caucasian) mixed factorial ANOVA was used to identify any significant main effects and interactions related to face type—where race of observer and face type were between-subject factors, and face race was within-subjects factor. A highly significant main effect of face type, $F_{1,177} = 61.21$, $p < 0.001$, $\eta_p^2 = 0.26$, was accompanied by a marginally significant interaction between face type and race of observer, $F_{3,177} = 2.32$, $p = 0.08$, $\eta_p^2 = 0.08$. Simple main effect analyses revealed that most race groups (Chinese, Indian, and Caucasian) performed significantly better in the whole-face than egg-shaped condition (all $p < 0.001$), and there was a marginally significant difference in the Malay group ($p = 0.07$).

Interestingly, there was a significant three-way interaction involving face type, face race, and race of observer (see **Figure 4** for means and standard errors), $F_{9,531} = 3.21$, $p = 0.001$, $\eta_p^2 = 0.05$. Separate analyses for the four observer races revealed that the interaction between face type and face race was significant for all the race groups. In Chinese participants, the presence of external features substantially improved their recognition of Malay and Caucasian faces (both $p < 0.001$) but not for Chinese ($p = 0.26$) and Indian faces ($p = 0.40$). Malay participants performed better in whole-face trials compared to egg-shaped trials only for Caucasian faces ($p = 0.03$) but not Chinese ($p = 0.14$), Malay ($p = 0.50$), and Indian faces ($p = 0.51$). Indian participants recognized Chinese ($p = 0.005$) and Malay faces ($p = 0.005$) significantly better in the whole-face condition, whereas no difference was found for Indian and Caucasian faces (both $p > 0.05$). Caucasian participants showed higher accuracy in the whole-face condition for Chinese and Malay faces (both $p < 0.001$), and a marginally significant effect for Indian faces ($p = 0.07$), but no difference for Caucasian faces ($p = 0.32$). Upon close examination, there was a general trend for the presence of external features to affect own-race face recognition to a smaller extent as compared to other-race faces in all race groups. We discounted the possibility that the lack of improvement for own-race face recognition was merely due to ceiling effects as the d' for own-race faces were not significantly negatively skewed (**Supplementary Table 2**).

Social Contact Questionnaire Responses

As in Experiment 1, the social contact questionnaire administered to these race groups showed that their performance did not positively correlate with self-reports of the quality and quantity of contact they had with own- versus other-race individuals.

Discussion

In Experiment 2, we further investigated the effect of external features on the magnitude of ORB by employing whole-face stimuli with external features. It was predicted that adding the external features would improve recognition accuracy, as external features are useful for recognizing unfamiliar faces (Axelrod and Yovel, 2010; Sporer and Horry, 2011). Consistent with our hypothesis, the results showed that ORB disappeared when participants were presented with whole faces with external features but not when presented with only internal features, suggesting that the external features provide important input information. Given the significant role of internal features in the representation of familiar faces compared to unfamiliar faces (Ellis et al., 1979; Megreya and Bindemann, 2009), we also hypothesized that such internal feature advantage could extend to faces of familiar race versus unfamiliar race. This hypothesis received strong support in a highly significant three-way interaction involving face type, face race, and race of observer. Our results showed that the presence of external features (compared to internal features only) did not significantly improve recognition of own-race faces, but did increase recognition accuracy for other-race faces, suggesting a greater dependence on external features for other-race processing and on internal features for own-race face processing.

Several face recognition studies employing face images with external features have reported evidence of ORB (Wright et al., 2003; Tanaka and Pierce, 2009; Tan et al., 2012; Su et al., 2017). For instance, ORB was found for African faces in Malaysian–Chinese children (Su et al., 2017) and young adults (Tan et al., 2012). Yet, our Experiment 2 failed to uncover this effect. The discrepant findings could stem from methodological differences between studies. Tan et al. (2012) and Wright et al. (2003) used identical pictures in the study and test phases, whereas Tanaka and Pierce (2009) placed internal features in a standard face template with identical hairstyle and facial contour. Our recognition task differed from these studies, in that we used different photographs (with changes in expression) of the same individuals at study and test phases in order to promote recognition strategies based on internal facial features.

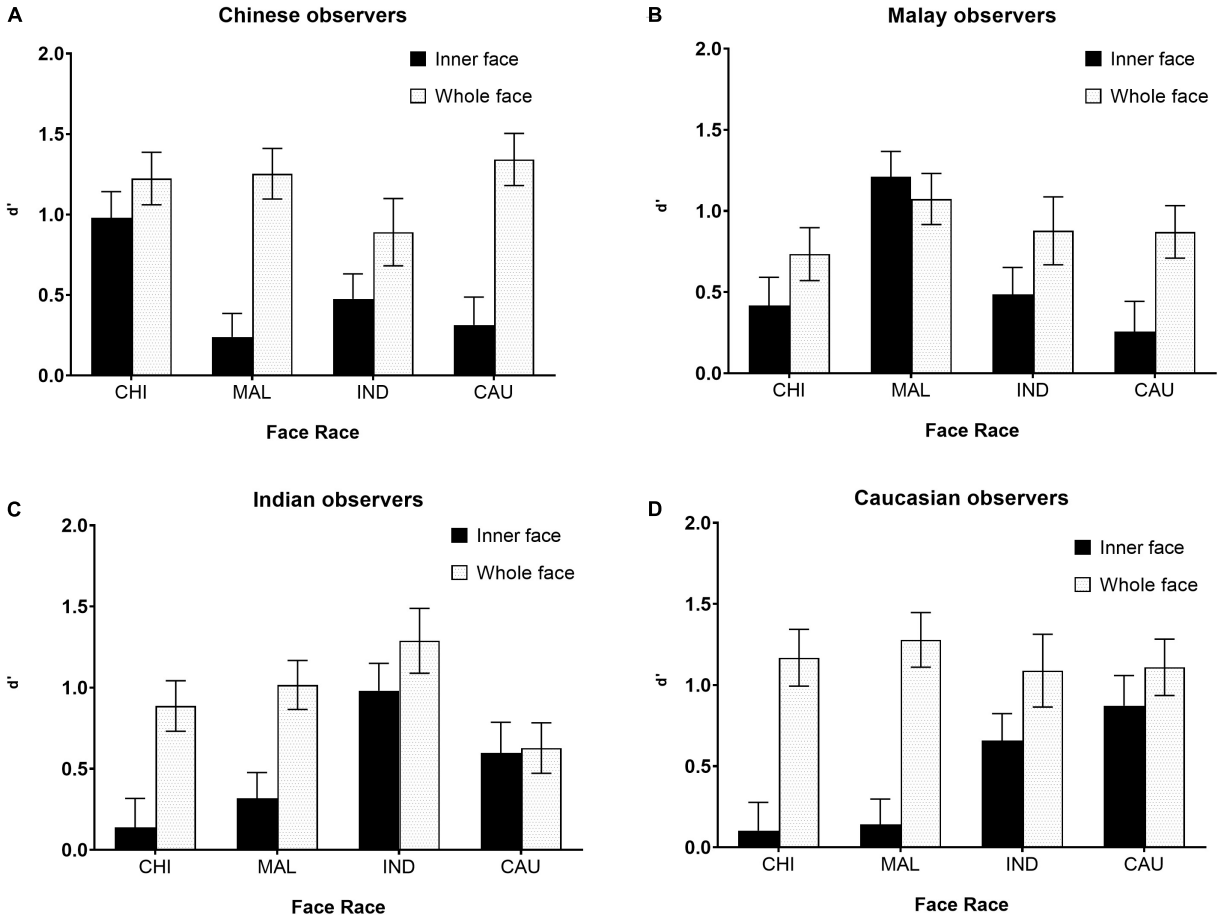

FIGURE 4 | d' for Chinese, Malay, Indian, and Caucasian faces in Chinese **(A)**, Malay **(B)**, Indian **(C)**, and Caucasian **(D)** participants in the recognition task. Face recognition was impaired for face images without external features. Surprisingly, however, the absence of external features led to a greater decline in the participants' ability to recognize other-race faces. Error bars represent standard error of the mean.

Previous research has shown that participants are less accurate at processing internal features (Rhodes et al., 2009; Hayward et al., 2017) and configural relationships between internal features (Tanaka et al., 2004; Michel et al., 2006) of other-race faces than own-race faces. In the current experiment, expression changes between the study and test phases might have increased the task difficulty to encode configural information from internal features. Furthermore, given that our whole-face sets include external features with a considerable degree of within-race variability, this might have increased participants' tendency to adopt non-face strategies based on external cues and consequently masked ORB in face memory.

Our results bring an interesting perspective to our understanding of the mechanisms by which own- and other-race faces are processed; own-race face recognition is less affected by the absence/presence of external features, likely due to the precision and flexibility of facial representations. A greater reliance on the processing of external features of other-race faces was demonstrated through a clear reduction in recognition accuracy when external features were removed. Here we suggest that recognition differences between own-race and other-race faces may be related to the efficacy of feature encoding, with internal features of own-race faces being processed more efficiently, whereas external features dominate representations of other-race faces.

GENERAL DISCUSSION

While the vast majority of previously published ORB studies have been conducted in less racially diverse communities (e.g. United States, United Kingdom, South Africa, and Germany) than Malaysia, recognition deficits for other-race faces have often been attributed to the amount of contact with other-race and own-race faces. The present study examined whether ORB is also present in a highly multiracial society, namely, Malaysia, in which individuals generally have increased day-to-day direct exposure to other-race faces. Several studies have shown that sufficient contact with other-race people can ameliorate ORB (Wright et al., 2003; Walker and Hewstone, 2006b; Fioravanti-bastos et al., 2014); yet, some studies have demonstrated that substantial interracial contact does not necessarily ensure that

other-race face recognition will improve (e.g. Cross et al., 1971; Ng and Lindsay, 1994; Walker and Hewstone, 2006a; Jackiw et al., 2008; Rhodes et al., 2009).

In Experiment 1, ORB was manifested in terms of better recognition sensitivity for own-race faces, not only in Caucasian participants, but also in Malaysian participants (Malay, Chinese, and Indian) who grew up in a racially diverse environment. These results clearly failed to support our prediction, derived from the contact hypothesis, of equally high recognition performance for own- and other-race faces in each group of Malaysian participants. Surprisingly, it seems that even Malaysian young adults had difficulty generalizing their perceptual expertise for own-race faces to other-race faces they frequently encountered in a multiracial environment. This adds to a body of evidence indicating that ORB in adulthood is a very robust effect and may not be as malleable as commonly assumed (Tanaka et al., 2013).

Our finding also raises an open question of why ORB seems to be reduced in face training studies (Hills and Lewis, 2006; Heron-Delaney et al., 2011; Anzures et al., 2013) but not in a multiracial environment. One explanation is that more "natural" face experience may not function in the same way as these laboratory manipulations. Most laboratory training methods only increase other-race face experience quantitatively via photographic exposure in extensive, intentional face learning tasks, which differ from casual individuating experience with faces from other races in the real world. Although training studies provide an indication regarding the flexibility of ORB as well as the plasticity of face recognition systems (Hills and Lewis, 2006; DeGutis et al., 2011; Hills and Lewis, 2011; Tanaka et al., 2013), the enhancement effect from training studies is often transient (e.g. Hills and Lewis, 2011).

The relationship between other-race contact and ORB in Malaysian and Caucasian samples was further assessed by examining the pattern of correlations between self-rated interracial contact and recognition performance of other-race faces. According to the contact hypothesis, the amount of contact that an individual has with another race should be positively correlated with the accuracy of recognizing individuals from that race. In the two experiments, although demographics imply that Malaysian participants generally had a considerable amount of exposure to other-race people, the multiple correlation analyses revealed that neither relative quantity nor quality of interracial contact predicted the magnitude of ORB. In fact, meta-analysis of ORB studies revealed that self-report measures of other-race contact accounted for less than 3% of the total variance found in ORB (Meissner and Brigham, 2001). The very modest contact effects typically found imply that interracial contact may not be one of the critical factors that mitigate ORB. Rather, it may just play a small, mediating role in ORB.

Another possibility for the lack of contact effect on ORB might be due to the measurement we used. As the social contact questionnaire did not separate past experience from current experience participants had with other-race people, it remains possible that the malleability of ORB is determined by the age at which experience with another racial group begins. This argument is supported by evidence from developmental studies showing that infancy (Liu et al., 2015; Chien et al., 2016; Singarajah et al., 2017) and childhood (Sangrigoli et al., 2005; de Heering et al., 2010; Su et al., 2017; Mckone et al., 2019) are sensitive periods beyond which the effect of experience on face recognition is markedly reduced. Future studies using a different contact questionnaire that distinguishes past from current interracial experience may offer a greater potential for revealing the link between perceptual expertise across development and plasticity of other-race face recognition.

Despite many years of interracial experience, ORB in Malaysian young adults does not seem to be attenuated or eliminated as compared to Western–Caucasian young adults who lived in communities that are relatively less racially and ethnically heterogeneous. This unexpected finding renders previous reports that ORB is less evident in multiracial populations (Chiroro and Valentine, 1995; Wright et al., 2001; Bar-Haim et al., 2006), can be reversed following cross-race adoption before the age of 9 years (Sangrigoli et al., 2005), and can be reduced by training (Hills and Lewis, 2006) difficult to interpret. Nevertheless, our data lead us to consider whether, in addition to interracial contact *per se* affecting the magnitude of ORB, the ability to recognize other-race faces might also be affected by the age at which that contact is obtained. Although the current study was not specifically designed to address this question as the period of contact was not clearly measured, it raises the intriguing possibility that Malaysian individuals living in a racially heterogeneous context might still lack childhood experience in individuating other-race individuals due to prototypical perceptual environmental in the early developmental stages of face recognition ability. In fact, there is evidence that Malaysians interact with other races less when they are children than when they are adults. The low level of interracial contact during infant and childhood in Malaysians is commonly reflected through same-race primary caregivers (Su et al., 2018) and the racially segregated educational systems in primary and secondary schools (Kawangit et al., 2012). For instance, Kawangit et al. (2012) reported that the Chinese usually sent their children to Chinese schools with their syllabi adopted from Mainland China; Malays sent their children to Madrasa (religious schools), and Indians to Tamil schools. Therefore, opportunities for Malaysians (Malays, Chinese, and Indian) to integrate and interact with other-race individuals as a community in early childhood may not be as frequent as expected.

Our conjecture that ORB might be specifically associated with low childhood contact would imply that the effectiveness of multiracial experience on tuning the adult face recognition system would differ, depending on individuals' early other-race experience. This idea parallels two concepts in existing literature: first, a sensitive period in children's language development in which second-language learning is better if exposure occurs earlier in development rather than later (Norrman and Bylund, 2016); ORB in face recognition may stem from a mechanism analogous to the language-familiarity effect (Fleming et al., 2014); and second, evidence of an infancy-specific exposure influence on ORB for faces (i.e. perceptual narrowing in which 3-month-olds can individuate faces from multiple races, and even non-human primate species, but 9-month-olds can individuate only own-race faces; Pascalis et al., 2001; Kelly et al., 2009, 2007). Hence, changes in perceptual experience during the critical period of the

development of ORB may play a crucial role in reorganizing the face representation to adapt to changes in multiracial experience in adulthood (Mckone et al., 2019).

Recent developmental studies have demonstrated a critical period for plasticity of ORB (Su et al., 2018; Mckone et al., 2019), and such recognition bias can be reduced by contact with the faces of another race during childhood (e.g. Sangrigoli et al., 2005; de Heering et al., 2010), pointing toward the importance of early individuating experience in developing mechanisms of remembering and distinguishing other-race faces. Perhaps such early formed recognition bias for own-race faces cannot be readily altered by increased exposure to other-race faces in adulthood. Future studies should further investigate the relative contributions of early and late interracial experiences to the reduction of ORB.

Another open question is whether people possess the necessary perceptual abilities to recognize other-race faces at the level of the individual, but only lack the social motivation to do so (Hugenberg et al., 2007). According to the social–cognitive models (e.g. Sporer, 2001), the source of ORB is not perceptual, but a resistance to individuate other-race faces due to their out- group status. Hence, the emergence of ORB may be due to motivational factors rather than to changes in perceptual expertise. Alternatively, ORB could be a product of converging factors involving social categorization, motivated individuation, and perceptual experience; for example, neither raw perceptual exposure nor the motivation to individuate is sufficient to attenuate ORB but requires both the proper motivation and practice to individuate other-race faces. Further research is required to confirm this hypothesis.

In addition to investigating ORB in multiracial context, the current study also bears on the issue of whether the contribution of external features changes as a function of perceived face race. In Experiment 2, we demonstrated that ORB disappeared when faces were presented with external features, suggesting that external features play a larger role in the recognition of other- than own-race faces (Sporer and Horry, 2011). Our current findings are compatible with the in-group/out-group model proposed by Sporer (2001), suggesting that perception of own- race faces automatically initiates a finer level of perceptual encoding processing that emphasizes the internal features of a face that helps distinguish the target from similar faces in memory. In contrast, other-race face perception promotes a categorization process that accentuates race-specific features at the expense of individuating information.

Experiment 2 provides strong support for the idea that external features, which comprise featural characteristics of information, play a more important role in other-race face recognition. While most face recognition studies have ignored the additional effects of external features, there is increasing evidence from behavioral and neuroimaging studies suggesting that external features are encoded alongside internal features within a holistic face representation (Jarudi and Sinha, 2003; Andrews et al., 2010; Axelrod and Yovel, 2010). As a result, although accurate face recognition can be achieved when only the internal features are presented (e.g. Anaki and Moscovitch, 2007), altering external features can sometimes disrupt face recognition (Fletcher et al., 2008; Toseeb et al., 2012). A more fruitful avenue for future research may be to investigate the extent to which altered external and/or internal features differentially affect facial representation of own- and other-race faces.

The current study has significant methodological implications for research in face recognition. The limited ecological validity of the laboratory use of stimuli displaying only internal features has been addressed and criticized frequently because the generalizability of the obtained results is questionable (e.g. Kelly et al., 2011). Results based on face images free from any cropping (e.g. with hair and facial contours included) are arguably more representative of performance in real-world viewing conditions; however, we suggest that using this type of stimulus may encourage reliance on external features for other-race faces (Megreya and Bindemann, 2009; Sporer and Horry, 2011), thereby masking the genuine ORB in face memory. In contrast, cropped face images without external features may accentuate the ability to process configural information from faces. Because the removal of external features is more detrimental to the recognition of other- than own-race faces, a face memory task that utilizes internal-features-only faces could be more sensitive in picking up a potentially subtle ORB. Because very different conclusions could have been drawn from studies due to the selection of stimulus type, future replications of ORB should take the stimulus type into account when comparing the results between studies.

In summary, this cross-racial study demonstrates that ORB in face recognition remains evident not only in Western–Caucasian participants, but also in Malaysian individuals who live in a highly multiracial population. It appears that Malaysians' substantial everyday exposure to different races does not necessarily help in developing a broadly tuned representation that accommodates multiple other-race faces. The results converge with existing literature to suggest that there is relatively little plasticity in face recognition in adulthood (e.g. Singh et al., 2017; Tree et al., 2017). Given the existing evidence that Malaysians interact with other races less when they are children (Kawangit et al., 2012; Su et al., 2018), the robustness of ORB in the multiracial population implies a relative lack of perceptual experience with other-race faces during childhood (de Heering et al., 2010; Su et al., 2018; Mckone et al., 2019; see also Sangrigoli et al., 2005). Additionally, the magnitude of ORB was modulated by the presence/absence of external features, such that other-race faces without external features were recognized poorly. This finding not only highlighted the significant methodological implications for ORB research, but also shed further light on the face representations and mechanisms that govern own- versus other-race face recognition. People encode and/or retrieve own- and other-race faces from memory in qualitatively different ways, with internal features of own-race faces being processed more effectively, whereas external features dominate representations of other-race faces.

DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/**Supplementary Material**.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics committee of the School of Psychology at the University of Nottingham Malaysia. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

HW, IS, and DK contributed to the conception and design of the study. HW collected the face stimuli and performed the statistical analysis and wrote the first draft of the manuscript. HW and IS wrote sections of the manuscript. All authors contributed to the manuscript revision, read and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.00208/full#supplementary-material

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

APPENDIX A

Social Contact Questionnaire.

Gender: Male/Female, Race:, Age:, and Participant Number:

For each of the statements listed below please identify to what extent you agree for each of the three groups of people.

	Malay people					**Chinese people**					**Indian people**					**White people**				
I often work closely (voluntary/paid work/studied) with	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Within my circle of friends I regularly socialize with	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
My closest friends are	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
In my family I have many	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
When having problems with my work I usually ask for help from	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
On a regular basis I interact with	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
For a prolonged period of time I have lived in the same house as	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
I regularly spend time at the homes of	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
I have often comforted/have been comforted by	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
I frequently give/receive personal advice to/from	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
I know lots of	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
For a prolonged period of time I have lived on the same street as	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
In the media I regularly see	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
In my current occupation I come across many	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Whilst socializing I come across many	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

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Beyond Behavior: Linguistic Evidence of Cultural Variation in Parental Ethnotheories of Children's Prosocial Helping

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This study examined linguistic patterns in mothers' reports about their toddlers' involvement in everyday household work, as a way to understand the parental ethnotheories that may guide children's prosocial helping and development. Mothers from two cultural groups – US Mexican-heritage families with backgrounds in indigenous American communities and middle-class European-American families – were interviewed regarding how their 2- to 3-year-old toddler gets involved in help with everyday household work. The study's analytic focus was the linguistic form of mothers' responses to interview questions asking about the child's efforts to help with a variety of everyday household work tasks. Results showed that mothers responded with linguistic patterns that were indicative of ethnotheoretical assumptions regarding children's agency and children's prosocial intentions, with notable contrasts between the two cultural groups. Nearly all US Mexican-heritage mothers reported children's contributions and participation using linguistic forms that centered children's agency and prosocial initiative, which corresponds with extensive evidence suggesting the centrality of both children's autonomy and supportive prosocial expectations in how children's helpfulness is socialized in this and similar cultural communities. By contrast, middle-class European-American mothers frequently responded to questions about their child's efforts to help with linguistic forms that "pivoted" to either the mother as the focal agent in the child's prosocial engagement or to reframing the child's involvement to emphasize non-help activities. Correspondence between cultural differences in the linguistic findings and existing literature on socialization of children's prosocial helping is discussed. Also discussed is the analytic approach of the study, uncommon in developmental psychology research, and the significance of the linguistic findings for understanding parental ethnotheories in each community.

Keywords: ethnotheory, prosocial helping, socialization, parenting, culture, toddlers, linguistic

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INTRODUCTION

A surge in research on children's prosocial motivation and development over the last two decades has deepened understanding of very young children's abilities and apparent inclinations to help and assist others. It is increasingly clear that toddlers from a number of communities are able to notice when help is needed in standardized research tasks and offer assistance voluntarily

(Warneken, 2015). The strength and apparent universality of this pattern in toddlers has supported the suggestion that early prosociality may be "rooted" in innate biological tendencies (Warneken and Tomasello, 2009; Callaghan and Corbit, 2018), toward, for example, social affiliation, emotional coregulation, and sharing goals.

However, more research is needed on the ecological realities of children's everyday helping to understand whether and how children extend their early prosocial abilities and inclinations into culturally relevant and socially complex forms of prosocial behaviors (note House et al., 2013). Evidence that toddlers are *able* to be helpful in standardized research tasks is important but does not address whether toddlers are *likely* to do so at home or whether their bids for involvement are met with opportunities that support the development of practices in which children learn to contribute and collaborate. Prosocial helping in these contexts closely relates to direct and indirect caregiver structuring efforts (Kärtner et al., 2010; Köster et al., 2016; Giner Torréns and Kärtner, 2017), as well as to the cultural values and assumptions that give them meaning.

A number of researchers have called for an increased focus on everyday contexts of children's development (Hedegaard, 2009; Dahl, 2017; Rogoff et al., 2018). Overall, evidence is needed to understand how individual and community processes are linked in everyday practices to provide insights beyond mere variable-based descriptions of behavior (Rogoff, 2003). Psychological research on children's development has increasingly recognized the limitations of approaches that overlook cultural and socialization processes, as well as the importance of cross-cultural evidence to understand how variation in prosocial behavior might be tied to socialization practices (Köster et al., 2015; Nielsen et al., 2017; Brady et al., 2018).

When the everyday contexts of children's helping are in focus, important questions emerge regarding children's prosocial development. For example, recent laboratory-based research has found that children younger than age 2 can help *voluntarily* and that requests for their assistance or incentives may undermine how and whether they help (Warneken and Tomasello, 2008, 2013, 2014; Hepach et al., 2012). Yet, middle-class European-heritage families commonly use incentives, requests, and task assignments at younger ages (Dahl, 2015; see also Waugh et al., 2015) and at older ages when middle-class children in various communities help both minimally and reluctantly (Ochs and Kremer-Sadlik, 2013; Coppens et al., 2016). What views, assumptions, and cultural values guide the deployment of these socialization practices when they may be unnecessary or even counterproductive to children's prosocial development? In communities where such practices are less common and children's voluntary contributions to everyday household work are more common (see Paradise and Rogoff, 2009), what views and values relate to different socialization processes and different prosocial outcomes?

Common experimental tasks in recent research on young children's prosocial helping present young children with situations in which the child's help is *needed* for an adult to successfully complete their work, a central aspect of some definitions of prosociality (Dunfield et al., 2011). However, a frequent if not predominant pattern of everyday helping at home entails young children getting involved with work that parents are already accomplishing without difficulty. Often, children's involvement may be instrumentally *un*helpful at the outset (see Hammond and Brownell, 2018). To understand how prosocial helping interfaces with children's patterns of involvement in everyday activities at home, we must ask: How do parents understand and respond to young children's curiosity or interest in taking part or helping, even when those bids risk slowing things down and may require parents to accomplish the work at hand while also guiding children? A long-standing speculation in research on young children's prosocial helping suggests that when this pervasive "unhelpfulness" is met with parenting practices that preclude children from taking part in everyday work, children's motivation to help prosocially may gradually diminish (Rheingold, 1982). Support for children regularly observing and taking part in everyday work appears to vary considerably across cultural communities, with middle-class children commonly prevented from doing so (Morelli et al., 2003; Rogoff, 2014).

Cultural perspectives in research on children's helping emphasize the embeddedness of children's prosocial development in the cultural values and socialization practices of their families and communities (e.g., Giner Torréns and Kärtner, 2017), a need to consider forces in play at both the "roots" (i.e., developmental origins) and "branches" (i.e., developmental trajectories) of children's prosocial development (Hay, 2009). Evidence of striking cultural differences in older children's prosocial helpfulness (e.g., Ochs and Izquierdo, 2009; Alcalá et al., 2014; Coppens et al., 2016) suggests that cultural values and socialization practices are important for young children's prosocial development and vary considerably across communities.

This study demonstrates that linguistic analyses can provide insights into how and why parents from different cultural communities interact with their children to shape the contexts and trajectories of their prosocial development. Inquiry into individuals' cultural perspectives can be methodologically challenging, as views, values, and cultural assumptions are often held and enacted implicitly. In this study, we show that parents' perspectives on children's helping can be studied by examining *ideational* features of interview data or "how individuals represent themselves and others as (inter)acting in the world" (Konopasky and Sheridan, 2016, p. 5). We document linguistic patterns that characterize *how* parents in different cultural communities report their children's help, as evidence by variation in assumptions regarding children's motivations and abilities, their learning and developmental processes, and parents' own roles in guiding children to learn to help and collaborate.

Parental ethnotheories are culturally patterned views, values, and assumptions that function as local guiding frameworks for understanding patterns of child behavior and guiding parents' approaches to caregiving and socialization. In this study we focus on parental ethnotheories related to children's efforts and motivation to help in everyday household work, a prominent venue for prosocial learning and development. Parental ethnotheories constitute one of three subsystems of the "developmental niche" or cultural context of children's

development – the others include "the physical and social settings of everyday life" and "the customary practices of child care" (Harkness et al., 2010, p. 77). The developmental niche framework theorizes the cultural organization of child development settings by, in part, accounting for cultural values and ideas that inform parents' structuring of settings they consider optimal for raising their children (e.g., Harkness and Super, 1992; Parmar et al., 2004).

This study's linguistically oriented analysis of parental ethnotheories regarding children's prosocial helping provides insight into the question: Why do children in societies all over the world readily and willingly contribute to everyday family work by middle childhood, yet children in many middle-class, postindustrial communities do not? Parental views and assumptions about children's helpfulness may be central to explaining this pattern. Indeed, despite the worldwide prevalence of voluntary, prosocial helping among young children, "many middle-class parents in the United States view [children helping out without prompting] as impossible," an unrealistic expectation (Ochs and Kremer-Sadlik, 2015b, p. 95).

Below, we review evidence on parental ethnotheories common to the two cultural communities included in the present study: middle-class European-heritage communities and indigenous or indigenous-heritage communities of Mexico and the Americas.

Research describes two prominent themes in the ethnotheories of parents and families of the middle class or what is often referred to in the literature as WEIRD backgrounds – i.e., Western, educated, industrialized, rich, and democratic (Henrich et al., 2010). On the one hand, numerous studies highlight children's personal autonomy and independence as cultural values and parental socialization goals that are definitional to "child-centered" middle-class cultural models of parenting. German, Dutch, and European-American parents of middle-class backgrounds showed high preferences for independence-oriented socialization goals and practices (Harkness et al., 2000; Keller et al., 2006, 2010). Kusserow's (2004) ethnographic study of individualisms in parental ethnotheories in several New York City communities found that "by age three Parkside [a community of largely white, affluent, highly educated families] children were already considered little competitors – small but complete 'little people' with their own tastes, desires, needs, and wants" (p. 81). Especially as children enter school, self-expression and children's competitive pursuit of preferences and desires are supported as developmental ends in and of themselves (Bellah et al., 2008), with parents socializing children for "movement through achievement space" (Gee et al., 2001).

On the other hand, considerable research describes many middle-class parents' orientations toward children's development as a parent-controlled endeavor. Middle-class parents in postindustrial communities are highly and intently involved in the organization and management of nearly all aspects of children's everyday lives, a paradigm that Lareau (2003) has called "concerted cultivation" and that LeVine et al. (1994) characterize as a "pedagogical" model of child development and good parenting (see also Popkewitz, 2003). This ethnotheoretical orientation may include implicit assumptions that the "engine" of children's growth and development is parental effort to not only organize but also motivate and incentivize children through enriching and self-enhancing developmental curricula at home, school, and numerous extracurricular activities. This adult-managed characteristic of middle-class childhoods suggests a hierarchical relation between adults' requests of and directives toward children and children's compliance in taking part – two separate systems.

Contradiction between independence values and parental control in middle-class cultural models of parenting and schooling has long been acknowledged. Whiting (1978) described a "dependency hang-up," which Weisner (2001) found to be prominent across over 18 years of longitudinal observation with United States middle-class families of varying lifestyles. The contradiction also pervades a number of middle-class institutions designed for children's learning and development. For example, Tobin (1995) observes that the early childhood education settings of many middle-class communities at once value children's "authentic" or "free" expression of emotions but permit such expression only within imposed, highly scripted, and normative models of speech, interaction, and emotional experience. In a detailed ethnographic study of middle-class family life in contemporary Los Angeles (see Ochs and Kremer-Sadlik, 2013), these contradictions were pervasive:

> *the much-championed ideology that children, at least by school age, should be relatively self-reliant was rarely apparent in children's behavior in CELF households. . . Many of these middle-class parents struggled with the potentially unwanted consequences of investing in their child as the center of their attention and energy. They worried that promoting children's self-absorption inhibits their self-sufficiency and attunement to helping others in their surroundings. (Ochs and Kremer-Sadlik, 2015a, p. 744)*

Deeper understanding of how middle-class parents balance or negotiate these practice-embodied ethnotheoretical currents in everyday interaction and activity in the home may be key to understanding a *developmental niche* that allows for waning prosociality in middle-class European-heritage children's everyday household participation.

Research with indigenous and indigenous-heritage communities in Mexico and the United States show that parental ethnotheories are closely linked to children's inclusion in family and community life as well as to cultural expectations of children's prosocial contributions. Gaskins (1999a) highlights three "principles of engagement" organizing Mayan children's learning and development and the cultural ethnotheories that relate to them. Although certainly not a characteristic of all indigenous communities, the principles have resonance with a wide range of similar cultural groups (Paradise and Rogoff, 2009; Lancy et al., 2010).

First, many parents of indigenous communities of the Americas structure children's everyday lives to emphasize the *primacy of "adult" activities* in children's learning (Gaskins, 1999a). Children's full integration in productive activities is valued specifically for children learning to help and collaborate (Rogoff, 2014). Age is seldom a requirement for helping; as soon as infants are able to sit on their own they can

start to observe others work, and as soon as they can walk they can start to help (Alcalá and Cervera Montejano, in preparation). Mazahua (indigenous, in Mexico) toddlers are often present when their mothers sell produce at the local market, and they are given opportunities to learn the ways mothers negotiate with clients and organize their produce stand even as they play (Paradise, 1994). In a Maya community in Chiapas, when 2-year-olds attempt to enter into work activities, adults "orient and reorient the activity" to facilitate children's participation, respecting and acknowledging their "agency in these coparticipatory interactions" (Martínez Pérez, 2015, p. 113). For example, a 21-month-old boy took initiative to help his grandmother shell beans, approaching her as she started the activity. The grandmother took this opportunity to show him how to sort the good pods from the rotten ones, guiding his attention to important details of the activity using repetition as the child imitated actions, and "...contributing to competence development without dissuading the child from taking on an agentive role" (p. 127).

Second, particular *ideas about children's learning and development* inform how many indigenous-heritage American parents support children's helping in everyday settings (Gaskins, 1996, 1999a). Yucatec Maya parents view development, including prosocial helping, as intrinsic to children and as unfolding gradually and naturally (Gaskins, 1999b, p. 110). Nonetheless, expectations for children's responsibility "circulate" in a variety of ways. In a Tz'utujil Maya community of Guatemala, parents communicate clear expectations that children attend and observe the work and other social activity going on around them, verbally correcting inattention, with the aim of children learning to pitch in to help (Chavajay, 1993). For many Mexican and Mexican-heritage mothers, having access to work and other mature activities allows children to become *acomedido/a* – attentive and responsive to when help is needed (López et al., 2015). Being *acomedido/a* is regarded as a vital cultural value and socialization goal for children – some parents state that helping only when asked has no merit (Alcalá et al., 2018). Maya mothers' ethnotheories of development are also grounded in rituals and cultural practices that indirectly guide children's development, such as the *hetzmek'* ceremony (i.e., Maya baptism) at around 4 months of age (Cervera Montejano, 2007). In this ceremony, the infant is presented with tools to help them be productive and with foods such as pumpkin seeds to help them be more intelligent, increase their memory, and be eloquent and "*alegre*." Development of intelligence or "understanding" – *na'at* in Maya – is described as "remembering their responsibility." Although expectations of responsibility are common among indigenous-heritage communities of the Americas, contingent *assignment* of chores or other responsibilities is rare (Coppens et al., 2016). "Too much teaching" is viewed as inefficient and motivationally distracting for socializing children's contributions (de Haan, 1999; see also Gaskins, 1999a; Cervera, 2016).

Third, in many indigenous-heritage American communities, the *independence of children's prosocial motivation* is both a goal of socialization and a cultural assumption of children's early social dispositions (Gaskins, 1999a). According to Yucatec Maya parental ethnotheories, when children have opportunities to observe others work, they become motivated (*se animan*) to learn to help (Alcalá and Cervera Montejano, in preparation; see also Paradise, 2005). Instead of attempting to motivate children's prosocial helping directly, young children attempting to help are often strategically rejected, as a way to provoke them and increase their autonomous motivation, awareness of others, and sense of responsibility. As toddlers insist on pitching in, despite rebuffs, adults reorient the activity breaking it down into a sequence that allows the child's involvement (Martínez Pérez, 2015). In a Quechua community in Peru, Bolin (2006) reports that "children are treated with respect and allowed to develop at their own pace, largely in accordance with their inclinations" (p. 152; see also Alcalá and Jiménez Balam, 2015). Respect is the catalyst that allows children to develop a sense of responsibility toward their family and community. Forcing or obligating a child to help is considered inappropriate in many indigenous American communities, as it may restrict the child's "development of understanding" or create family animosity, disrupting the social fabric that supports children's development (Alcalá and Cervera Montejano, in preparation; Bolin, 2006). Chavajay and Angelillo (2014) note that there is no word for "control" in Tz'utujil Maya that relates to parenting practices; instead, the word "guidance" is common along with "respect," which are long-term developmental goals that apply to both parents and children.

In any community, language plays a key role in connecting idealized values and developmental goals with the everyday practices that shape children's prosocial helping and development. The present study draws on linguistic anthropological perspectives in the traditions of Heath (1983), Schieffelin and Ochs (1986a,b), Goodwin (1990), Wortham (2001a), and Goodwin and Cekaiate (2018) – among many others – to develop insights regarding the cultural and parental ethnotheories that may guide parents' socialization of children's prosocial helping, and may help to explain cultural variation in the trajectories of children's prosocial development from toddlerhood to middle childhood.

We illustrate the potential of linguistic analyses for understanding cultural variation in parental ethnotheories of children's prosocial development with data from interviews with mothers of toddlers from two cultural backgrounds: US Mexican-heritage families with background in indigenous-heritage cultural practices and middle-class European-American families with extensive schooling background over several generations. The interviews asked mothers about their child's help in everyday household work and the ways that children usually became involved, and our analyses examine how mothers report their children's involvement. This linguistic analysis leverages methodological strengths of two common approaches to studying parental ethnotheories: asking parents explicit questions about their views (see Coppens and Rogoff, in preparation) and examining naturally occurring talk among family members interacting at home (e.g., Ochs and Kremer-Sadlik, 2015a). Reflexive conversational interviews in this study created a shared topical focus designed to solicit and evoke parents' views on children's helping, and our analyses center on implicit features of language-in-use, where "danger that the linguistic means are consciously manipulated

with respect to social desirability is practically negligible" (Keller et al., 2004, p. 294).

MATERIALS AND METHODS

Participants and Communities

Participants were mothers from two cultural communities who had a 2- to 3-year-old child – 20 US Mexican-heritage mothers and 20 middle-class European-American mothers, living near Monterey and San Francisco bay areas of California. The US Mexican-heritage mothers' toddlers averaged 2.6 years (9 girls, 11 boys), and the middle-class European-American mothers' toddlers averaged 3.2 years (10 girls, 10 boys). All families averaged two household members under 18 years old and two household members 18 years old or older (usually, two parents).

We refer to the two communities as US Mexican-heritage Background in Indigenous Ways (BIW) and European-American Extensive Schooling Experience (ESE). These labels are intended to denote entire constellations of cultural values and practices, rather than single variables such as "indigeneity" or "education attainment," which fits with a way of theorizing cultural phenomena as situated within dynamic, historically significant cultural *paradigms* (Rogoff et al., 2014; Dayton and Rogoff, 2016). Our emphasis in sampling decisions was families' likely participation in such paradigms, although practical concerns preclude testing this experience comprehensively.

In the US Mexican-heritage BIW families, parents averaged 9.2 grades of schooling completed and grandparents averaged 4.6 grades. This level of schooling is consistent with communities in Mexico and the United States that have some historical continuity with indigenous communities of Mexico (Bonfil Batalla, 1996; Rogoff et al., 2014). In addition, families' regional backgrounds were in Mexican states with strong indigenous histories, including rural areas of Michoacán, Oaxaca, and Jalisco. Most parents worked in agricultural harvesting and packing, service-sector jobs, or construction. In the European-American ESE families, parents averaged 17.0 grades of schooling completed and grandparents averaged 16.0, characteristic of a cultural group usually referred to as middle class (Bronfenbrenner et al., 1996; Lareau, 2000). All parents in this community were born in the United States. Most parents worked in education, in business-sector jobs, or in healthcare.

Interviews

Mothers participated in one 45- to 60-min semistructured interview conducted conversationally, in the language and location of the mother's choosing, without their children. Most (88%) of the US Mexican-heritage BIW mothers chose to be interviewed in Spanish; all of the European-American ESE mothers' interviews were in English. In each community, about half of the interviews were in the family's home and half at a public park. A bilingual Mexican-heritage female research assistant who was blind to the study's hypotheses led the interviews, and the first author, male and also bilingual, routinely and systematically added a few conversational or clarification questions. In each interview, one of the researchers shared the mother's ethnicity.

