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PAPER

The role of experience during childhood in shaping the other-race effect

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Abstract

It is well known that adults' face recognition is characterized by an 'other-race effect' (ORE; see Meissner & Brigham, 2001), but few studies have investigated this ORE during the development of the face processing system. Here we examined the role of experience with other-race faces during childhood by testing a group of 6- to 14-year-old Asian children adopted between 2 and 26 months in Caucasian families living in Western Europe, as well as a group of age-matched Caucasian children. The latter group showed a strong ORE in favour of own-race faces that was stable from 6 to 14 years of age. The adopted participants did not show a significant reversal of the ORE, unlike a recently reported study (Sangrigoli et al.*, 2005), but rather comparable results with Asian and Caucasian faces. Their pattern of performance was neither influenced by their age of adoption, nor by the amount of experience they accumulated during childhood with other-race faces. These results indicate that the balance of performance with Asian and Caucasian faces can be modulated, but not completely reversed, in children whose exposure to own- and other-race faces changes drastically during the period of maturation of the face recognition system, depending on the length of exposure to the new face race. Overall, experience appears to be crucial during childhood to shape the face recognition system towards the most predominant morphologies of faces present in the environment.*

Introduction

Human adults are better at discriminating and recognizing individual faces of their own race as compared to faces of a different race. This phenomenon is reported in the face literature as the 'other-race effect' (ORE) and its robustness and reliability have been generalized in different ethno-cultural groups, across different memory tasks (e.g. old/new recognition task) and dependent variables (e.g. Accuracy, RTs) (for a meta-analysis, see Meissner & Brigham, 2001). Researchers generally agree that the ORE is due to a lack of visual experience at processing faces of a different race than the faces of a single race as seen in everyday life in most unicultural societies (e.g. Le, Farkas, Ngim, Levin & Forrest, 2002). However, there is little agreement about how our differential experience with other-race and same-race faces underlies the ORE (Slone, Brigham & Meissner, 2000). Some authors have argued that our perceptual system is unable to generalize its expertise gained at processing same-race faces to other-race faces (e.g. Goldstein & Chance, 1980; Rhodes, Tan, Brake & Taylor, 1989), leading to a differential mental representation of same-race and other-race faces (e.g. Valentine, 1991). In this context, recent studies have supported the view of a differential representation for same-race and other-race faces, showing that facial features of other-race faces are less strongly integrated into a global (so-called 'holistic') representation than facial features of same-race faces (Michel, Caldara & Rossion, 2006a; Michel, Rossion, Han, Chung & Caldara, 2006b; Tanaka, Kiefer & Bukach, 2004). Other authors have rather proposed a socio-cognitive account of the ORE, according to which the reduced performance on other-race faces is due to an emphasis on category membership (i.e. race) for other-race faces ('*It's an African*'), at the expense of individuality ('*It's Bob*') (e.g. Levin, 2000).

Very few studies have investigated the ORE during the development of the face processing system (Brigham, 2002). Spontaneous visual preference for same-race faces has not been observed in newborns, but as early as in 3-month-old infants (Bar-Haim, Ziv, Lamy & Hodes, 2006; Kelly, Quinn, Slater, Lee, Gibson, Smith, Ge & Pascalis, 2005; Kelly, Liu, Ge, Quinn, Slater, Lee, Liu & Pascalis, 2007a). More classical recognition paradigms revealed the presence of an ORE in 13- to 16-year-old adolescents (Walker & Hewstone, 2006), 9- to 20-year-old adolescents (Corenblum & Meissner, 2006), 6- to 20-year-old participants (Chance, Turner & Goldstein, 1982;

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Goldstein & Chance, 1980), 3- to 5-year-old children (Sangrigoli & de Schonen, 2004a), 6- to 9-month-old infants (Kelly, Quinn, Slater, Lee, Ge & Pascalis, 2007b) and 3-month-old infants (Sangrigoli & de Schonen, 2004b). These latter studies were performed with Caucasian children or adolescents at different stages of the development of their face processing system, which is known to evolve until puberty (e.g. Carey, Diamond & Woods, 1980; Mondloch, Geldart, Maurer & Le Grand, 2003). Other studies (Feinman & Entwhistle, 1976; Pezdek, Blandon-Gitlin & Moore, 2003) reinforced the evidence for an ORE onset during childhood by testing both Caucasian and non-Caucasian children.