Mothers were introduced to the study during recruitment and on the consent form simply as an investigation of how children help around the house. The session began with casual inquiry about the child's school and afterschool activities and the family's weekend plans, as well as questions regarding family composition, home languages, and parents' occupations. (Further demographic information was requested at the end of the interview.)

The conversational interview included open-ended (e.g., In a normal day, does your child help around the house? How? What do they do?) and semistructured questions regarding the kinds of things the 2- to 3-year-old helped with around the house. All mothers were asked whether and how voluntarily the child helped with a scripted list of household tasks, which was the focus of our analysis in this study. In this scripted list, there were 27 tasks, some that benefit the whole family (e.g., washing family dishes or clothes, sweeping the kitchen, taking out the trash) and some related to the child's personal things and spaces (e.g., putting away their toys, making their bed). Questions were omitted if mothers had reported the task in prior portions of the interview.

Protocols for participant recruitment, interviews, and data security and confidentiality were approved by the University of California, Santa Cruz Institutional Review Board. All research participants gave written informed consent in accordance with the Declaration of Helsinki.

Coding

We coded exchanges between the interviewer and the mother regarding questions about children's helping that used a specific "child-as-agent-helping" form, for example: "Does your child help with washing the dishes?" This linguistic form positions the child as the subject and agent and positions helping as the object of the child's actions. Because the scripted list of household tasks was asked conversationally, the child-as-agent-helping questions were asked in both complete and abbreviated versions. For example, following the mother's response to the above question about the dishes, the interviewer might have asked, "And, what about helping with putting clean dishes away?" or "How about setting the table?" Abbreviated questions were only included in the analysis when they closely followed a complete child-as-agent-helping question.

Our analyses focused on the linguistic form of mothers' responses to child-as-agent-helping questions. We identified three main ways that mothers in each community responded:

(1) The mother's response maintains linguistic *continuity with the child-as-agent-helping* form. Even simple "yes" or "no" responses to questions such as, "Does your child help with taking out the trash?," would be coded here. Parent responses may indicate "we" if the activity is commonly done together or is collaborative, for example: "Sure, Jonah sometimes helps with the dishes when we have some time in the morning to wash them."

The next two codes describe two kinds of "pivots" in the linguistic features of mothers' responses.

(2) The mother's response *pivots to a caregiver-as-agent* linguistic form. A mother may pivot to position *herself* as the agent in response to a question about whether *the child* helped with washing clothes, for example noting that she does not "have" the child get involved with the work or that she has not "let" the child do that type of work.
(3) The mother's response *pivots to non-helping as the object of the child's actions*. For example, the mother may report the child "liking" to play with water or being "interested" in brooms. This is not the same as liking to help or being interested in some activities over others. The response suggests a view that the child is, for example, playing and not helping or does not either care about or understand the idea of helping with work that is taking place.

Coding was conducted primarily by the first author, bilingual, and a native English speaker. Half (50%) of the interviews in Spanish (in the US Mexican-heritage BIW community) were independently coded by the third author, bilingual, and a native Spanish speaker. Differences in coding were few, and all were resolved via discussion.

RESULTS

Overall, across all 20 mothers' interviews in each community, 191 child-as-agent-helping questions were asked among the European-American ESE families (average of 9.6 questions per mother), and 247 such questions were asked among the US Mexican-heritage BIW families (average of 12.4 questions per mother). **Figures 1**, **2** show within- and between-community patterns in mothers' responses at two units of analysis: patterns at the level of linguistic utterance (i.e., the figure "cells") and at the level of individual mothers (i.e., the figure "columns"). **Table 1** summarizes the findings quantitatively, at both levels of analysis.

With linguistic utterances as the unit of analysis, cultural-group comparisons showed significant differences in response patterns. In the European-American ESE community, 49% (94/191; see **Figures 1B,C**) of the child-as-agent-helping questions were followed by a "pivot" of some kind, whereas in the US Mexican-heritage BIW community, this was the case for only 2% (6/247; see **Figures 2B,C**) of the child-as-agent-helping questions, $p < 0.001$, Barnard's exact test (BET; Barnard, 1945; Mehta and Senchaudhuri, 2003). Cultural-group differences in proportions of utterances were also statically significant regarding each of the two types of pivots, as indicated in **Table 1**.

With individual mothers as the unit of analysis, cultural-group comparisons also showed significant differences. In the European-American ESE community, 85% (17/20; see **Figures 1B,C**) of mothers responded with at least one pivot during their interviews, compared to 25% (5/20; see **Figures 2B,C**) of mothers in the US Mexican-heritage BIW community, $p < 0.001$, BET. Cultural-group differences in proportions of mothers were also statically significant regarding each of the two types of pivots, as indicated in **Table 1**.

Linguistic "Pivots," Common Among Mothers in a Middle-Class European-American Community

In this section, we provide several contextualized examples of the linguistic "pivot" patterns that were common in the European-American ESE mothers' speech. Our purpose in examining such patterns was to develop insights into mothers' assumptions about children's helping at the level of cultural ethnotheories, providing clues about the cultural paradigms that inform prosocial socialization strategies that structure the child's immediate environment.

Below, we illustrate a common pattern in the European-American ESE mothers' speech with the following exchange between interviewers (I-1 is the primary interviewer; I-2 is the secondary interviewer and first author) and one mother, which begins with a follow-up question to an earlier question about helping:

1 ***I-1:*** *So, you mentioned the silverware, but what about other like, washing other family dishes?*
2 ***M:*** *I don't have her wash any dishes yet.*
3 ***I-1:*** *Okay. Mm-hmm. And sweeping the kitchen or the living room?*
4 ***M:*** *Oh, she loves to sweep but I usually, umm, I sweep an area and then I move somewhere else and then*
5 *I go, "Oh, Lara, do you wanna help me sweep?" And then I have her go back to the area that I've*
6 *already done. [laughter] Otherwise, you know how kids sweep. . .*
7 ***I-1:*** *Yeah.*
8 ***M:*** *Like. . . Ahh. Ugh.*
9 ***I-2:*** *They just kinda. . . [laughter]*
10 ***M:*** *Sometimes, I'll sweep a pile and I'll have her get the Dustbuster and then she can dust bust it.*
11 ***I-1:*** *Oh, okay.*
12 ***I-2:*** *Oh, the pile up. The. . . yeah, yeah, yeah.*
13 ***M:*** *Yeah, that works pretty well.*
14 ***I-1:*** *And for that, does she like, umm, does she. . . Do you like make her. . . Tell. . . Ask her like to sweep in*
15 *the area that you were with? You were in before, because you see that she's interested? Or. . .*
16 ***M:*** *Umm, yeah. She usually, if I'm sweeping, she says "Oh, I wanna sweep too."*
17 ***I-1:*** *Okay.*
18 ***I-2:*** *Okay.*
19 ***M:*** *And I'm like, "Oh, great."*

The interviewer's questions on lines 1 and 3 of the above excerpt are examples of an abbreviated *child-as-agent-helping* prompt, which followed conversationally 26 s after the complete child-as-agent-helping question, "Does [the child] help set or clear the table?" The mother's responses (line 2; lines 4–6, 10) are archetypical and community-typical examples of a linguistic pivot from *child-as-agent* to *caregiver-as-agent* in reports about

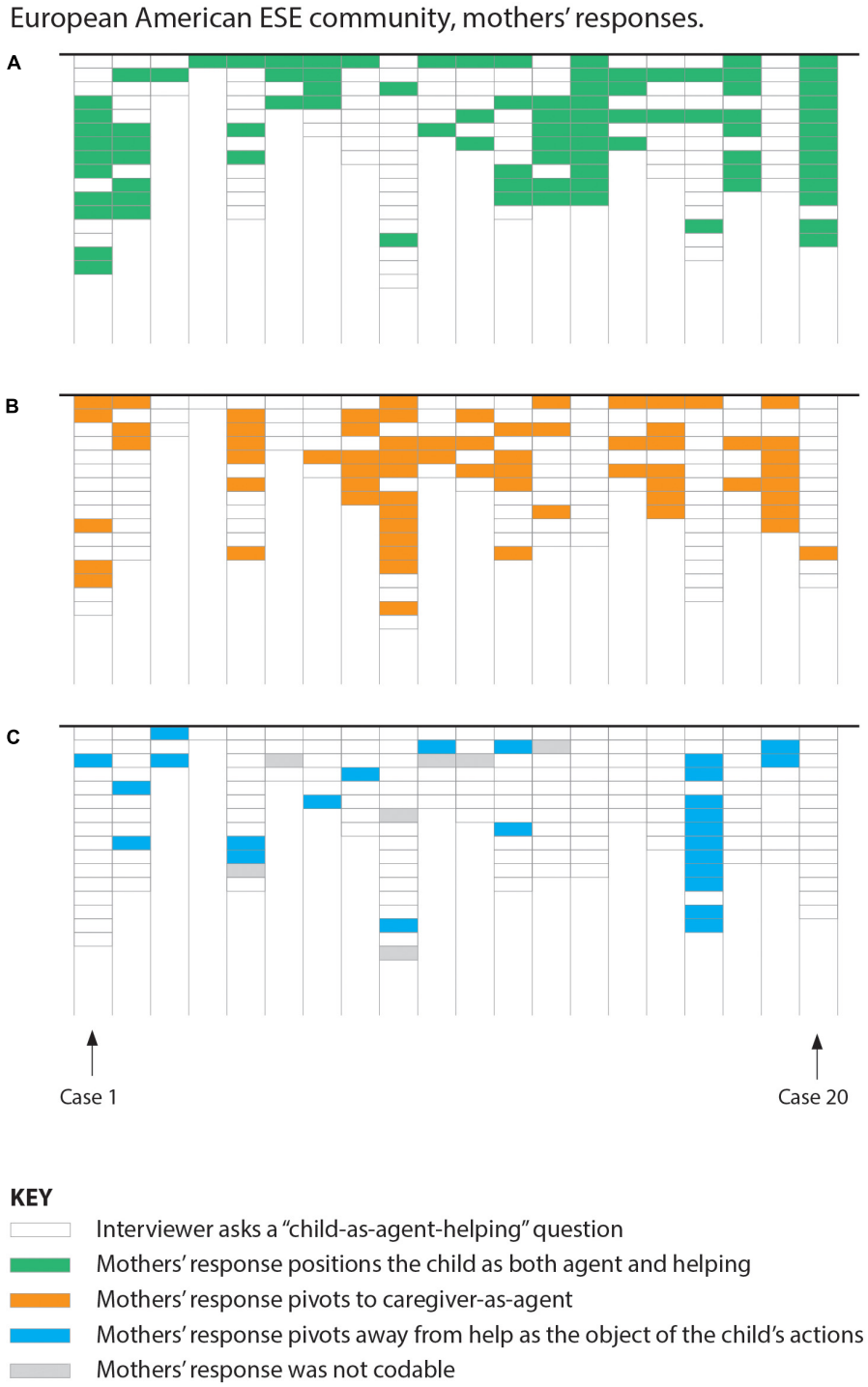

FIGURE 1 | Case graph showing European-American ESE mothers' responses. Panels **(A–C)** should be read as "layers" which separately show each type of coded response (color-filled cells) against the overall number of interview prompts (no-fill cells). Vertical columns represent coding for one mother, disaggregated by coding type across panels **(A–C)**. Cells represent one coded response to a "child-as-agent-helping" interview question.

the child helping. In the interviewer's questions, the child is consistently positioned as the agent of the sentence (as in "Does *your child* help. . ."). In the mother's utterances, she alters the original structure of the sentence, pivoting from a child-as-agent structure to position herself as the agent in the sentence, as in "*I* don't have her wash any dishes yet" (line 2).

The mother's response to the second prompt in this excerpt (lines 4–6) conveys rich information regarding cultural

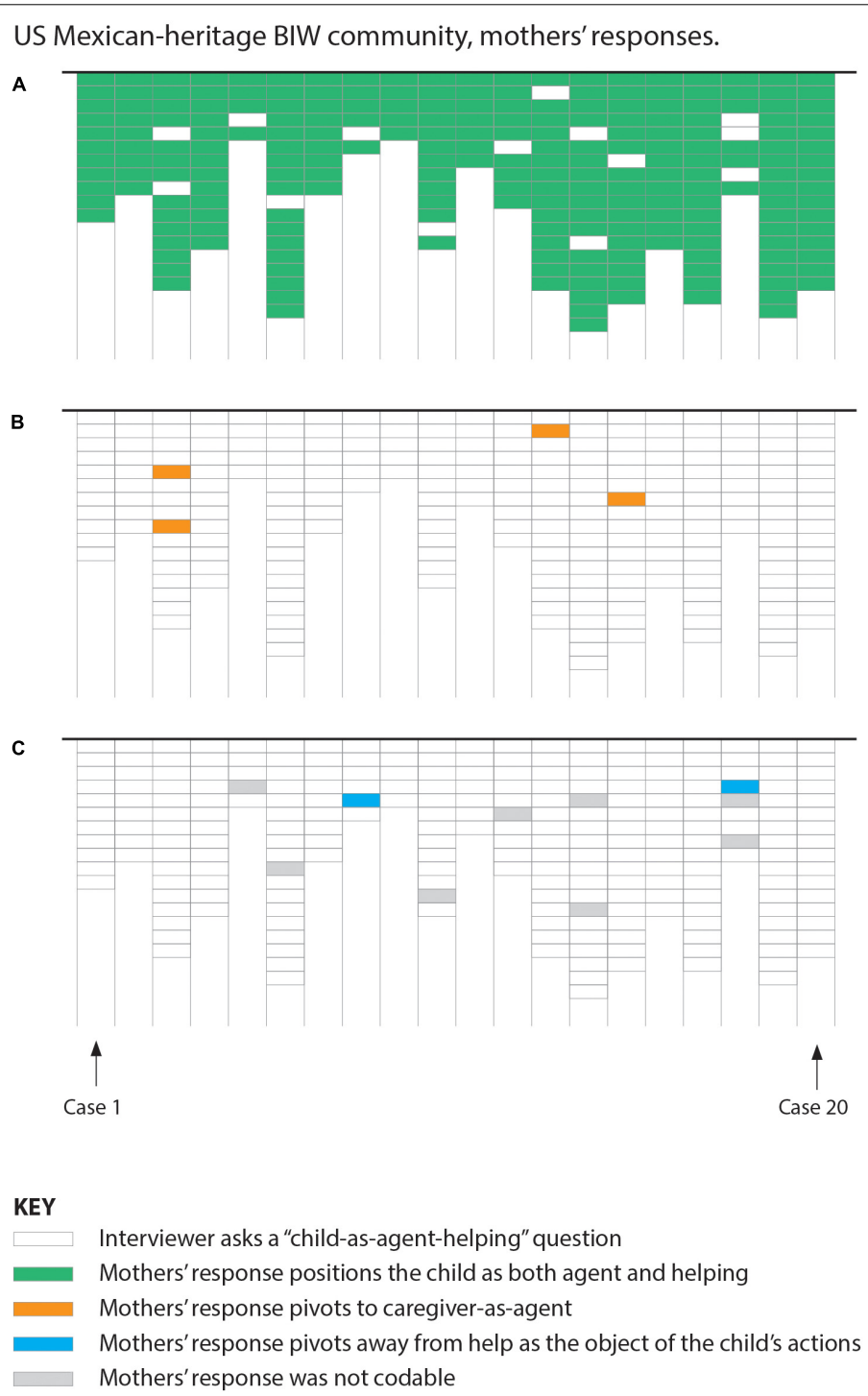

FIGURE 2 | Case graph showing US Mexican-heritage BIW mothers' responses. Panels **(A–C)** should be read as "layers" which separately show each type of coded response (color-filled cells) against the overall number of interview prompts (no-fill cells). Vertical columns represent coding for one mother, disaggregated by coding type across panels **(A–C)**. Cells represent one coded response to a "child-as-agent-helping" interview question.

assumptions about children's motivations to help and everyday family socialization practices regarding the child's involvement in household work. In line 5, the mother reports that the child "loves to sweep;" however, it is not clear whether the mother is reporting that the child loves to *help* sweep or that the child *loves sweeping*, nor whether their sweeping is connected to involvement in productive household work. However, it is clear by the end of this excerpt that the mother does not love the child's involvement

TABLE 1 | Summary of within-group patterns and between-group cultural contrasts in responses to child-as-agent interview questions among US Mexican-heritage BIW and European-American ESE mothers.

		Mothers responding with a linguistic "pivot"		
	# of mothers	**Any Pivot**	**Caregiver-as-agent Pivot**	**Away-from-help Pivot**
US Mexican-heritage BIW	20	5 (25%) **	3 (15%) **	2 (10%) *
European American ESE	20	17 (85%)	16 (80%)	12 (60%)
		Responses with a linguistic "'pivot"		
	# of interview prompts	**Any Pivot**	**Caregiver-as-agent Pivot**	**Away-from-help Pivot**
US Mexican-heritage BIW	247	6 (2%) **	4 (2%) **	2 (1%) **
European American ESE	191	94 (49%)	68 (36%)	26 (14%)

The upper two rows show summaries with individual mothers as the unit of analysis. The lower two rows show summaries with single utterances (i.e., an interview question prompt with the mothers' response) as the unit of analysis. Statistical significance of tests for cultural differences is indicated with $^{**}p < 0.001$ and $^{*}p < 0.01$ and was conducted with Barnard's exact test.

in sweeping. The mother's reported frustration (line 8) with the child's skill or with their manner of becoming involved is reported as a rationale ("otherwise" in line 6) for the mother giving the child "mock work" that occupies the child and distracts them, segregating the child from the productive aspects of the work (see Coppens and Rogoff, in preparation). Managing and limiting the child's access to the "real work" may be common in this cultural community (Rogoff et al., 1993; Klein and Goodwin, 2013; Klein et al., 2013), and a linguistic pivot away from the child-as-agent suggests the connection of this managerial approach to cultural ethnotheories that de-emphasize the importance of children's own prosocial initiative.

Of note in this excerpt is the impact of the mother's linguistic pivots on the interactional trajectory of the interviewer's questions. The primary interviewer (I-1) is both trained and accustomed to asking about the child's involvement in household work using the child-as-agent-helping form. However, in lines 14–15, this interviewer becomes conflicted about how to frame subsequent questions with a conversationally appropriate linguistic agent, based on the mothers' prior pivots. The interviewer begins with a child-as-agent-helping prompt ("umm, does she. . ."), stops, and begins a new question that deviates from the scripted form of the interview questions ("Do you like make her. . . Tell. . . Ask her like to sweep. . .?"). In an attempt to fit the interview questions to the mothers' frame of reference, the interviewer takes the mother's lead in both positioning the mother as the linguistic agent and asking questions about the mother's management and control of the child's involvement (i.e., "make," "tell," and "ask"). Both adjustments, as well as the interactional context that gave rise to them immediately prior, carry important ethnotheory significance for understanding socialization into helping in the European-American ESE community.

In linguistics, the adoption of an interlocutor's speech pattern is called *accommodation* (Giles et al., 1991). It is more common for interlocutors to accommodate to the structure of their interlocutors' speech than it is for them to not accommodate (we have been referring to non-accommodation as a linguistic "pivot" so far). In fact, non-accommodation runs the risk of communicating impoliteness or rudeness (Giles and Gasiorek, 2013). For a speaker to consistently not accommodate to their interlocutor's speech is the linguistically dispreferred pattern, which usually indicates that what is being communicated is distinct and meaningful. The interviewer's accommodation, which itself created discomfort as it required the interviewer to deviate from the script, underscores the linguistic preference toward accommodation. The consistent non-accommodation in the European-American ESE mothers' speech, in which they "pivot," indicates that the structure to which the mother pivots conveys cultural meaning. When the meaning is not distinct or important for the speaker, the linguistic preference to accommodate the interlocutor's linguistic structure usually takes precedent.

Another European-American ESE mother's response below also clearly illustrates linguistic pivots from child-as-agent-helping to caregiver-as-agent.

1 ***I-1:*** *Does she help with, like, setting or clearing the table?*
2 ***M:*** *Uh, sometimes, yeah. But it's not. . . I don't make her do it every time.*
3 ***I-1:*** *Yeah.*
4 ***M:*** *Yeah.*
5 ***I-2:*** *Okay.*
6 ***I-1:*** *So it's like not an expectation. . .*
7 ***M:*** *No, no. She doesn't have any, like chore expectations yet. Yeah.*
8 ***I-2:*** *Yeah, yeah.*
9 ***I-1:*** *Uh, what about, like helping with like washing family dishes, or. . .*
10 ***M:*** *That would be her greatest joy in life. [chuckle] So, yeah, we'll do, let her do that. Yeah, she loves*
11 *to play with water.*
12 ***I-2:*** *Okay.*
13 ***M:*** *Since we're in the drought, I've gotten a little more squeamish about that one, so maybe if people told*

14 *you other strategies, you can tell me [chuckle] at the end, I don't really know. 'Cause that's like, the*
15 *big thing, like she would love to just stand there, and I normally would take the glass, although she's*
16 *getting better with glass right now, and put that in the dishwasher first, and then leave anything that's*
17 *like metal or plastic in there and just let her wash it, but, like I definitely. . . Like she wants the water*
18 *running now and she couldn't reach it, so I could just put a little trickle for a while. And now she can*
19 *reach it, so then she wants more water, so I'm getting a little. . . Like that actually is like, her number. . .*
20 *like, playing with water, she loves. She loves to wash dishes.*

This excerpt illustrates both types of linguistic pivots that were coded in this study. Similar to the previous example, this mother positions her own efforts to *assign* chores to the child and enforce compliance (e.g., line 2, and later clarifications) and her efforts that *permit* the child's involvement (e.g., "let her do. . ." on line 10) as agentic rather than continuing with the interviewer's child-as-agent-helping prompts. Both responses suggest an ethnotheory that the child's involvement originates with the caregiver's efforts to organize the child's access to opportunities to help, rather than with, for example, the child's initiative (Alcalá and Cervera Montejano, in preparation; Ochs and Kremer-Sadlik, 2013). The responses also suggest an ethnotheory about children's motivation to help that assumes the necessity of firm caregiver directives (i.e., assignments caregivers "make" the child do).

The above excerpt also illustrates linguistic pivots that reframe the child's intentions away from helping and toward the child's assumed efforts to engage in non-help activity – in this excerpt, play (which was predominant in the European-American ESE community for this kind of pivot). In lines 10–11 and lines 19–20, the mother follows descriptions of the child's engagement in washing dishes with statements that indicate the child's "greatest joy in life" or "her number [one]" interest is in playing with water. Understood alongside reports that the mother does not expect the child to contribute helpfully, this mother describes the child's motivation to be involved in household work as a desire to play.

The next excerpt from a European-America ESE mother shows another away-from-helping pivot, its clarity underscored in line 14, a response to a follow-up question.

1 ***I-1:*** *What about like vacuuming?*
2 ***M:*** *Oh, he loves to vacuum. Yeah. I mean what kid doesn't? It's pretty fun. He especially likes the hose*
3 *and the corners.*
4 ***I-2:*** *So does he manage the whole big kind of thing?*
5 ***M:*** *So like he'll come up behind me, and like help me push it. But he mostly uses the little hose in the*
6 *corners and things, like gets the sides whatever that's called, I can't think of the side. . . What is this called?*
7 *Can't even think what they're called right now at the bottom. . .*
8 ***I-2:*** *Baseboards?*
9 ***M:*** *Thank you.*
10 ***I-2:*** *Yeah. [chuckle]*
11 ***M:*** *I don't get a lot of sleep. [chuckle]*
12 ***I-2:*** *That's all right. [laughter]*
13 ***I-1:*** *And why do you think he participates in that?*
14 ***M:*** *I think it's because it's loud and fun. I think that's the main reason.*

Similar to the previous excerpt, this mother's response (lines 2–3) immediately pivots away from helping as the purpose of this child's – indeed, of any child's – involvement in vacuuming. To be sure, the mother characterizes the child pushing the vacuum with the mother as "help;" however, this is not a motivational attribution. In both linguistic pivots (lines 2–3) and denotational reports (see lines 13–14), the mother makes clear that the child's central motivation is play.

"Children-as-Agents-Helping," a Predominant Linguistic Pattern Among Mothers in a US Mexican-Heritage Community

In this section, we give contextualized examples of the linguistic pattern that overwhelmingly characterized mothers' responses in the US Mexican-heritage BIW families (as well as for some mothers in the European-American ESE families). We also provide evidence of related features of these mothers' reports, where children's assumed motivations to help were discussed in parallel with children's growing but incomplete skills in contributing.

This first excerpt – in Spanish, then translated to English – from a US Mexican-heritage BIW mother shows the child-as-agent-helping linguistic continuity pattern.

I-1: *Um, ¿Y, ah, ¿qué tal como cuando va a lavar usted? Como, ¿Pone su ropa a los – su lugar o sí le ayuda a doblar cosas? ¿Sí?*
M: *Sí. Ella sí lo ayuda de lavar – guardar cosas, doblar ropa y guardarla pues. Sí.*
I-1: *Ajá. ¿Y cuándo comenzó a ayudarle con eso?*
M: *No, cuando ya hace eso un año.*
I-1: *¿Un año?*
M: *Sí, sí.*
I-1: *¿Y usted le pidió o ella –?*
M: *No pues, solita, solita quiere agarrar todos cosas.*

1 ***I-1:*** *Um, ¿And, ah, what about when you're going to do laundry? Is it, does she put her clothes away or*
2 *help to fold things? [responding to the mother's gesture] Yes?*
3 ***M:*** *Yes. Yes, she helps with the laundry – putting clothes away, so folding and putting them away. Yes.*
4 ***I-1:*** *Ok. And, when did she start to help you with that?*
5 ***M:*** *No, when she was around, what, a year.*
6 ***I-1:*** *A year old?*
7 ***M:*** *Yes, yes.*
8 ***I-1:*** *And you asked her or she–?*

9 ***M:*** *No, by herself, by herself she wants to get her hands on all kinds of things.*

The above excerpt illustrates the linguistic continuity pattern between the interviewer's question and the mother's response, continuing to position the child as a helping and helpful agent (question in lines 1–2, response in line 3). Additionally, of note in the above excerpt is a commentary clarifying that the child's help did not originate developmentally with parents' efforts and may continue to be driven by the child's initiative.

This evidence of cultural ethnotheories regarding children's development of prosocial helping did not solely arise in US Mexican-heritage BIW mothers' reports of children making contributions; most mothers also maintained continuity with the child-as-agent-helping prompt when reporting that their children did not contribute in a particular task – in the case of one US Mexican-heritage BIW mother:

I-1: *Uh-huh. ¿Y qué tal como cocinar?*
M: *No, todavía no.*
I-1: *¿No?*
M: *No.*
I-1: *¿Aunque esté o si está preparando algo pequeño o-*
M: *Uhm, sé pero, todavía ella está muy chiquita. No se motiva todavía.*

1 ***I-1:*** *Uh-huh. And what about like cooking?*
2 ***M:*** *No, not yet, no.*
3 ***I-1:*** *¿No?*
4 ***M:*** *No.*
5 ***I-1:*** *Even if you're just preparing something small, or. . .*
6 ***M:*** *Um, I understand, but she's still pretty little. She hasn't gotten motivated yet.*

This mother's responses were straightforward with regard to tasks in which her child did not contribute – she explicitly responded with something similar to "no, not yet" in at least six instances during the interview and seemed to imply such a report in several other responses. Yet, even this brief response suggests important ethnotheoretical information. In line 6, the mother gives a developmental rationale for the child not contributing in stating that the child is "still pretty little" and has not contributed to that "yet," suggesting that she expects that the child will do so at an older age. The key contextual element in this utterance is the mother's use of *motivarse*, a reflexive verb in Spanish that translates to "motivating one's self." The mother suggests that, in due course, developmentally, children motivate themselves to help with increasingly sophisticated contributions – the family and cultural expectation that children contribute is "in place," and children are given space to exercise agency in starting to help. The ethnotheoretical assumption presented here is that assigning household work to children, a practice common in middle-class European-heritage communities (Goodnow, 1988; Goodnow and Delaney, 1989; Klein and Goodwin, 2013; Gaskins, 2015; Coppens et al., 2016), is both unnecessary and may conflict with an agency-centered emphasis on children learning to motivate themselves.

The linguistic continuity pattern – overwhelmingly characteristic of mothers' reports in the US Mexican-heritage BIW community (see **Figure 2**) – was a common way that mothers in this community reported their children's involvement such that children's agency and their assumed intentions or motivations to help were emphasized.

Helping While Learning to Contribute: US Mexican-Heritage Mothers' Negotiations of Skill and Prosocial Intention in Ethnotheories of Toddlers' Helpfulness

One of the more striking features of the US Mexican-heritage BIW mothers' reports was that children's agency-in-helping was asserted in coordination with mothers' recognition that children were still learning how to contribute. Linguistic patterns provide key evidence for a particular cultural approach to negotiating an apparent socialization paradox in young children's prosocial development: How can toddlers with relatively low skills be involved in opportunities to contribute, when their helpful intentions outpace their skills?

US Mexican-heritage BIW mothers commonly reported their child's participation in everyday household work *as help*. The two excerpts below are particularly striking because both mothers appear to distinguish the instrumental contribution of the child's efforts – *did it contribute?* – from their assumptions regarding what the child was getting involved to do, or the *helpful, prosocial intention* of the effort.

I-1: *¿Ayuda a poner o a limpiar la mesa?*
M: *Sí.*
I-1: *¿Después de comer?*
M: *Uh-huh. Sí, por ejemplo, cuando vamos a comer, hay que tomar, por ejemplo, si vamos a tomar agua. Luego trae un agua o que el jugo. O que vamos a poner las cucharas, él abre los cajones pero le ayudamos porque ahí están los cuchillos.*
I-1: *Okay.*
M: *"Yo te los doy," y ya él los pone.*
I-1: *Mm-hmm.*
M: *Pero sí, sí-sí-sí ayuda.*

1 ***I-1:*** *Does [the child] help to set or clear the table?*
2 ***M:*** *Yes.*
3 ***I-1:*** *After the meal?*
4 ***M:*** *Uh-huh. Yes, for example, when we're going to eat, there needs to, for example, if we're going to*
5 *drink water. Then he brings over the water or juice. Or say we're setting the spoons, he opens the*
6 *drawers but we help him because that's where the knives are.*
7 ***I-1:*** *Okay.*
8 ***M:*** *"I'll give them to you," and then he sets them.*
9 ***I-1:*** *Mm-hmm.*
10 ***M:*** *But, yes, yes–yes–yes he helps.*

This mother ended reports of the toddler helping in this way (i.e., line 10) – as if to say, "despite what I just described, he really does help!" – four times during just the next 3 min of the

interview. The mothers' efforts to resolve the apparent contrast between the material realities of the child's contributions (which are small) with the value of those contributions for the mother are clear in the use of repetition to insist that the interviewer be left with the impression that the mother considers the child's involvement to be *about helping*.

Another US Mexican-heritage BIW mother addresses this contrast more playfully:

M: *Por decir, si la ve y doblé la ropa, él-él está ayudándome, pero me ayuda, pero me está tumbando la ropa. [risas] Y uno a veces más trabajo.*
I-2: *¿Pero intentando de ayudar?*
M: *Sí. Sí, él tra- intentando de ayudar, él me da, sí me da mucho más trabajo. Igual si estoy barriendo y tengo la basura, él agarra la escoba, me la- toda me la separa de un lado para otro. Ni modo. [risas]*
I-1: *¿Y usted cómo-cómo se siente cuando mira eso? Cuando pasa eso.*
M: *Ah, pues, um, mira me da gusto porque quiere ayudar, pero luego me enoja porque me- porque me hace el tiradero. Sí, pero se pasa porque es un niño.*

1 ***M:*** *For instance, if he sees that I folded the clothes, he is helping me, but he's helping at the same time that*
2 *he's tumbling over piles of clothes. [laughter] And it's at times more work.*
3 ***I-2:*** *But, does he do it trying to help?*
4 ***M:*** *Yes. Yes, as he's trying to help he gives, yes he gives me much more work. It's the same if I'm sweeping*
5 *and I have the pile, he grabs the broom and splits up the pile over to one side then another. What can you*
6 *do? [laughter]*
7 ***I-1:*** *And, how do you feel when you see that? When that happens.*
8 ***M:*** *Ah, well, um, look it makes me happy because he wants to help, but then I get mad because he makes a*
9 *mess. Yea, but it gets overlooked because he's a child.*

This mother was laughing and smiling throughout this part of the interview, calmly recounting the situation. She followed this excerpt with commentary about how this situation is met with her own guidance and instruction in (but not exclusion from) the household work and that "*está chiquito pero va a aprender*" ("he's little but he's going to learn").

A related linguistic pattern and evidence of cultural ethnotheory is embodied in mothers' use of the Spanish word, *según*. Nearly half (9/20) of the mothers in the US Mexican-heritage BIW community added this small linguistic feature to reports of their toddler helping at least once during the interview. For example:

M: *Y él según la-la tiende, pero hay veces que la he dejado así, porque vea que él lo hizo y es su forma como de ayudarme.*
I-1: *Uh-huh.*
M: *Luego su papá, "Ay, tú, no la acomodamos," "No, porque si él me está ayudando y él piensa que ya está bien, está bien, pues él poco a poco se va enseñando."*
I-2: *Uh-huh.*
M: *Sí.*

1 ***M:*** *And [seguìn] he makes it, but there are times that I leave it as it is, because I see that he did it and it's*
2 *his way of helping me.*
3 ***I-1:*** *Uh-huh.*
4 ***M:*** *Later his Dad, "Ay, you, we didn't make the bed," "No, because if he is helping me and he thinks that it's*
5 *done well, that's fine, little by little he's showing himself how."*
6 ***I-2:*** *Uh-huh.*
7 ***M:*** *Yes.*

Según is a lexically encoded evidential, a linguistic feature that marks the second-hand source of the information being reported (Maldonado and De la Mora, 2015) – in the above excerpt, the information source is the child, or more specifically the mothers' assumptions about what the child's perspective is regarding their efforts to make the bed. A common evidential in English is "according to" – e.g., "according to experts…". *Según* can be approximately translated to "according to," and it can be used as a pragmatic marker indicating that the information reported may be true for the person being referred to, but that the speaker (i.e., the mother) may or may not align with the information as accurate, revealing a distinct *epistemic stance* (Maldonado and De la Mora, 2015). For example, there is a pragmatically implied difference in a speaker's epistemic stance (or assessment of the truth claim) in the two sentences: "according to Jim, he helped," as compared to "Jim helped."

In this excerpt, it is crucial to accurately understand which information the mother is questioning. This mother explicitly punctuates the child's prosocial intentions (lines 1–2), which is perhaps necessary because prosociality is not obvious in the outcome of the child's efforts to make the bed (line 1). The use of *según* evidentially marks the report that the child makes the bed, and the pragmatics of this move are "explained" in the "but there are times that I leave it as is…" that follows – the mother is qualifying the child's contribution in terms of how well the bed is made.

However, the mother does not attenuate her claim regarding the helpful, prosocial intentions of the child. On the contrary, this mother (a) creates an ethnotheory-significant ideational space by ventriloquizing the child's father, who she voices as lamenting that the bed has not been made, and then (b) uses the father's voiced perspective as a foil against which her own perspective can be clarified. Rooted in Bakhtin (1982), this is an understood linguistic pattern whereby individuals, often implicitly, "make their points by positioning themselves with respect to others' voices, not by speaking directly in their own" (Wortham, 2001b, p. 51). Moreover, these positionings are not merely personal but "provide evidence of how local meanings are shaped by larger institutional

contexts" such as ethnotheories (Samuelson, 2009, p. 53; see also Tannen, 2010).

This mother appears to be arguing that, "If I intervene to correct the bed-making (which the child is learning to do better and better), I run the risk of undermining the helpfulness (which the child is already doing well)." *Según*, in this way, is used to distinguish between children skillfully contributing and prosocially helping. Several other US Mexican-heritage BIW mothers used *según* similarly, for example:

M: *Y ya lo levanta y así. Pero sí, hasta eso sí nos ayuda en la-en la casa. Luego quiere él barrer, y según barre. "Pues mira, deja darle otra vez, porque ya se sa-salió más basura", o cualquier cosa, pero sí, sí nos ayuda.*

1 ***M:*** *And then he picks it up like this. But yes, even this way yes he helps us around the house. Later he wants to*
2 *sweep, and [según] sweeps. "Well look, go ahead and give it another once over because there's some*
3 *trash that slipped away," or whatever, but yes, yes he helps us.*

Another US Mexican-heritage BIW mother reported:

M: *Ella me, siempre me quiere ayudar, que a lavar los trastes, según ella agarra la escoba y se pone a barrer.*

1 ***M:*** *She, she always wants to help me, whether it's washing dishes, [según] her she grabs the broom and gets*
2 *going sweeping.*

And still another US Mexican-heritage BIW mother:

M: *Sí, todo aquí en la casa también, donde uno puede lavar, no alcanza a lavarla atrás y lo pone así ya y lavar, según dice, lavar las cosas. Todo lo quiere hac – "Le voy a ayudar limpiar aquí o aquí." todo lo quiere hacer, pues sí está bien nomás que no lo agarres cosas que – de peligroso.*

1 ***M:*** *Yes, everything here at home too, wherever someone can wash, she can't reach to wash in back and so*
2 *she sets it up like this and washes, [según] she says, washes things. She wants to do it all – "I'm going to*
3 *help clean here or here." She wants to do it all, so yes it's good as long as she doesn't get into things that*
4 *are dangerous.*

The fact that these mothers use *children's initiative* in getting involved in everyday household work as evidence of their prosocial intentions to help, even when that involvement may result in a contribution that is imperfect or creates more work for parents, both aligns with mothers' response continuity with interviewers' child-as-agent-helping questions and centers children's agency as a central priority for this community's cultural approach to socializing children's development of prosocial helpfulness.

In summary, as shown in **Table 1**, of the 94 total pivots among European-American ESE mothers, 68 pivots (vs. 4 of 6 pivots in the US Mexican-heritage BIW community) were instances where mothers responded by positioning a caregiver as the linguistic agent instead of the child and 26 pivots (vs. 2 of 6 pivots in the US Mexican-heritage BIW community) replaced helping as the object of the child's activity with another action (e.g., play). Eighty percent (16/20) of the European-American ESE mothers responded to a child-as-agent-helping question with a pivot that positioned a caregiver as the linguistic agent instead of the child, and 60% (12/20) of European-American ESE mothers replaced helping as the object of the child's activity with another action. Among US Mexican-heritage BIW mothers, such pivots were far less common (15% or 3/20 and 10% or 2/20, respectively).

DISCUSSION

This study examined linguistic patterns in mothers' responses to queries about their children's help to better understand the *ethnotheories* that may guide how mothers organize and intervene in children's prosocial engagement. The findings of this study make an important contribution toward understanding cultural differences in parental ethnotheories, family socialization of children's prosocial development, and ultimately toward understanding possible cultural differences in children's prosocial helping.

Middle-class European-American mothers in this study frequently did not accommodate the linguistic form of interviewers' questions about the everyday household activities in which their toddler was involved – questions that positioned the toddler as agentic in helping (Giles et al., 1991). Instead, these mothers often "pivoted" to a linguistic frame that placed their own organizational or motivational efforts as central to the child's helping (see **Figure 1B**). Such pivots are meaningful linguistic moves; they function as a bid for revision to the intersubjective ground of meaning between interlocutors. Furthermore, this kind of non-accommodation or "pivot" is unusual in conversational exchange, suggesting that the ethnotheoretical frame to which mothers pivoted is important to their views and values. These finding suggest that middle-class European-American mothers may assume that children's development of prosocial helping originates with *mothers'* efforts to cultivate helpful dispositions through organizing, managing, and controlling children's participation in everyday household work (see Lareau, 2000). Such parent-controlled approaches to socializing children's prosocial helping may be common to middle-class European-American families (Ochs and Kremer-Sadlik, 2013; Coppens et al., 2016), despite the voluntariness of children's early efforts to get involved. Similarly, the linguistic features of several middle-class European-American mothers' reports indicated doubt regarding children's helpful intentions when getting involved with everyday household tasks (see **Figure 1C**). For example, some mothers responded to questions about their child helping in ways that "pivoted" to reframe the intentions assumed of children in the interviewers' questions (i.e., that children intended to help) into reports that assumed children's intentions were to play or do other non-work activities (see also Coppens and Rogoff, in preparation). Some middle-class

parents may assume that children are too young to engage with, understand, or be compelled by the needs of others in complex and dynamically coordinated everyday productive endeavors.