However, contradictory results are characterizing the developmental course of the ORE. Whereas Chance and collaborators (1982), as well as Feinman and Entwhistle (1976), proposed that the ORE is increasing with age, more recent studies suggest that the ORE bias develops early and remains relatively stable across a wide age span (Corenblum & Meissner, 2006; Pezdek *et al.*, 2003; Sangrigoli & de Schonen, 2004a). Unfortunately, these latter studies present limitations such as the absence of reported response times data (Pezdek *et al.*, 2003), the small number of face stimuli used in the recognition stage (Pezdek *et al.*, 2003), the limited age span represented (3- to 5-year-old children; Sangrigoli & de Schonen, 2004a; older children and adolescents whose face recognition system might be nearly mature; Corenblum & Meissner, 2006) and the discontinuity in the age groups assessed (Pezdek *et al.*, 2003). Thus, there is still considerable uncertainty about the ORE trajectory during development.

In addition, studies that aim to inform about the role of experience in shaping the ORE have been carried out only on adult participants. Most significantly, Sangrigoli, Pallier, Argenti, Ventureyra and de Schonen (2005) tested adults of Korean origin adopted in France between 3 and 9 years of age, and showed that their ORE was reversed by experience with a new race of faces: they were significantly better at recognizing Caucasian than Asian faces. Moreover, their advantage for other-race faces was as large as the ORE of a control group of French participants. These results are particularly interesting because they indicate that the face recognition system remains plastic enough during childhood to reverse the ORE.

However, following this recent study, an important theoretical question remains unsolved: it is unclear whether the reversed ORE occurred in these Asian participants as a result of their experience accumulated with Caucasian faces while the face processing system was still developing and/or because of their extremely long experience with Caucasian faces since their adoption (23 years on average). It may well be that these participants would still have been good at performing with faces of their own race if tested within a few years of their adoption, during childhood, when their face processing system was still under development. In other words, it may well be that Asian adopted participants tested as children, after limited exposure to Caucasian faces, would still be able to process own-race (Asian) faces at a good level. To clarify this issue, we tested here a sample of 23 Asian children between 6 and 14 years of age, who were adopted early (between 2 and 26 months), in a European country (Belgium). This is the first goal of the present study.

The second goal is justified by the need to replicate and extend Sangrigoli *et al.*'s (2005) study, which had several potential methodological limitations. First, the task used in that study (a delayed match-to-sample task) was not the most widely used and most sensitive to measure the ORE (Meissner & Brigham, 2001). Hence, despite the fact that targets were presented for a very short time (120 ms or 250 ms), accuracy rates during the task were very high and the size of the ORE was very small (i.e. differences of 1.3% to 2.3% between same-race and other-race face conditions). Second, the study was conducted on a very small sample of participants (12 participants by group). Third, response times, which may be sensitive indicators of the adults' ORE (Meissner & Brigham, 2001) and may have complemented the small differences observed in accuracy rates between conditions, were not reported. Finally, only a few black-and-white face stimuli (12 pairs of Caucasian faces and 12 pairs of Asian faces), with external features (e.g. hairline) present were used in this experiment. Thus, participants could have based their judgment on these external diagnostic cues only. Their intrinsic characteristics (e.g. hair texture varying naturally more in Caucasian than in Asian faces) could also have induced a general improvement of performance with a specific face category.