In sharp contrast, such "pivots," whether in regard to children's agency or children's assumed intentions to help, were almost entirely absent among US Mexican-heritage mothers (see **Figures 2B,C**). Linguistic features of these mothers' reports centered children's efforts to get involved with ongoing work as driving children's prosocial development. These findings suggest that US Mexican-heritage mothers "locate" the origins of children's prosocial development in the early initiatives of young children and may organize their socialization practices in the home to support children's autonomy, interpersonal responsibility, and collaborative dispositions (Keller et al., 2006; Correa-Chávez et al., 2015; Coppens et al., 2016). Similarly, US Mexican-heritage mothers almost never pivoted away from the linguistic frame that assumed children's helpful intentions when reporting their toddler's everyday involvement in family household work (see **Figure 2C**). On the contrary, these mothers commonly, and at times spontaneously, reported children's involvement in everyday work *as help* (e.g., "when my child comes into the kitchen to help me"), positioning the child as a contributing member of the family. These findings are consistent with a large body of ethnographic evidence describing indigenous and indigenous-heritage American parents support for children's autonomy in collaborative efforts and cultural expectations for children's prosocial helpfulness.

Findings in the US Mexican-heritage BIW community are not entirely consistent with a "relational pathway" of children's prosocial development found among some communities in India and rural Brazil (Kärtner and Keller, 2012; Köster et al., 2016), with *hierarchical* social relations and adult *assignment* of responsibilities as key elements (see Köster and Kärtner, 2019). Mexican-heritage mothers in this study prioritized children's initiative in collaborative, more horizontal social relations with children. This emphasis on children's autonomy exists part and parcel with cultural expectations regarding children's prosocial helpfulness, which were communicated not as task assignments or requests but through children's meaningful inclusion in shared endeavors (Rogoff, 2014), creating but not imposing an "inviting horizon" for children's prosocial development Lee, 1961 (see also Rogoff, 2003; Paradise, 2005). Refined understanding of similarities and differences between these pathways holds strong potential for advancing theories of children's prosocial development.

The two kinds of linguistic pivots that characterized half of the focal responses by middle-class European-American mothers oppose, respectively, the two core aspects of a widely accepted definition of prosocial helping – "voluntary behavior intended to benefit another" (Eisenberg et al., 2015, p. 114). In so far as such linguistic patterns provide evidence of parental ethnotheories, middle-class European-American parents' emphasis on their own agency in eliciting children's help may in practice circumvent children's opportunities for *voluntary* engagement. Likewise, although less common in these data, middle-class parents' assumptions that children's efforts to get involved in everyday household work lack helpful *intentions* may in practice contribute to parents restricting children's opportunities to learn what helping means and what it entails. To the extent that the linguistic "pivots" found in this study are indicative of ideas that inform parents' approaches to socializing children's prosocial behavior, such ethnotheories may inform socialization practices that undermine the very prosocial behaviors they ostensibly aim to develop.

At issue in understanding parental ethnotheories regarding young children's prosocial helping is not necessarily the accuracy of parents' appraisals of children's intentions or motivations. When toddlers get involved in ongoing household work, their motivations are often ambiguous. Is the child trying to help? Are they interested to play, and ambivalent to or unaware of ongoing work? Is the child drawn into everyday work as a way to spend time with a caregiver? Indeed, several motivations may be relevant to children's interests in getting involved in household work. In contrast with research aiming to discern children's prior or "underlying" prosocial intentions, our findings raise the possibility that the *assumptions* that parents make about children's interests, motivations, and intentions play a key role in informing parents' use of some socialization approaches over others and in organizing the opportunities that children have for collaborative engagement in meaningful family and community work.

The questions of this study have their roots in recent findings suggesting that the often-assumed trajectory of young children's prosocial development – with toddlers eager to help in everyday household work and older children becoming reluctant or resistant to do so (Rheingold, 1982; Hay and Cook, 2007) – may be a pattern specific to many middle-class communities and generally uncharacteristic of children's prosocial development in other communities. For example, in a cross-sectional study, Coppens and Rogoff (in preparation) found that middle-class European-American children's helping at home was limited to just a few low-complexity tasks at both age 2–3 and age 6–7, whereas indigenous-heritage US Mexican children's help doubled across the same ages. Moreover, middle-class European-American children's help became less voluntary and more driven by parental directives from age 2–3 to age 6–7, whereas indigenous-heritage US Mexican children's help became more voluntary and characterized by children's autonomy and initiative. Other researchers have found similarly pervasive patterns of voluntary helping among children in many non-Western communities (Lancy, 2018).

More research is needed to document and validate evidence of cultural variability in the trajectories of children's prosocial development, especially focusing on naturalistic settings of children's everyday lives and on ecologically valid experimental settings (Rogoff et al., 2018). Yet, a parallel question is also pressing: With helpfulness among toddlers seeming to be so pervasive, where do cultural differences in children's prosocial helping come from?

The importance of understanding parental ethnotheories for developmental questions may stem from their *proleptic* quality (Cole, 1996). Ethnotheories are not simply views that are "held" by parents; they play an important role in how parents interpret children's actions and how those interpretations inform the

guidance that parents provide to children (Goodnow, 1996). For example, Cole (2007) describes British parents' deployment of culturally stereotypical gender assumptions in talk to and about infants, arguing that "parents' (purely *ideal*) recall of their [gendered] past and imagination of their child's future, becomes a fundamental *materialized* constraint on the child's life experiences in the present" (italics in original, p. 240). Proleptic cultural processes – linking ethnotheories (i.e., *idealized* cultural models) with children's behaviors and socialization processes (i.e., *material* features of developmental settings) – may be quite common worldwide, even if their content differs from one community to the next. For example, some indigenous-heritage families of Mexico continue the Aztec practice of burying a child's umbilical cord to connect the child to both gendered community expectations (boys' and girls' *ombligos* were buried in different locations, reflecting the tasks in which they were hoped to contribute) as well as to *place* – a physical, cultural, and spiritual location (Rogoff et al., 2014).

Taken as a whole, children's efforts to engage with ongoing work and the socialization practices that parents use to respond to children's efforts constitute a "developmental niche" in which prosociality is defined in terms of local expectations for children's help and is idealized as a developmental goal (Super and Harkness, 1986). For example, if mothers assume that children's motivation is to play when getting involved with everyday work, they may guide children toward non-work activities that allow the child to play without interrupting household work. Such socialization practices may communicate low expectations that children notice ongoing work, offer to assist, or take responsibility for work around the home. Likewise, ethnotheoretical assumptions that children are inherently motivated to help may lead mothers to provide expanded and supported opportunities for children to learn to be helpful and to learn to collaborate. This kind of trajectory for prosocial development may be supported by expectations that communicate to children, even if implicitly, that their *help* is valued in ongoing productive endeavors, and children may catch on to the meaning of shared work as a result. For example, when asked why they helped at home, Maya children responded, "because I live there" or "*porque el trabajo me lo dice*" (Alcalá et al., in preparation). Although such cultural expectations are rarely examined in studies of children's helping, they may have a gradual and important impact on children's prosocial development.

Extending the Study of Cultural Patterns in Parental Ethnotheories

This study contributes insights into cultural aspects of children's prosocial development by leveraging linguistic evidence in ways that expand the cultural and methodological basis of psychological and developmental research. In developmental psychology research, interview data are frequently underleveraged for understanding cultural phenomena. Our estimation is that the vast majority of developmental research using interviews attends to the *denotational text* (Wortham et al., 2011) or the "content" reported in the interview – recalled actions or behaviors of the interviewee or others, such as what work parents remember children helping with at home on a regular basis. By extension, asking *cultural* questions of such data requires comparing the denotational reports of informants from different cultural backgrounds. Although interviews can be useful when observational studies are not possible, it is perhaps not surprising that many researchers prefer observational or experimental evidence that does not rely on parents' recollections.

Interview data often outpace the potential contribution of observations in examining an important aspect of developmental phenomena: parents' *views*, *ideas*, *beliefs*, and *ethnotheories* regarding, for example, children's prosocial helping. However, parents' ideas and ethnotheories are difficult to study even using interviews because (a) the culturally rooted values and assumptions that guide parents' socialization practices are often experienced implicitly, challenging the viability of methodological approaches that require parents to directly and explicitly report on what they likely experience to be common sense (Geertz, 1975), and (b) the communicative act of asking people questions functions quite differently across cultural communities (Briggs, 1986). Interviewing is never a straightforward process of "collecting" information. Moreover, direct questions to parents about topics with high social desirability across communities – such as the prosocial helpfulness of their children – may yield few cultural differences (de Guzman et al., 2012), complicating attempts to explain otherwise notable cultural differences in children's prosocial helping (Alcalá et al., 2014; Coppens et al., 2016). Although some researchers have developed innovative approaches for eliciting implicitly held assumptions (e.g., Levy and Hollan, 1998; Keller, 2003; Adair and Kurban, 2019), the empirical study of cultural values and ethnotheories continues to be challenging despite its importance for linking individual and cultural processes.

Our study shows that attention to the *interactional text* of interviews (Wortham et al., 2011) – how language is *put to use* for particular social purposes in both naturally occurring talk and structured research interviews – can reveal cultural expectations and values in ways that are difficult to study otherwise. At times, these interactional features of interviews are difficult to overlook. For example, in a study of mothers' views on young children's helping in a community near Guadalajara, México, almost half of the indigenous-heritage mothers that were interviewed resisted an interview question frame about "fairness," indicating that it was a poor fit for understanding mothers' views on children's prosocial responsibilities (Coppens et al., 2016). For example:

> ***Interviewer:*** *Would it be fair or unfair to ask a child to make their mother's bed?*
> ***Mother:*** *No because, in my case that has never happened because [my child says,] "Mamá, let me make your bed." In other words, they do it themselves without anyone telling them to.*
> ***I:*** *So would it be fair or unfair to you?*
> ***M:*** *Well that's neither here nor there*
> ***I:*** *OK. So you're saying that here your kids do it/*

M: *(interjects)/Everything.*
I: *without being asked, right?*
M: *Yeah, they just do it.*

Explicit analytical focus on the social or interactional features of research encounters is rare in psychological research – patterns of interaction between researchers and participants in both interviews and laboratory tasks are often ignored entirely (Packer, 2018). Ignoring such interactional patterns precludes analysis of the social power dynamics present and inevitable in all research, potentially undermining efforts to address issues of equity. Carefully understood, such dynamics can reveal themselves not as "bias" but an important source of evidence regarding the questions and phenomena of interest to psychological researchers (Briggs, 1986), as we have aimed to show in this study. Considerable progress is needed in this area. Our study is one example of systematic and formal approaches to examining and interpreting interactional features of language in research on children's prosocial development, offering considerable potential for understanding the cultural values, ideas, and ethnotheories that parents draw on in talk about their children and about their children's prosocial helping. We briefly mention two related efforts by other researchers below.

Keller et al. (2004) used discourse analysis to examine cultural variation in caregivers' views and ethnotheories regarding what kinds of care are "best" for young children. As with our study, Keller et al. were interested to use the "style" or linguistic form of mothers' reports to examine cultural perspectives children, families, and parenting – "verbal embodiment, the linguistic means chosen in a given speech-act, can shed light on the implicit aspects of ethnotheories" (p. 294). For example, Keller et al. interpret mothers' use of "I" statements as evidence of broad alignment with "independent" (vs. "interdependent") cultural models of parenting. Although we suggest caution in such micro- to macro-interpretative leaps (Wortham, 2012), the analysis nonetheless raises important questions and issues in the study of parental ethnotheories.

Renowned experts in linguistic anthropology, Ochs and colleagues' research in the *Center on the Everyday Lives of Families* (Klein et al., 2009; Ochs and Kremer-Sadlik, 2013, 2015b) has made valuable contributions to understanding middle-class patterns of children's everyday prosocial helping. Using detailed linguistic analyses, Ochs and Kremer-Sadlik (2015a) illustrate "coordination troubles" among middle-class families in Los Angeles where parent–child talk both reflects and reifies cultural values, expectations, and ethnotheoretical assumptions. Their data consist of naturally occurring talk in middle-class homes, which also provides evidence of how cultural expectations of responsibility may be communicated to children. For example, after issuing clear directives to two children, imploring their help with cleaning the kitchen table, a middle-class mother "undermines her own authority and rationalization by voicing an imagined ironic disparaging response that she attributes to [one of the children]. . . Mother: "*deep, creaky voice*" 'Yeah, right mom.'" (p. 733). The mothers' reflexive and ventriloquized response may have the effect of communicating to the child that what is culturally expected is reluctance to help as well as negotiation of the child's responsibilities to be helpful. This kind of evidence has important implications for the study and understanding of children's prosocial development in everyday family and community contexts.

These patterns in parental ethnotheories may align with and complement observational findings, providing multilevel insights into cultural features of children's prosocial helping and development.

Limitations

Our study was designed to examine theoretically and methodologically significant evidence of parental ethnotheories in two cultural communities. Although we present evidence on the prevalence of several linguistic patterns with ethnotheoretical significance in our sample, much larger samples would be needed to confidently generalize these findings to the entire cultural communities or groups. Our samples are most appropriate for *analytical generalization* or for contributing to theory regarding how culturally variable parental ethnotheories may relate to cultural variability in children's prosocial helping across development (Firestone, 1993).

To our knowledge, this is the first study in the developmental sciences to connect evidence of linguistic "pivot" patterns to cultural research on parental ethnotheories and the socialization of children's prosocial development. Further research is needed to understand the interactional features of social science interviews that may permit or preclude this kind of language use. Our study is also the first to connect the Spanish linguistic evidential "*según*" to research on parental ethnotheories of children's prosocial development. In general, we encourage further study regarding both cultural variability in children's prosocial helping and examination of cultural processes – linking, for example, parental ethnotheories, socialization practices, and children's prosocial helping behaviors.

CONCLUSION

In conclusion, we offer a cautionary note on the future of comparative cross-cultural research in psychology, including studies of children's helping and prosocial development. A decade has passed since the publication of Henrich et al. (2010) paper in which the now famous "WEIRD" acronym was coined – Western, educated, industrialized, rich, and democratic. The convenient label has been referred to in over 1,000 published studies (including some of our own prior work). Their analysis contrasted the often-anomalous patterns of performance in experimental research among participants of "WEIRD" cultural backgrounds with the patterns of participants of numerous other cultural backgrounds. The impact of this paper continues to expand, and we strongly agree with its arguments calling for greater sampling diversity across the world's cultural communities and more cautious and empirically tested generalization on the basis of evidence from this non-majority group. If cultural research on children's prosocial development and in psychology in general is expanding; these authors share credit with

numerous scholars who have, over decades, advocated for such a "turn."

Nevertheless, the WEIRD label – perhaps due in part to its provocative double entendre – risks reinvigorating the kinds of simplistic, dichotomous cultural comparisons that long-characterized cross-cultural research in psychology. Movement, migration, and cultural hybridity are central to the experiences of a rapidly expanding proportion of the world's population – if dichotomies such as *individualist versus collectivist* ever adequately characterized cultural contrasts (cf. Rogoff, 2003), their validity should be under increased scrutiny. Our caution at present is that explicit or implied dichotomous contrasts between "WEIRD" and "non-WEIRD" cultural groups do not productively advance the field of cultural research in children's development. As we have endeavored in this paper, when researchers take care to explore family practices and patterns with attention to cultural context, cultural contrasts and, comparisons can be explored in ways that are neither reductive nor dichotomous. Thomas (1958) cautioned similarly with regard to research on Cherokee cultural values:

> *What really bothers me methodologically is that Cherokees sound so much like other American Indians. You could, almost, substitute the word Cherokee for much of the material present on Navajo values or Chippewa, and so on, around the country. We haven't the terms to really describe this behavior and thus differentiate, except at a gross level. . . . [Are] we really seeing American Indians at even this gross level? Are we seing [sic] tribal societies? Or are we just seeing the European in negative? (p. 25)*

This study responds to the need for both within- and across-community sophistication in cultural research in psychology by drawing on the ethnographically informed methodological and analytic traditions of linguistic anthropology. In doing so, we highlight a collaborative, prosocial socialization paradigm common among many indigenous-heritage Mexican families in and outside of the United States as an inspiring model of cultural strengths for organizing opportunities for children, alongside adults, to learn and develop prosocially by contributing, collaborating, and belonging (Coppens et al., 2014; Rogoff et al., 2017). This model provides a promising horizon for revising and expanding theories of children's prosocial development.

DATA AVAILABILITY STATEMENT

The data used in this study are held in encrypted online storage by the first author, and inquiries regarding the data should be addressed to the first author. Due to special circumstances of confidentiality required for some of the families in this study, data cannot be made publicly available.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the University of California, Santa Cruz Institutional Review Board. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

ADC contributed study design and data collection. ADC and AIC contributed early conceptualization and analysis. ADC and LA coded the data. ADC wrote the first draft of the manuscript. ADC, AIC, and LA wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Impact of Music on Working Memory in Rwanda

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Previous research shows that listening to pleasant, stimulating and familiar music is likely to improve working memory performance. The benefits of music on cognition have been widely studied in Western populations, but not in other cultures. The purpose of this study was to explore the impact of music on working memory in a non-Western sociocultural context: Rwanda. One hundred and nineteen participants were randomly assigned to a control group (short story) or one of four different musical conditions varying on two dimensions: arousal (relaxing, stimulating) and cultural origin (Western, Rwandan). Working memory was measured using a behavioral task, the n-back paradigm, before and after listening to music (or the short story in the control condition). Unlike in previous studies with Western samples, our results with this Rwandan sample did not show any positive effect of familiar, pleasant and stimulating music on working memory. Performance on the n-back task generally improved from pre to post, in all conditions, but this improvement was less important in participants who listened to familiar Rwandan music compared to those who listened to unfamiliar Western music or to a short story. The study highlights the importance of considering the sociocultural context in research examining the impact of music on cognition. Although different aspects of music are considered universal, there may be cultural differences that limit the generalization of certain effects of music on cognition or that modulate the characteristics that favor its beneficial impact.

Keywords: music, working memory, Rwanda, trauma, cognition, arousal, valence, familiarity

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INTRODUCTION

Listening to music is a common activity, whether simply for the pleasure it promotes or for its psychological and cognitive benefits (Huron, 2007). The positive effect of music on emotion and stress regulation is well documented (Sloboda et al., 2001; Krout, 2007; DeNora, 2011; Chanda and Levitin, 2013; Hallam and MacDonald, 2013; Saarikallio et al., 2013; Habibi and Damasio, 2014). A beneficial effect of music on cognitive performance has also been reported. Studies have demonstrated higher performance on a number of cognitive tasks following exposure to music (Nantais and Schellenberg, 1999; Särkämö et al., 2008; Sutton and Lowis, 2008; Smith et al., 2010;

Schellenberg and Weiss, 2013). This positive effect has been established for visuospatial tasks (Nantais and Schellenberg, 1999; Thompson et al., 2001; Husain et al., 2002; Schellenberg, 2005; Pietschnig et al., 2010), verbal tasks (Sutton and Lowis, 2008) and mathematical reasoning (Smith et al., 2010), speed of information processing (Schellenberg et al., 2007), creativity (Schellenberg et al., 2007), short-term visual memory (Chraif et al., 2014), and working memory (Mammarella et al., 2007; Chew et al., 2016; Palmiero et al., 2016). The vast majority of studies have focused on the effect of music on cognitive functioning in Western populations; very little research has investigated the effect of music in non-Western cultural contexts (Schellenberg et al., 2007; Chew et al., 2016). The purpose of this study was to examine the impact of music on working memory in an African culture, in Rwanda.

The literature also reports an alteration in cognitive performance related to traumatic exposure or highly stressful life events (Philip et al., 2013; Honzel et al., 2014; Scott et al., 2015). Trauma, as potentially experienced by a large part of the Rwandan population during the 1994 genocide perpetrated against the Tutsi, is therefore likely to negatively affect performance in certain cognitive tasks (Blanchette et al., 2019). Given the reports that music can have a positive effect on cognitive performance and emotion regulation, we examined whether this positive effect can be observed in Rwanda, a non-Western culture that could particularly benefit from it because of its widespread exposure to trauma.

The positive effect of music on cognition was first associated with Mozart's music. In several studies, the performance of a group of students in a visuospatial task proved superior after they listened to Mozart's music (Sonata for Two Pianos in D major, KV 448), compared to silence, a relaxation recording (Rauscher et al., 1993) or a short story (Rauscher et al., 1995). Subsequent research has found that the positive effect of music was not limited to Mozart's compositions but could be observed with several types of music sharing certain characteristics (Nantais and Schellenberg, 1999).

Arousal is one of these characteristics (Thompson et al., 2001; Schellenberg, 2005). The arousal hypothesis states that listening to stimulating music characterized by fast tempo promotes a higher level of arousal among participants, which contributes to improved cognitive performance (Husain et al., 2002). One study manipulated the tempo of a musical excerpt to create a fast tempo version and a separate slow tempo version. Performance on a visuospatial task was superior after listening to music with fast tempo compared to music with slow tempo, supporting the arousal hypothesis (Husain et al., 2002).

Mood is another important characteristic associated with the effect of music on cognitive performance (Thompson et al., 2001). For example, the major mode, usually associated with happiness, favors the induction of a positive emotional state among participants (Dalla Bella et al., 2001; Gabrielsson and Juslin, 2003; Hunter et al., 2010). Music in major mode induces more positive mood which may also contribute to improving performance. In a study that manipulated the mode of a musical excerpt, participants who listened to the music in major mode showed a more positive mood, and better cognitive performance, than those who listened to music in minor mode (Husain et al., 2002). Music-induced mood changes is therefore another factor that can explain the cognitive improvement following music exposure.

In addition to arousal and mood, familiarity appears to be a third factor that can influence the effect of music exposure on cognitive performance. One study examined how background music affected academic performance and learning (Chew et al., 2016). Performance on a verbal memory task was significantly better when participants listened to music that was familiar to them, compared to unfamiliar music. Familiar music can also improve creativity (in drawing; Schellenberg et al., 2007).

In sum, music can improve cognitive performance (Nantais and Schellenberg, 1999; Nittono et al., 2000; Thompson et al., 2001; Sutton and Lowis, 2008), especially when it is familiar, when it promotes arousal, and when it induces a positive mood.

However, some of the results found in the literature are mixed. The positive effect of music is not always present or not always related to mood, arousal or familiarity. For example, in a study that used Mozart's Sonata for two pianos in D major (a commonly-used piece; Thompson et al., 2001), working memory performance was less enhanced after listening to music than after a rest period (Kuschpel et al., 2015). Other data showed a beneficial effect of music on cognitive performance without, however, observing a link with self-reported arousal or mood (Smith et al., 2010). Another study looked at the effect of participants' favorite music on their working memory performance (Hirokawa, 2004). Results indicated increased arousal when listening to music but no significant difference in working memory performance compared to other conditions: listening to relaxation instructions or remaining in silence.

These results conflict with those of studies showing a positive effect of music on cognition. These inconsistencies may however, largely be attributed to experimental procedures that vary from one study to another, particularly in regard to the difficulty of the cognitive task, the duration of music exposure, and the nature of the control group. The procedure in our study was modeled after the procedure used by Schellenberg and colleagues, as our hypotheses mainly rely on their work (see section "Materials and Method").

The benefits of music for cognition have been widely studied in Western populations but very little in other cultures. Given the prominent place music occupies in all cultures (Peretz and Lidji, 2006; Munyaradzi and Zimidzi, 2012), it is important to test whether its effect on cognition is universal. In our study, we focused on Rwanda, an African country with a musical culture that is different from the Western one (see article by Munyaradzi and Zimidzi, 2012), and where music holds an important place (d'Ardenne and Kiyendeye, 2015).

The potential benefits of music may be particularly important to study in a country where a majority of individuals have been exposed to major trauma, during the 1994 genocide perpetrated against the Tutsis. One study has shown a negative link between the severity of traumatic experiences related to the genocide and short-term memory capacity, more than 20 years after the genocide (Blanchette et al., 2019). Another study showed impaired memory skills in Rwandan orphans, four years after

the genocide (Dyregrov et al., 2000). Further, studies have documented that music has had a positive impact in reducing stress and anxiety in exposed populations in Rwanda (Walworth, 2003; Pelletier, 2004; Panteleeva et al., 2017; de Witte et al., 2019).

Studies of Western populations show that listening to music may improve cognitive performance, notably the working memory. In this study, we aimed to investigate the impact of music on working memory performance in a non-Western sociocultural context, Rwanda. We tested whether listening to music deemed familiar, pleasant and stimulating would enhance performance in a working-memory task.

MATERIALS AND METHODS

Study Design

We studied the effect of music which varied according to two dimensions: origin (Western or Rwandan) and level of arousal (relaxing or stimulating). We measured working memory performance using an n-back task with two levels of difficulty (1-back or 2 back).

Participants

One hundred and nineteen Rwandans participated in the study. Recruitment was done by Rwandan research assistants who verbally disseminated the information in different neighborhoods in Kigali (capital of Rwanda). Data collection took place over two three-week periods in July 2015 and August 2015. There were three inclusion criteria: (1) being at least 30 years of age, so that participants would have been old enough at the time of the genocide to remember the events; (2) having been present in Rwanda during the genocide; and (3) being able to speak and read Kinyarwanda. This last criterion was necessary because a large part of the study required reading questionnaires and task instructions on a computer screen. Seven participants had incomplete n-back measures (missing a data point in one of the four conditions), they were not included in the analyses. Participants who performed below the chance threshold (50%; $n = 9$) and those who performed worse in the 1-back condition (lower level of difficulty) than in the 2-back condition (higher level of difficulty; $n = 11$) were excluded from statistical analyses because of the possibility that they did not sufficiently understand the working memory task. The final sample included in the analyses therefore included 92 participants.

Participants were compensated 8,000 RWF, equivalent to approximately $ 15 CAD at the time of the study. An information letter was read to the participants, and they signed a consent form, before participating in the study.

Procedure

This study was part of a larger research project exploring mental health, cognitive health and openness to reconciliation in Rwanda. Participants completed other questionnaires and cognitive tasks. The average total duration of the experimental procedure was approximately 3 h. The average duration of the tasks related to the study reported here was approximately 1 h.

The study was performed entirely on laptop computers. Questionnaires and tasks were presented using the E-Prime 2.0.10.353 software. Participants first answered a set of questionnaires aimed at documenting their mood and stress levels at the beginning of the task, as well as their degree of exposure to the genocide. They then completed the working memory task twice, before and after exposure to a sound excerpt (music or short story) which lasted 10 min. Participants wore headphones to listen to the sound excerpt. They were required to complete an assessment of their mood and arousal level before and after exposure to the sound excerpt. A subjective evaluation of the sound excerpt was performed at the end of the experiment.

At each moment, between four and seven participants were tested simultaneously, within the same room, each on a different computer. A doctoral student from the Université du Québec à Trois-Rivières (the first author) and one to two research assistants of Rwandan origin were present at all times to ensure the smooth running of the study, to provide clarification and information, and to assist participants with computer usage.

Participants were randomly assigned to one of five groups. Four experimental groups listened to music excerpts, which varied according to two dimensions: its origin (Western or Rwandan) and its effect on arousal (relaxing/slow tempo or stimulating/fast tempo). Participants in each group listened to musical excerpts which could be either Western and relaxing, Western and stimulating, Rwandan and relaxing or Rwandan and stimulating. Participants in the control group listened to a succession of two neutral short stories narrated in Kinyarwanda (one described the landscape seen on a trip to the mountains, the second described a child's journey on the way to school).

Material

Questionnaires

The questionnaires used in the study were translated from French or English to Kinyarwanda by two independent translators. The questionnaires were presented in the same order for all participants. For each question, participants selected a response by pressing the corresponding key on the numeric keypad. The possibility of not answering a question was always available by pressing the key "(9) I prefer not to answer."

Profile of Mood States

A translated Kinyarwanda version of the Profile of Mood State Brief (POMS-B) questionnaire was used to measure participants' mood. We used an abbreviated version of the original 65-item questionnaire (McNair et al., 1971). The POMS-B is a short version that contains 30 adjectives describing feelings and states of mood that the respondent may have experienced in the last week. This questionnaire is commonly used in cross-cultural studies. It has been validated and translated into several languages (Chen et al., 2002; Yeun and Shin-Park, 2006; Andrade et al., 2013). We used the three subscales of the POMS-B that were of interest to our hypotheses: Tension-Anxiety, Depression-Discouragement, and Vigor-Activity. Participants were asked to respond to items on a visual analog scale from *Not at all* to *Extremely*, in order to indicate the degree to which each adjective described their mood.

Perceived Stress Scale

The Perceived Stress Scale (PSS) measures the degree of stress associated with everyday life events (Cohen et al., 1983; Mimura and Griffiths, 2004; Cerclé et al., 2008). Participants responded to 14 items asking how often they had experienced a number of stress-related feelings or thoughts within the last month, using a Likert scale ranging from *Never* (0) to *Very often* (0). Total scores ranged from 0 to 56; a higher score corresponding to a higher level of stress. The PSS has good psychometric properties (Cohen et al., 1983) and is translated into 25 languages other than English (Lee, 2012). Given the absence of validated version in Kinyarwanda at the time of the study, we translated the English version for the present study.

Trauma Exposure

We assessed the severity of trauma exposure with the 9-item questionnaire used by Pham et al. (2004). Participants were asked if they had been exposed to potentially traumatic events related to the genocide: (1) damaged or lost property; (2) being forced to flee; (3) serious illness; (4) disability or illness resulting from the genocide; (5) sexual violence; (6) injuries to the body; (7) death of a close relative; (8) death of a close relative as a result of genocide-related illness; and (9) close relative who has been severely disabled as a result of the genocide. Participants were asked to answer each item with *Yes* (1) or *No* (0). The trauma exposure score ranged from 0 to 9. We included this questionnaire to control that the five groups were equivalent in terms of trauma exposure.

Sound Excerpts

The specific pieces of music used in the four conditions to compose the sound excerpts are presented in **Table 1**. The music of Western excerpts was instrumental. Considering the musical culture in Rwanda and the fact that Rwandan music is known to mostly contain lyrics, the Rwandan excerpts chosen for the study included lyrics. Finally, a combination of two short stories narrated in Kinyarwanda was presented to the control group.

All sound excerpts were normalized to a maximum amplitude of -1.0 decibels and faded in and out for 1 s, to avoid a startle effect and to obtain a gradual transition between silence and sound, and vice versa. The sound excerpts were presented using headphones for a duration of 10 min and the volume was previously adjusted to be comfortable (around 70 dB). At the end of the study, participants rated the valence, arousal level, and familiarity of the sound excerpt they had listened to, on scales ranging from 0 (very unpleasant, very relaxing, or not at all familiar) to 4 (very pleasant, very stimulating, or very familiar). The short stories were found to be neutral in terms of valence, activation and familiarity by participants in the control group.

TABLE 1 | Titles of the sound excerpts.

Group		Sound excerpts
Origin	**Arousal level**	
Western	Relaxing	*Twenty Eight Parallel* (Vangelis)
		Rousseau Meditation From Thais (John Massenet)
		Ave Maria (Charles Gounod)
		The Lord Bless you and keep you (John Rutter)
Western	Stimulating	*Trumpet Concerto in E-Flat Major (Hob. VII e,1) III. Finale: Allegro* (Joseph Haydn)
		Minute Waltz Op. 64 No. 1 in D flat (Frédéric Chopin)
		Rodondo Alla Turca (Wolfgang Amadeus Mozart)
		Dance of the Hours (Amilcare Ponchielli)
Rwandan	Relaxing	*Umunezero* (Ceìcile Kayirebwa)
		Kamaliza (Mutamuliza Annonciata)
		Rugamba (Abeza Banjye)
Rwandan	Stimulating	*Ineza Y'Umuntu* (Theogene Uwiringiyimana)
		Yakobo (Iriba Choir)
		Gutazira
Short story		*Inkuru y'umwana w'umunyeshuri wibagiriwe ikayi mu rugo* (Dancille Mukarubibi)
		Akarere k'iburasirazuba (Dancille Mukarubibi)

The composers appear in parentheses.

Working Memory Task

After completing the questionnaires and before listening to the sound excerpt, participants performed an n-back task. In this task, a sequence of stimuli is presented on the screen. Participants must determine whether each stimulus is the same as the one presented *n* items earlier in the sequence. **Figure 1** shows an example of stimuli sequences for 1-back and 2-back conditions. This task has been used to study working memory in both clinical and healthy populations (Blanchard et al., 1996; Rose and Ebmeier, 2006; Wild-Wall et al., 2011; Philip et al., 2016). This task requires monitoring, updating and manipulating information which is temporarily stored in working memory (Owen et al., 2005; Wild-Wall et al., 2011).

Considering the sociocultural context and the level of education of the sample, images of animals from the African continent, considered familiar stimuli, were used instead of the letters or numbers commonly used in n-back tasks (Schoofs et al., 2008; Schmiedek et al., 2014; Philip et al., 2016). Studies in the literature typically use 2-back and 3-back conditions (Schoofs et al., 2008; Lilienthal et al., 2013; Schmiedek et al., 2014). These studies include highly educated Western samples. We thus chose 1-back and 2-back conditions for our sample, which was on average, less educated.

Participants first completed two experimental blocks, one 1-back and one 2-back block, always starting with the 1-back one. After having listened to the 10-min sound excerpt (i.e., music or short story), they completed another two experimental blocks, again one 1-back and one 2-back. Each block consisted of 48 trials with a randomized presentation of the images. Each image was presented for 1 second, with two-second inter-stimulus intervals. Participants had to press one of two color-coded keys (green for "yes" or red for "no") to indicate whether the stimulus presented on the screen was the same as the one presented n-trials earlier. Prior to the experimental blocks, detailed instructions with examples were given to ensure a good understanding of the task. Participants were also required to complete a practice block with 20 trials for each level of difficulty. Feedback was given indicating the number of correct and incorrect responses obtained on the practice block.

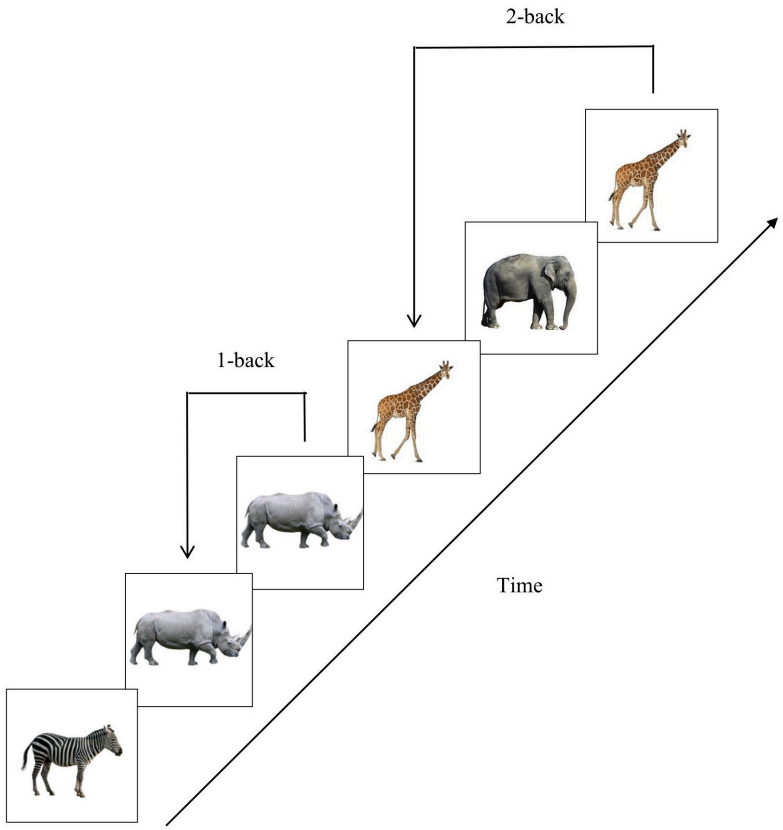

FIGURE 1 | Representation of the procedure for the n-back task. Images of animals were presented successively. On each trial, participants had to indicate whether the image was the same as the one presented 1 or 2 items before.

Self-Reported Psychological Measures

Before and after exposure to the sound excerpt, participants were asked to report their mood and their level of arousal on a Likert scale ranging from 0 to 4 (mood: *very sad* to *very happy*, and arousal level: *Very calm* to *Very excited*).

RESULTS

Statistical analyses were performed using the SPSS software. A first series of analyses was carried out to validate that the groups were equivalent, in terms of sex, age, and level of education, as well as in level of stress, mood and degree of trauma exposure (see **Table 2** for descriptive statistics). The mean trauma exposure score for all participants was 4.42 (SD = 2.10) on the scale ranging from 0 to 9. An analysis of variance (ANOVA) was performed with group as a between-subject factor. There were no significant differences between groups, on age, perceived stress, mood and trauma exposure, $F(4, 85) < 1.28$, and $p > 0.13$. Gender and level of education also did not significantly differ between groups, $X^2 < 12.0, p > 0.20$.

Working Memory Performance

Analysis of variances were carried out to determine if performance on the n-back task differed according to difficulty level (1-back, 2-back), time (pre-, post-sound exposure), and group (Western relaxing music, Western stimulating music, Rwandan relaxing music, Rwandan stimulating music, control group). The ANOVA revealed a main effect of difficulty level, $F(1, 87) = 222.46$, $p < 0.001$, $n^2_p = 0.72$ and time (pre, post), $F(1, 87) = 26.57$, $p < 0.001$, $n^2_p = 0.23$. Participants performed better in the 1-back condition than in the 2-back condition, and performed better after sound exposure than before. There was also a marginally significant interaction between time and group, $F(1, 87) = 2.19$, $p = 0.08$, $n^2_p = 0.09$. Difficulty level did not interact with group, $F(4, 87) = 0.57$, $p = 0.69$, $n^2_p = 0.02$, time and difficulty did not interact, $F(1, 87) = 0.49$, $p = 0.83$, $n^2_p = 0.001$, and the three way interaction was not significant, $F(4, 87) = 0.31$, $p = 0.88$, $n^2_p = 0.01$.

To explore the contribution of the dimensions of music, a second ANOVA was performed, comparing the four groups who listened to music, excluding the 18 participants who listened to the narrated story. N-back performance (pre, post), averaged across 1-back and 2-back conditions, was compared according to the level of arousal of the music (relaxing or stimulating) and its origin (Western or Rwandan). The interaction between time and origin was significant, $F(1, 70) = 7.35$, $p < 0.01$, $n^2_p = 0.10$. There was less improvement following music exposure when participants listened to Rwandan music ($M = 0.01$, SD = 0.08) compared to Western music ($M = 0.06$, SD = 0.08). No other

TABLE 2 | Characteristics of participants according to the assigned group.

Group	Origin				
	Western	Western	Rwandan	Rwandan	Short story
	Arousal level				
	Relaxing	Stimulating	Relaxing	Stimulating	
Sex					
Men	*n* = 6	*n* = 12	*n* = 10	*n* = 8	*n* = 8
Women	*n* = 9	*n* = 10	*n* = 9	*n* = 10	*n* = 10
Age					
M (SD)	34.29 (4.76)	34.45 (7.24)	35.89 (7.96)	32.78 (2.37)	32.12 (1.69)
Level of education					
M (SD)	3.50 (0.76)	3.14 (1.06)	2.63 (0.83)	3.11 (0.96)	2.89 (0.83)
PSS					
M (SD)	30.00 (3.70)	30.59 (3.83)	34.32 (6.27)	30.06 (7.86)	31.06 (5.89)
POMS Anxiety					
M (SD)	6.79 (3.89)	6.00 (4.64)	7.16 (5.47)	5.50 (4.34)	4.83 (3.64)
POMS Mood					
M (SD)	6.64 (4.78)	5.24 (4.55)	6.74 (5.42)	4.94 (4.56)	4.72 (3.74)
POMS Vigor					
M (SD)	11.71 (3.05)	12.00 (2.30)	11.79 (3.97)	11.78 (4.25)	10.78 (3.37)
Trauma exposure					
M (SD)	4.87 (2.16)	4.38 (1.88)	4.32 (1.89)	4.33 (2.47)	4.28 (2.27)

PSS, Perceived Stress Scale; POMS Anxiety, Profile of Mood States Tension-Anxiety scale; POMS Mood, Profile of Mood States Depression-Discouragement scale; POMS Vigor, Profile of Mood States Vigor-Activity scale.