In the current study, we measured the ORE both in accuracy rates and response times using a classical old/new paradigm (see Michel *et al.*, 2006a, 2006b) and a large set of carefully controlled stimuli presented without external features, but in full colour (which is arguably a diagnostic cue for between- and within-race face categorization). The main aim of the study was to examine the role of experience on the ORE in a group of 23 Asian adopted children who underwent a radical change in the category of faces predominantly seen in the visual environment while their face processing system was still under maturation (Carey *et al.*, 1980). In comparison, we tested a group of 84 age-matched Caucasian children who were almost exclusively exposed to own-race faces during their development. Crucially, as they were tested during childhood (vs. adulthood, after 23 years of exposure on average to Caucasian faces in Sangrigoli *et al.*, 2005), Asian children's time of exposure with the new face category was limited to 6 to 14 years in the present study. We hypothesized that if being suddenly exposed to Caucasian faces when the face recognition system is still developing is sufficient to erase the advantage at processing Asian faces, then Asian adopted children should show a reversed ORE in favour of other-race, i.e. Caucasian, faces. On the contrary, if Asian adopted children are still showing good sensitivity at processing Asian faces, even after a 6- to 14-year period of exposure to the new face race, then they should either perform better with Asian than Caucasian faces or at least show relatively better recognition abilities with Asian faces when compared to Caucasian children. Finally and according to recent results (de Heering & Rossion, 2008), we hypothesized that the length of exposure to a specific face category should be considered as a crucial factor that influences the face recognition system.

Methods

Participants

Twenty-three children (Mean age = 116 months; *SD* = 29; one male) originating from China (*n* = 13) or Vietnam (*n* = 10) took part in the experiment. They were adopted between 2 and 26 months and had spent between 60 and 164 months in Belgium at the time of testing. All of them had normal or corrected-to-normal vision. Eighty-four age-matched 6- to 14-year-old Caucasian children (Mean age = 119 months; *SD* = 30; 37 males) recruited from different schools in Brussels (Belgium) and its surroundings participated in the study. All of them had a normal or corrected-to-normal visual acuity.

Stimuli

Eighty Caucasian (i.e. Belgian; 40 male) and 80 Asian (i.e. Chinese; 40 male) adult face stimuli were used in the present experiment. They led to a strong ORE in Asian and Caucasian adult participants tested in previous studies (Michel *et al*., 2006a, 2006b). All pictures were coloured full-front faces, without make-up, posing with neutral expression. Their external features were also removed (see Figure 1). They were unfamiliar to the participants and were arranged on a black frame subtending approximately 8 × 10 degrees of visual angle.

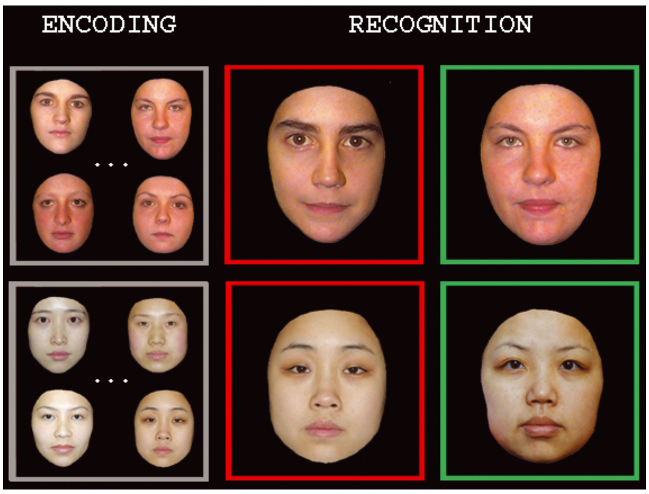

Figure 1 *Examples of Caucasian and Asian faces used during the encoding and recognition stages.*

Procedure

The task (i.e. old/new paradigm) was presented to the children as a memory game in which s/he would have to identify a previously seen face among two faces: the target and a distractor. To familiarize the children with the instructions, they were first confronted with three Caucasian and two Asian faces that they had to memorize and then identify among pairs of Caucasian or Asian faces. Following this short practice, participants performed eight experimental blocks. Each experimental block was composed of an encoding and a recognition stage where the gender (male (M) or female (F)) and the race (Asian (A) or Caucasian (C)) were fixed. Consequently, a participant saw either Asian male (AM), Asian female (AF), Caucasian male (CM) or Caucasian female (CF) faces in an experimental block. To counterbalance gender and race order effects, the experimental blocks were distributed as follows throughout the experiment: AF-AF-CM-CM-AM-AM-CF-CF (distribution 1) or CF-CF-AM-AM-CM-CM-AF-AF (distribution 2). During the encoding stage, 10 faces (AM, AF, CM or CF) appeared sequentially in the middle of the screen for 3 seconds followed by a 1 second blank interval. To ensure that children were paying attention to the stimuli, they were asked to judge orally if the face was pleasant or not. The experimenter pressed the boxes for the children because they had extra difficulties associating their judgments with the response boxes that were not made for this purpose (see below). Given this, neither children's qualitative responses (pleasant/unpleasant) nor their response times collected during the encoding stages were included in the analyses. A recognition stage was composed of the 10 targets (AM, AF, CM or CF) presented during the encoding stage, each coupled with a same-race (A or C) and same-gender (M or F) distractor, with the left and right position of the target counterbalanced across trials. Pairs of faces were presented on the screen until the participant's response. We used a red and a green wooden response box corresponding to the red and green frame respectively surrounding the left and right face appearing on the screen (see Figure 1) in order to help the children perform the recognition stages adequately and to collect both their accuracy rates and response times. Children were tested individually in a quiet room at a distance of 50 cm from the screen of a laptop computer. Data were collected using E-Prime 1.1.

Results

Every Caucasian child achieved above 60% of correct responses at least in the Caucasian and/or the Asian condition. They showed higher accuracy rates with

Caucasian (M = 73%, SD = .08) than with Asian faces (M = 66%, SD = .09; $t(83)$ = 6.048, p < .0005). This advantage at recognizing Caucasian faces was not present on response times (Caucasian faces: M = 1976 ms, SD = 715; Asian faces: M = 1988 ms, SD = 705; $t(83)$ = .336, p = .738). Their ORE, calculated as the ratio between their performance in the Asian and Caucasian conditions (Accuracy Ratio: (C − A)/(C + A)), was not influenced by participants' gender ($t(82)$ = −1.103, p = .273) and was stable across age, as suggested by the absence of any correlation between the magnitude of the ORE and the age (months) of children, Bilateral Pearson correlation = −.051, p = .323.

The Asian adopted sample of participants also performed better than chance level (60%) in the Asian and/or in the Caucasian condition. They performed equally well with Caucasian (M = 70%; SD = .08; M = 2601 ms, SD = 1090) and Asian (M = 67%; SD = .08; M = 2477, SD = 872) faces, both when considering their accuracy rates ($t(22)$ = 1.448, p = .162) and their response times ($t(22)$ = 1.137, p = .268). We further tested whether this pattern of results was dependent on participants' ethnic origin (Chinese vs. Vietnamese), their age of adoption (early adoption vs. late adoption) and/or the time they were confronted with Caucasian faces (limited experience vs. greater experience) (see Table 1). For ethnic origin, it clearly appeared that Chinese children's balance of performance with Asian and Caucasian faces (Accuracy Ratio: (C − A)/(C + A)) did not differ significantly from Vietnamese children's balance ($t(21)$ = 0.95, p = .925). Regarding age, the early adopted group did not show better performance with Caucasian faces than the late adopted group ($F(1, 21)$ < .0001, p = .999), even when controlling for the amount of experience accumulated with Caucasian faces ($t(21)$ = .08, p = .937). Likewise, adopted children with greater experience with Caucasian faces did not show a greater balance in favour of Caucasian faces than adopted children with less experience with this face category ($F(1, 21)$ < .0001, p = .999), when controlling for their mean age of adoption ($t(21)$ = .143, p = .888). In short, these results suggest that Asian children's balance of performance between the Asian and the Caucasian conditions was not influenced by the amount of experience (6 to 14 years) accumulated with Caucasian faces and was equally modulated, whether adoption occurred at 2 or 26 months of age. Moreover, this balance was stable across time, as suggested by the absence of any correlation between the accuracy ratios (i.e. C − A)/(C + A)) and the age (months) of these children, Bilateral Pearson correlation = .033, p = .882.