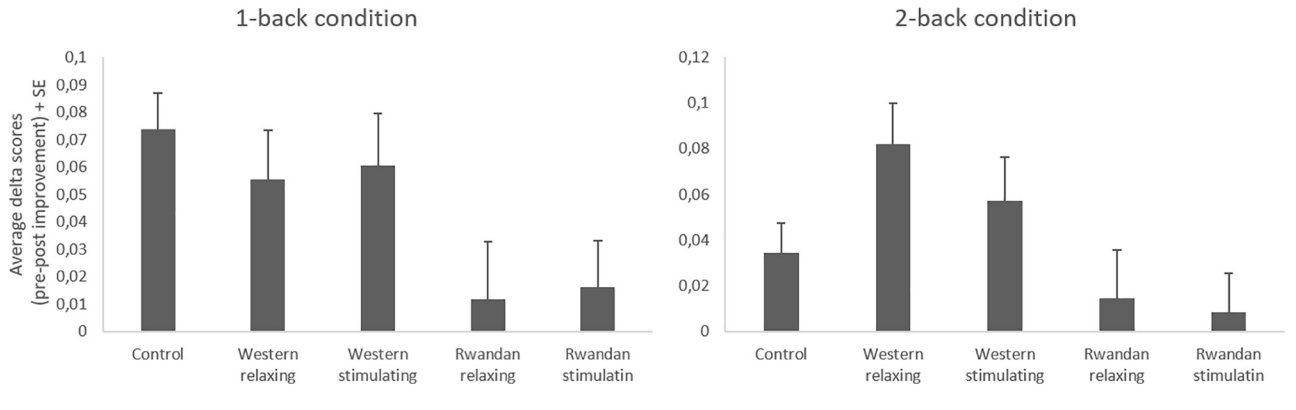

FIGURE 2 | Average improvement (pre-post change score, with SE) in Working Memory performance in the different conditions after listening to one of four types of music (unfamiliar-Western vs familiar-Rwandan; stimulating vs relaxing) or a short story (control condition).

effect was significant, $F(1, 70) < 0.08$, $p > 0.78$, excluding the main effect of time $F(1, 70) = 16.46$, $p < 0.01$.

To examine the interaction in another way, we performed paired sample *t*-tests to compare performance pre and post-sound exposure, for each group separately (see **Figure 2**). A more conservative level of significance was used in these analyses ($p < 0.01$). These *post hoc* tests confirmed a significant improvement in working memory performance in the control group $t(17) = 3.94$, $p < 0.001$, and in the groups who listened to Western relaxing music, $t(14) = 3.41$, $p < 0.001$, or Western stimulating music, $t(21) = 3.37$, $p < 0.001$. The improvement was not significantly greater after listening to Western music than after listening to a narrated story (control condition), $t(61) = 0.64$, $p = 0.52$.

There was no significant improvement in the groups who listened to Rwandan relaxing music, $t(18) = 0.76$, $p = 0.46$ or Rwandan stimulating music, $t(17) = 0.62$, $p = 0.55$.

Evaluation of the Musical Excerpts

Another series of analyses was carried out on participants' evaluation of the musical excerpts. The mean evaluations of arousal, familiarity and valence are presented in **Table 3**. Three ANOVAs were performed, on each of these dependent measures, examining the effect of the level of arousal and the origin of

TABLE 3 | Means (SD) of the evaluations of the musical excerpts.

Group	Origin			
	Western	Western	Rwandan	Rwandan
	Arousal level			
	Relaxing	Stimulating	Relaxing	Stimulating
Arousal level*	2.20 (1.32)	2.00 (1.15)	1.15 (0.93)	2.00 (1.41)
Familiarity*	1.07 (0.87)	1.24 (1.10)	2.95 (1.22)	3.33 (0.97)
Valence*	1.57 (1.14)	1.52 (1.19)	2.89 (0.88)	3.06 (0.87)

*Standard deviations appear in parentheses. *As perceived by participants. Rating on a scale from 0 (minimum) to 4 (maximum).*

TABLE 4 | Means (SD) of mood and arousal assessments by participants.

Group	Origin				
	Western	Western	Rwandan	Rwandan	Short story
	Arousal level				
	Relaxing	Stimulating	Relaxing	Stimulating	
Mood					
Pre	1.71 (1.31)	1.77 (1.19)	2.18 (1.07)	2.37 (1.09)	2.53 (1.13)
Post	2.00 (1.37)	2.24 (1.18)	2.35 (1.22)	3.00 (0.82)	2.83 (1.15)
Arousal level					
Pre	1.59 (1.18)	0.82 (0.59)	1.41 (0.62)	1.13 (0.50)	1.47 (0.80)
Post	1.06 (1.06)	1.05 (0.92)	1.35 (0.86)	0.87 (0.96)	1.28 (0.96)

Standard deviations appear in parentheses. Pre: pre-sound exposure; Post: post-sound exposure. Rating on a scale from 0 (minimum) to 4 (maximum).

the music as between-subjects variables. For arousal, there was a significant interaction between origin and level of arousal, $F(1, 70) = 3.73$, $p = 0.05$. $n^2_p = 0.05$. Participants rated the Rwandan stimulating music as more arousing than the Rwandan relaxing music, $t(35) = 2.28$, $p < 0.05$, $d = 0.94$. The difference was not significant for Western music, $t(35) = 0.49$, $p = 0.62$, $d = 0.16$.

Rwandan music was considered more familiar than Western music, $F(1, 69) = 63.11$, $p < 0.001$, $n^2_p = 0.48$. Finally, Rwandan music was considered more pleasant than Western music, $F(1, 69) = 33.23$, $p < 0.001$, $n^2_p = 0.33$. Rwandan music was therefore rated as more familiar and pleasant than Western music and the arousal level of stimulating Rwandan music was considered superior to relaxing music. No other effects were significant.

Evaluation of Participants' Mood and Level of Arousal

We analyzed participants' self-assessments of mood and arousal before and after sound exposure using two ANOVAs (see **Table 4**). For mood, there was a significant interaction between time and group, $F(4, 82) = 2.59$, $p = 0.04$. Paired sample t-tests comparing self-reported mood pre and post-sound exposure showed a significant difference only in the group "Rwandan stimulating music," $t(15) = -3.10$, $p = 0.01$. Participants in this group reported a happier mood after sound exposure. For arousal self-ratings, the interaction between time and group was not significant, $F(4, 82) = 0.48$, $p = 0.75$.

DISCUSSION

This study aimed to explore the impact of music on working memory in a Rwandan sociocultural context. We explored the impact of music on working memory in a Rwandan population exposed to the 1994 genocide perpetrated against the Tutsi. Based on findings from studies of Western samples, our hypothesis was that listening to a familiar, pleasant and stimulating music would increase working memory performance.

Contrary to these predictions, our results do not show any positive effect of familiar, pleasant and stimulating music on working memory in this Rwandan sample. This contrasts with the improvement observed when participants were exposed to less familiar, Western music, or to a short story. This study does therefore not replicate results obtained in previous studies with Western samples, where familiar music was more likely to improve cognitive performance than unfamiliar music. Our results question the universality of the effect of familiarity. They suggest that, in non-Western populations, familiar music may not necessarily have a positive impact on cognitive performance, even when it is considered pleasant and stimulating, the two other features that have been shown to be associated with a beneficial impact of music on cognition.

Although our results appear to suggest that listening to Western music improved WM performance, this improvement was not greater than the one observed when participants listened to a narrated story. In all these conditions, participants' performance improved with time and/or practice. This is noteworthy as it suggests that listening to familiar and pleasant music was in this case detrimental and masked an improvement that was otherwise observed. In this sense, listening to familiar and pleasant music interfered with performance.

Our results add to the conflicting evidence suggesting that the effect of music is not systematically observed, and may depend on the control condition that it is compared to, with effects being found more often when music is compared to silence, than to a control condition where a narrated story is presented (Hirokawa, 2004; Mammarella et al., 2007; Kuschpel et al., 2015; Chew et al., 2016; Palmiero et al., 2016). Furthermore, the potential interference effect of the control condition might differ depending on the task. In our study, we used a pictorial version of the n-back, instead of the letters or numbers that are typically used. All this needs to be considered when assessing the impact (or lack thereof) of Western music on working memory.

Although different aspects of music are considered universal, it is possible that the sociocultural context limits the generalization of certain effects of music on cognition, or at least modulates the characteristics that make music have an impact. The positive effect of music on cognitive performance has been demonstrated mainly in Western populations. Cognitive schemata related to music, such as melodic perception and emotional response, are likely, however, to be greatly influenced

by culture (Gribenski, 2005; Demorest et al., 2008). The sociocultural context is important to consider when it comes to musical understanding and interpretation (Fiske and Royal, 2002). The results obtained in our study could be partly explained by the fact that cognitive schemata for musical information are culturally derived. If cognitive musical schemata differ between Rwandan culture and Western culture, the expected effects of music may also differ.

The Western and Rwandan excerpts induced similar levels of positive feelings and arousal, which are two important contributing factors. There are, however, many other important differences between the two types of music. The instruments featured in Rwandan music are different (including the ingoma, ikembe, and umuduri, unknown in Western music). Timbre and typical tempo may also differ. In our study, the Rwandan music contained lyrics while the Western music did not. However, the control group, who listened to a short story which also contained words, did show a significant improvement in working memory. Therefore, the lack of improvement with Rwandan music cannot be explained simply by the presence of lyrics. It is important to remember, however, that Western studies that show a positive effect on cognitive performance, for the most part, use music without lyrics. To determine whether features intrinsic to Rwandan music are responsible for the lack of effect, we will need to run additional studies, presenting the same excerpts to a Western sample.

It is important to highlight the methodological strengths of this study. First, the ratings of the selected music were entirely consistent with the intended type of each music. Rwandan music was evaluated as more familiar and pleasant than Western music. The arousal level of stimulating music from all origins was considered higher than that of relaxing music. Second, the n-back task showed the expected effect of level of difficulty. This confirms the validity of our adaptation of this working memory task, using images.

Future research should investigate more precisely the mechanisms responsible for the impact of music on cognitive performance. This would shed light on the specific reasons why the effect of music on cognition may differ depending on the sociocultural context, Western or African. It is important to better understand the cognitive and emotional processes involved in order to have a more accurate and informed understanding of the impact of music on cognitive performance. The role of cognitive resources in relation to music and cognitive performance should be investigated. The study of musical cognition from a cultural point of view will lead to a better understanding of the similarities and differences observed across cultures.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved, in Rwanda, by the National Ethics Committee of the Republic of Rwanda, the National Commission for Unity and Reconciliation and the National Commission for the Fight against Genocide. In Canada: the Ethics Committee of the Université du Québec à Trois-Rivières. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SG carried out the experiment under supervision from SC and IB. SG wrote the manuscript with support from IB, SC, NG, and ER. All authors provided critical feedback and helped shape the research, analysis and manuscript.

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The Development of Context-Sensitive Attention Across Cultures: The Impact of Stimulus Familiarity

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Across cultures, there are marked differences in visual attention that gradually develop between 4 and 6 years of age. According to the social orientation hypothesis, people in interdependent cultures should show more pronounced context sensitivity than people in independent cultures. However, according to the differential familiarity hypothesis, the focus on the salient object should also depend on the familiarity of the stimulus; people will focus more on the focal object (i.e., less context sensitivity), if it is a less familiar stimulus. To examine the differences in visual attention between interdependent and independent cultures while taking into account stimulus familiarity, this study used an eye-tracking paradigm to assess visual attention of participants between 4 and 20 years who came from urban middle-class families from Germany (n = 53; independent culture) or from Nso families in a rural area in Cameroon (n = 50; interdependent culture). Each participant saw four sets of stimuli, which varied in terms of their familiarity: (1) standard stimuli, (2) non-semantic stimuli, both more familiar to participants from Germany, (3) culture-specific matched stimuli, and (4) simple stimuli, similarly familiar to the individuals of both cultures. Overall, the findings show that mean differences in visual attention between cultures were highly contingent on the stimuli sets: In support of the social orientation hypothesis, German participants showed a higher object focus for the culture-specific matched stimuli, while there were no cultural differences for the simple set. In support of the differential familiarity hypothesis, the Cameroonian participants showed a higher object focus for the less familiar sets, namely the standard and non-semantic sets. Furthermore, context sensitivity correlated across all the sets. In sum, these findings suggest that the familiarity of a stimulus strongly affects individuals' visual attention, meaning that stimulus familiarity needs to be considered when investigating culture-specific differences in attentional styles.

Keywords: visual scene perception, holistic and analytic perception, eye-tracking, stimulus familiarity, cross-cultural research

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INTRODUCTION

The way in which people attend to their visual field differs strongly between cultures. This has been demonstrated by various cross-cultural studies that have mainly focused on educated urban middle-class participants in Western and Eastern cultural contexts (e.g., Masuda and Nisbett, 2001; Nisbett et al., 2001; Nisbett and Masuda, 2003). In particular, Masuda and Nisbett (2001) describe two prototypical attentional styles: a holistic style with a higher context sensitivity and

the focus on the broader perceptual field; and an analytic style in which the focus is on salient objects and their characteristics. While the holistic style has been described as being typical for East Asian adults, the analytic style is considered to be more typical for Western adults. In order to explain where these differences originate, it has been proposed that these cultural differences in cognitive patterns are due to differences in the social orientation of the participants (Markus and Kitayama, 1991; Nisbett et al., 2001; Varnum et al., 2010). That is, while independent cultures endorse autonomy and consider the self as separate from others, interdependent cultures emphasize relatedness and interconnection of the self and others (Triandis, 1989; Markus and Kitayama, 1991). These differences in social orientation are considered to be a driving force behind the differences in cognitive patterns, which explains why interdependent cultural contexts, such as East Asian societies, show a more holistic style, and independent cultural contexts, such as Western societies, show a more analytic style (Masuda et al., 2019; Nisbett et al., 2001). There are also studies outside the East-West dichotomy that support the assumption that cultures differing in social orientation also show corresponding differences in cognitive styles (e.g., Kitayama et al., 2006; Knight and Nisbett, 2007; Uskul et al., 2008). For example, Uskul et al. (2008) compared different types of subsistence, namely farmers, fishers, and herders within Turkey. The authors could demonstrate that communities that are characterized by group collaboration that fosters greater interdependence, such as farming and fishing communities, show a more holistic cognitive style than communities that tend to emphasize individual decision-making and social independence, such as herding communities (Uskul et al., 2008).

Cultural differences in attentional styles have been reported consistently across a variety of tasks, such as picture description and recognition tasks (Masuda and Nisbett, 2001), change blindness (Masuda and Nisbett, 2006), and eye-tracking paradigms (e.g., Chua et al., 2005). For example, Chua et al. (2005) presented naturalistic pictures with a clear focal object and a background (e.g., tiger in the woods) and found that Chinese graduate students showed higher context sensitivity as they spent more time looking at the background than US-American graduate students.

Empirical evidence indicates that cross-cultural differences in attentional styles start to develop in the late preschool years, around 4 to 6 years, and become further pronounced in the years thereafter (Duffy et al., 2009; Imada et al., 2013). For example, Imada et al. (2013) compared the visual attention of 4- to 9-year-old children from Minneapolis, USA, and Kyoto, Japan, in an optical illusion and picture description task. They showed that children from around 6 to 7 years, but not younger, display culture-specific attentional styles. This means children from Kyoto, Japan, show a more holistic style, as they showed greater illusion and described more often the background, than children from Minneapolis, USA. These differences further increase at 8 to 9 years of age (Imada et al., 2013).

A recent study extended the research on the development of culture-specific attentional styles to cultures other than educated urban middle-class families from the USA or East Asia. Köster et al. (2018) compared the holistic and analytic attention to visual scenes of 5-year-old children from the Nso culture (rural Cameroon), Münster (urban Germany), and Kyoto (urban Japan) in three different tasks, namely eye-tracking, picture description, and an optical illusion. One of their main findings was that the context sensitivity across the different tasks, which were unrelated, was less consistent than suggested by previous studies. Furthermore, while some tasks revealed the expected cultural differences, others pointed in the opposite direction. Looking at the eye-tracking task in more detail, Köster et al. (2018) used two different sets of stimuli to measure children's spontaneous gaze behavior, namely a set of natural pictures and a set of non-semantic pictures, in which geometric objects were displayed in front of abstract backgrounds. The set of non-semantic stimuli were chosen with the rationale that the stimuli were unfamiliar to children in all three cultures. However, against expectations, the children from rural Cameroon showed a higher object focus for both natural and non-semantic objects than children from urban middle-class families in Japan and Germany. The authors proposed that this reversed pattern may be due to an unfamiliarity effect, because both the natural and non-semantic stimulus types are less common in the Nso children's lifeworld. More specifically, the animals and vehicles presented in the natural stimuli set do not occur in Nso children's everyday life and – due to the fact that these children are much less familiar with books or electronic media – also the non-semantic stimuli that roughly resembled comics in everyday life – seemed unfamiliar. This unfamiliarity may have led to an increased interest in the presented objects (Caparos et al., 2012; Bremner et al., 2016).

Familiarity has been considered as an important aspect in memory and cognitive processing (Snodgrass and Vanderwart, 1980), as familiarity of visual scenes facilitates encoding and categorization (Pashler, 1988). Because the physical environment differs profoundly between different cultural contexts (Miyamoto et al., 2006), people are exposed to very different visual information. To date, it has not been systematically tested whether and how the familiarity of stimuli influences participants' attentional styles in experimental settings and thereby may affect the findings of cross-cultural studies.

The present study set out to close this empirical gap by examining how different types of stimuli, varying in familiarity, affect cross-cultural differences in context sensitivity in an eye-tracking task. Specifically, we were interested in, first, whether perceptual styles are consistent across stimulus categories and, second, whether the familiarity of the stimuli influences the cross-cultural differences in visual attention.

To analyze how the familiarity of stimuli affects cross-cultural differences in analytic and holistic attention, we selected two cultural communities, in particular a middle-class sample from Münster, urban Germany, and a sample from the Nso culture, living in a mainly subsistence-based farming ecology in Kumbo, rural Cameroon. The main reasons for selecting these samples were three-fold: (1) the samples differ in social orientations as described above: they represent an independent and interdependent cultural orientation, respectively; (2) the visual environments in these contexts

are highly different; and (3) data exists on the attentional styles for both cultural communities (Köster et al., 2018).

The urban German middle class represents a prototype of an independent (Markus and Kitayama, 1991) – or autonomous (Keller and Kärtner, 2013) – cultural context. Families and household sizes are usually small. Parents are occupied in professional jobs and have high levels of formal education. Parental behavior and socialization focus on dyadic interactions and individual development, such as making choices independently (Kärtner, 2015; Köster et al., 2016). Before children enter school at the age of 6 or 7, they usually attend kindergarten. The majority of children graduate from school at the age of 18 to 19 and then enter University or start to work.

Children from the Nso culture in rural Nsoland in the North West region of Cameroon grow up in large, extended family settings. Livelihood depends on subsistence-based farming which plays a central role for family alimentation. Most parents are farmers and engage their children in household tasks and fieldwork from early on (Köster et al., 2018). This cultural context is considered as prototypically relational (Keller and Kärtner, 2013) and socialization practices focus on taking responsibility associated with social roles in hierarchical social relationships. Child care in this setting becomes a communal responsibility promoting harmonious relationships between family members and the social reference group (Keller, 2007), where from toddlerhood on, children's life becomes more influenced by peer-groups and siblings than by adults (Nsamenang and Lamb, 1994; Yovsi and Keller, 2003). Nso developmental goals are obedience, conformity, and respect for authority with long-term consequences for developing a cohesive society where members are cooperative, responsible for each other, develop a sense of collective identity and belongingness (Yovsi, 2003). In Kumbo, children attend preschool from 4 to 6 years before they start primary school. School attendance is obligatory and regular from preschool to at least the end of primary school (grade 6 with about 12 years of age). After that, the majority of children attend at least secondary education and only a small minority continues with high school or university.

Given that attentional styles gradually develop during childhood (Imada et al., 2013), the present study covers a wide age range focusing on linear change across age, and captures the early preschool years, when culture-specific attentional styles emerge, to adolescence, when attentional styles should already be fully established. Considering previous findings, we expected that the context sensitivity of participants in both settings would increase with age (Imada et al., 2013).

Children and adolescents from both cultural contexts participated in an eye-tracking task assessing their spontaneous attention to four different sets of pictures varying in familiarity. The first two sets are similar to the stimuli used in the study by Köster et al. (2018): we used a set of natural pictures and a set of non-semantic stimuli. Both sets should be more familiar to participants in Münster than in Kumbo. As the first set resembles the set that has been used in previous studies with a similar task (e.g., Chua et al. 2005; Köster et al. 2018), we refer to this set as the standard set. In addition, we used a culture-specific matched set, consisting of culturally adjusted, natural stimuli that have been matched across cultures, and we used a set of simple stimuli. These two sets should be equally familiar in Münster and Kumbo (see **Figure 1**). The standard, culture-specific matched and simple set have been rated by experts from the respective cultural context to back up these assumptions.

Given the social orientation hypothesis – the assumption that in a cultural context, the social orientation is associated with the dominant cognitive style (Varnum et al., 2010) – we hypothesized that rural Nso participants from Kumbo would have a more context sensitive attentional style, spending less time looking at the object, than urban middle-class participants from Münster. Regarding the differential familiarity hypothesis, we expected that this cross-cultural difference in visual attention should be strongest for the sets of stimuli that are equally familiar for both cultures, namely the culture-specific matched set and the simple set. Following the findings from Köster et al. (2018), there might be a less distinct or even reversed pattern for the standard set and the non-semantic set of stimuli.

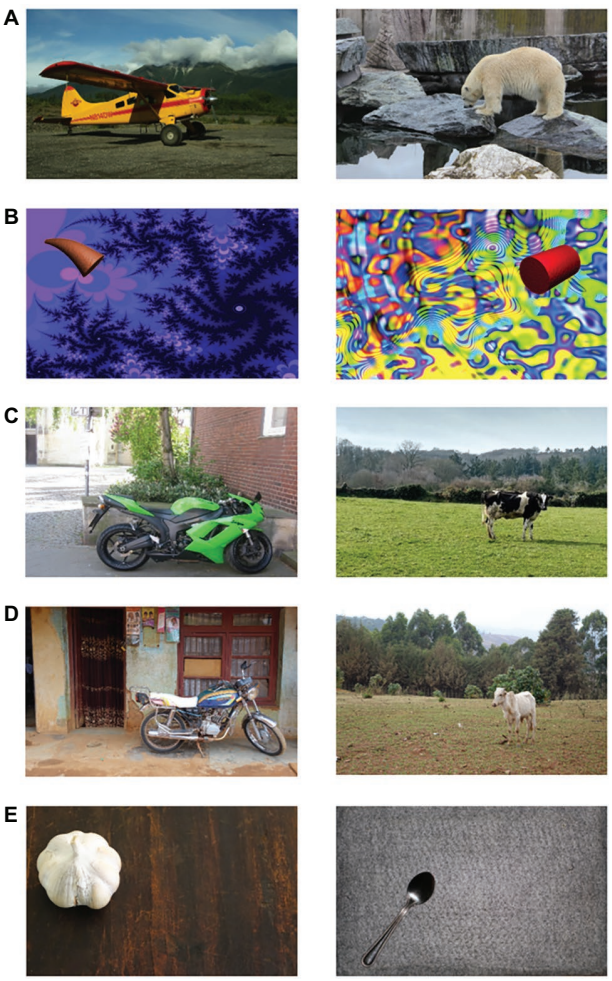

FIGURE 1 | Example stimuli used in the different sets: **(A)** standard set, **(B)** non-semantic set, **(C)** culture-specific matched set in Germany, **(D)** culture-specific matched set in Cameroon, and **(E)** simple set.

MATERIALS AND METHODS

Participants

The final sample consisted of 53 participants of middle-class families from Münster in urban Germany and 50 participants of subsistence-based farming families of the Nso-culture from Kumbo in rural Cameroon. The age range was between 4 and 20 years. All participants had normal or corrected to normal visual acuity. In Münster, families were contacted via a database from the local university. In Kumbo, children were recruited by word of mouth. Informed written consent was obtained from parents in both contexts, and children gave informed assent. For their participation, families in Kumbo received financial compensation of 1000 CFA, which was equivalent to 1.50 € at that time. Participants in Münster received cinema vouchers. The type and amount of compensation have been discussed with local assistants to determine a locally appropriate compensation for the time spent.

An additional 12 participants in Kumbo and 15 participants in Münster were not included in the analyses because they did not meet the defined criteria. These were, first, that participants had no more than one degree of deviation when calibrating the eye-tracker and, second, that they were looking at the monitor for at least 70% of the presentation time (indicated by the tracking ratio). Three additional children were excluded because in one case the child did not feel well (Kumbo: $n = 1$) or because of technical problems occurring in the eye-tracking task (Münster: $n = 2$).

The gender distribution did not systematically differ between both samples (64.2% females in Münster, 56.0% females in Kumbo, $\chi^2 = 1.21$, $p = 0.311$). Furthermore, there was no significant age difference between cultures [$M = 11.75$ years, $SD = 5.6$ in Münster, $M = 10.64$ years, $SD = 4.6$ in Kumbo, $t(101) = -1.099$, $p = 0.274$].

Stimuli and Procedure

Participants attended one experimental session, and each participant saw all four sets of stimuli. In sum, each participant saw 120 pictures: 40 standard, 40 non-semantic, 20 culture-specific matched (either from Münster or Kumbo) and 20 simple pictures. In Kumbo, the laboratory was set up in a quiet room of a house, whereas in Münster, participants visited the university laboratory with a parent. The four stimuli sets differed in familiarity (as described below), and for each set the participant received the instruction to "…watch the pictures as you like…"

Standard Set

This set consisted of 40 real pictures displaying a focal object (animals and vehicles) in front of an urban or nature background (see **Figure 1A**). Pictures were either taken by the authors, obtained from a public domain database[1] or were selected from the set used by Chua et al. (2005). These pictures are considered to be biased because they are more familiar to participants from Münster than to participants from Kumbo, as some of the depicted objects, such as boats or camels, are well-known to participants from Münster, either from direct experience or from books and other media, while they are much less familiar to participants from Kumbo who have limited access to picture books and other media. Even if animals or vehicles are known, both the object and the background are more familiar to children and adolescents from Münster than to children and adolescents from Kumbo.

Non-semantic Set

Further, 40 non-semantic pictures with abstract objects in front of abstract backgrounds were shown (see **Figure 1B**). We used artificial objects commonly used in experimental psychology (greebles, fribbles, geons, and multipart geons, e.g., Gauthier and Tarr, 1997, taken from an online database: http://wiki.cnbc.cmu.edu/Novel_Objects). Abstract backgrounds were either fractal pictures (Kaspar and König, 2011; created with quadrium 2.0, quadrium.en.softonic.com) or details of an abstract drawing (see Köster et al., 2017). Because these are novel, non-semantic objects and backgrounds, they are unknown in both samples, Münster and Kumbo. However, as suggested by Köster et al. (2018), due to limited access to media, such as books, cartoons, or electronic media, abstract shapes are less familiar to children and adolescents from Kumbo.

Culture-Specific Matched Set

These equivalent sets were designed to be similarly familiar in Münster and Kumbo. We compiled two sets of 20 real pictures with animals, vehicles, and buildings as focal objects. One set of pictures was taken in Münster and, therefore, should be highly familiar to children in Münster, and the other set was taken in and around Kumbo. The participants only saw the set with the stimuli from their respective cultural context. Pictures were matched over the two sets in the sense that they depicted the same kind of object in front of an equally complex background (e.g., a typical domestic animal on a typical field, see **Figures 1C,D**) in the respective setting. Moreover, the position of the salient objects, as well as their size was matched across cultural settings.

Simple Set

Finally, we presented a simple set of 20 pictures with common, everyday objects in front of a simple background (e.g., a garlic clove on a wooden table, see **Figure 1E**), This set was designed to avoid culture-specific compositions in order to retain similar familiarity to children and adolescents from both Münster and Kumbo. The same set of pictures that were taken in and around Kumbo were presented in both contexts, namely to participants in Kumbo and Münster.

Familiarity Rating

In order to back up the assumptions concerning the familiarity of the stimuli sets, the pictures of the standard, culture-specific matched and the simple set were rated by experts that were highly familiar with the respective environment. These experts, namely adolescents or adults living in urban Germany ($n = 5$, 100% female, $M_{Age} = 24.20$ years) or rural Cameroon

[1]https://pixabay.com

(n = 6, 50% female, M_{Age} = 25.00 years) judged the familiarity of the pictures of the standard, culture-specific matched and the simple set for children and adolescents living in their own cultural context. Pictures were presented in randomized order and rated on a 4-point Likert scale (1 = familiar to 4 = unfamiliar). While pictures from these three sets all depict specific objects and backgrounds, which can be easily rated in terms of how common they are in the participants' everyday life, this was not the case for the abstract shapes in the non-semantic set. Thus, we decided to exclude the non-semantic set from the rating. In support of the assumptions, the standard set was rated as more familiar in Münster (M = 2.17, range = 1.30–2.48) than in Kumbo (M = 2.88, range = 2.30–3.28), U = 3.00, p = 0.03. The culture-specific matched pictures were rated as highly familiar in the respective cultural contexts (Kumbo: M = 1.01, range = 1.00–1.05; Münster: M = 1.25, range = 1.10–1.40), with a value even closer to 1 for the Cameroonian experts, U = 0.00, p = 0.004. The mean values for the simple set all ranged between familiar and rather familiar for all experts, with higher familiarity ratings by Cameroonian experts (M = 1.01, range = 1.00–1.05 vs. Münster: M = 2.00, range = 1.55–2.35), U = 0.00, p = 0.004. Overall, these findings support the assumptions concerning the familiarity of the stimuli sets described above.

Assessments started with either the standard or the culture-specific matched set, with the respective other set being second. Then, participants saw either the non-semantic set or the simple set, with the respective other set being last. The order of the sets was counterbalanced, and pictures were randomized within each set and separated by a blank screen. Following studies that conducted a similar task with children (Köster and Kärtner, 2018; Köster et al., 2018), trials started with a fixation dot (shown for 1 s), followed by the stimulus (5 s). The stimulus presentation procedures were implemented in psychophysics toolbox (Version 3.0.12, on MATLAB, Version R2013a) and with the presentation program ExperimentCenter (Version 3.5.169, SensoMotoric Instruments GmbH, Teltow, Germany). Participants' gaze behavior was recorded binocularly, at a sampling rate of 250 Hz. Individual fixations were identified using a saccade-based velocity-threshold identification filter with a minimum fixation duration of 50 ms and a saccade peak velocity threshold of 40°/s in the eye-tracking software BeGaze, Version 3.5.101, which is a standard measure used in multiple former studies (e.g., Köster and Kärtner, 2018; Köster et al., 2018). The presentation was on a 15.6-in notebook display in Cameroon and a 24-in desktop monitor in Germany, both with a resolution of 1920 × 1080, but the stimuli were presented with the same dimensions of approximately 20 cm × 32 cm at a distance of 50–70 cm from the participant in both cultural contexts. To calibrate the eye-tracker, participants made saccades to a grid of nine fixation dots on the screen, and four dots were used to validate the calibration results.

Fixations were exported for further analyses in MATLAB (Version 2013a). The BeGaze software was used to define areas of interest (AOIs) around the focal object of each picture to distinguish the focal object from the background. To quantify participants' visual attention to the object relative to their visual attention to the context, we computed an object score separately for each of the four sets. For each picture, the total duration of all fixations made into the AOI of the object was divided by the duration of all fixations on the picture (object and background area) within the 5 s of stimulus presentation. As a consequence, pictures that were not fixated at all, were not included in the mean score. Based on the object score for each picture, we then calculated the mean object score for each set separately. A score of 1 would mean that the participant only looked at the object, while a score of 0 would indicate that a participant only looked at the background. The lower the mean object score of a participant is, the higher is his or her context sensitivity.

For the culture-specific matched set, where different stimuli were used for the two samples, the average size of the AOIs was slightly larger in the German picture set (M = 15.2%, SD = 8.2) than in the Cameroonian picture set (M = 11.9%, SD = 6.1). Since this trend might lead to an increased object focus, we decided to exclude the five pairs of matched pictures in which the differences in object size between the German and the Cameroonian pictures were largest (i.e., between-set difference in the AOIs of at least 9% of the size of the total picture). This resulted in similar average AOI sizes between the German set (M = 12.4%, SD = 6.9) and the Cameroonian set (M = 11.5%, SD = 6.5), $t(28) = -0.365$, p = 0.718. Thus, the final object score for the culture-specific matched set was based on 15 pictures in each cultural context. For the other sets, the average size of the AOIs was as follows: M = 12.8%, SD = 7.0 for the standard set; M = 6.8%, SD = 1.6 for the non-semantic set; and M = 13.6%, SD = 4.3 for the simple set.

RESULTS

Context-Sensitivity Across Sets and Cultures

To test for the cross-cultural and age differences in attentional style and whether these depend on the familiarity of the stimuli used, the object scores, defined as the relative gaze duration on the focal object, for each set were entered as the dependent variable in separate multiple regression analyses. As independent variables, we included culture (1 = Münster, 0 = Kumbo), age (z-standardized) and, to test whether the effect of age was moderated by culture, the interaction term culture × age.

Standard Set

For the standard set, the regression model was significant, $F(3, 99) = 9.925$, $p < 0.001$, with an adjusted R^2 of 0.208. As depicted in **Figure 2A**, the results indicate that participants from Kumbo had higher object scores than participants in Münster ($\beta = -0.327$, $p < 0.001$). While there was no significant effect of age ($\beta = -0.070$, p = 0.624), there was a marginally significant age × culture interaction ($\beta = -0.270$, p = 0.061), indicating that developmental changes in context sensitivity differed across cultural contexts. Given the fact that moderator effects are generally difficult to detect, we followed the advice of Pedhazur (1997) and interpret interactions when they achieve the 0.10 level of significance. To determine the simple effects of age, this analysis was followed up by a regression analysis with object score as the dependent and age as the independent variable, separate for the two cultural contexts.

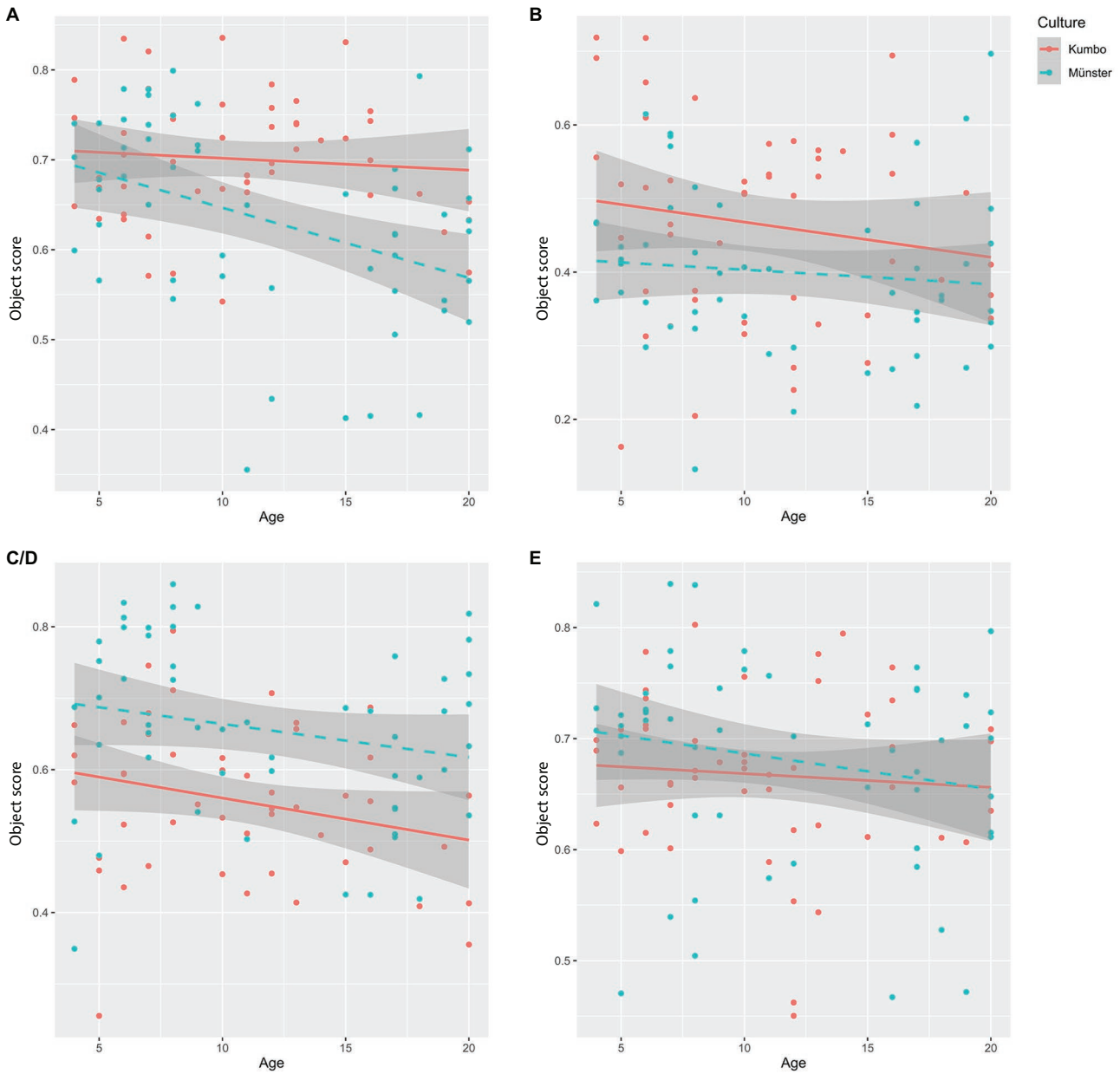

FIGURE 2 | Object scores across culture and age in the **(A)** standard set, **(B)** non-semantic set, **(C/D)** culture-specific matched set, and **(E)** simple set.

While there was a significant regression model in Münster, $F(1, 51) = 10.277$, $p = 0.002$, with an adjusted R^2 of 0.151, in which age was negatively associated with the object scores ($\beta = -0.410$, $p = 0.002$), the regression model was not significant in Kumbo, $F(1, 48) = 0.364$, $p = 0.549$, $R^2_{adj} = -0.013$.

Non-semantic Set

For the non-semantic set, there was a significant regression model, $F(3, 99) = 2.979$, $p = 0.035$, with an adjusted R^2 of 0.055. While culture was a significant predictor ($\beta = -0.240$, $p = 0.015$), neither age ($\beta = -0.192$, $p = 0.222$) nor the interaction term ($\beta = 0.088$, $p = 0.572$) were significantly associated with the object score. As depicted in **Figure 2B**, participants in Kumbo had higher object scores than participants in Münster.

Culture-Specific Matched Set

In the culture-specific matched set, we compared the gaze behavior between participants from Kumbo and Münster on their respective culture-specific set. We found a significant regression model, $F(3, 99) = 8.378$, $p < 0.001$, with an adjusted R^2 of 0.178. There was a positive effect of culture on the object score ($\beta = 0.421$, $p < 0.001$), a marginally significant

age effect (β = −0.241, p = 0.101), but no significant effect of the interaction term (β = 0.039, p = 0.789). In line with our hypotheses, there was a significantly higher object focus in Münster than in Kumbo (see **Figure 2C/D**).

Simple Set

For the simple set, there was no significant regression model, $F(3, 99) = 1.108$, $p = 0.349$, with an adjusted R^2 of 0.003. On a descriptive level, object scores were slightly higher in the Münster sample than in the Kumbo sample (see **Figure 2E**).

Consistency of Attentional Styles Across Set

In order to analyze whether the different sets of stimuli index participants' attentional style more generally, we calculated the internal consistency between the object scores of the four sets. Cronbach's α for age-corrected residuals was α = 0.604 in Münster and α = 0.556 in Kumbo.