When contrasting the 23 Asian adopted children's to the 23 first tested Caucasian children's balances of performance with Asian and Caucasian faces (Accuracy Ratio: (C − A)/(C + A)) in order to control for potential group size effects, we found an interaction between participant's race (Asian or Caucasian) and the race of the face (Asian or Caucasian), ($F(1, 44)$ = 4.604, p = .037). Note that this limited set of 23 Caucasian children was representative of the whole Caucasian group since they showed an advantage at recognizing Caucasian over Asian faces on accuracy rates (p < .0005) but not on response times (p = .351) that was not correlated to their age (p = .236). Subsequent t-tests indicated that Asian adopted children did not differ from Caucasian children when considering separately their performance for the Asian ($t(44)$ = 1.602, p = .116) or the Caucasian faces ($t(44)$ = 1.070, p = .291). This interaction arose because the adopted participants performed slightly worse with Caucasian faces (70% vs. 73% for the non-adopted group) and better with Asian faces (67% vs. 66%) than Caucasian children. The significant interaction was confirmed by an analysis of participants' accuracy ratios (i.e. (C − A)/(C + A)) that revealed a significant difference between the groups ($t(44)$ = 2.139, p = .038) (see also Figure 2).

General discussion

In line with some previous observations (Corenblum & Meissner, 2006; Pezdek *et al.*, 2003; Sangrigoli & de Schonen, 2004a) but inconsistent with others (Chance *et al.*, 1982; Feinman & Entwhistle, 1976), 6- to 14-year-old Caucasian children demonstrated a clear ORE in favour of own-race faces that did not increase with age. We also found that children of Asian origin (Chinese or Vietnamese) adopted into Caucasian

Table 1 *Magnitude of the ORE (Accuracy Ratio: (C − A)/(C + A): means (M), standard deviations (SD)) in Asian adopted children according to (1) their age of adoption (Early adopted group < Median = 10 months of age < Late adopted group) when the time they spent in Belgium is controlled (t(21) = .08, p = .937) and (2) the time they spent in Belgium accumulating experience with Caucasian faces (Limited experience group < Median = 106 months < Greater experience group) when controlling for the children's age of adoption (t(21) = .143, p = .888)*

		Age of Adoption (months)	
Magnitude of the ORE (Accuracy Ratio = (C − A)/(C + A))		Early adoption (< 10 months)	Late adoption (> 10 months)
Time in Belgium (Amount of accumulated experience with Caucasian faces, months)	Limited experience (< 106 months)	M = .02 SD = .06	M = .03 SD = .08
	Greater experience (> 106 months)	M = .02 SD = .08	M = .03 SD = .09