DISCUSSION

The present study aimed at investigating how the familiarity of stimuli affects cross-cultural differences in context sensitivity expected along the social orientation hypothesis. For this purpose, participants from Münster in urban Germany and Kumbo in rural Cameroon saw four different sets of stimuli varying in familiarity while their spontaneous gaze behavior was recorded in an eye-tracking paradigm.

Overall, we found support for the differential familiarity hypothesis and partial support for the social orientation hypothesis: When the stimuli were highly familiar for both cultural contexts, we found a significantly higher object score for participants from Münster than for participants from Kumbo. These results are in line with the social orientation hypothesis that predicts higher context sensitivity in interdependent than in independent cultures (Varnum et al., 2010). While this pattern was significant for the culture-specific matched set, there was a descriptive though non-significant trend for the simple set, with a tendency to higher object scores in Münster than in Kumbo. If, however, the stimuli were systematically less familiar to participants of one of the cultures, the pattern of results changed: For the standard and non-semantic sets, we found a higher object score in Kumbo than in Münster.

This finding – which is unexpected based on the social orientation hypothesis alone – is similar to the findings from Köster et al. (2018), based on samples with a broader age range. Taken together, these findings indicate that the cross-cultural differences in context sensitivity are highly sensitive to the stimulus material used. Specifically, if the overall scene is less familiar, more attention is directed to the focal object, which can lead to reversed findings than would be expected based on the cultural orientation of the participants. When looking at visual stimuli of the type used in this study, namely the standard and the non-semantic stimuli, previous studies have shown that the focal object is fixated first (see Chua et al., 2005; Köster and Kärtner, 2018). If the stimulus is unfamiliar, the exploration of the object may take longer and, thus, due to the limited presentation time, less time remains to explore the context. This might explain why participants look at the object for longer if the stimuli are unfamiliar, as we found for the standard and the non-semantic set in Kumbo.

However, this does not explain the findings for the simple set: although the stimuli are familiar in both cultural contexts – according to the expert judgments, somewhat more so for the Kumbo participants – context sensitivity did not differ between cultures. Two explanations are plausible: first, it might be that – due to the fact that the pictures were taken in Kumbo – the depicted backgrounds, but not the objects, were more typical for Kumbo participants, which led the Münster participants to explore the backgrounds more. As a consequence, the two effects (familiarity and social orientation) neutralized each other, leading to similar results on both cultures. Second, as the background is quite simple in this set (e.g., a tabletop) and does not provide much potential for exploration, the saliency of the object compared to the background might have been even higher. Possibly, culture-specific patterns of context sensitivity may only come into effect if stimuli, including the context, are sufficiently complex. Based on these data, the potential explanations cannot be further scrutinized, but both suggest that the cross-cultural differences in context sensitivity are highly susceptible to the stimulus material used.

Furthermore, we expected age-related changes in attentional styles, namely that context sensitivity would increase with age (Imada et al., 2013). While there was no significant age effect for the simple set and only descriptive trends for the non-semantic and the culture-specific matched set, there was a culture-specific pattern for the standard set. More specifically, context sensitivity increased for the Münster sample but remained at the same level across ages for the Kumbo sample. It is conceivable that the unequal familiarity of the standard set might have influenced the results in the sense that we found the expected age change in Münster, where participants were relatively familiar with the stimuli, while in Kumbo, the unfamiliarity of the presented stimuli might have led to an increased interest in the object across all age groups. Consistent with other studies, the descriptive results consistently hint at an increase in context sensitivity with age. While the *a priori* power analysis (f^2 = 0.15, α = 0.05, β = 0.80) indicated a minimum sample size of N = 77 to detect medium effects of age in the regression analysis, the potential effects seem to be rather small. While our focus was on testing for linear age effects across a broader age range, larger sample sizes are advisable, especially, when interested in contrasting specific age groups around age of emergence.

Finally, we explored whether perceptual styles are consistent across the different stimulus sets. The internal consistencies of the gaze behavior across sets show that all four sets capture similar aspects of participants' attention. While there was no correlation between the context sensitivity measured with different tasks (i.e., eye-tracking, picture description, and optical illusion) in the study by Köster et al. (2018), the results of this study indicate that the four sets capture a sufficiently similar concept.

It should be noted that it would have been of additional interest to run a fully-balanced design with both groups of

participants observing the stimuli of their own and the other culture (i.e., both culture-specific sets). By doing so, it would have been possible to compare the participants' gaze behavior when looking at the respective unfamiliar set to further back up our results. However, here our main focus was to compare the culture-specific matched set, that is highly familiar in a given culture, to a standard set of stimuli used in other studies analyzing the development of cross-cultural differences in attentional styles, which allows important conclusions about the validity of earlier findings and the influence that stimulus familiarity might have on spontaneous visual attention. A further limitation concerns the unequal AOI sizes of the different sets: When inspecting the absolute object scores across sets, it is important to keep in mind that these cannot be compared directly, but the different AOI sizes between sets may have influenced the respective absolute object scores (e.g., object scores were smallest in the non-semantic set, which also had the smallest AOIs). Having said this, the rationale of this study remains unaffected since the question whether the familiarity of the stimuli affects gaze behavior is addressed by analyzing whether the cross-cultural differences vary by stimulus familiarity.

Taken together, these findings provide considerable potential for further research as they highlight the importance of the stimulus materials and tasks used to assess the concept of context sensitivity across different cultural contexts. For future research, it would be advisable to carefully develop appropriate stimuli reflecting the actual lifeworld of participants from different cultural contexts. In this respect, it should be taken into account that the overall scene of a stimulus, including object and background, is equally familiar across the cultures being compared. In most of the previous studies on analytic and holistic visual attention (e.g., Chua et al. 2005), this issue has not been addressed in detail. In their study, Masuda and Nisbett (2001) expressed the concern that the higher familiarity of the underwater stimuli in Japan compared to the US might have affected the results. However, when adapting stimuli categories in a second study that used wildlife stimuli instead (considered to be more familiar in the US), they replicated their results in a recognition task and did not find any influence of stimulus familiarity. One reason might be that these studies are mainly conducted in urban, industrialized contexts in the Western and East-Asian hemisphere, where differences might be less obvious; this issue might become more apparent when comparing rural and urban contexts (see Caparos et al., 2012). However, to extend findings on cultural differences in analytic and holistic perceptional styles and the underlying mechanisms, it is particularly important to investigate more diverse cultural contexts, and, in this respect, to carefully develop the stimuli used in order to conduct studies in a culturally sensitive and fair way.

Furthermore, in this study we only considered the effect of stimulus familiarity on spontaneous gaze behavior. It remains an open question how stimulus familiarity affects other tasks capturing attentional styles. For example, Senzaki et al. (2014) demonstrated that cultural differences in context sensitivity become especially pronounced when participants are asked to verbally describe visual scenes. Thus, it would be interesting to investigate how the presentation of differently familiar pictures is reflected in the verbal descriptions of participants from different cultural contexts.

This study has shown that stimulus familiarity is a central aspect to take into account when investigating cross-cultural differences in context sensitivity. Specifically, stimulus familiarity should be taken into account when analyzing other aspects that influence perceptual patterns in order to understand the mechanisms behind cross-cultural differences, such as cultural socialization practices. For example, Köster and Kärtner (2018) proposed that perceptual styles are socialized via a verbal route in parent-child interactions during the preschool years. This supports the widely shared assumption that attentional styles are socially transmitted (Masuda and Nisbett, 2001; Senzaki et al., 2016; Masuda, 2017), but specific cross-cultural evidence for this proposal is still missing. In this context, the present results have important implications for the compilation of stimuli in future studies, which are set out to test cross-cultural differences in visual attention.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical approval was not provided for this study on human participants because all details of the ethical guidelines have been followed. This research was conducted in accordance with the Declaration of Helsinki and the Ethical Principles of the German Psychological Society (DGPs), the Association of German Professional Psychologists (BDP), and the American Psychological Association (APA). It involved no invasive or otherwise ethically problematic techniques and no deception and therefore, according to National jurisdiction, does not require a separate vote by a local Institutional Review Board; see the regulations on freedom of research in the German Constitution [§ 5 (3)], and the German University Law (§ 22). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JK and MK designed the study and the stimuli. MK and RY recruited the sample and conducted the study. SJ analyzed the data. SJ, JK, and MK wrote the manuscript. JK supervised the research. All authors contributed to the article and approved the submitted version.

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The Development of Context-Sensitive Attention in Urban and Rural Brazil

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Human perception differs profoundly between individuals from different cultures. In the present study, we investigated the development of context-sensitive attention (the relative focus on context elements of a visual scene) in a large sample (N = 297) of 5- to 15-year-olds and young adults from rural and urban Brazil, namely from agricultural villages in the Amazon region and the city of São Paulo. We applied several visual tasks which assess context-sensitive attention, including an optical illusion, a picture description, a picture recognition and a facial emotion judgment task. The results revealed that children and adults from the urban sample had a higher level of context-sensitive attention, when compared to children and adults from the rural sample. In particular, participants from São Paulo were more easily deceived by the context elements in an optical illusion task and remembered more context elements in a recognition task than participants from rural Amazon villages. In these two tasks, context-sensitivity increased with age. However, we did not find a cultural difference in the picture description and the facial emotion judgment task. These findings support the idea that visual information processing is highly dependent on the culture-specific learning environments from very early in development. Specifically, they are more consistent with accounts that emphasize the role of the visual environment, than with the social orientation account. However, they also highlight that further research is needed to disentangle the diverse factors that may influence the early development of visual attention, which underlie culture-specific developmental pathways.

Keywords: holistic and analytic perception, context-sensitivity, development of visual attention, cognitive development, cross-cultural comparison, urban versus rural context

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INTRODUCTION

Over the past decades it has been established that human perception differs markedly between cultures. In their seminal work, Masuda and Nisbett (2001) investigated how North American and East Asian participants differ in their perception of visual scenes and have described two prototypical perception styles, North Americans being more analytic, primarily focusing on focal

objects of a scene, and East Asians being more holistic, showing a higher sensitivity for context elements of a visual scene (also defined as low versus high context-sensitivity).

These differences in visual perception have been documented in a number of studies and across several experimental paradigms. In particular, Masuda and Nisbett (2001) found that US-Americans tended to report a focal fish swimming in an aquarium, while Japanese participants described and remembered more details from the background, including plants and smaller animals in an aquarium scene. Furthermore, Doherty et al. (2008) found that Japanese participants are more easily deceived by context elements in optical Ebbinghaus illusions, namely when adjusting a focal element within a deceptive context, in contrast to participants from the United Kingdom. Regarding the perception of social stimuli, Masuda et al. (2008) found that Japanese participants were influenced by context information to a higher degree than North Americans: In a facial emotion judgment task participants were asked to judge the emotion of a person presented in the center of a social scene, surrounded by people with the same or a different emotion. Participants from Japan adjusted their judgment of the emotion of the focal person more strongly to the emotions of the people in the background, when compared to participants from the United States. These studies have shown consistent cross-cultural differences in visual perception, with a higher context-sensitive attention in participants from Eastern compared to Western cultural groups.

This raises the critical question, when and how cultural differences in visual perception develop. It has been suggested that the social construction of attention plays a central role in the ontogeny of different perception styles (Masuda and Nisbett, 2001; Nisbett and Masuda, 2003), such as the way close others guide the attention early in development (Senzaki et al., 2016; Köster and Kärtner, 2018). Focusing on cultural models more generally, the social orientation hypothesis (Varnum et al., 2010) posits that holistic perception is associated with an interdependent cultural model, with an emphasis on the individual as a part of their social group. In contrast, an analytic perception style is associated with an independent cultural model, with an emphasis on an individual's autonomy (Markus and Kitayama, 1991). This is consistent with findings from classical comparisons of visual perception between the United States (being a prototypical independent culture) and East Asian cultural groups (being a prototypical interdependent culture), as reported above. However, another theoretical account, the visual environment hypothesis, emphasizes that the visual and physical environment differs between North American and East Asian cities (Miyamoto et al., 2006; Morling and Lamoreaux, 2008). For example, urban environments in East Asian cities are visually more complex and therefore afford higher levels of context-sensitivity (Miyamoto et al., 2006). These differences in the physical environment may likewise influence the development of visual perception between those cultural groups.

Concerning its early development, Imada et al. (2013) describe that context-sensitive attention develops in the early school years. In their study, 6- to 7-year-olds from Kyoto, Japan, showed significantly higher levels of context-sensitive attention than children of the same age from Minneapolis, United States, in an overall score, which was the aggregated result of a picture description task and an Ebbinghaus illusion. This difference between the two cultural groups increased with age, throughout the early school years. However, in the picture description task, cross-cultural differences were already present in 4- to 5-year-olds when analyzing children's references to context elements versus focal elements. Studies testing other aspects of visual cognition provided evidence that cultural differences may emerge even earlier (Kuwabara and Smith, 2012, 2016).

In recent developmental studies on cross-cultural differences in context-sensitive attention, a specific focus lied on the comparison between participants from rural and urban environments (Bremner et al., 2016; Jurkat et al., 2020; Köster et al., 2018). Bremner et al. (2016) reported that children from a traditional Himba society in rural Namibia showed significantly less deception in an Ebbinghaus illusion task than did children growing up in the nearest urban settlement in Namibia or children growing up in urban United Kingdom. In another study, Köster et al. (2018) applied an Ebbinghaus illusion task with 5-year-olds from three different cultural groups (urban Germany, rural Cameroon, urban Japan) and found significantly less deception in an optical illusion task for children from rural Cameroon than for the two urban samples. The same study also found a higher object focus in the rural sample from Cameroon in an eye-tracking paradigm. However, there were no differences between children from an independent culture (Germany) versus children from an interdependent culture (Japan) in these tasks, at this age. These studies provide first evidence that context-sensitive attention, as measured with classical paradigms, may be higher in children from urban compared to rural samples, and closely resemble the results of much earlier studies conducted with adult participants (Segall et al., 1966; Jahoda and Stacey, 1970).

Studies that compare urban versus rural environments are a critical extension to the contrast between participants from Eastern and Western samples. Specifically, the differences reported in the studies above can less well be interpreted within the social orientation explanatory framework, because individuals from rural environments are commonly described as being socially more closely oriented toward each other than in urban environments (Greenfield et al., 2003; Kagitcibasi, 2005; Keller, 2007). They are, on the other hand, compatible with a visual environment hypothesis, because it is likely that urban contexts are more complex than rural environments in terms of physical and social affordances (Miyamoto et al., 2006; Morling and Lamoreaux, 2008; Linnell and Caparos, 2019). Note that theoretical accounts on cultural variation in human development have long emphasized the role of differences in the physical and social affordances between urban and rural settings (Greenfield et al., 2003; Keller, 2007). However, to date, this line of research has mainly focused on rural settings on the African continent, in contrast to urban samples in the United States and European countries. It is thus a critical question, and may further inform the different accounts on the development of visual perception styles, if the differences between urban versus rural cultural

environments would generalize to participants from further urban and rural environments.

Toward this end, in the present study, we provide data for an urban and a rural environment in Brazil, two populations which, to our knowledge, have not yet been investigated in terms of the development of visual perception styles. Specifically, we compare the development of context-sensitive attention between urban São Paulo and rural subsistence-based villages in the Brazilian Amazon region near Belém, in a variety of experimental tasks. We know from former studies that these urban and rural environments within Brazil differ not only in terms of their social and ecological (i.e., environmental) structure, but also in their cultural orientation (Seidl-de-Moura et al., 2008; Köster et al., 2016). Namely, participants from urban Brazil typically emphasize an autonomous development (i.e., independence), while participants in rural Brazil emphasize a relational cultural model (i.e., being conceptually closer to an interdependent cultural model). In order to characterize differences in context-sensitivity and their ontogenetic development, we collected the data from a large number of children between 5 and 15 years of age and, in addition, of adults between 20 and 30 years of age, to estimate the developmental end points. We applied a set of tasks, which had already been successfully used in studies investigating the development of visual perception styles (Masuda et al., 2008; Köster et al., 2017, 2018). We used a picture description task, an Ebbinghaus illusion task, a picture recognition task, and a task focusing on the judgment of facial emotions. We chose those four paradigms, because all of them have formerly been applied in studies comparing context-sensitive perception between cultural groups. While the social orientation hypothesis would predict higher context-sensitivity in the rural villages in the Amazon region, according to the visual environment hypothesis, one may expect higher degrees of context-sensitivity for the sample from São Paulo. Furthermore, we hypothesized that cross-cultural differences would develop throughout the school years in the sample of children, and to be specifically pronounced in the adult sample.

MATERIALS AND METHODS

Participants

The final sample consisted of 297 participants. We assessed 131 children between 5 and 15 years of age (M = 10;10, SD = 3;18, 49% females) and 32 adults between 20 and 30 years of age (M = 24;25, SD = 3;64, 69% females) in rural agricultural villages in the municipality of Castanhal in the state of Pará in northern Brazil. Three additional adults were excluded from analysis because they grew up in nearby urban settlements. Furthermore, we assessed 103 children (M = 9;42, SD = 2;87, 54% females) and 31 adults (M = 23;52, SD = 3;08, 52% females) from capital São Paulo (metropolis in southern Brazil). Two additional children in São Paulo participated but were excluded from analysis because their parents reported that they were from a rural region in São Paulo state (n = 1) or adopted (n = 1). One adult did not specify their age. It was estimated by substituting with the sample mean. Not all participants completed the full set of tasks. Thus, analyses for each task are based on the subset of participants that completed a specific task. For all analyses, the samples were split into four age groups, 5- to 7-year-olds, 8- to 11-year-olds, 12- to 15-year-olds, with the fourth age group comprised of adults between 20 and 30 years of age. This strategy allows for more specific conclusions and interpretations of differences between relevant age groups (see Imada et al., 2013, for a similar approach), because we did not necessarily expect linear developmental trajectories of context-sensitivity. In the rural sample, the number of children in each age group was 34 in the group of 5- to 7-year-olds, 48 in the group of 8- to 11-year-olds and 49 in the group of 12- to 15-year-olds. In the urban sample the distribution was 28 in the group of 5- to 7-year-olds, 47 in the group of 8- to 11-year-olds and 28 in the group of 12- to 15-year-olds.

The recruitment in rural Brazil was done in cooperation with local healthcare centers and testing was conducted in schools or in families' homes. In São Paulo children were recruited and assessed in *Parque Villalobos*, a spacious urban park located in a neighborhood primarily inhabited by middle class and upper-middle class families. However, the park is also commonly visited by families from different parts of the city and its outskirts, making the sample more heterogenous in terms of socio-economic status. Adults from São Paulo were recruited and participated on the University of São Paulo campus and were mostly students.

Each adult participant and each parent of the underaged participants gave their informed written consent before participating in the study. Furthermore, we obtained informed assent from each child prior to testing.

Stimuli and Procedure

The experiment included four different visual attention tasks, an optical illusion task, a picture description task, a picture recognition task, and a task involving judgment of facial emotions. Tasks were presented in this order (fixed) to avoid different carry-over effects between participants.

For the rural sample, all testing was done by the first author, fluent in Portuguese. In São Paulo about half of the child sample was assessed by the first author while the other half, as well as the adult sample was conducted by a local research assistant. Stimuli presentation and data recording were conducted on laptop computers, using a customized offline version of Labvanced (Finger et al., 2017). Stimuli were presented on a 15.6″ screen or a 14″ screen, but with the same absolute presentation size of stimuli on both screens. The distance between participants and the monitor was kept constant, at around 50 cm.

Optical Illusion Task

Participants were presented with two variants of the Ebbinghaus illusion (Köster et al., 2018 for the use of a similar set of tasks). The participant was asked to adjust the size of a red-colored target shape, which was indicated by a black arrow, until it matched the size of a reference shape which was also colored in red. Both shapes were surrounded by deceiving context elements colored in gray (see **Figure 1A**). Shapes were adjusted via two keys on a keyboard. Both versions of the illusion were presented in

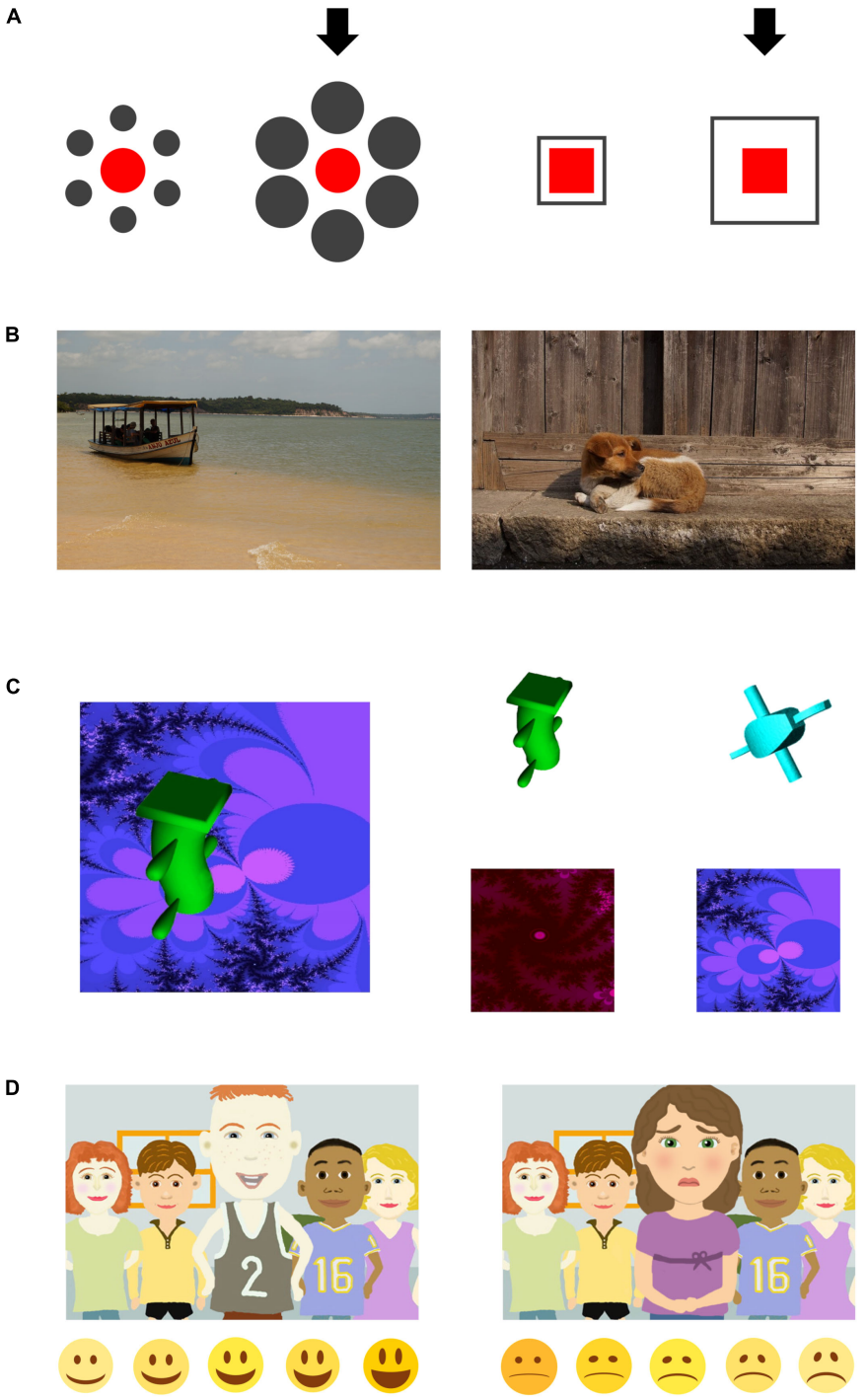

FIGURE 1 | Example stimuli for the applied tasks. **(A)** Optical illusion task. The arrows in the two different types of illusion trials indicate the side on which the red target element was adjusted by the participants. **(B)** Picture description. Subjects were asked to verbally describe images depicting either animals or means of transport. **(C)** Recognition task. The left panel shows an exemplary stimulus presented during the first phase. The panels on the right show the two-alternative-forced-choice options for object (top) and background (bottom) presented during the second phase. **(D)** Judgment of facial emotions. Participants saw stimuli with happy (left) or sad (right) focal persons. After each stimulus, a corresponding emoticon-scale was presented (bottom).

two variations, with the target element being surrounded either by the smaller context elements or the larger context elements. These variations were then displayed with the target element on either side of the screen. Thus, the resulting number of trials was 4 for each version and a total of eight trials, presented in a fixed order.

Participants were instructed to not attend to the context, but only to the red elements, to avoid a relative interpretation of the task instruction. Before being presented with the actual illusion trials, participants completed four warm-up trials introducing the task with the same instruction (to adjust the size of the target element until it matches the reference element), but without the presence of gray context elements. These warm-up trials were also used as a measure for the accuracy of the participants' size adjustments.

We summarized the results into a single context-sensitivity score for each participant, namely the mean deception over all trials of each version of the Ebbinghaus illusion. Specifically, the mean deception was computed by subtracting the mean deviation between target and reference element in illusion trials with context elements (in percent) from the mean deviation in trials without context elements (in percent). In other words, the context-sensitivity score reflects the difference between the adjusted element and the red reference element in percent, corrected for the participants' accuracy. Higher scores on this measure indicate a higher context-sensitivity.

Participants, whose mean degrees of deception in trials without context stimuli were higher than 10% or deviated by more than 3*SD* from the mean of the participants' respective age group, were excluded from analysis due to insufficient accuracy. We excluded $n = 3$ children from the youngest age group in São Paulo and $n = 1$ adult from São Paulo.

Picture Description Task

Participants were shown eight photographs containing a focal object (animals and means of transport) in front of a background (e.g., natural scenes or buildings), see **Figure 1B**. Pictures were selected in consultation with local researchers and based on our experiences with previous adoptions of this paradigm, ensuring that participants from both cultural groups would be familiar with the presented stimuli. Participants were instructed to describe what they saw on the pictures ("Please describe to me what's in the pictures") to the experimenter, who was sitting on the other side of the screen, allegedly not knowing the pictures himself. Each picture was presented for 15 s.

The descriptions were audio recorded and later coded for the number of references to the focal object and its features (e.g., boat, has people on it) and the background and its features (e.g., the sky, it's blue), using (MAXQDA, 2019). In order to quantify participants' context-sensitivity in verbal descriptions, we computed a context-sensitivity score: All references to the background and its features were divided by the sum of all references to the object and the background, including features. Thus, a score of 1 would indicate that a participant only talked about the background, while a score of 0 would indicate that a participant only referred to the object. Inter-rater agreements for 18% of the data were sufficiently high (rural sample: $\kappa_{object} = 0.81$, $\kappa_{background} = 0.76$; urban sample: $\kappa_{object} = 0.82$, $\kappa_{background} = 0.81$). Cohen's kappas were calculated using the Brennan and Prediger method (Brennan and Prediger, 1981). The timestamps for corresponding codes had to overlap at least 33% to be considered congruent between coders.

Participants who misunderstood the task or whose context-sensitivity score deviated by more than 3*SD* from the mean of the participants' respective age group, were excluded from analysis. For the rural sample we excluded $n = 1$ children from the youngest age group, $n = 2$ children from the 8- to 11-year-old age group, $n = 3$ children from the 12- to 15-year-old age group, and $n = 1$ adult. For the urban sample we excluded $n = 2$ children from the 8- to 11-year-old age group.

Picture Recognition Task

Participants were shown a set of 16 abstract images, each presented for 3 s. Stimuli consisted of fractal pictures (created with Quadrium, 2009) as backgrounds, and abstract, non-semantic objects retrieved from an online database as salient focal objects (see **Figure 1C**). Similar stimuli have been adopted in a previous study by Köster et al. (2018). We chose abstract, non-semantic stimuli in order to avoid possible confounding effects caused by semantic stimuli. Subjects were instructed to look at the pictures attentively because the experimenter would later "ask a few questions about these pictures." Stimuli were presented in a fixed order.

In a subsequent retrieval phase, participants were shown stimuli pairs of either focal objects or backgrounds. Each pair consisted of a previously presented focal object/background and either an entirely new object/background or a modified version of the same object/background serving as a distractor. For each pair, the participants were instructed to select the object or background they had seen during the presentation phase, in a two-alternative-forced-choice paradigm. The stimuli pairs were presented in a fixed order, according to the prior presentation phase. Stimuli were modified using (GNU, 2012).

The context-sensitivity measure for the picture recognition task was computed by dividing the number of correctly recognized background stimuli by the total number of correctly recognized stimuli (objects + backgrounds), with a higher score indicating higher context-sensitivity. As a control measure, we analyzed overall recognition performance of the subjects and determined a higher than chance (>50%) rate recognition of target stimuli as the threshold for sufficient memory performance which would qualify the participant's data to be further analyzed. Prior to analysis we excluded seven children (rural sample: $n = 3$ from the youngest age group and $n = 1$ out of the 8- to 11-year-olds; urban sample: $n = 3$ from the youngest age group) because they failed to recognize the presented stimuli above chance (>50%).

Judgment of Facial Emotions

In the facial emotion judgment task, participants saw 24 social stimuli containing a group of five cartoon-style people expressing sadness or happiness (see **Figure 1D**). One salient person stood in the foreground while four others stood in the background. Each stimulus was presented for 5 s and then followed by a screen showing five emoticons depicting either sadness or happiness (depending on the emotion of the central person on the previous picture), at five different levels of intensity (see **Figure 1D**). Participants were instructed to "tell (the experimenter) how the

person in the middle is feeling" by pointing at or clicking on the emoticon which best described the figure's emotion.

Emotions were either congruent or incongruent between the focal person and the background persons. This is, they either showed the same emotion or the oppositional emotion. The social stimuli came from a study by Masuda et al. (2008). For the purpose of this study we selected the stimuli which matched Brazilian ethnicities best, not using the entire stimuli pool. The emoticon-scale was created using Microsoft PowerPoint. We developed it with the youngest participants in mind and with having in mind that in rural Brazil responding to finely graded numerical scales is very uncommon also for older children and adolescents, based on a former study the research group conducted in the same region (Köster et al., 2016).

Following the hypothesis and results of Masuda et al. (2008), congruence between the background figures' emotion and the central figure's emotion should lead to this emotion being perceived more intensely and thus receiving ratings of higher intensity, more so in individuals with higher context-sensitive attention. Context-sensitivity measures for this task were computed by calculating sum scores for each of the four different levels: (a) happy and congruent background, (b) happy and incongruent background, (c) sad and congruent background, (d) sad and incongruent background. We calculated two distinct measures of context-sensitivity for the happy and the sad focal faces by subtracting the incongruent sum scores from the congruent sum scores. Higher measures index higher context-sensitivity.

Prior to the analysis we excluded $n = 12$ subjects because they either had obvious difficulties understanding the task or almost exclusively chose the highest degree of intensity on the emoticon scales in their answers. Ten of the excluded subjects were children from the rural sample ($n = 5$ out of the youngest age group, $n = 4$ out of the 8- to 11-year-old age group and $n = 1$ out of the 12- to 15-year-old age group) and $n = 2$ were children from São Paulo ($n = 1$ out of the youngest age group and $n = 1$ out of the 8- to 11-year-old age group). Explorative analyses of the four sum scores revealed no extreme outliers deviating $>3SD$ from the mean of the participants' respective age group, such that there were no further exclusions.

RESULTS

Optical Illusion Task

For the participants' deception in the illusion task, we conducted a 4 (age group) × 2 (cultural group) ANOVA. This revealed significant main effects for age group, $F(3,285) = 4.816$, $p = 0.003$, $\eta^2 = 0.048$, and cultural group, $F(1,285) = 8.185$, $p = 0.005$, $\eta^2 = 0.028$, but no interaction between age group and cultural group, $F(3,285) = 0.705$, $p = 0.550$, see **Figure 2A**. Across cultures, the mean deception was lowest in the group of 5- to 7-year-olds

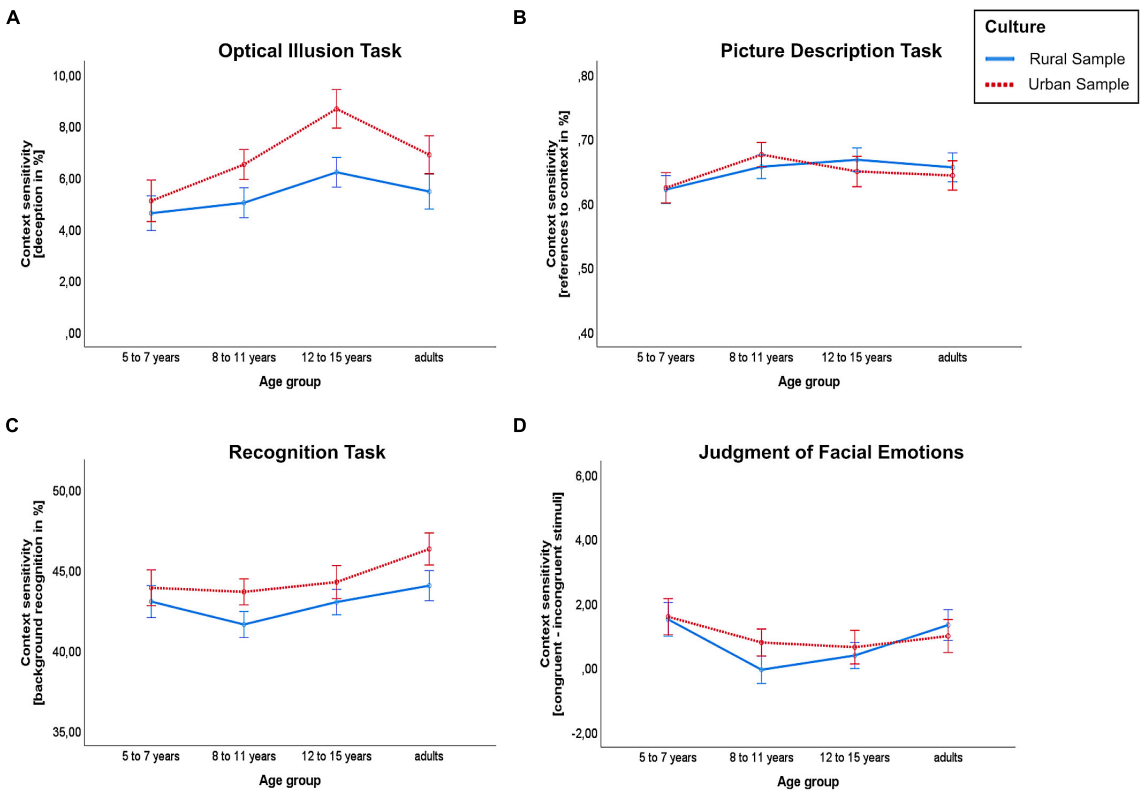

FIGURE 2 | Context-sensitivity scores by culture and age group for **(A)** the Ebbinghaus illusion, **(B)** the picture description, **(C)** the recognition task and **(D)** the judgment of facial emotions (happy stimuli set). Higher values indicate higher context-sensitivity. Whiskers depict one standard error of the mean.

(M = 4.9%) and increased with age throughout the children and adolescent sample: 8- to 11-year-olds (M = 5.7%), 12- to 15-year-olds (M = 7.5%). However, the mean was descriptively lower in the adult group than in the group of 12- to 15-year-olds (M = 6.3%). Bonferroni corrected pairwise comparisons revealed significant differences between 5- to 7-year-olds and 12- to 15-year-olds (−2.602, 95%-CI[−4.511, −0.694], p = 0.002) and between 8- to 11-year-olds and 12- to 15-year-olds (−1.759, 95%-CI[−3.447, −0.071], p = 0.036).

Picture Description Task

A 4 (age group) × 2 (cultural group) ANOVA revealed no significant main effect for age group, $F(3,277) = 1.602$, $p = 0.189$, or cultural group, $F(1,277) = 0.029$, $p = 0.864$. Furthermore, the interaction effect between age group and cultural group was non-significant, $F(3,277) = 0.435$, $p = 0.728$, see **Figure 2B**.

When comparing the volume (the total number of references), we found a main effect for age group, $F(3,277) = 24.202$, $p < 0.001$, $\eta^2 = 0.208$, and cultural group, $F(1,277) = 34.948$, $p < 0.001$, $\eta^2 = 0.112$, and an interaction between age group and cultural group, $F(3,277) = 4.704$, $p = 0.003$, $\eta^2 = 0.048$. Specifically, the volume increased with age and this increase was higher in the urban sample compared to the rural villages. The mean volumes in the rural sample were as follows: M = 31.3 in the group of 5- to 7-year-olds, M = 33 in the group of 8- to 11-year-olds, M = 36 in the group of 12- to 15-year-olds and M = 42 in the adult group. In contrast, the mean volumes in the urban sample were M = 32.7 in the group of 5- to 7-year-olds, M = 40.7 in the group of 8- to 11-year-olds, M = 46 in the group of 12- to 15-year-olds and M = 61.3 in the adult group.

Recognition Task

For participants' recognition of background versus object elements, we found a significant main effect for age group, $F(3,279) = 3.175$, $p = 0.025$, $\eta^2 = 0.033$, and cultural group, $F(1,279) = 4.438$, $p = 0.036$, $\eta^2 = 0.016$, but no interaction between age group and cultural group, $F(3,279) = 0.213$, $p = 0.888$, see **Figure 2C**. Across cultures, the mean context-sensitivity score was descriptively lower in the group of 8- to 11-year-olds (M = 42.6%) than in the youngest age group (M = 43.6%) and in the group of 12- to 15-year-olds (M = 43.5%), while it was descriptively highest in the adults group (M = 45.4%), see **Figure 2C**. A Bonferroni corrected pairwise comparison revealed a significant difference between 8- to 11-year-olds and adults (−2.792, 95%-CI [−5.197, −0.388], p = 0.013).

Judgment of Facial Emotions

The context-sensitivity measures for the sad stimuli set and for the happy stimuli set did not correlate significantly (r = −0.015, n = 279, p = 0.807). Hence, we analyzed them separately. Exemplarily, we plotted the results for the happy stimuli set (see **Figure 2D**). A corresponding graph, depicting the ANOVA results for the sad stimuli set, is provided in the **Supplementary Material.**

For the sad stimuli, we found no significant main effect for age group, $F(3,271) = 1.028$, $p = 0.38$, or cultural group, $F(1,271) = 0.164$, $p = 0.686$. The interaction between age group and cultural group was also non-significant, $F(3,271) = 0.094$, $p = 0.963$.

However, for the happy stimuli, the ANOVA revealed a significant main effect for age group, $F(3,271) = 2.852$, $p = 0.038$, $\eta^2 = 0.031$. The main effect for cultural group was non-significant, $F(1,271) = 0.191$, $p = 0.662$, as was the interaction between age group and cultural group, $F(3,271) = 0.529$, $p = 0.663$, see **Figure 2D**.

Across cultures, the mean context-sensitivity score for the happy stimuli set was descriptively lower in the group of 8- to 11-year-olds (M = 0.33) and in the group of 12- to 15-year-olds (M = 0.46) than in the youngest age group (M = 1.56) and in the group of adults (M = 1.21). Bonferroni corrected pairwise comparisons revealed no significant differences between age groups.

TABLE 1 | Correlations between task measures split by sample. Measures for the two scales in the judgment of facial emotions task are reported separately.

Context sensitivity score	1.	2.	3.	4.
Rural sample				
1. Optical illusion				
2. Picture description	0.02			
3. Picture recognition	0.02	0.11		
4. Emotion judgment (happy scale)	0.08	−0.05	0.15	
5. Emotion judgment (sad scale)	0.06	0.06	−0.08	−0.01
Urban sample				
1. Optical illusion				
2. Picture description	−0.09			
3. Picture recognition	−0.05	0.08		
4. Emotion judgment (happy scale)	−0.18*	0.06	−0.12	
5. Emotion judgment (sad scale)	0.12	0.17	0.19*	−0.02

*The table displays Pearson's correlation coefficients, corrected for age (partial r). *p < 0.05, uncorrected.*

Correlations Between Task Measures

We calculated partial correlations between the task measures for each cultural group, controlling for participants' age. All correlations were based on the maximum number of observations available for both measures. Only 2 out of 20 correlations reached $p < 0.05$ (uncorrected), see **Table 1**. The reported correlations are uncorrected and serve illustration purposes.

Comparisons Between Cultures Split by Age Group

Note that the non-significant interactions did not call for subsidiary t-tests, split by age groups. However, these tests are provided for each task in the **Supplementary Material.**

DISCUSSION

Overall, the results of the present study revealed that children and adults from urban São Paulo showed a higher level of context-sensitivity compared to participants from rural villages in the Brazilian Amazon region. Namely, we found that children and adults from São Paulo were more easily deceived by context elements in the optical illusion task

and remembered more context elements in the recognition task, when compared to children and adults from the rural villages. Across both tasks, context-sensitivity increased with age. However, we did not find a cultural difference in the picture description and the facial emotion judgment tasks. There were no consistent correlations between the different tasks, which is consonant with findings on similar tasks in studies contrasting adult participants from East Asia and the United States (Na et al., 2010) and children from rural and urban environments (Köster et al., 2018).

The results of the optical illusion and recognition tasks resemble former developmental studies that compared differences in perception styles between urban and rural environments (Bremner et al., 2016; Köster et al., 2018). While this former research focused on samples from rural environments on the African continent and urban samples in the United States or Europe, the present study extends these findings to the South American continent. Thus, the present findings further support theoretical frameworks that emphasize the relevance of the visual environment for cultural differences in perception styles (Miyamoto et al., 2006; Morling and Lamoreaux, 2008). Like former studies, these findings do not suggest that the social orientation hypothesis (Varnum et al., 2010) generalizes to cultural contrast beyond the comparison between East Asian and United States populations (cf. Jurkat et al., 2020).

Several ideas have been put forward to explain these differences in context-sensitivity between rural and urban environments. An initial proposal mainly focused on cultural differences in optical illusions in adult participants, emphasizing that individuals in urban environments are exposed to more "carpentered-corners", which make spatial perception more reliant on geometrical shapes, and may thus lead to a higher degree of deception in optical illusion tasks (Segall et al., 1966; Jahoda and Stacey, 1970; Henrich et al., 2010). However, it is not clear how this explanation accounts for memory effects of elements of visual scenes in the present study or cultural differences in picture descriptions found in a former study (Köster et al., 2018). Therefore it is critical to look at further differences between urban and rural environments that could possibly explain cross-cultural differences in the development of perception styles (Miyamoto et al., 2006; Morling and Lamoreaux, 2008). From a general viewpoint, visually and physically more complex environments may afford higher levels of context-sensitivity (Miyamoto et al., 2006). In a more specific account, it has been argued that diverse factors in urban environments lead to a more explorative information processing and higher levels of context-sensitivity, opposed to a more task-focused perception style in rural samples (Linnell et al., 2013; Linnell and Caparos, 2019). This line of research suggests that this effect is mediated by stress factors related to urban living (Lederbogen et al., 2011) leading to an increased neurophysiological activation linked to arousal processes and attentional states (Linnell and Caparos, 2019).

Another, more methodologically oriented, explanatory account is that participants from urban environments are generally more familiar with the visual stimuli in the commonly applied tasks (Jurkat et al., 2020; Köster et al., 2018) which allows them to process stimuli more efficiently, first the object, and then the context information. In accordance with this proposal, it has recently been shown that context-sensitive attention measures depend on the type of stimuli used, and that results may look different, tilted more toward the social orientation hypothesis, when stimuli are more carefully adjusted to the specific environment they are tested in Jurkat et al. (2020). Possibly, this may explain why we did not find a difference in context-sensitive attention in the picture description task in the present study, where we explicitly used pictures that were familiar to participants from both urban and rural Brazil.

Other than expected, in the optical illusion and the recognition task, we did not find a differential development between the two cultural groups. That is, although the cultural difference is descriptively less pronounced in the youngest age group (5- to 7-year-olds), the analyses did not reveal significant interaction effects between culture and age. This is in line with former studies contrasting rural and urban populations (Bremner et al., 2016; Köster et al., 2018) in the sense that cultural differences in perception between urban and rural environments were present earlier, compared to studies that investigated cultural differences in perception along the independent versus interdependent dimension (Imada et al., 2013). Thus, rural versus urban differences in visual perceptual development may follow a different developmental trajectory than the East-West contrast and, in consequence, may potentially rely on different developmental processes. Furthermore, we neither found a cross-cultural difference in context-sensitivity in the picture description, nor in the facial emotion judgment task. Noteworthy, in the picture description task, participants from São Paulo were verbally more fluent – i.e., the total number of references was larger in this sample – and this difference emerged with age, two effects which both may have affected the present results. For the facial emotion judgment task, it remains unclear whether it captures the same aspects of context-sensitivity as measured in the more perceptually based tasks. Alternatively, the differences found between Westerners and East Asians may indeed rely on more socially constructed differences in cognition, associated with independence and interdependence (Masuda et al., 2008).

Overall, we found a differential pattern of results between tasks and also no consistent evidence for a correlation between tasks, which corresponds to the findings of former studies (Na et al., 2010; Köster et al., 2018). Thus, cross-cultural differences in visual attention are highly task- and stimulus-dependent (see also Jurkat et al., 2020; Köster et al., 2018) and their early development seems to be more complex than previously assumed. In particular, both environmental affordances and social orientation may contribute, each in their own ways, to different aspects of children's perceptual development. It may thus be critical for future research in developmental science, to take into account different attention systems (Posner and Petersen, 1990; Raz and Buhle, 2006) and to identify different developmental processes that shape different facets of human visual attention across

cultures (Köster and Kärtner, 2019). For instance, it is important to better understand early visual experiences children are exposed to in different cultures (Miyamoto et al., 2006; see also Kuwabara et al., 2020), but also specific social interaction experiences, which may lead to different developmental pathways (Keller and Kärtner, 2013). For example, the way close others structure children's visual attention in early development and thereby adjust their attentional focus to different elements of the physical and social environment (Köster and Kärtner, 2018; Rogoff, 2003). Further research is certainly needed to disentangle the diverse factors that shape cross-cultural and inter-individual differences in human cognition throughout development.

DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the **Supplementary Material.**

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

PM, JK, and MK conceptualized the study. PM, NS, and MK designed the study. PM conducted the study with the support of LC and BR. PM and MK analyzed the data and wrote the manuscript. All authors provided critical feedback to the manuscript. MK supervised the study.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.01623/full#supplementary-material

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Cross-Cultural Differences in the Generation of Novel Ideas in Middle Childhood

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Innovation and creativity have recently been in the center of the debate on human cultural evolution. Yet, we know very little about childrens' developing capacity to generate novel ideas, as a key component of innovation and creativity, in different cultural contexts. Here, we assessed 8- to 9-year-old children from an autonomous and a relational cultural context, namely Münster (urban Germany; $n = 29$) and Banten (rural Cameroon; $n = 29$). These cultural contexts vary largely in their ecology, social structure, and educational system, as well as the cultural models on children's individual development and thinking. Therefore, they provide an optimal contrast to investigate cultural similarities and differences in development of creative capacities. We applied classical divergent thinking tasks, namely an alternative uses task and a pattern association task. In these tasks, children are asked to generate as many ideas as possible what an object could be used for or what a pattern could be. First, our study revealed a good internal consistency and inter-task correlations for the assessment of children's fluency and the generation of unique ideas in both cultures. Second, and most critically, we found significantly higher levels of creative capacities in children from Münster in contrast to Banten. This was reflected in both a higher number of ideas (fluency) and a higher number of unique ideas (uniqueness). Third, looking at the type of answers that children gave in the alternative uses task, we found that children from Münster and Banten uttered a similar number of conventional ideas, but that children from Münster uttered more ideas to manipulate an object, invent novel things with an object, and involve an object in play or pretend play, or in a fantasy story. This demonstrates that early creative development is strongly influenced by the cultural context and substantiates the cultural nature of human cognitive development.

Keywords: cross-cultural comparison, creativity and innovation, cognitive development, alternative uses task, middle childhood

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INTRODUCTION

In the current debate on human unique cognitive capacities, a central role has been ascribed to both innovation and imitation as two central psychological mechanisms underlying human cultural evolution (e.g., Legare and Nielsen, 2015; van Schaik, 2016). According to these accounts, high-fidelity imitation is key to acquire the cultural repertoire, and this competence emerges early in development. Innovation is equally important and complementary in the sense that it allows refining and expanding the cultural repertoire within and across generations. Ontogenetically, innovation emerges later, but imitative capacities remain relevant throughout development.

Increasing competence and experience of the individual allows for the development of higher levels of innovation, with adolescents and young adults being the most likely innovators (van Schaik, 2016). Thus, individual problem solving and creativity play a central role as the driving forces of innovation in human cultures. In support of this idea, Neldner et al. (2019) report data that show that, across three different tasks and five different cultures, children are relatively poor tool innovators before age five and become much more proficient by age nine, across cultures.

At the same time, Neldner et al. (2019) found support for cross-cultural variation in children's proclivities to innovate. More specifically, while innovation across the non-Westernized small-scale society groups was, in general, similar, the innovation of children from a Westernized city was considerably higher. In a study on imitative flexibility in 6- to 8-year-olds from a US-American metropole and a small-scale society in Ni-Vanuatu, Clegg and Legare (2016) found Ni-Vanuatu children engaged in higher imitative fidelity than US-American children. As one reason, the authors discuss that caregivers in US-American educated urban middle-class families favor divergent thinking in young children, rather than conformity, which might support children's individual inventiveness, leading to these cultural differences. This interpretation is further supported by a study on the role of conformity in US-American educated urban middle-class and rural Ni-Vanuatu adults' judgments of children's intelligence (Clegg et al., 2017). Based on multivocal ethnography, this study found that US-American adults were less likely to endorse high-conformity children as intelligent, often citing creativity as a justification for their judgments. In contrast, Ni-Vanuatu adults were more likely to endorse Ni-Vanuatu high-conformity children as intelligent.

A central component of creativity and innovation is children's capacity to generate novel ideas (i.e., divergent thinking) as an indicator of their creative capacities (Runco and Acar, 2012). That is, the generation of novel, original ideas (e.g., Guilford, 1950) is a critical prerequisite for the production, implementation, and dissemination of innovative and useful ideas and products (Puccio and Cabra, 2010; Sawyer, 2012). Specifically, divergent thinking tasks provide a measure for the quantity and originality of ideas that children generate (e.g., Wallach and Kogan, 1965; Guilford, 1966; Torrance and Ball, 1984). For example, in the so-called alternative uses tasks, children are asked to generate different ideas about the use of objects, or in a pattern association task, to generate several ideas on what a black-and-white pattern could be (Wallach and Kogan, 1965; Ward, 1968). Across several studies, these tasks have been found to be highly suited to assess children's creativity, because they show a high reliability (i.e., a high internal consistency and inter-task correlations) and are clearly distinct from classical IQ measures (e.g., Wallach and Kogan, 1965; Pankove and Kogan, 1968; Cropley and Maslany, 1969). Furthermore, they have been applied across a broad age range (e.g., Ward, 1968) and have been shown to be relatively stable over time (Kogan and Pankove, 1972). Finally, especially the alternative uses and pattern association tasks seem to be suited for an application in non-Western and rural contexts because they are conducted with very simple materials, which are likewise familiar (objects) or novel (pattern) to children in these contexts (cf. Jurkat et al., 2020).

To date, a few studies have applied this or similar tasks in non-Western contexts, mostly looking at creativity in children from the Asian continent (e.g., Rudowicz et al., 1995; Rudowicz, 2003, 2004; Marsh, 2010), with a similar level of industrialization and education like in Western cultural contexts. Thus, in the light of the current debate on cross-cultural differences in imitation and innovation between Western and non-Western rural contexts of developing countries, outlined above, it would be intriguing to investigate cross-cultural similarities and differences in the generation of novel ideas during middle childhood in children from more diverse cultural contexts.

Toward this end, in the present study we selected two often-studied prototypical cultural contexts, which differ profoundly in their ecology, social structure, and educational system, namely the city of Münster with families from the educated middle-class in Germany, and the village of Banten, a subsistence-based farming ecology in rural Cameroon, near the municipal of Kumbu. The city of Münster is a typical Western context, more specifically representing a prototype of an independent (Markus and Kitayama, 1991) – or autonomous (Keller and Kärtner, 2013) – cultural context. Families and household sizes are usually small. Parents are occupied in professional jobs and have high levels of formal education, and children usually attend the kindergarten from age two or three and visit the school from around age six. Parental behavior and socialization focus on autonomy and individual development, such as making choices independently (Kärtner, 2015; Köster et al., 2016). Children from the Nso culture in the village of Banten, a typical non-Western context, grow up in large, extended family settings in subsistence-based villages. This cultural context has been characterized as relational (Keller and Kärtner, 2013). This is, socialization practices focus on obedience and taking on responsibilities, which is associated with social roles in hierarchical social relationships (Keller, 2007). Most parents are farmers and engage their children in household tasks and fieldwork from early on (Köster et al., 2018), and do so in an assertive and demanding tone of voice (Köster et al., 2016). Children visit the preschool from around age four and the educational style is dominated by a strong hierarchal relation between pupils and the teacher.

Children from both cultural contexts participated in child-friendly versions of the alternative uses and a pattern association task (adapted from Ward, 1968), to assess their abilities for divergent thinking. We assessed children's generation of novel ideas, by the number of ideas (fluency) and the number of unique ideas (uniqueness), as two classical indicators for divergent thinking. Our main proposal was that children from urban Germany would be more fluent in their generation of novel ideas and that they would generate more unique ideas. In addition, to get a better idea on the cross-cultural similarities and differences concerning the content of the ideas generated, we rated the different types of object uses in the alternative uses task (conventional uses, object manipulations, innovative ideas, play ideas, pretend play suggestions, and fantasy ideas). Our hypothesis was that children from urban Germany may generate more innovative, play, pretend play, and fantasy ideas, as an expression of their higher levels in the generation of novel and creative ideas.

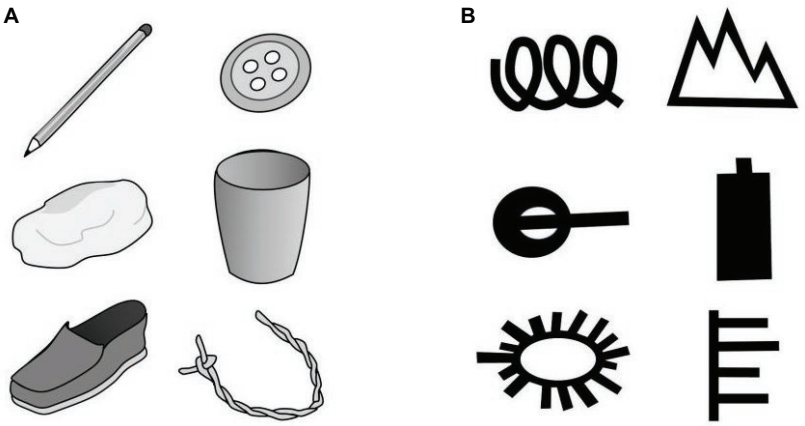

FIGURE 1 | The objects and pattern used in the creativity tasks. **(A)** Schematic drawings of the objects of the alternative uses task. The objects given to the children were real objects. **(B)** The pattern presented to the children in the pattern association ask. Children were presented the pattern printed on a card, one after another. Note that the item on the upper left corresponds to example item, used for the instruction and training of each task.

MATERIALS AND METHODS

Participants

The final sample consisted of 29 8- to 9-year-old children from urban Germany (M = 8.69 years, SD = 0.59, 52% girls) and 29 same-aged children from rural Cameroon (M = 8.25 years, SD = 0.69, 69% girls). One additional child in Münster came to the lab but did not want to participate. All other children could be included in the analysis.

In Münster, families were contacted *via* a database from the university. In Kumbo, children were recruited in cooperation with local schools. Families received financial compensation in Kumbo and cinema coupons in Münster for their participation. Note that in Kumbo, the date of birth was not exactly known for most children and thus estimated by the mothers. Informed written consent was obtained from parents in both contexts, and children gave informed assent.

Stimuli and Procedure

Children took part in one experimental session. In Kumbo, the laboratory was set up in a quiet room of the school, whereas in Münster, participants visited the laboratory of the university with a parent. During the session, the child and the experimenter were alone in the room with two chairs and a table and the room was kept as plain as possible. This is, we removed all loose objects in the room (e.g., pictures, rubbish bin, etc.) to avoid that these objects could support children in forming specific ideas.

Children first took part in an alternative uses task and then in a pattern association task. The procedure of both tasks was adapted, as close as possible, from a study with children at the same age, by Ward (1968). Both tasks were introduced as a game. All sessions were video-recorded for subsequent transcription and coding of the ideas of the child.

Note that these tasks are commonly differentiated as being semantical (alternative uses task) and figurative (pattern association task) within the Torrance Tests of Creative Thinking (TTCT; Torrance, 1984). Furthermore, there are more recently developed tests in the field, such as the Creative Thinking-Drawing Production (TCT-DP), which may be better in reflecting the processes of creative thinking. However, in the present study we selected those two tasks, because our main focus was on children's generation of novel ideas, these tasks were probed with children at school-age (Ward, 1968), and we considered them highly suitable (in terms of comparability) for an application the two highly different cultural contexts.

Note that we kept the order of tasks constant across cultures, because the main focus was on the difference between cultures and not the differences between tasks. We started with the alternative uses task, because it is closer to children's daily experiences, such that we considered it the better start for children to warm up and understand the structure of the tasks.

Alternative Uses Task

The task was conducted for five real objects, one after another: a piece of string, a cup, a shoe, a stone, and a button (see **Figure 1A**). The task started with a training object (a pencil, not included in the final analysis) and was introduced as a game called *What can you use it for?* The experimenter began by introducing the first object "We are first going to play with a pencil [handing over a pencil to the child]. Now, I want you to tell me all the things you can think of that you can do with a pencil, or what you can play with it or what you can make with it." The experimenter positively acknowledged each idea (e.g., "yes, this is a good idea") and encouraged the child to continue (e.g., "What else can you think of? What else can you do, play or make with a pencil?"). Children could continue until they stated that they had no further ideas. In case the child generated less than four ideas, the experimenter encouraged the child one more time to think of further uses. For the first object (i.e., the pencil), the experimenter suggested two additional uses in the end. This was to be sure that children would understand the task correctly (i.e., "You could also use it to dig in the dirt, you could use it as a flagpole and put a small flag on it, or

you could put wheels on it to create a toy car"). Thereafter, the experimenter repeated the same protocol for the five test objects.

Pattern Association Task

The task was conducted with five abstract patterns (see **Figure 1B**), each printed on a card. Again, the task was introduced by the experimenter with a training pattern (**Figure 1B**, upper left pattern), who said "Now we play a game called *What could this be?* The first thing we play with is this pattern [showing the pattern to the child]. Now, I want you to tell me all the things you can think of that this could be." The behavior of the experimenter was identical as for the alternative uses task (see above). Again, for the first pattern the experimenter added some more suggestions in the end (i.e., "Look, this could also be a tail of a pig, three times the letter 'e' or a fence").

Data Coding and Analysis

Data Preprocessing

All ideas uttered by the child were transcribed from video. Children in Cameroon spoke Lamnso, the local language, and their ideas were transcribed into English by a local research assistant.

In the first step, we excluded ideas that were redundant, irrelevant, or too unspecific. An idea was redundant, if it was uttered before by the child for a specific object, or if it implied the same action performed with the object, or fulfilled exactly the same function as an idea that was uttered before. Examples for redundant object uses would be that a pencil could be used for painting or drawing, or that a cup could be used as a container for stones or as a container for earth. For the pattern, ideas would be redundant if they were repeated, highly similar, or synonymous. Examples for redundant ideas would be house or villa, or a spoon or a wooden spoon. An idea was excluded as irrelevant in case it was not a response to the question (e.g., this is black and white) or if the uttered idea could not be related to the object (e.g., to use a pencil for a papernose). In accordance with Ward (1968), an idea could not be discarded as irrelevant, if it was uttered by at least two children. Finally, we excluded an idea as too unspecific, in case it did not imply a specific action or purpose. Examples for unspecific ideas would be one could "put the object somewhere" or that one could "make something out of it."

Finally, before the analysis, we identified ideas across participants, which referred to the same use or purpose. Those ideas received the same label and were considered as identical ideas. Examples for ideas considered as identical were to tear something apart or to pull something apart or also the examples given above for ideas that were considered redundant to each other. The preprocessed data were used in all subsequent analysis steps.

Fluency and Uniqueness

In a first step, we analyzed participants' fluency, that is, the mean number of different ideas that a participant generated for each object. Furthermore, we analyzed the number of unique ideas, the mean number of ideas per object that was only uttered by one child.

Types of Object Uses

To better understand which aspects the ideas of the children between cultures would be similar or different, we developed six different categories of ideas (for a similar approach, see Oncu et al., 2015). These categories were Conventional, Manipulation, Innovation, Play, Pretend Play, and Fantasy.

Conventional

Conventional means that the idea corresponds to the intended purpose of an item, namely that its use is functional with a reasonable (not playful) goal. Because the number of conventional uses is defined by an object, we developed a list with the conventional uses for each object. For example, for a pen, this was to write, paint, draw, or to sharpen it (see also Oncu et al., 2015).

Manipulation

Manipulation referred to a non-functional change of the condition or location of an object that does not have a playful character. For example, to break the pencil apart or to throw it into a corner.

Innovation (and Tool Use)

Innovation and tool use were defined as novel uses that are realistic, functional, and follow a reasonable goal but are not a conventional use of this object. According to Beck (1980), this would include the creation of new tools, and specifically involve four distinct actions: detach, subtract, reshape, and add/combine the object (see also Neldner et al., 2019, for a cross-cultural study on tool innovation). An example would be to use the pen as a flagpole.

Play

Play was defined as any action with the object that does not follow an instrumental goal. Examples would be to throw a pen up and catch it again or to balance it on a finger.

Pretend Play

Pretend Play was defined as any symbolic use of the object. Namely, any use where the identity of the object was alternated to replace another object (Bruner, 1972; see also Oncu et al., 2015). An example would be that a pen would be used as a telephone.

Fantasy

Fantasy ideas were those that were unrealistic, in the sense of a fairytale character. For example, beyond the symbolic character of pretend play, the object was turned into something that does not exist or used for something that is not possible. An example would be that the child would stand on the pencil and fly with it or as a magic sword to fight dragons.

We established the interrater reliability for the coding of the categories for >20% of the data (i.e., six children in each context). The agreement between two independent coders was good (Münster: Cohens κ = 0.85, Banten: Cohens κ = 0.81).

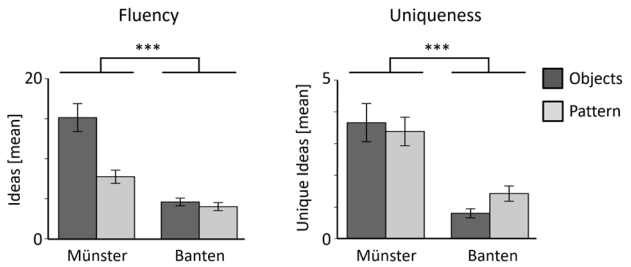

FIGURE 2 | The mean fluency and unique ideas for children from both cultures. Fluency corresponds to the mean number of ideas uttered by the children, per object. Uniqueness corresponds to the mean number of ideas only uttered by one child, per object. ***$p < 0.001$.

RESULTS

Fluency and Uniqueness

First, we tested the internal consistency for the fluency and uniqueness scores across objects and patterns. This revealed high consistencies for both cultures and tasks (see **Table 1**). Furthermore, we tested the correlations between the four scores, separated for both cultures. This revealed highly significant correlations between the different scores within cultures (see **Table 2**). Thus, in accordance with previous studies with children, the tasks seem to be reliable in assessing children's production of creative ideas and did so in both cultural contexts.

The mean values and SEs for children's fluency and uniqueness are displayed in **Figure 2**. We tested the cross-cultural differences in fluency and uniqueness, by subjecting those scores to two separate mixed ANOVAs with Culture (Münster, Banten) as between-subject factor and Task (Object, Pattern) as a within-subject factor. Children's fluency was much higher in Münster compared to Banten, main effect Culture, $F(1, 56) = 35.60$, $p < 0.001$, $\eta p^2 = 0.39$, and much higher for Objects compared to Patterns, main effect Task, $F(1, 56) = 23.74$, $p < 0.001$, $\eta p^2 = 0.30$. There was also a significant Culture × Task interaction, $F(1, 56) = 17.29$, $p < 0.001$, $\eta p^2 = 0.24$, indexing that in Münster the difference in fluency between Objects and Pattern was higher than Banten. Children's number of unique ideas were also much higher in Münster compared to Banten, main effect Culture, $F(1, 56) = 25.59$, $p < 0.001$, $\eta p^2 = 0.31$. However, we did not find a main effect of Task, $F(1, 56) = 0.31$, $p = 0.579$, $\eta p^2 = 0.01$, and also no interaction between Culture × Task, $F(1, 56) = 2.11$, $p = 0.152$, $\eta p^2 = 0.04$.

TABLE 1 | Consistency of fluency and unique responses across the five test items.

	Object		Pattern	
	Fluency	**Uniqueness**	**Fluency**	**Uniqueness**
Münster (urban Germany)	0.97	0.92	0.89	0.85
Banten (rural Cameroon)	0.92	0.78	0.89	0.83

Values indicate Cronbach's α.

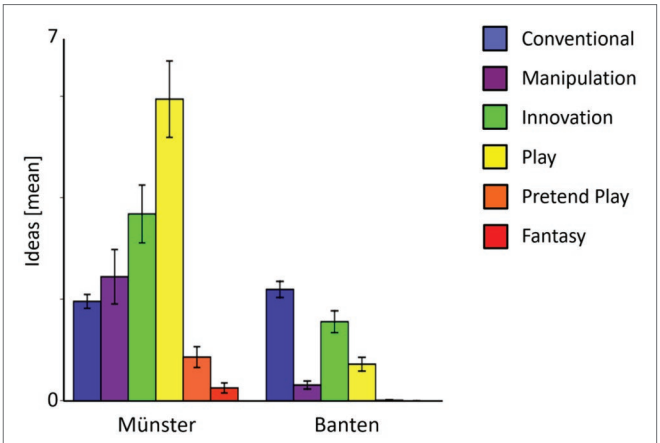

FIGURE 3 | The mean number of object uses uttered within each of the six categories for the alternate uses task (Conventional, Manipulation, Innovation, Play, Pretend Play, and Fantasy). The cross-cultural comparison was not significant for Conventional responses ($p = 0.456$), but highly significant for all other categories, namely Manipulation ($p < 0.001$), Innovation ($p = 0.001$), Play ($p < 0.001$), Pretend Play ($p < 0.001$), and Fantasy ($p = 0.012$).

Types of Object Uses

We tested the cross-cultural differences in the types of object use, by subjecting those scores to a mixed ANOVA with Culture (Münster, Banten) as between-subject factor and Type (Conventional, Manipulation, Innovation, Play, Pretend Play, and Fantasy) as within-subject factor, displayed in **Figure 3**. Looking at which categories children's ideas differed, we found a main effect of Culture, $F(1, 56) = 33.85$, $p < 0.001$, $\eta p^2 = 0.38$, reflecting the difference in fluency between both cultures. We further found a main effect Type, $F(5, 280) = 38.87$, $p < 0.001$, $\eta p^2 = 0.41$, and a significant Culture × Type interaction, $F(5, 280) = 24.31$, $p < 0.001$, $\eta p^2 = 0.30$. Looking at the cross-cultural comparison at the level of single types, the only type of object uses that did not differ significantly between cultures was the Conventional use, $t(56) = -0.75$, $p = 0.456$. Children from Münster gave significantly more responses in all other categories, namely Manipulation, $t(56) = 3.96$, $p < 0.001$, Innovation, $t(56) = 3.60$, $p = 0.001$, Play, $t(56) = 6.87$, $p < 0.001$, Pretend Play, $t(56) = 4.14$, $p < 0.001$, and Fantasy, $t(56) = 2.59$, $p = 0.012$.

TABLE 2 | Correlations between the different scores.

	2.	**3.**	**4.**
Münster (urban Germany)			
1.Object fluency	0.93^{***}	0.47^{**}	0.52^{**}
2.Object uniqueness		$0.36^{(*)}$	0.44^{*}
3.Pattern fluency			0.97^{***}
4.Pattern uniqueness			
Banten (rural Cameroon)			
1.Object fluency	0.88^{***}	0.69^{***}	0.73^{***}
2.Object uniqueness		0.54^{**}	0.56^{**}
3.Pattern fluency			0.92^{***}
4.Pattern uniqueness			

$^{(*)}p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

DISCUSSION

Most critically, the present study revealed significantly higher levels in the generation of novel and original ideas in children from educated urban middle-class families in Münster, Germany, in contrast to children from families with a basic level of formal education that live in subsistence-based farming ecology in Banten, rural Cameroon. This was reflected in a higher fluency and uniqueness of ideas that children from Münster generated for objects and patterns. Furthermore, the type of answers that children gave in the alternative uses task showed that children from Münster and Banten uttered a similar number of conventional ideas, but that children from Münster uttered more ideas in all other categories. These were ideas to manipulate the object, invent novel things with the object, and involve the object in a play, a pretend play, or in a fantasy story.

Consistent with earlier studies (Wallach and Kogan, 1965; Ward, 1968), we found that the tasks were highly reliable (across different objects and patterns used) and that the different measures for children's creative capacities (fluency for objects, uniqueness for objects, fluency for patterns, and uniqueness for patterns) were highly correlated. Although all tasks were framed as a game to motivate the children, it is difficult to disambiguate the degree to which the results in the tasks are influenced by children's tendency to interact and converse with the experimenter or their verbal fluency. Importantly and in support of the conclusion drawn above, we found that children from Münster and Banten did not differ in the number of conventional ideas they uttered, indicating that there was no general difference in children's readiness to participate in the task and express their ideas to the experimenter.

These data nicely complement the findings on children's innovation proclivities by Neldner et al. (2019). Using tool manipulation during a problem-solving task as the key indicator of innovation, they similarly found that, first, children were reasonably proficient innovators by age nine and, second, that innovation of children from a Westernized city was considerably higher than of children from small-scale societies. Together, this converging evidence points toward considerable cross-cultural variation in key capacities for creativity and innovation during middle childhood between WEIRD cultures and small-scale cultural communities.

The present findings further emphasize that the development of creativity and innovation depends largely on culture-specific learning experiences. Thereby, they raise intriguing questions for different aspects of children's culture-specific learning experiences that explain the cultural variability in creativity. Noteworthy, as a result of the choice of two very different cultural contexts, it is a limitation of the present study that those contexts differ in a high number of social (i.e., socialization goals and parenting strategies) and ecological factors (i.e., household structure, educational system, parental education, urbanization, and mode of subsistence). Thus, it remains a matter of debate and potential future investigation to better understand which factors are critical in shaping early creative capacities. In the following, we will speculate on a few processes that may underly the cross-cultural variation identified here.

A central role in culture-specific developmental pathways is ascribed to the early parent-child interaction (Keller, 2007; Keller and Kärtner 2013; for an example on childrens' cognitive development, see Köster and Kärtner, 2018). Consistent with the idea that cross-cultural variation in children's innovation might be driven by caregivers' ethnotheories about creativity or compliance as key features of the talented child (Clegg and Legare, 2016; Clegg et al., 2017), we have specifically chosen the two cultural contexts in the present study to reflect the prototype of an autonomous versus a relational cultural context, which have been shown to differ profoundly in parental values (Keller, 2007). For instance, parents in autonomous cultural contexts typically value independent thinking, uttering one's opinion, and generating novel ideas (Keller, 2007) which are also reflected in various aspects of their parenting behavior (Keller et al., 2004; Kärtner, 2015; Köster et al., 2016). On the other hand, parents from relational cultural contexts typically value conformity and the respect of hierarchical social relations (Keller, 2007). On the behavioral level, this is reflected in an assertive and insistent way parents instruct their children (Köster et al., 2016). These differences in cultural values and practices are likewise reflected in the educational system. While in urban Germany, there is an emphasis on individual thinking and discourse, in rural Cameroon, the emphasis lies on repeating correct responses instructed by the teacher. Besides a potential role of parental socialization and the differences in educational contexts, children's ecological environment may play a central role in the development of creativity and innovation. The environment of children in Western, urbanized contexts is largely enriched by toys and tools of all sorts, providing them with a diversity of experiences that may facilitate their generation of ideas what function objects could provide.

While these theoretical considerations fit neatly with the stark contrast in creative development found in school-aged children in the present study, for future research, it is essential to empirically test the role of different experiences children make across cultures on their innovative and creative potential (cf. Köster and Kärtner, 2019). For example, one could specifically test the effect of different parenting strategies and styles or different educational systems on children's creative development.

To conclude, our findings substantiate a profound impact of the cultural context on children's creative development and highlight that human cognitive development can only be fully understood in the broader developmental and cultural context.

DATA AVAILABILITY STATEMENT

The data underlying the analyses is available in the **Supplementary Material** of this article.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent toparticipate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

MK conceptualized and designed the study, assessed and analyzed the data. JK and RY provided critical feedback on the study design and data analysis. MK and JK wrote the paper, RY provided critical revisions. All authors approved the submitted version of the article.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.01829/full#supplementary-material.

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Cultural Differences in Mixed Emotions: The Role of Dialectical Thinking

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Who can feel both happy and sad at the same time, but not discomfort? This study aimed to investigate the cultural differences in mixed emotional experiences induced by conflict stimuli among American and Chinese undergraduate students. In total, 160 Americans and 158 Chinese watched two different valence advertisements (one predominantly positive and the other predominantly negative) that elicited mixed emotions; their feelings were assessed through self-reported measures. Findings indicated the impact that cultural differences have in people's mixed emotional experiences depends on the emotional components of the mixed emotional situations. The Americans and Chinese both experience a comparably intense mixture of emotions in different valence situations, but their discomfort toward conflicting stimuli is different. Further, dialectical thinking may be a mechanism behind the influence of cultural differences in people's mixed emotional experiences. Implications for emotion theory and research are discussed.

Keywords: culture, dialectical thinking, mixed emotions, discomfort, thinking style

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INTRODUCTION

On November 16, 2015, Oxford Dictionaries announced that their "Word of the Year" was an emoji: "Face with Tears of Joy." It was the first time that Oxford Dictionaries chose a pictograph as its "Word of the Year," representing a break with past winners, which were mostly old-fashioned, string-of-letters-type words. This emoji represents the experience of sadness mixed with joy, a "bittersweet" feeling. *Mixed emotions* represent a subset of emotion blends, which were defined as the co-occurrence of any two or more *same-valence* or *opposite-valence emotions* (Larsen and McGraw, 2011, 2014). This study surveyed 160 American and 157 Chinese undergraduate students as well as private sector employees to examine cultural differences in the experience of mixed emotions between the two groups. They were assessed through self-reported measures, using different valence advertisements as means to reflect peoples' complex emotional experiences in response to emotion inducing stimuli.

Previous research demonstrates that the experience of mixed emotions is influenced by response format (Schimmack et al., 2001, unpublished), one's *openness* (de Rivera, 1984; Tang and Singer, 1997), resilience (Ong and Bergeman, 2004), and age (Coats and Blanchard-Fields, 2008; Ersner-Hershfield et al., 2008). Moreover, mixed emotions have a positive impact on a person's well-being; hence, it may buffer the negative consequences of stressful events on an individuals' health (Berrios et al., 2018). Some researchers began to focus on the influence of

culture on the experience of mixed emotions, suggesting that *East Asians* experience more mixed emotions than *North Americans* (Bagozzi et al., 1999; Kitayama et al., 2000). Thus, our study targets this research question. We aimed to investigate *cultural differences* in the *experience of mixed emotions*, as well as to explain how the *dialectical thinking style* may affect undergraduate students' experiences of mixed emotions.

Cross-cultural studies have repeatedly documented that the *Western* and the *Eastern epistemologies* and *systems of thought* diverge in important ways (Peng and Nisbett, 1999; Hamamura et al., 2008; Miyamoto et al., 2010). *Eastern philosophies* are largely rooted in *Confucianism*, *Taoism*, and *Buddhism*, which can be described as *dialectical*. Dialectical thinking features the three principles of *contradiction* (i.e., two opposing positions can both be true), *change* (i.e., two opposing positions may lie on different points of a temporal continuum), and *holism* (i.e., all things in the universe are interrelated). *Western culture*, which is largely based on *Greek* and *Aristotelian logic*, can be characterized as *linear* or *synthesis-oriented*. These logical thinking styles feature three key principles: the *law of identity* (i.e., if anything is true, then it is true), the *law of excluded middle* (i.e., any statement is either true or false), and the *law of non-contradiction* (i.e., no statement can be both true and false; Peng and Nisbett, 1999). This thinking tradition tends to limit the degree to which Westerners engage in dialectical processing.

A growing number of cross-cultural research studies indicate that East Asians engage in dialectical thinking, and that this propensity may also influence their emotions (Spencer-Rodgers et al., 2010). People in *independent-based cultures* (e.g., the United States) tend to experience emotions in *opposite ways*, whereas people in *interdependent-based cultures* (e.g., China) experience emotions in *dialectic ways* (Bagozzi et al., 1999). In summary, dialecticism sees opposite-valence emotions (e.g., mixed emotions) as compatible with each other, whereas Western philosophies consider these emotions to be *conflicting*.

Previous research mainly focused on two aspects of cultural differences in mixed emotions: the *frequency* and the *intensity* of the *mixed emotional experience*; Bagozzi et al. (1999) had Asian and American subjects recall and indicate the *frequency* with which they experienced positive and negative emotions and found that the frequency estimates of positive and negative emotions were positively correlated for Asians, whereas negative correlations were found for Americans. Kitayama et al. (2000) asked participants from Japan and America to estimate the *frequency* in which they experienced positive and negative emotions; they found similar correlations between positive and negative emotions: they were less negative in dialectic cultures than in non-dialectic cultures, and, based on the correlational indices of co-occurrence. This led to the conclusion that Asians experience mixed emotions more frequently than Westerners. However, although positive correlations between two variables may imply this, they co-occur frequently. For example, strong negative correlations do not necessarily imply that they co-occur less frequently (Zelenski and Larsen, 2000; Larsen et al., 2017). Additionally, there is a concern about what has been reported as "mixed emotions," as specific reports might reflect people's semantic knowledge about the stimulus they experience during scientific experiments (Russell, 2017; Itkes et al., 2019). Therefore, these aforementioned mixed emotion reports could have reflected people's semantic judgments instead of their actual mixed emotional feelings.

Some researchers focused on how thinking style affects the *intensity* of the mixed emotional experience. To investigate the mechanism behind the notion that dialectical thinkers experience greater mixed emotions than non-dialectical thinkers, Spencer-Rodgers et al. (2010) experimented with Chinese and Euro-American undergraduates by making them experience mixed emotion life events. The results showed that Chinese people tend to engage in dialectical thinking; they exhibit greater mixed emotional experience than Euro-Americans, and dialecticism mediated participants' mixed emotional experiences, reinforcing the significance of cultural differences. However, Leu et al. (2010) found no evidence that dialectical thinkers experience more mixed emotions than non-dialectical thinkers. In their study, participants reported their emotional response toward standardized positive, negative, and mixed situations that depicted episodes in a protagonist's daily life. Results showed that cultural differences in the opposing emotions associations were found in positive events, and not in mixed or negative ones.

We may infer from the inconsistency of the aforementioned studies that the overall valence of the situation may have a mediation effect on how cultural differences affect mixed emotional experiences. Indeed, Miyamoto et al. (2010) found that the Japanese reported more mixed emotions than the Americans in *predominantly pleasant situations* (PPS), whereas there were no cultural differences in mixed emotions in *predominantly unpleasant situations* (*PUS*) or the mixed situations. Corroborating Miyamoto's findings, Hui et al. (2009) had Chinese participants report their emotional experiences to a positive and a negative event every week over 15 weeks, and they found an interaction between dialectical thinking and event valence. Specifically, non-dialectical thinkers tended to experience more mixed emotions in positive than in negative events.

Additionally, traditional model on mixed emotional experience concentrated on the associated negative consequences (e.g., anxiety and stress; Williams and Aaker, 2002). According to the Cognitive Dissonance Theory (Festinger, 1957), the experience of conflict creates uncomfortable tensions or discomfort; Chinese, who are more prone to dialectical thinking, are more likely to accept contradiction in reality and to synthesize contradiction than Westerners, who are more prone to linear thinking (Peng and Nisbett, 1999). Thus, cultural differences in the attitude toward contradictions manifest themselves through emotional constructs, which are manifested based on the extent to which the contradictory elements elicit them; for example, Westerners exhibit tension or discomfort when presented with situations that elicit cognitive, emotional, or behavioral contradictions (Cacioppo and Berntson, 1994). In that topic, Oceja and Carrera (2009) investigated different processing patterns of mixed emotions and found that highly simultaneous pattern elicited greater tension than sequential and prevalent patterns.

In order to account for the emotional nature of a given situation (Miyamoto et al., 2017), we induced mixed emotions by presenting two different advertisements with varying valences (Williams and Aaker, 2002). We hypothesized that (H1) both the Chinese and American people are capable of experiencing mixed emotions, but the intensity of the experience varies depending on the situation; specifically, in PPS, the Chinese experienced more mixed emotion than the Americans, whereas in PUS, the Americans experienced more mixed emotion than the Chinese. Notably, the Chinese are more inclined to engage in dialectical thinking, and they tend to deal with apparent contradictions in a compromising way, which may advocate tolerance of more blended emotions. Thus, we inferred that there is a difference between how the Americans and Chinese experience contradictions. Further, we have also tried to explain how the dialectical thinking style may affect the discomfort elicited by confronting opposing emotional stimuli. We hypothesized that (H2) the Chinese will tend to engage in dialectical thinking, and in PPS, it will be easier for them to identify negative meanings in positive events; as such, they will experience more mixed emotions and discomfort. Contrastingly, Americans will tend to engage in linear thinking, and in PPS, they will try to amplify the significance of positive emotions, thus reducing the impact of negative emotions; in doing so, they will experience less intense mixed emotions regarding the same situation. However, in PUS, both the Chinese and Americans may experience the same level of mixed emotion and discomfort. Owing to this, the Chinese try to find positive meanings in negative events, whereas the Americans have to be motivated to regulate their negative emotions. Regarding mixed emotion calculation, early studies used variable correlations to index mixed emotional experience (Russell, 1980; Watson and Tellegen, 1985; Remmington et al., 2000). To address the limitations of using correlations, we applied two co-current indexes to indicate the intensity of mixed emotional experience.

MATERIALS AND METHODS

Participants

In total, 160 American individuals participated in this study. Among them, there were 57 undergraduates (18 males, 39 females, mean age = 20.32 years) from the University of California, Berkeley, and 103 individuals (55 males, 48 females, mean age = 39.35 years) were recruited from Amazon Mechanical Turk. All the American participants were Anglo-, African-, Hispanic-, or Indian-Americans, including 80.0% Anglo-Americans, 11.25% African-Americans, 6.25% Hispanic-Americans, and 2.5% Indian-Americans. In total, 158 Chinese individuals participated in this study. Among them, there were 122 undergraduate students (32 males, 90 females, mean age = 19.80 years) from the Capital Normal University in Beijing, China, and 36 individuals (20 males, 16 females, mean age = 29.74 years) were recruited from an advanced technological enterprise in Shanghai. Undergraduate participants were recruited from both universities' Introduction to Psychology for course credit. American participants from Amazon Mechanical Turk and Chinese workers were paid.

This study was carried out in accordance with the recommendations of the guidelines of Human Research Ethics Committees of both the Capital Normal University and the University of California, Berkeley. All participants provided written informed consent prior to their participation. We affirm that such consent was in accordance with the Declaration of Helsinki. The protocol was approved by the Human Research Ethics Committees of both the Capital Normal University and the University of California Berkeley.

Materials

Advertisements

Two advertisements were used in the study as *conflict stimuli* (Williams and Aaker, 2002). Each advertisement included a colorful photograph and a corresponding, contradictory advertising message (that reflected the opposite emotion of the image); this was intended to elicit two different emotional ambivalence states: predominantly pleasant and predominantly unpleasant mixed emotions, respectively.

Participants in the PPS read the message "My grandpa passed away years ago. He was a college professor and he dedicated his whole life to education. I loved spending time with him. I'm happy that he was alive long enough to get to know me and help raise me"; in the PUS, they read "I have been dreading this moment, but it has finally arrived. A chapter in my life is ending, and the future is still uncertain. I'll miss the neighborhood and the friends I've made. I really do not want to leave. It's a sad and nostalgic time." This message elicits a predominantly unpleasant mixed emotion with stronger feelings of sadness than happiness.

To enhance external validity, positive-valence product content was included in the advertisement to enhance external validity and was consistently presented in all conditions. For example, one positive-valence content stated, "Watson color film has top color quality-plus; the texture will always be sharp, never grainy. Just like life."

Dialectical Self Scale

The 32-item *Dialectical Self Scale* (DSS; Spencer-Rodgers et al., 2001, unpublished) was designed to assess subjects' ability to think dialectically. The scale is composed of three subscales: contradiction, cognition change, and behavior change. Here is a sample item: "When I hear two sides of an argument, I often agree with both." Participants rated each item on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The DSS possesses adequate cross-cultural validity and reliability (Hamamura et al., 2008). In our study, the Cronbach's α values were 0.69 (Chinese) and 0.87 (Americans).

Emotion Measurement

Participants were asked to imagine themselves as in the situations described in the advertisements. Then, they rated nine different emotions on a 7-point scale from 1 (not at all) to 7 (very strongly), such as "If you were the grandson, how sad would

you feel?" Positive emotions were happy, delighted, and joyful; negative emotions were sad, sorrowful, and depressed; discomfort emotions were tense and nervous. Positive affect (PA), negative affect (NA), and discomfort were separately computed by averaging each of their three corresponding items. A Factor analysis was conducted to explore whether discomfort items are different with the negative emotion items. Both discomfort and negative emotion items were loaded well (i.e., 0.727–0.829) on a single factor (Eigen = 3.942, 65.71% of the variance). But, the loading of tense, anxious, and nervous is higher than sad, sorrowful, and depression. In this study, the relative Cronbach's α values were 0.872 (PA), 0.759 (NA), and 0.758 (discomfort).

We computed each participant's mixed emotional experience using Schimmack's (2001) MIN as one of the indexes of mixed emotions. Schimmack (2001) developed a direct measure of co-occurrence, indexing mixed emotions as the smaller one of a given observation's positive and negative emotion ratings [MIN (positive emotion, negative emotion)]. Higher MIN scores indicate greater mixed emotions, whereas lower scores indicate smaller mixed emotions. We also used the negative acceleration model (NAM; Scott, 1966) as another index of mixed emotions by applying the following formula: ([2 * S] + 1)/(S + L + 2), where S is the smaller, and L is the larger mean affect rating. Higher scores indicate greater mixed emotions (Spencer-Rodgers et al., 2010).

Additional Measures

We used one item to measure the extent to which participants experienced conflict, namely, "How conflicted would you feel in this type of event?" Participants rated the item on a 7-point scale from 1 (not at all) to 7 (very strongly).

All the experimental materials were written in English as well as in Chinese and applied to the corresponding native participants. Specifically, the Chinese version was applied after translating and back-translating with the assistance of doctoral candidates in Psychology, and to improve its adherence to Chinese cultural norms, this version underwent some minor adjustments when compared with the original English version.

Procedures

Participants were told that this study aimed to assess consumers' response to potential advertisements. They were instructed to view its appeal just as if they were reading it in a magazine. Randomly, participants were presented with three different advertisements. After reading each advertisement, participants were asked to rate their subjective feelings about the advertisement and respond to the other abovementioned items.

After finishing each emotional measurement, participants were instructed to copy a 3D sketch to avoid the overlapping of the induced emotions. Each emotional measurement took approximately 10 min. After finishing one measurement, the students proceed to the next advertisement. The order of the presentation of the advertisements was counter-balanced.

Subsequently, participants were asked to complete the DSS and a demographic questionnaire. After the questionnaire, participants were debriefed and thanked for their participation.

RESULTS

Manipulation Check

The ratings of overall positive and negative emotions were analyzed to check for the general valence of each situation. The results of repeated measurement MANOVA revealed a significant main effect of situation on positive emotion, $F(1, 315) = 551.277$, $p < 0.01$, $\eta^2 = 0.636$, and on negative emotion, $F(1, 315) = 250.207$, $p < 0.01$, $\eta^2 = 0.584$. Least significance difference analyses indicated that participants in the PPS ($M = 4.781 \pm 0.084$) experienced significantly more positive emotions than those in the PUS ($M = 2.469 \pm 0.077$), $p < 0.001$; participants in the PUS ($M = 3.867 \pm 0.091$) experienced significantly more negative emotion than those in the PPS ($M = 1.738 \pm 0.059$), $p < 0.001$. No cultural differences were observed.

For each type of situation, we computed the number of participants that rated conflict greater than 0 (not at all), regardless of the intensity of the emotions. In the PPS, 53.1% of the participants reported perceived contradictions, whereas the rate was 90.3% in the PUS.

Cultural Differences in Dialectical Thinking

The independent sample t-test results showed significant differences between the Chinese and Americans, $t(315) = 11.422$, $p < 0.01$. Specifically, the dialectical thinking of Chinese participants ($M = 4.275$, $SD = 0.239$) was significantly higher than that of American participants ($M = 3.946$, $SD = 0.273$).

One-way ANOVA was conducted to compare the difference between different races on dialectical thinking. The results indicated that there were significant differences between the races, $F(4, 317) = 33.547$, $p < 0.01$. Specifically, dialectical thinking in the Chinese was significantly more prevalent than that in the Anglo- ($M = 3.932$, $SD = 0.258$), African- ($M = 3.971$, $SD = 0.370$), and Hispanic-Americans ($M = 4.039$, $SD = 0.306$); no significant differences were found between the Chinese and Indian-Americans ($M = 4.072$, $SD = 0.149$).

Cultural Differences in Mixed Emotions

The results of repeated measurement ANOVA showed no significant effects of situation and culture or interaction between them on MIN scores, $p > 0.05$, after controlling for sex, age (Larsen et al., 2007), and multicultural experience (Ritter et al., 2012). The descriptive statistics of the main variables are shown in **Table 1**.

A repeated MANOVA indicated no significant main effects of situation and culture or interaction between them on NAM scores, $p > 0.05$, after controlling for sex, age, and multicultural experience.

Cultural Differences in Discomfort Induced by Conflict Stimuli

A repeated measurement ANOVA on discomfort was performed. **Figure 1** presents the cultural differences in participants' discomfort induced by conflict stimuli in two different situations.

After controlling for sex, age, and background, a significant main effect of culture was found, $F(1, 313) = 128.707$, $p < 0.001$, $\eta^2 = 0.291$; a main effect of situation, $F(1, 313) = 8.780$, $p < 0.01$,

TABLE 1 | Averages and standard deviations of emotions induced by conflict stimuli ($N = 318$).

	Dialectical thinking	PPS					PUS				
		PA	NA	MIN	NAM	Discomfort	PA	NA	MIN	NAM	Discomfort
Americans	3.946 ± 0.273	4.811 ± 1.670	1.733 ± 1.106	1.584 ± 0.901	0.491 ± 1.700	1.516 ± 0.902	2.497 ± 1.504	4.074 ± 1.681	2.051 ± 1.022	0.595 ± 0.173	4.217 ± 1.618
Chinese	4.275 ± 0.239	4.756 ± 1.301	1.748 ± 0.999	1.713 ± 0.897	0.519 ± 0.166	1.883 ± 1.102	2.427 ± 1.209	3.681 ± 1.537	2.019 ± 0.907	0.620 ± 0.163	2.965 ± 1.102

This table presents all the averages and standard deviations of emotions in predominantly pleasant situation and predominantly unpleasant situation. PPS, predominantly pleasant situation; PUS, predominantly unpleasant situation; PA, positive emotions; NA, negative emotions. MIN and NAM represent different calculations of mixed emotions.

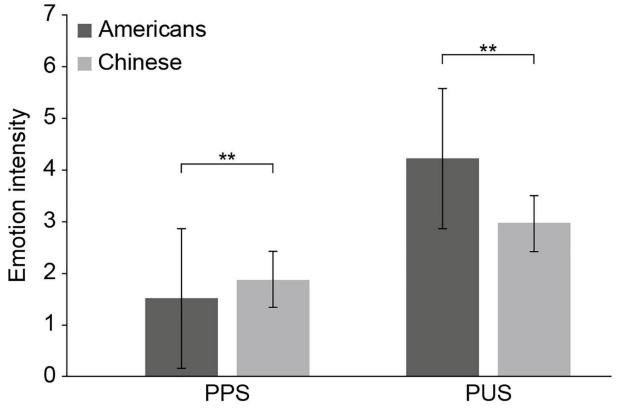

FIGURE 1 | Cultural and situational differences in discomfort induced by conflict stimuli. Condition means of discomfort in predominantly pleasant situation and predominantly unpleasant situation. Error bars indicate 1 standard error of the mean (SE). PPS, predominantly pleasant situation; PUS, predominantly unpleasant situation.**$p < 0.01$.

$\eta^2 = 0.027$, and culture and situation had significant interactions with discomfort, $F(1, 313) = 63.996$, $p < 0.001$, $\eta^2 = 0.170$.

Results of simple effect analysis indicated that: in the PPS, Chinese participants significantly felt more discomfort than Americans, $t(315) = 3.244$, $p < 0.01$, $d = 0.364$; in the PUS, American participants significantly felt more discomfort than Chinese, $t(315) = -7.087$, $p < 0.001$, $d = 0.796$.

Mediation of Dialectical Thinking in the Relationship Between Culture and Mixed Emotional Experience

The correlation of all variables mentioned before is shown in **Table 2**. We conducted mediation analyses on the two different situations separately (PPS and PUS).

In the PPS, results indicated that culture significantly negatively predicted dialectical thinking, $\beta = -0.543$, $p < 0.001$. When culture and dialectical thinking both entered the model, dialectical thinking significantly positively predicted MIN, $\beta = 0.188$, $p < 0.05$, and discomfort, $\beta = 0.213$, $p < 0.01$. The direct effect of culture was not significant on MIN, NAM, and discomfort, $\beta_{MIN} = -0.01$, $\beta_{NAM} = -0.04$, $\beta_{DIS} = -0.09$, $p > 0.05$. The Bootstrap confidence intervals of the indirect effect of culture on MIN were [−0.121, −0.009], indicating that dialectical thinking played a significant indirect effect on the relationship between culture and MIN, $\beta = -0.079$, $p < 0.001$. The Bootstrap confidence intervals of the indirect effect of culture on NAM were [−0.117, −0.001], indicating that culture had a significant indirect effect on NAM, $\beta = -0.061$, $p < 0.001$. The Bootstrap confidence intervals of the indirect effect of culture on discomfort were [−0.173, −0.059], indicating that culture had a significant indirect effect on discomfort, $\beta = -0.116$, $p < 0.001$. **Figure 2** shows the standardized values of our mediation model, and the model fit indexes are shown in **Table 3**.

However, in the PUS when culture and dialectical thinking both entered the model, the effects of dialectical thinking on

TABLE 2 | Correlations between dialectical thinking and emotional experience induced by conflict stimuli (N = 318).

	1	2	3	4	5	6	7	8	9	10	11	12
1. Culture	1											
2. Dialectical thinking	−0.541**	1										
3. PA1	0.018	0.027	1									
4. NA1	−0.007	0.087	−0.208**	1								
5. MIN1	−0.072	0.118*	−0.044	0.876**	1							
6. NAM1	−0.086	0.108	−0.543	0.726**	0.825**	1						
7. Discomfort1	−0.180***	0.213**	0.010	0.613**	0.676**	0.516**	1					
8. PA2	0.026	0.053	0.241**	0.068	0.115*	−0.030	0.188**	1				
9. NA2	0.122*	−0.018	0.214**	0.214**	0.202**	0.038	0.130*	−0.288**	1			
10. MIN2	0.017	0.026	0.244**	0.237**	0.287**	0.097	0.348**	0.646**	0.157**	1		
11. NAM2	−0.074	0.013	0.035	0.114*	0.159**	0.109	0.248**	0.420**	−0.355**	0.773**	1	
12. Discomfort2	0.371**	−0.126*	0.150**	0.185**	0.195**	0.087	0.158**	−0.046	0.647**	0.210**	−0.152**	1

*PA1 represents the positive emotions in a predominantly pleasant situation. NA1 represents the negative emotions in a predominantly pleasant situation. MIN1 and NAM1 represent the mixed emotional experience in a predominantly pleasant situation. Discomfort1 represents the tense and nervous induced in a predominantly pleasant situation. PA2 represents the positive emotions in a predominantly unpleasant situation. NA2 represents the negative emotions in a predominantly unpleasant situation. MIN2 and NAM2 represent the mixed emotional experience in a predominantly unpleasant situation. Discomfort2 represents the tense and nervous induced in predominantly unpleasant situation. *p < 0.05; **p < 0.01; ***p < 0.001.*

MIN, NAM, or discomfort were not significant, $\beta = -0.031$, $p > 0.05$. Similarly, the direct effects of culture on MIN, NAM, or discomfort were not significant.

DISCUSSION

The present study investigated the cultural differences in people's mixed emotional experiences, including its byproducts (discomfort induced by conflict stimuli in different situations), and explain how differing thinking styles affect these experiences. The initial findings show no cultural differences in mixed emotions between the two groups, but cultural differences in discomfort. Dialectical thinking mediated these cultural differences in mixed emotional experience and discomfort. These results support our hypotheses. The present study expands on previous studies by exploring the role of dialectical thinking in the cultural differences in mixed emotion and its byproduct (discomfort).

Cultural Differences in Mixed Emotional Experiences in Different Situations

We analyzed the interaction between culture and advertisement messaging on different indexes of mixed emotions, MIN and NAM, as well as discomfort. No significant cultural differences were found in either MIN or NAM. Thus, both indexes of mixed emotions provided consistent evidence that Americans and Chinese experienced the same mixed emotions in the PPS and the PUS, and that Chinese felt more mixed emotions than Americans only in the PUS. The findings indicated that both Americans and Chinese have the ability to perceive and experience the mixed emotional stimuli; hence, when confronted with conflict, they both experience conflicting emotions. These findings support our hypothesis (H1) and coincide with those of Leu et al. (2010) and provide a valuable supplement to Spencer-Rodgers et al. (2010) work. Further, we also compared the cultural differences in different indexes of mixed emotions and found consistent evidence (Spencer-Rodgers et al., 2010).

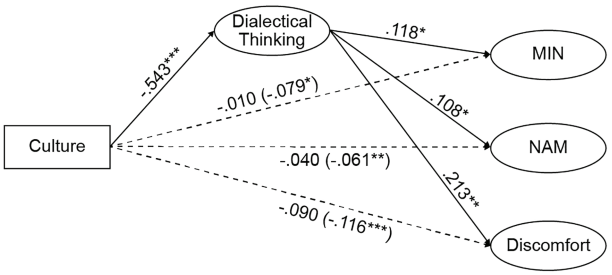

FIGURE 2 | Mediation scheme of dialectical thinking in the association between culture and mixed emotional experience (MIN, NAM, and discomfort) in the predominantly positive situation. Illustrated values depict the standardized path parameters of mediation model in predominantly pleasant situations. Chinese participants were coded as 0; American participants were coded as 1; culture served as the independent variable; dialectical thinking as the mediation variable; MIN, NAM, and discomfort in predominantly pleasant situation as the outcome variables; sex and age were control variables. Values in brackets depict the indirect effects of culture on three different predictors. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

TABLE 3 | Model fit indexes of the mediation analysis in the predominantly positive situation.

	CMIN/DF	NFI	RFI	IFI	TLI	CFI	RMSEA
Model	1.34	0.994	0.981	0.999	0.995	0.998	0.033

However, results also showed that the same stimuli made Chinese and American participants experience different degrees of discomfort. First, the discomfort rose as the intensity of mixed emotions increased in both situations; however, the discomfort increased more in the PUS than in the PPS. Second, in the PPS, Chinese reported significantly more discomfort than Americans; in the PUS, Americans reported significantly more discomfort than Chinese.

This pattern of results has several important implications. First, the findings show that both the American and Chinese participants experienced comparable mixed emotions in response to positive and negative situations. Previous research on culture

and mixed emotions has tended to neglect situational factors; we hope our situational account may explain some previous inconsistent findings on culture and mixed emotions (Hui et al., 2009; Miyamoto et al., 2010). Second, we explored the association between culture and discomfort that accompanies mixed emotions. Though previous studies claim that mixed emotions can make one tense and nervous, little attention has been paid to the cultural differences of discomfort when individuals were confronted with conflicting stimuli. To our knowledge, this study is the first attempt to explore the cultural differences in discomfort that accompany mixed emotions to deepen extant understandings of the experience of mixed emotions.

Mediation of Dialectical Thinking in Cultural Differences in Mixed Emotional Experiences

Why do American and Chinese people experience comparable mixed emotions, but different levels of discomfort in both positive and negative situations? Peng and Nisbett (1999) have suggested that a dialectical style of thinking may explain the cultural differences in contradiction processing. One plausible alternative mechanism is that because the Chinese tend to engage in dialecticism they therefore habitually process both positive and negative information with more ease.

The results of mediation analyses indicated that dialectical thinking does indeed play a complete mediating role in the impact of cultural differences in MIN, NAM, as well as in discomfort in the PPS. We believe that the PPS findings may be related to features of dialecticism, namely, the expectation for change and tolerance of contradictions (Peng and Nisbett, 1999). Dialecticism also dictates that the valence of an event is likely to change with time and perspective (Ji et al., 2001). This means that, when confronted with positive events, the Chinese tend to think that such happiness might endure for a short time, so they start looking for potential negative implications, that is, they start planning ahead for a future rainy day. Contrastingly, Americans tend to maximize the happy moment they are living because they tend to think they are currently experiencing it owing to a deeply rooted principle in the American culture: "Happiness is a basic right that everyone can pursue"; this principle detracts from paying too much attention to the fact that such positivity will not last forever.

Nevertheless, in the PUS, the mediating effect of dialectical thinking on cultural differences in mixed emotional experience was not observed. This finding denotes that dialectical thinking can interpret the cultural differences in mixed emotional experience in PPS, which is in accordance with the previous research that dialectical thinkers and non-dialectical thinkers differ in their level of mixed emotions only in positive events, but not in negative events (Hui et al., 2009). This may due to different mechanisms. Dialectical thinkers may be driven by their balanced event appraisal style to experience mixed emotions, whereas non-dialectical thinkers may be motivated by their self-affirmation to generate positive implication to cope with negative events (Larsen et al., 2003).

These results shed light on a thinking style account for why some individuals experience mixed emotions more discomfort. Previous studies explore the association of dialecticism and mixed emotional experience, which is correlational, and cannot draw causal inferences (Hui et al., 2009). In this study, we introduced the mixed emotional experience and provided empirical support for the associations. This study addressed how an ideological thinking style can explain the cultural differences in mixed emotions and provided us a further insight into how people process and experience the ambivalence in different cultures. When studying mixed emotions in a global context, the cultural factors and the thinking style factors should be taken into account.

CONCLUSION

This study suggests that the impact that cultural differences have on people's mixed emotional experiences depends on the emotional components of mixed emotional situations. Further, it suggests that the American and Chinese both experience mixture of emotions in different valence situations, but their discomfort toward the conflicting stimuli is different. Additional dialectical thinking may be a mechanism behind the influence of cultural differences in people's mixed emotional experiences. Together, the findings contribute toward future theorizing on social cognition and emotion.

DATA AVAILABILITY STATEMENT

The datasets generated for this study can be found in the https://mfr.de-1.osf.io/render?url=https://osf.io/zrt3k/?direct%26mode=render%26action=download%26mode=render.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Research Ethics Committees of both Capital Normal University and University of California Berkeley. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

WZ, AY, and DL contributed equally to this work. WZ and KP served as the corresponding authors for the manuscript. PF and KP contributed significantly to the theory development, with KP contributing to research resources. DL contributed to the initial research design and data collection. WZ contributed to additional data collection, data analysis, as well as drafting and revising of the manuscript. AY contributed to the additional data collection, as well as the drafting and revising of the manuscript. All authors contributed to the article and approved the submitted version.

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OPINION
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There and Back Again: A (Reversed) Vygotskian Perspective on Digital Socialization

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Keywords: cultural-historical psychology, digital technologies, mediation, zone of proximal development, cognitive development

INTRODUCTION

Among the most important current advances of the contemporary material and non-material culture is the development of digital technologies as new tools or instruments of the human mind. Their reciprocal influence on the human mind is, in turn, becoming one of the front edges of research in both personality and cognitive psychology and neighboring disciplines, such as philosophy of mind, neurobiology, and cultural anthropology. The unprecedented speed of technological development, together with the merging of digital and wireless technologies with human daily routines across the planet, makes this research quite complicated. One of the first-priority tasks for psychology is to develop methodology which could become a foundation for the study of co-development of human mind and digital technologies, including both common-use devices and applications for data generation, storage, and processing.

VYGOTSKY'S *INSTRUMENTAL METHOD* AND MEDIATION

Over half a century earlier, the founder of cultural-historical psychology Lev Vygotsky proposed a framework to understand cultural development of human higher mental (psychological) functions (Vygotsky, 1978; Cole, 1996). As one of the core concepts, he introduced a concept of cultural mediation as acquisition of new *cognitive tools* (such as concepts, or digits, or mnemonics) from adults within a so-called *zone of proximal development*. The latter refers to a gap between a child's unaided performance in a certain new domain and performance supported by an experienced adult. Mediation transforms the structure of human mental functions, so that psychological tools become the essential part of the entire cognitive system, and "limitlessly broadens the range of activities within which the new psychological functions may operate" (Vygotsky, 1978, p. 55).

In his paper entitled *The instrumental method in psychology*, Vygotsky wrote: "In human behavior, we can observe a number of artificial means aimed at mastering one's own psychological processes. These means can be conditionally called psychological tools or *instruments*… Psychological tools are artificial and intrinsically social, rather than natural and individual. They are aimed at controlling human behavior, no matter someone else's or one's own, just as technologies are aimed at controlling nature" (Vygotsky, 1982, vol. 1, p. 103, my translation). What is crucial, these tools emerge similarly in human evolution and in individual development and are "inherited" from social environment through the process called *socialization*. In this paper, I will demonstrate that the idea of the instrumentality of human mind might be fruitful for the understanding of our mind's transformation together with new technologies through digitally mediated socialization.

In Vygotsky's cultural-historical psychology, the acquisition of means allowing to control one's mental functions and behaviors as the core part of a child's socialization is described as

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internalization, or transformation of externalized social forms of these functions into internal. According to Vygotsky, higher psychological functions are first divided or shared between a child and an adult. What the child cannot do on her own, she can perform together with an adult who meanwhile introduces cultural tools which mediate cognition and performance (e.g., words for naming, indicating and categorizing; numbers for counting; mnemonic tools for remembering, etc.). Mental operations not yet available to a child on her own but available together with an adult define the child's zone of proximal development. Then, these culturally inherited *tools of the mind* (cf.: Bodrova and Leong, 2007) are internalized through the course of development to become tools of an individual mind.

VYGOTSKIAN FRAMEWORK IN THE MODERN CONTEXT

In our days, the Vygotskian framework is becoming more and more popular in the developmental cognitive science. This tendency dates back to the publication of Vygotsky's *Mind and Society* in English (Vygotsky, 1978), immediately followed by a resonant article by Toulmin *Mozart in Psychology* (Toulmin et al., 1978). Vygotsky's ideas about cognitive development in general and distributed cognition in particular found further elaboration, first of all, in the area of evolutionary cognitive science, for example, in the studies of human communication, joint attention, and shared intentionality (Tomasello and Carpenter, 2007), and in the so-called *neuroarchaeology*, a new interdisciplinary research area which aims at studying how human brain and mind change through the historical development of material tools and environment (e.g., Malafouris, 2013).

Nowadays, the world and in particular technologies change faster than one could imagine, providing new forms of support for our memory, spatial navigation, attentional orienting, visual search, emphasizing an urgent need to investigate how human mind develops and changes in a culture which does not remain unchangeable (Cole and Packer, 2016), and in which digital technologies play a central role. Its current development could be best described as creating new *artifact ecologies* (Bødker and Klokmose, 2011), or "environments where multiple heterogenous technologies co-exist and are interlinked as a unified system" (Vasiliou et al., 2015, p. 55). What's remarkable about human artifact ecologies now is digitalization of social interactions, which Vygotsky considered a necessary condition of socialization. Or, to take a somewhat different perspective, from the very birth a child is embedded in a *sociotechnical system*, allowing to master "a cultural tool kit," which nowadays includes new digital tools together with older ones, such as literacy or numeracy (Pea and Cole, 2019).

MEDIATION, INTERNALIZATION, AND DIGITAL TECHNOLOGIES

I argue that the current boost of digital technologies causes two remarkable *reversals* in the course of cognitive development as outlined in Vygotsky's "cultural-historical psychology."

First, according to Vygotsky, for centuries, the trend in both individual cognitive development and the cognitive evolution as a whole was from external to internal tools of the mind, e.g., from real knots to mental notes, or from chops on the wood to mental calculations. From the cultural-historical psychology viewpoint, socialization is internalization (see also: Pea and Cole, 2019). Today, human higher psychological functions are becoming mostly externalized again due to the use of new digital tools, such as reminders, web search instead of memory search, highlighted keywords which guide our visual attention, etc. In other words, the humanity moves back from internalization to what I would call "new externalization," with digital tools becoming an integral part of our cognitive system. In philosophy, this phenomenon has been described as Extended Cognition (Clark and Chalmers, 1998). From the psychological viewpoint, this all means reconstruction of the system of higher psychological functions through the digitally mediated activity (cf. Kaptelinin and Nardi, 2009). What is unique about digital technologies is that "extension" goes far beyond the tool (device or application) itself and is unavailable without it. In other words, such tools provide extended access rather than just support, or scaffolding. As a consequence, the borders between one's cognitive system and a technical device become blurred, with no clear understanding where, for instance, one's memory ends and a distributed world-wide web memory begins. This, in turn, influences how we remember and recall when our memory is not externally scaffolded (Ward, 2013). Such changes have also been reflected upon within the Embodied Cognition framework, as a result of "off-load of cognitive work onto the environment"(Wilson, 2002, p. 626). It is one of the reasons why this framework might be fruitfully integrated with cultural-historical approach (Zhang et al., 2018).

A similar reorganization of cognition by cultural practices has been demonstrated in multiple domains of human cognition and organization of movement, for a multitude of cultural practices, starting from counting and reading. These changes, in turn, lead to the reorganization of functional systems in the brain, which can be revealed not only by functional neuroimaging (for counting, see, e.g., Hanakawa et al., 2003), but even in the volumetric changes of specific brain structures and tracts. Surprisingly, Vygotsky discussed these neural changes driven by cultural practices over eight decades ago, when he introduced his principle of signification in human behavior: "… a man introduces artificial stimuli, signifies behavior, and by means of the signs creates new connections in the brain from outside. Admitting this, we presume a new regulatory principle of behavior, a new understanding of determination of human reactions, namely a principle of signification. A man creates externally new connections in the brain, controls his brain and thus controls his body" (Vygotsky, 1982, vol. 3, p. 91, my translation). Now, these structural changes and the human brain plasticity are becoming a major point of interest in a so-called *cultural neuroscience* (e.g., Kim and Sasaki, 2014) across a wide variety of cultural practices, such as music (Gärtner et al., 2013; etc.), chess (Hänggi et al., 2014), and many others. They have been mostly studied in adult learners, but it is more than plausible, especially in the light of association between the brain structural

changes and the age of the training onset (for music, see Vaquero et al., 2016), that they start from birth, as soon as the child finds herself in the social environment forcing to acquire a variety of cultural practices.

Second, the zone of proximal development is also being transformed by digital devices, because children now mostly master these devices on their own, without joint activities with adults, and the adults don't even need to share their skills and experience. The situation has obviously changed during the last three decades when the zone of proximal development in computer-mediated education was extensively discussed (Crook, 1991). Moreover, sometimes children are much ahead of their parents and teachers in their use of tablets, mobile apps, etc.

To make this point more straightforward, let's consider the standard sequence of a certain cultural practice or mental tool acquisition during socialization, as outlined by Vygotsky, who has distinguished four steps in this process. First, an adult applies a practice to a child, e.g., saying "We're back home, wash your hands" or holding a child's visual attention on a way through a labyrinth in an illustrated magazine using the child's index finger. Second, a child applies it back to the adult. It's easy to imagine a child saying to her mom: "Mommy, we're back home, wash your hands!" Third, a child applies the practice to herself in a loud speech: "We're back home, I go wash my hands!" Finally, the practice becomes fully mastered by a child, or internalized, and no external mediation is needed any more: the child just goes to the bathroom to wash her hands after coming back home. What's clearly seen in this example is a common vector of the child's development: from a shared externalized function to the private internalized one. Just the same can be observed, for example, for mediated remembering or counting.

With the introduction of digital devices, the developmental trajectory of digital natives becomes less predictable for the previous generation, diverging from the above-mentioned *inter-individual to intra-individual* trend described by Vygotsky. For ages, all children were being born into a "wholly and completely socially mediated" reality, in Vygotsky's words. Now, it's also a digitally mediated reality which begins shaping a child's life quite early. According to the recent USA statistical data, by the age of 1, almost all children from low-income families were already exposed to their parents' mobile phones. By the age of 2, they used the devices without the adult involvement. By the age of 4, about 75% of children had their own mobile devices (Kabali et al., 2015).

Of course, digital devices and applications do incorporate certain social and/or cultural practices, as well as any other cultural artifact, such as a spoon, forcing a baby to use it in a certain culturally determined way, transforming her natural movements. However, with the new digital technologies, the adult is no longer necessary as an instructor, and the child's attention, memory, cognition, and activity are being shaped and organized by the interaction with the device itself.

May I emphasize that, whereas some of our cultural practices are just behavioral, the other are linked to material objects, which guide their use by new members of a certain culture. To describe this sort of guidance, Malafouris (2013) in his Material Engagement Theory of cultural evolution introduces a term *material (enactive) sign*, clearly opposing his understanding to Vygotsky's who contrasts material tools and signs: "We should not expect to find *many* similarities with tools in those means of adaptation we call signs" (Vygotsky, 1978, p. 53). For Malafouris, who criticizes the above-mentioned principle of signification and the representational nature of the first human artifacts, material sign is "a constitutive part of what it expresses" (Malafouris, 2013, p. 116), which "can be engaged in real space and time" (Malafouris, 2013, p. 117). However, this makes Malafouris' approach more complementary than opposing to Vygotsky's approach, together with their common understanding of human as an "artificial" being, ever developing through both material and social engagement (Theiner and Drain, 2017).

Extending Malafouris' ideas, I would hypothesize that the new gadgets become *material signs* of a sort for the developing generation, embodying new digital affordances, just as choppers, primitive material tools, embodied specific affordances and prompted the further actions on them at the earlier stages of human evolution. On the one hand, this matches well the proposal of radical embodied cognitive neuroscience "to think of cognitive function in the brain as context-sensitive" (Kiverstein and Miller, 2015), or driven by available affordances. On the other hand, this means that the very concept of the zone of proximal development requires reconsideration, so that it could incorporate not only human-human (child-adult), but also human-computer interaction *per se*. The more general perspective at the zone of proximal development assumes that it becomes *bidirectional*. A child might well act in the adult's "zone of proximal development," teaching the adult to use a certain digital device or a service, with a previous step (an adult instructing a child) missing in the sequence. This transformation echoes Mead's definition of "prefigurative [cultures] in which adults learn also from their children" (Mead, 1970, p. 31).

CONCLUSIONS

New digital technologies apparently challenge the cultural-historical approach toward cognitive development. However, the constructivist nature of this approach and the concept of cultural mediation might provide new insights on extended cognition and its evolution.

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Cultural Differences in Face Recognition and Potential Underlying Mechanisms

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The ability to recognize a face is crucial for the success of social interactions. Understanding the visual processes underlying this ability has been the focus of a long tradition of research. Recent advances in the field have revealed that individuals having different cultural backgrounds differ in the type of visual information they use for face processing. However, the mechanisms that underpin these differences remain unknown. Here, we revisit recent findings highlighting group differences in face processing. Then, we integrate these results in a model of visual categorization developed in the field of psychophysics: the RAP framework. On the basis of this framework, we discuss potential mechanisms, whether face-specific or not, that may underlie cross-cultural differences in face perception.

Keywords: face processing, culture, visual perception, cultural psychology, face identification

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Vision has long been considered as encapsulated, immune from higher-level influences. Because of this conception, the necessity of testing participants representing the diversity of individuals composing our world has not always been as emphasized as it is today. In the field of visual psychophysics, going back only 15 years from now, a majority of studies were based on very small and homogeneous samples, most often composed of participants of White-European descent. With the emergence of the field of cultural psychology, the reliance on homogeneous samples of participants has been questioned and even labeled as "WEIRD," an acronym for samples composed of individuals from *Western, Educated, Industrialized, Rich,* and *Democratic* countries (Henrich et al., 2010a,b). An increasing number of studies are now revealing that individuals coming from different geographical areas or having different cultural backgrounds show differences in visual processes that have long been assumed to be universal (e.g., Segall et al., 1963; Morris and Peng, 1994; Chua et al., 2005; McKone et al., 2010).

The field of visual perception features pioneering studies in cultural psychology, amongst them studies showing that visual illusions, such as the Müller-Lyer effect, are weaker in some remote societies (Rivers, 1905; Segall et al., 1963). Since then, a large majority of the research investigating the impact of culture on visual perception has focused on comparing East-Asian and Western populations. This research has highlighted behavioral patterns suggesting that East-Asians and Westerners differ in the way they deploy their attention over the visual environment, with East-Asians spreading their attention more broadly than Westerners (Ji et al., 2000; Kitayama et al., 2003; Nisbett and Masuda, 2003; Nisbett and Miyamoto, 2005; Boduroglu et al., 2009; McKone et al., 2010). For example, when asked to identify a target letter in a hierarchical figure, like a large letter

"E" (the global level) composed of smaller letters "T" (the local level), East-Asians prioritize global information more strongly than Westerners (McKone et al., 2010). In a related vein, it has been shown that East-Asians are better than Westerners at detecting changes (e.g., a square changing color, or an object disappearing) in their peripheral visual field, whereas Westerners are better than East-Asians at detecting changes in their central visual field (Masuda and Nisbett, 2006; Boduroglu et al., 2009). Finally, when viewing visual scenes during a memorization task, East-Asians fixate the background more than Westerners, whereas the latter fixate focal objects more (Nisbett and Masuda, 2003; Chua et al., 2005; Nisbett and Miyamoto, 2005).

Recent advances have also revealed the presence of important cultural variations in the core processes involved in face recognition (e.g., Blais et al., 2008; Miellet et al., 2011; Caldara, 2017; Tardif et al., 2017). The general pattern of findings with face recognition is consistent with the results, described above, typically obtained with non-face objects. More specifically, compared with Westerners, East-Asians tend to rely more on peripheral vision to process facial features, congruent with the idea that they may spread their attention more broadly on face stimuli, as was suggested for non-face objects. Given the similarity in the patterns obtained with faces and non-face objects, one may be tempted to interpret the East-vs-West differences by appealing to the same theoretical models for the two classes of stimuli. However, in the field of face recognition, many studies have provided evidence that faces should be considered a special class of stimulus, relying on specific processes that differ from non-face processes (Duchaine and Yovel, 2015; but see Gauthier and Bukach, 2007). In the present article, we will revisit the cultural differences that have been observed in face recognition. Most importantly, we will draw from theories that have been proposed in the fields of visual perception and cultural psychology to discuss potential mechanisms, whether face-specific or not, that may underlie cross-cultural differences in face perception. It is worth noting that the present article will focus on face recognition and will not cover the rich literature on how culture impacts facial expression of emotions (e.g., Yuki et al., 2007; Jack et al., 2016; Cordaro et al., 2018; Yamamoto et al., 2020). In fact, face recognition and facial expression processing rely on partly different mechanisms and cerebral pathways (Haxby et al., 2000; Kanwisher and Yovel, 2006; Duchaine and Yovel, 2015). For instance, emotional expression reflects emotional experience, which itself can vary from one culture to another (Matsumoto et al., 2008). Thus, cultural variations in facial expressions and their processing are likely to involve other mechanisms than the ones underlying face recognition, and a review and discussion of this literature would be beyond the scope of the present work.

FACE PERCEPTION IS NOT UNIVERSAL

The ability to recognize a face has been crucial for the survival of our species, allowing us to distinguish friends, with whom collaboration is likely, from foes who are a potential threat. A long tradition of research has investigated the visual processes underlying this ability, for instance in terms of the eye movements involved in the sampling of visual information or in terms of the nature of the information which is extracted.

The first studies that recorded eye movements during face processing revealed a triangular pattern, where fixations on the eyes and mouth areas were most frequent (e.g., Yarbus, 1965/1967). Although this average pattern has long been considered universal, studies have since highlighted the presence of important inter-individual variations (Peterson and Eckstein, 2013; Mehoudar et al., 2014). Most importantly for the present discussion, differences have been documented between cultural groups (Blais et al., 2008). Specifically, East-Asians fixate more on the center of faces and less on the eyes and mouth areas than Westerners. Interestingly, however, both groups rely on the information contained in the eyes and mouth area, as was later demonstrated using a gaze-contingent paradigm (Caldara et al., 2010): when only a small area (measuring 5 degrees of visual angle or less) around the fixation location is visible, East-Asians fixate the eyes and mouth to a similar degree as Westerners. This suggests that, under normal viewing conditions, East-Asians actually process the eyes and mouth areas while fixating on the center of faces; they thus rely more on peripheral processing than Westerners to extract facial information (Miellet et al., 2013). Taken together, these results are congruent with the aforementioned findings in hierarchical-figure and scene perception suggesting that East-Asians rely more on global visual information and peripheral processing by applying a broader spread of attention.

If the different eye fixation patterns observed for East-Asians and Westerners reflect differences in the spread of their attention then, given the links between the spread of attention and the spatial resolution of the extracted visual information (Shulman and Wilson, 1987; Balz and Hock, 1997; Goto et al., 2001), one should expect East-Asians to rely more on lower spatial frequencies than Westerners when they process faces. A study by Tardif et al. (2017) indeed found such differences in the spatial frequency tuning of East-Asians and Westerners, both when they identified faces and when they categorized them based on familiarity. Moreover, it was later shown that these differences emerge during the early stages of face processing, with East-Asians using lower spatial frequencies than Westerners as early as 30 ms after stimulus onset (Estéphan et al., 2018). This early time course implies that the differences observed are not related to late decisional processes, such as social norms dictating where to look in a face, but instead tap into early automatic processes. Such processes could potentially be bottom-up, primarily guided by information saliency; alternatively, they could be guided, in a top-down manner, by mental representations of the stimuli shaping attentional habits during stimulus processing. Taken together, these results indicate that marked differences can be found in the very nature of the visual information extracted by individuals coming from different cultures. In fact, spatial frequencies are considered amongst the most basic kind of visual information processed by the primary visual system (Tootell et al., 1981;

DeValois and DeValois, 1988; Everson et al., 1998; Sowden and Schyns, 2006).

A FRAMEWORK WITHIN WHICH TO THINK ABOUT THESE CROSS-CULTURAL DIFFERENCES

However interesting it is to reveal differences in visual-sampling processes between East-Asians and Westerners, as of now we do not know the mechanisms that underlie such differences. We think that the RAP framework (Gosselin and Schyns, 2002), a model of visual categorization, may offer an interesting starting point from which to explore the potential mechanisms that cause the observed differences.

The RAP framework proposes that the visual information that can be efficiently used by an observer to perform an object categorization task, called potent information, results from an interaction between the visual information available in the object which needs to be categorized and the visual information represented in the observer's memory from previous encounters with similar objects. Here, the term "object categorization task" is used in its broadest sense, referring to tasks involving the identification or categorization of a visual stimulus, for instance a face, a letter, a written word, or a visual scene. RAP is an acronym for $R \otimes A = P$, where R is the visual representation of an object that is stored in memory, A is the available visual information contained in that object, $\otimes$ is an interaction term, and P is the potent visual information to recognize or categorize that object.

This framework entails that the potent visual information "P" will depend on the task at hand, because the available information "A" depends on the task. For instance, let us imagine the simple scenario where the task is to categorize the shape of an object that is a blue square. This object contains both color and shape information but, if one wants to categorize its shape, the fact that it is blue will not help with the decision. Thus, in the RAP framework, the available information "A" to categorize the shape of this object would be its shape, not its color. Because the potent information only includes information that is both available and stored in the visual representations, color would not be potent in this scenario. Now, let us apply this idea to a more complex stimulus and task, such as identifying the roman letter "p." Imagine an individual who has always read texts written in the font "Times New Roman," where the lower case "p" has the appearance depicted on the left side of **Figure 1**. Based on their exposure to that font, they have developed a mental representation "R" of the letter "p" containing both the curved part and the vertical tail visible in **Figure 1**. Now, imagine that this individual is required to read text written in the font "Lucida Blackletter." A letter "p" written in that font is displayed on the right side of **Figure 1**. Notice that, in that font, an additional feature is present: a termination feature in the middle of the vertical tail, where the curved part of the "p" crosses and passes through the vertical line, creating an "x" shape. This additional feature is available "A"; it provides information that would allow an objective, computational observer to recognize the letter as a "p." However, in the case of our individual whose mental representation of the letter "p" only includes the curved part and the vertical tail, this termination feature in the middle of the vertical tail will not be potent "P."

According to the RAP framework, the differences reported in previous studies with regards to the spatial frequency tuning of face processing in East Asians and Westerners would be categorized as differences in potent (P) information. In fact, the method used to compare the spatial frequency tuning in both Tardif et al. (2017) and Estéphan et al. (2018), called Bubbles (Willenbockel et al., 2010; Royer et al., 2017), was shown to specifically measure potent (P) information (Gosselin and Schyns, 2002, 2004). Thus, the findings described in the previous section indicate that lower spatial frequencies are more potent for East Asians than for Westerners, and higher spatial frequencies are more potent for Westerners than for East Asians. According to the RAP framework, various factors could explain this pattern of results. First, the available information "A" may differ between Asian and Caucasian faces (for instance, because of differences in the variability of some important facial features), in a way that would predict their respective tuning. Second, even if the available information does not differ, East-Asians and Westerners may still weigh differently the importance of different kinds of facial information, and thus generate different mental representations "R." Representational differences could emerge for multiple reasons, involving bottom-up processes such as early differences in spatial frequency sensitivity preceding face-specific mechanisms, top-down processes such as differences in attentional strategies, or both. In the next sections, we will develop these possibilities.

Available Information and Culture

The difference in spatial frequency utilization between East-Asians and Westerners could arise from exposure to faces in which the available spatial frequencies are not the same. More specifically, if the natural variations of facial morphologies in East-Asian populations were best described by lower spatial frequencies than in Western populations, one could expect the visual system of these populations to develop visual strategies where processing lower spatial frequency information is prioritized to recognize faces.

To the best of our knowledge, available spatial frequencies have never been compared across different face ethnicities. However, the knowledge gathered so far suggests that differences in available frequencies are not to be expected. In fact, one factor that could affect spatial frequency utilization is how objectively similar the faces are within a given population. In a study by Tardif et al. (2017), it was shown that more similar faces were associated with the utilization of higher spatial frequencies in a face recognition task. Thus, differences in the available spatial frequencies could emerge if the degree of dissimilarity, or visual heterogeneity, were larger in one population than the other. However, Caldara and Abdi (2006) showed, using an image set composed of over 300 White Caucasian and East Asian faces, a similar degree of visual heterogeneity with both face

FIGURE 1 | On the left side, a p written in the font Times New Roman. On the right side, a p written in the font Lucida Blackletter.

ethnicities. This finding is also in line with an anthropometric study showing no evidence of differences in facial heterogeneity across three ethnic groups, namely Whites, Blacks and Asians (Goldstein, 1979).

Despite evidence pointing toward an overall similar level of heterogeneity in White and East Asian faces, the possibility remains that the level of heterogeneity of local features might differ. For instance, exemplars within one face ethnicity may vary more in terms of the shape of the mouth, whereas they may vary more in terms of the shape of the eyes within another ethnicity. Such differences could in turn affect spatial frequency tuning. Thus, we think that future studies should empirically compare available spatial frequencies to allow a better understanding of the mechanisms underlying cultural differences in face recognition.

Visual Representations and Culture

Another factor potentially explaining cultural differences in face recognition is that East-Asians and Westerners may weigh spatial frequencies differently when generating representations of faces that are then stored in memory. But why would this happen? One possibility is that a generally higher sensitivity to lower spatial frequencies (or higher spatial frequencies) could translate, via bottom-up processes, into the creation of visual representations of faces tuned toward lower (or higher) spatial frequencies. This possibility has been evaluated as a first candidate mechanism in a study by Tardif et al. (2017). The contrast sensitivity function was measured in two separate tasks using non-face stimuli (sinusoidal gratings) and compared between East Asian and Western participants. No difference was found, suggesting that the difference observed with faces is not caused by differences in early sensitivity as such (Tardif et al., 2017).

Differences in visual representations could also emerge because, as the visual system develops, various factors modulate the attentional processes involved in the viewing of complex objects such as faces. The few hypotheses that have been proposed so far to explain the cultural differences in visual perception, which we will describe in the next paragraphs, all posit the existence of factors that bring about differences in the way attention is deployed during the processing of visual objects and/or faces. Such differences affect the input received by the visual system: when deploying attention over a narrower spatial area, the spatial resolution of the processed visual information becomes higher (Balz and Hock, 1997; Goto et al., 2001). Thus, if the visual input received by observers with different attentional strategies differs, the visual representations (R) built upon that input will likely differ. Down the line, these different representations (R) would lead to differences in potent (P) information, even when the available (A) information is controlled, for example, in lab settings.

One theory in the field of cultural psychology posits that exposure to an individualistic vs. collectivistic system of values impacts general perception in a way that could be congruent with the pattern of results found with faces (Nisbett et al., 2001). More specifically, this theory proposes that individuals exposed to individualistic systems of values perceive the world in a more analytical manner, for instance by narrowing their attention, which would facilitate the processing of focal objects. In contrast, individuals exposed to a more collectivistic system of values would perceive the world in a more holistic manner, by spreading their attention more broadly and processing the context more. This theory is supported by many visual-perception studies investigating differences between East-Asian and Western individuals with non-face objects (Ji et al., 2000; Kitayama et al., 2003; Nisbett and Masuda, 2003; Nisbett and Miyamoto, 2005; Boduroglu et al., 2009; McKone et al., 2010). Under this theoretical framework, exposure to collectivistic (vs. individualistic) values could drive individuals to deploy their attention more broadly (vs. less broadly) over faces, leading to different representations (R). These representations would, in turn, bring about the observed differences in potent (P) information, whereby East Asians and Westerners rely on different spatial frequencies and eye movement strategies during face recognition. However, the evidence that cultural differences in face processing can be explained by differences in individualism-collectivism is tenuous at best (e.g., Kelly et al., 2011; Liu et al., 2019).

More recently, additional findings have given rise to an alternative hypothesis to explain general perceptual differences between individuals coming from different cultures. In particular, traditional Himba individuals - a population coming from a remote part of northern Namibia - display behavioral patterns congruent with a narrow spread of attention and a reliance on analytical processing, despite living in a more interdependent society than Western individuals (Caparos et al., 2012). For instance, they are less affected by the Ebbinghaus illusion, suggesting that they can more easily ignore the context in which an object appears, when the task requires to do so. Interestingly, a series of studies show that behavioral patterns are congruent with the spread of attention increasing with urban exposure (Caparos et al., 2012, 2020; Linnell et al., 2013; Bremner et al., 2016).

Specifically, in a recent paper, two of the present authors (Linnell and Caparos, 2020) proposed that urban exposure promotes changes in the neuromodulatory locus coeruleus-norepinephrine (LC-NE) arousal system, and this results in the adoption of an explorative mode of visual sampling. They proposed that this shift may impact both covert and overt attention (where covert attention involves attending without moving the eyes whereas overt attention involves eye movements toward the attended location). According to this view, an increased arousal state associated with urban exposure could lead both to covertly attending to broader areas of space

and to increasing overt spatial exploration through more eye movements toward non-focal objects. Thus, according to this theoretical framework, an increased arousal state could impact attention distribution and lead to the development of face representations (R) that are in lower spatial frequencies, thereby leading to differences in potent (P) information. Nevertheless, this hypothesis remains speculative and several other factors could explain the differences observed between rural and urban populations with non-social visual stimuli. With regard to face stimuli, the studies comparing East Asians and Westerners have not controlled for the degree to which participants had been exposed to urban environments. In many eye-tracking studies (e.g., Blais et al., 2008; Caldara et al., 2010; Rodger et al., 2010; Miellet et al., 2013), all of the participants were tested in the same city (Glasgow, Scotland) but could have grown-up in any village or city of a Western or East Asian country. In other eye-tracking studies (e.g., Miellet et al., 2010, 2012; Kelly et al., 2011) as well as studies comparing spatial frequency tuning for faces (Tardif et al., 2017; Estéphan et al., 2018), Western participants were tested in a medium sized city (Gatineau, Canada or Glasgow, Scotland; populations of ∼280 and ∼600 K, respectively) and East Asian participants were tested in a large city (Hangzhou or Guangzhou, China; populations of ∼10.3 million and ∼15.3 million, respectively), but again they could have grown-up in any village or city of a Western or East Asian country. Thus, in all of these studies, the main variables associated with the two aforementioned theories, that is, urban exposure and exposure to an individualistic vs. collectivistic system of values, were confounded. Thus, further studies examining face processing in populations within the same culture but with varying degrees of urban exposure would help disentangle the two potential explanations described above, namely exposure to different systems of values and exposure in different degrees to an urban environment.

Moreover, both of these potential explanations make the prediction that cultural difference in the spatial frequency sensitivity function and eye movements in face processing generalizes to other classes of objects than faces. For instance, cultural differences observed in eye movements during face processing have been shown to generalize to homogeneous non face objects (Kelly et al., 2010). In addition, previous neuroimaging findings have shown a cultural specialization, during non-face object processing, in areas of the visual cortex associated with the processing of spatial frequencies (Ksander et al., 2018). However, the spatial frequency content of the stimuli was not manipulated during the experiment – only broadband stimuli were presented – and the interpretation that the cultural difference in terms of cerebral activity reflected the processing of different spatial frequencies was made using a posteriori analyses. In contrast, Tardif et al. (2017) found no difference in spatial frequency tuning between East Asians and Westerners when using low-level sinusoidal gratings. Likewise, studies on letter identification with spatial frequency manipulation might point toward non-generalizability of cultural differences, at least where letters are concerned. Like faces, letters (or characters) are prevalent in many countries and represent a culturally meaningful visual input. Interestingly, it has been demonstrated that spatial frequency use for letter identification is determined by letter stroke frequency (Majaj et al., 2002) or letter complexity (Wang and Legge, 2018), where more complex characters require higher spatial frequencies for reliable recognition. Chinese characters typically contain higher stroke frequencies/more complexity than common alphabetical letters (e.g., Wang et al., 2014). If letter complexity is a determining factor for spatial frequency use, we might for instance expect Chinese observers to use higher spatial frequencies than Western observers during reading. However, this idea remains speculative since, to our knowledge, Chinese observers have not been directly compared with Western observers on such tasks.

These results pertaining to spatial frequencies with non-social stimuli are very interesting, with some pointing toward a possible generalization of cultural differences in spatial frequency tuning across different stimulus classes (e.g., Kelly et al., 2010; Ksander et al., 2018) and some not (e.g., Majaj et al., 2002; Tardif et al., 2017; Wang and Legge, 2018). A possibility worth considering is that cultural differences in attentional deployment might interact with the nature of the task and stimuli. For instance, it is possible that the range of available spatial frequencies is wider for faces and homogeneous objects, thus allowing an observer to select information in accordance with their "default" attentional bias: higher spatial frequencies for Westerners and lower spatial frequencies for East Asians. However, with other classes of stimuli, such as sinusoidal gratings and perhaps letters, the available information might be more constrained, thus forcing individuals from both cultural groups to rely on the same range of spatial frequencies. To properly address the question of generalizability, more studies using an experimental paradigm designed to measure the impact of culture on the utilization of spatial frequencies with non-face objects are still needed. Those studies should also manipulate the range of available spatial frequencies of the stimuli in order to explore the possible interaction between attentional biases to a range of spatial frequencies and the nature of the visual input.

In fact, if cultural differences in the spatial frequency sensitivity function in face processing do not generalize to other classes of objects than faces, then this may indicate that face-specific mechanisms underpin this pattern of finding. As explained in the Introduction section, multiple studies point to the existence of face-specific mechanisms. It is true that the pattern of findings with faces integrates well within the general framework where East-Asians, or individuals leaving in highly urbanized environments, are more global and/or spread their attention more broadly, whereas Westerners, or individuals living in less urbanized environments, are less global/more local and/or spread their attention more narrowly. However, it remains possible that this is either just a coincidence or only part of the explanation.

If the difference in the spatial frequency sensitivity function is face-specific, it could emerge from social practices promoting the encoding of specifically face representations using different spatial resolutions. One potential mechanism that we believe could have a face-specific impact is the spontaneous distance

occurring between a mother's face and her infant's eyes. In fact, as distance increases between a stimulus and an observer, the availability of higher spatial frequencies decreases. To the best of our knowledge, only one study has compared mother-infant distance during face-to-face interactions in East-Asian and Western populations (Fogel et al., 1988). This study revealed that Japanese mothers stand farther from their child compared with American mothers. Thus, by affecting the visual information to which babies have access (the available (A) information), the mother-infant distance could in turn promote the encoding of visual representations (R) of faces in lower spatial frequencies in East Asians than in Westerners, thereby leading to the observed differences in potent (P) information. Given that faces are the most frequent stimuli to which an infant is exposed (Sinha et al., 2007), cross-cultural differences in mother-infant distance during early development may be an important factor to consider when attempting to understand the representation of visual faces across cultures.

CONCLUSIONS AND FUTURE DIRECTIONS

The ability to process faces is of the utmost importance for the success of our social interactions. Yet, it has now become clear that individuals can achieve similar abilities at this task while using strikingly different strategies of visual-information sampling. We started this article by alluding to the idea of encapsulated vision: could the East-West differences in low-level face processing be considered evidence against the theory that vision is modular (Pylyshyn, 1999) and that perception is not influenced by cognition (Firestone and Scholl, 2016)? We do not think this is the case. In fact, according to Firestone and Scholl, in order to qualify as evidence of top-down influence of cognition on perception, an effect must not be explained by differences in attentional strategies, since attention affects the input received by the visual system. As discussed throughout the present article, East-West differences in the visual processes underlying face recognition most likely reflect differences in the way these groups of individuals deploy their attention over space. Moreover, although the mechanisms underlying the development of such differences in attentional deployment remain unknown, the plausible candidates discussed here all represent long-term influences shaping visual information extraction processes: being exposed to individualistic or collectivistic systems of values, modulation of arousal associated with different degrees of urban exposure, or a face-specific mechanism emerging from differences in social norms for interpersonal distancing. These long-term influences may in fact shape visual processes such that the differences observed in adults of different cultural groups are bottom-up rather than top-down. The finding, by Estéphan et al. (2018), that differences in spatial frequency tuning across East Asians and Westerners emerge as early as 30 ms following stimulus onset supports this idea. More research will be needed to understand the mechanisms underlying the cultural differences observed in visual perception. Such an understanding will in fact be needed to decide whether these cross-cultural differences in face processing can be considered evidence against the idea of encapsulated vision.

We believe that the ideas presented above emphasize the importance of including more varied participant samples - rural, urbanized, and exposed to different systems of values and social norms - as well as different object classes - faces compared to complex scenes or simple objects or characters - in order to better understand the visual mechanisms that are specific or not specific, as the case may be, to face perception.

Moreover, when comparing populations with different cultural backgrounds, one needs to take great care to ensure that the methods used are comparable, for instance, as regards the participants' familiarity with the stimuli presented, or how they understand instructions and tasks. Methods involving implicit measures, in which responses are not required by the participants, may be ideally suited to working around problems with instructions and tasks. One potentially interesting paradigm for addressing the question of attentional breadth and spatial frequency tuning is pupillometry. In fact, studies have shown that pupil dilation is associated with both increasing attentional breadth (Daniels et al., 2012) and the processing of lower spatial frequencies (Hu et al., 2019).

In summary, the task of untangling the mechanisms that underpin face recognition is an intricate one. The development of face perception remains nested in multifaceted cultural backgrounds that we can only ever approximate with current measures. Following up on this line of thought, it becomes ever more apparent how necessary it is to explore the interaction between culture and face perception, and then from diverse perspectives.

AUTHOR CONTRIBUTIONS

CB wrote the first manuscript draft. CB, KL, SC, and AE contributed to revisions of the following drafts and final version of manuscript. All authors contributed to the article and approved the submitted version.

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Individual Pride and Collective Pride: Differences Between Chinese and American Corpora

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This study investigated cross-cultural differences in individual pride and collective pride between Chinese and Americans using data from text corpora. We found higher absolute frequencies of pride items in the American corpus than in the Chinese corpus. Cross-cultural differences were found for relative frequencies of different types of pride, and some of them depended on the genre of the text corpora. For both blogs and news genres, Americans showed higher frequencies of individual pride items and lower frequencies of relational pride items than did their Chinese counterparts. Cross-cultural differences in national pride, however, depended on the genre: Chinese news genre included more national pride items than its American counterpart, but the opposite was true for the blog genre. We discuss the implications of these results in relation to the existing literature (based on surveys and laboratory-based experiments) on cultural differences in individual pride and collective pride.

Keywords: corpora individual and collective pride, Chinese, American, collective pride, individual pride

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INTRODUCTION

Pride is a basic human emotion and refers to a self-conscious emotion derived from one's achievements. Depending on whether such achievements are attributable to oneself or to a group to which one belongs, the sense of pride is labeled as either individual or group/collective pride (Berkowitz and Levy, 1956; Zander et al., 1972; Chakrabarti, 1992; Liu et al., 2014). Examples of groups include one's family, friends, team, and nation. Previous research has documented cross-cultural differences in pride in general and in individual pride and collective pride in particular, but no study has examined cultural differences in individual pride and collective pride using text corpora.

A number of studies have shown that pride may be influenced by culture (Stipek et al., 1989; Mauro et al., 1992; Stipek, 1998; Eid and Diener, 2001; Scollon et al., 2004; Neumann et al., 2009). Eid and Diener (2001) identified the differences between individualistic cultures and collectivistic cultures with respect to self-reflective emotions (e.g., pride and guilt). Of relevance to the current study is the finding that the frequency and intensity of pride were lower in collectivistic cultures than in individualistic cultures. Because Eid and Diener (2001) used scenarios involving personal achievements, it is not known whether group or collective pride showed the same pattern of cultural differences. Recently, Sznycer and colleagues conducted two cross-cultural studies on pride-eliciting situations: one (Sznycer et al., 2017) involving 16 countries across four continents, but all being

Western, Educated, Industrialized, and Democratic (WEIRD) cultures, and the other (Sznycer et al., 2018) involving 10 non-WEIRD small communities across Central and South Americas, Africa, and Asia. They found a high level of cross-cultural similarity (mean $r = 0.81$) within the WEIRD samples and a much lower level of agreement among the non-WEIRD samples ($r = 0.21$). It is also worth noting that like Eid and Diener (2001), Sznycer et al. (2017, 2018) focused on individual pride (all 10 scenarios in their 2018 study and 22 of the 25 scenarios in their 2017 study were about individual pride, with only three in their 2017 study being about relational pride; no scenarios covered national pride).

Theoretically, members of individualistic cultures tend to construe the self as separate from their social context and develop independent self-construal and individual pride, whereas members of collectivistic cultures tend to perceive the self as a constituent of the social context and thus develop interdependent self-construal and collective pride (Markus and Kitayama, 1991). Indeed, an earlier study indicated that different types of pride were distinctly influenced by cultural backgrounds. Stipek (1998) found that individuals in collectivistic cultures (e.g., China) would experience stronger pride if their children were accepted into a prestigious University than if they themselves were accepted, whereas people in individualistic cultures (e.g., the United States) would experience equal pride in these two circumstances. Through a cultural priming study, Neumann et al. (2009) also noted that cultural orientation affected the experience of pride: Interdependent self-construal priming led to greater pride in achievements of others, whereas independent self-construal priming led to greater pride in personal achievements.

Cross-cultural research on pride remains quite limited. Furthermore, relevant studies have primarily relied on the questionnaire or scenario data, which are subject to social desirability and self-serving biases (Taylor and Brown, 1988; Dunning et al., 1989, 1991; Lindeman and Verkasalo, 1995; Paulhus and John, 1998; Dunning, 1999; Robins and Beer, 2001). One method to overcome the limitations of self-report data is to use semantic analysis, which can mitigate ethnocentric bias (Gladkova, 2010) as well as social desirability and self-serving biases (Cohen, 2011). Several scholars have examined cultural differences using corpus-based methods (Gladkova, 2010; Apresjan, 2013). For example, Apresjan (2013) found that Russian speakers tended to express more passive emotions (e.g., fear) than English speakers, whereas English speakers tended to express more active negative emotions (e.g., anger).

Another limitation of the existing research on cultural differences in pride is its lack of differentiation of collective pride. Recent research has indicated that collective pride should be divided into relational pride and national pride (Liu et al., 2014; White and Branscombe, 2019). Relational pride concerns one's family, friends, and township (e.g., "When your friends achieve success" and "When your hometown is praised"). In contrast, national pride is tied to national achievements (e.g., "When a Chinese scientist receives the Nobel Prize") (van Hilvoorde et al., 2010; Kavetsos, 2012; Meier and Mutz, 2016). Some studies have focused on national pride (Hjerm, 1998; Evans and Kelly, 2002; Smith and Kim, 2006), but they have not considered individual pride and relational pride.

The current study explored cultural differences in the frequencies of individual pride items and collective pride items between American and Chinese corpora. Considering that the suppression of pride is highly valued in China (Eid and Diener, 2001), we hypothesized that the absolute frequency of pride in the American corpus would be higher than that in the Chinese corpus. Within the pride items, however, we hypothesized that the frequency of mentions of individual pride would be higher in the American corpus than in the Chinese corpus, whereas the frequency of mentions of collective pride would be lower in the American corpus than in the Chinese corpus. Because previous research showed that emotional expressions differed by the genre of the corpus (Mahdar, 2018), we utilized two genres (blogs and news) to see whether cross-cultural differences depended on the genre.

METHOD

Corpus Selection

We used two freely available corpora in this study: the Corpus of Contemporary American English (COCA; available at https://www.english-corpora.org/coca/) and Beijing Language and the Culture University Corpus Center (BCC; available at http://bcc.blcu.edu.cn/). The COCA contains more than 1.0 billion words of the English text (20 million words per year from 1990 to 2019) and is equally divided among spoken language, fiction, magazines, newspapers, academic texts, web pages, blogs, and TV/movies. The spoken genre mainly included conversations from TV and radio programs in the United States, and the fiction genre included short stories and plays from magazines. Magazines and newspaper genres were from nearly 100 different magazines and newspapers from across the United States. The academic genre included literature from peer-reviewed journals covering the range of science, social sciences, and humanities. Web pages included web genres of academic, argument, fiction, information, and so on, from the US portion of the GLoWbE corpus. Blogs included texts from the US portion of the GloWbE corpus that were classified by Google as blogs. TV/movies included subtitles from OpenSubtitles.org and later the TV and movies corpora.

BCC contains nine languages, from which we selected modern Chinese. It includes more than 15 billion words of Chinese text (1990-2017) extracted from news, spoken language (e.g., microblogs), science and technology, literature, and other language styles. News genre materials were derived from the main newspapers in China, and the spoken genre mainly included information from microblogs. Science and technology genres included articles in academic journals published in China, and literature mainly included literary works.

To summarize, both corpora are very large and widely used and should be considered as comprehensive data of language use in their respective countries (Davies, 2010; Apresjan, 2013; Cheung and Larson, 2018; Darriba, 2019; Gao and Joh, 2019;

Dang, 2020; Lu and Coxhead, 2020). To improve comparability of the two corpora, namely, blogs and news, we selected English blogs (only available for the year 2012) and Chinese blogs (only available for the year 2013). The news genres covered the years from 1990 to 2019 for both Chinese and English corpora.

Sampling

In the English corpus, we selected "pride" and "proud" along with their grammatical variations, including "prided," "prides," "priding," "prouder," and "proudest" (Apresjan, 2013). In the Chinese corpus, we selected "自豪," "自大," and "骄傲," which are Chinese synonyms for "pride" and "proud." These words were used as search keywords. For each keyword found in the corpora, the search returned the text that included 20 Chinese characters or punctuations before each keyword and 20 Chinese characters or punctuations after each keyword in the Chinese corpus, and 15 words or punctuations on each side of the keyword in the English corpus. These strings of texts were considered as items. On occasions when multiple keywords were contained in the same item, they were treated either as a single occurrence when multiple occurrences were about the same type of pride or as separate occurrences when they were about different types of pride. We identified 10,909 and 10,542 items in the blog and news genres of COCA, respectively, and the corresponding numbers of items were 42,502 and 45,675 in the BCC. From these items, we randomly selected about 1,500 items from each type of items (1,533 English blog items, 1,462 English news items, 1,512 Chinese blog items, and 1,574 Chinese news items; the minor variations were due to an effort to ensure that the distribution of the various keywords in the final selection was the same as that for the corpora). In sum, we included 2,995 items from COCA and 3,086 items from BCC.

Classification

Following Liu et al. (2014), we classified all items by pride type based on their linguistic context. Individual pride reflects personal qualities or behavior; relational pride concerns admirable qualities or behavior of one's friends, family members, hometown, or school; and national pride is related to admirable qualities or behavior of a nation (see **Table 1**).

Four bilingual research assistants, one majoring in both psychology and English and the others majoring in psychology and passed College English Test Band 6 (CET-6, which is considered as proficient enough to read English newspaper articles and materials of general interests), were divided into two groups: One group classified 854 English and 1,589 Chinese items, and the other group classified 2,141 English and 1,497 Chinese items. These four coders were trained how to classify the text by type of pride: individual pride, relational pride, national pride, general pride (the items with little or no information to be coded by the above types of pride), and non-pride (the items with the keyword but not related to pride as an emotion, e.g., a pride of lions, see an example in **Table 1**). The two coders in each group practiced on 100 Chinese items and 100 English items and discussed any misclassifications. Finally, these two coders in each group independently coded all materials. For one group, the intercoder reliability (kappa coefficient) was 0.87 [95% CI: 0.85, 0.89] for the Chinese materials and 0.84 [95% CI: 0.81, 0.87] for the English materials. For the other group, the intercoder reliability was 0.90 [95% CI: 0.88, 0.92] for the Chinese materials and 0.82 [95% CI: 0.79, 0.84] for the English materials. A kappa coefficient of 0.81–1.00 is considered as showing as an almost-perfect agreement (Landis and Koch, 1977). For the items, the two coders disagreed (363 English items and 253 Chinese items); they were discussed and resolved in a group session involving the two coders as well as one of the corresponding authors. The non-pride items (170 English and 28 Chinese items) were excluded from further analysis, yielding 1,465 English items and 1,493 Chinese items from the blog genre and 1,360 English items and 1,565 Chinese items from the news genre in the final analysis.

The frequency results were analyzed using a chi-squared test. To determine which type of pride differed significantly between the two corpora, we calculated the adjusted standardized residuals (z-score) by standardizing the difference between observed values and expected values (Sharpe, 2015). The absolute value of adjusted residuals >2 is considered to be significant at $\alpha = 0.05$ (Haberman, 1973).

RESULTS

The total frequencies of the pride items were much higher in the English corpus (86.93 and 85.74 usages per million words for the blog genre and the news genre, respectively), than in the Chinese corpus (14.17 and 22.84 usages per million words).

For the blog genre, a chi-squared test showed a significant association between culture (Chinese and American) and pride (individual, relational, national, and general), $\chi^2(3, N = 2{,}958) = 97.13$, $p < 0.001$, Cramer's $V = 0.18$, which indicates slightly larger than a medium effect size (0.17) according to Cohen (1988). For the news genre, a chi-squared test showed a significant association between culture and pride, $\chi^2(3, N = 2{,}925) = 278.50$, $p < 0.001$, Cramer's $V = 0.31$, which is larger than a large effect size (0.29) (Cohen, 1988). For both genres, compared with the Chinese corpus, the American corpus contained more items pertaining to individual pride and fewer items pertaining to relational pride (see **Table 2**). For national pride, cross-cultural differences showed opposite patterns for the two genres: The Chinese news genre contained more national pride items than its American counterpart, whereas the opposite was true for the blog genre. The remainder category (general pride) also showed opposite patterns—a higher frequency for Chinese blogs than for American blogs but a lower frequency for Chinese news than for American news.

DISCUSSION

We used the corpus-based methods to examine cultural differences in individual and collective (i.e., relational and national) pride between Americans and Chinese. These methods can mitigate to some extent the clear methodological disadvantages of questionnaire-based methods, including ethnocentric, social desirability, and self-serving biases (Taylor and Brown, 1988; Dunning et al., 1989, 1991; Lindeman and

TABLE 1 | Examples of individual pride and collective pride.

Type	English	Chinese	
		Original item	**English translation**
Individual pride	No, I'm just joking. I've always **prided** myself on not having standard pick-up lines, which makes things that much more	不大愿意受人控制"、"你以自己能独立思考而自豪"、"你希望别人尊重你"……诸如此类的描述	"[You] are not willing to be controlled by others," "you are **proud** of your ability to think independently," "you want others to respect you," and so on
Relational pride	That women's chief priority is to serve their families, she not only took **pride** in her two daughters' achievements but also encouraged our career plans. We took	了!宝贝，加油!妈妈为你的沉着和勇敢感到骄傲!但愿大家都平平安安，和和美美!但愿我的一	! Come on, Dear! Mom is **proud** of your composure and courage! May everyone be safe and at peace! I wish my
National pride	Must feel substantial and look majestic enough to engender national **pride**. # On the other hand, this currency cannot be costly to	愈来愈强盛。我不禁为祖国的成就感到无比的自豪、骄傲，在心中呼喊着：祖国，生日快乐！我衷	More and more powerful. I cannot help but feel extremely **proud** of the achievements of my motherland, and I cry in my heart: Happy Birthday to my motherland! I sincerely
General pride	Physical gatherings and return to digital realms. Instead, alt-right gangs such as the **Proud** Boys, the Atomwaffen Division, and their followers, have become bolder, engaging in	大众音乐文化，倒真是"来不得半点的虚伪和骄傲"。听众一般并不会因为社会炒作的厉害不厉害	The popular music culture, which really "cannot afford to have any dishonesty and **pride."** The audience will generally not fall for any hypes
Non-Pride	Such as lions, which often hunt and raise their cubs along rivers. Lion **prides** have the highest reproductive success when their territories are in areas where rivers come together	好是个黄金单身汉吧!12月21日综合报导自大S替小S代班主持《康熙来了》收视屡创新高。	You'd better be a desirable bachelor! On December 21, it was reported that **since Big** S replaced Little S as the host, the TV show "Here Come Kang & Xi" has set a new record in its ratings. ["since big" has the same characters as self-pride in Chinese]

TABLE 2 | Individual pride and collective pride in Chinese and American corpora.

	China		America		*z*-score
	Frequency	**Percent %**	**Frequency**	**Percent %**	
Blog genres					
Individual pride	547	36.6	660	45.1	−4.67
Relational pride	532	35.6	444	30.3	3.09
National pride	64	4.3	158	10.8	−6.73
General pride	350	23.4	203	13.9	6.75
News genres					
Individual pride	402	25.7	668	49.1	−13.40
Relational pride	657	42.0	430	31.6	5.84
National pride	414	26.5	117	8.6	13.23
General pride	92	5.9	145	10.7	−4.66

The absolute value of z-score >2 is considered to be significant.

Verkasalo, 1995; Paulhus and John, 1998; Dunning, 1999; Robins and Beer, 2001; Cohen, 2011).

Our first finding was that the American corpus had higher baseline usage of pride-related words than the Chinese corpus. This finding suggests that Americans tend to express pride, whereas Chinese tend to suppress the expression of pride. Indeed, as mentioned earlier, Eid and Diener (2001) previously found that Chinese reported experiencing pride at a lower frequency and with a lower level of intensity than did Americans. More than for the emotion of pride, researchers (e.g., Russell and Yik, 1996) have recognized that Chinese people consider it to be a desirable trait to suppress many kinds of emotions (both positive and negative).

Within the usage of pride-related items, we found that the American corpus (of both news and blog genres) included a higher proportion of individual pride items and a lower proportion of relational pride items than the Chinese corpus. These findings are consistent with our hypothesis derived from a theoretical discussion of the implications of individualism-collectivism and independent/interdependent self-construal of emotions (Markus and Kitayama, 1991; Triandis and Gelfand, 1998; Brewer and Chen, 2007). Our results also echo empirical evidence from prior research using questionnaires (Stipek, 1998; Scollon et al., 2004) and cultural priming (Neumann et al., 2009).

Expressions of individual pride in interdependent cultures may be decreased or avoided to minimize potential interpersonal

conflict and maintain social harmony (Scollon et al., 2004; Matsumoto et al., 2008). Indeed, individual pride may be associated with negative emotions in Asian cultures (Stipek, 1998; Scollon et al., 2004). Chinese individuals may also be more modest than individuals in Western cultures, especially in terms of individual pride (Heine et al., 1999). However, relational pride is encouraged in Eastern cultures; several studies have suggested that collective culture promotes pride for others (such as one's family, friends, and team) (Stipek et al., 1989; Neumann et al., 2009; Liu et al., 2014).

In terms of national pride, however, we found that cultural differences depended on the genre. The Chinese news genre contained more national pride items than did the American news genre, but the opposite was true for the blog genre. A possible explanation is that the traditional Chinese news media (such as newspapers and news journals) still play a significant propaganda-related role by focusing on the positive achievements of the country (Stockmann and Gallagher, 2011). In contrast, the American news media may be more critical of their government, hence focusing less on national achievements. Private citizens, on the other hand, might have reacted to the national news media and hence showed an opposite pattern. Future research is needed to test this speculation.

Finally, there were also cultural differences in the general pride category—more such items in the Chinese blog genre than in the American blog genre, but the opposite for the news genre. This pattern does not easily lend to a theoretically meaningful explanation. However, because these data were based on the proportions (i.e., relative to other categories), it might have just reflected the consequences of the other cultural differences discussed above. To our knowledge, this study is the first to examine cultural differences in individual and collective pride based on specific corpora. Our findings extend the collectivistic characterization of Chinese to include relational pride and national pride. The results also support the notion that culture as well as other factors (e.g., political factors) plays an important role in emotional expression (e.g., Mesquita and Frijda, 1992; Kitayama et al., 1997, 2006; Matsumoto et al., 1998; Mesquita, 2001; Tsai and Park, 2014; Tsai et al., 2016).

Several limitations of this study and their implications for future research need to be mentioned. First, we relied on limited cultural corpus samples (Chinese and American), to represent individualistic and collectivistic cultures. We did not include other major varieties of English language such as British and Australian English, which have been found to involve different cultural scripts in emotional expressions (Goddard, 2012). Future research should replicate our finding using corpora from other varieties of the English language as well as other languages representing individualistic cultures (e.g., German and French) and collectivistic cultures (e.g., Japanese, Korean, Mexican, and Spanish). Second, we did not analyze temporal changes in individual pride and collective pride. Several recent studies have indicated that cultural patterns can shift over time (Twenge et al., 2013; Hamamura and Xu, 2015; Zeng and Greenfield, 2015). Future research should consider time-series analysis. Such an approach may also reveal the importance of single events on national pride (c.f., the role of sporting events in national pride, Kavetsos, 2012). Finally, our text analysis can be complemented by cross-cultural experiments that would reveal relevant cognitive and emotional mechanisms.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found at: http://bcc.blcu.edu.cn/; https://www.englishcorpora.org/coca/.

ETHICS STATEMENT

This study was carried out in accordance with recommendations of the Research Ethics Committee of Renmin University of China with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the Research Ethics Committee of Renmin University of China.

AUTHOR CONTRIBUTIONS

CL and GY designed the original study and conducted final critical revision. JL, HW, and LY conducted literature searches and statistical analysis. CL and CC wrote and revised the manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.513779/full#supplementary-material

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