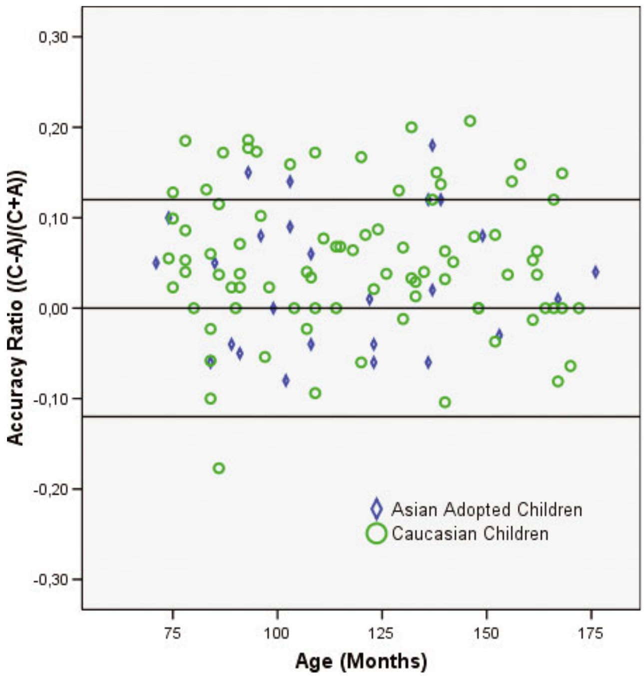

Figure 2 *Distribution of the ORE of Asian adopted children (◇) as compared to Caucasian children (o). Negative scores indicate participants' tendency at performing better with Asian faces whereas positive scores indicate their tendency at performing better with Caucasian faces.*

families living in Europe between 2 and 26 months performed equally well with Caucasian faces and Asian faces when tested 6 to 14 years after adoption. Their balance of performance with Asian and Caucasian faces (Accuracy Ratio: (C − A)/(C + A)) was neither correlated with their age of arrival in the European country, nor with the duration of exposure to other-race faces during childhood (< 106 months; > 106 months). These results reinforce the recent observation (Sangrigoli *et al.*, 2005) that the advantage at processing own-race faces can be modulated by experience with other-race faces if exposure starts during development. Indeed, Asian adopted children did not show the classical ORE in favour of own-race faces.

However, the present results do not entirely fit with Sangrigoli and collaborators' (2005) observations since we did not observe any reversal of the ORE in Asian adopted children. More specifically, whereas these authors showed a reversed ORE in their adult participants, the adopted children who were tested here did not perform better with other-race faces. This lack of reversal is unlikely to result from methods (e.g. stimuli, task) being not sufficiently controlled since we tested a much larger sample of participants, used a more sensitive old/new recognition task as compared to a face matching task, and had a larger set of stimuli presented without external features. As a result, Sangrigoli and collaborators' (2005) adult participants appeared to perform at ceiling even for other-race faces (above 92% for all conditions) while our participants performed between 66% and 73%. Consequently, we found an own- and other-race face difference that was much more substantial (i.e. 7% for our Caucasian participants as compared to 2.1% in Sangrigoli *et al.*, 2005). Similarly, the small advantage in accuracy rates (i.e. 3%) that we found in Asian adopted children for Caucasian faces did not reach significance, but was nevertheless higher than the effect reported by Sangrigoli and colleagues (2005) (i.e. 2.3%). This is most likely due to a greater variance induced by the classical old/new paradigm we used here as compared to a two-alternative forced choice matching task performed at ceiling by participants (Sangrigoli *et al.*, 2004a). Given these methodological differences, one should remain cautious in attributing too much importance to the fact that the two studies tested different populations (adults vs. children) to account for their differential results. Because of the greater sensitivity and external validation of the paradigm used here, we believe that a replication of Sangrigoli *et al.*'s study would be interesting with identical or similar parameters to the ones used here.

Keeping these elements in mind, the present results seem to indicate that visual experience is crucial during the period of maturation of the face recognition system. This is consistent with a whole line of research (e.g. Corenblum & Meissner, 2006; Cross, Cross & Daly, 1971; Feinman & Entwistle, 1976; Furl, Phillips & O'Toole, 2002; Hancock & Rhodes, 2008; Kuefner, Macchi Cassia, Picozzi & Bricolo, 2008; Kuhl, 1994, 1998; Levin, 2000; Sangrigoli & de Schonen, 2004a, 2004b; Sangrigoli *et al.*, 2005; Walker & Hewstone, 2006) that argues in favour of the idea that behavioural effects of experience during development may differ markedly and qualitatively from the effects of experience later in life. For example, Furl and colleagues (2002) recently suggested the importance of considering development as a critical temporal window during which experience is progressively warping the face representational system. According to the authors, once in place, the system limits the encoding of new faces and is consequently less sensitive to the new inputs. This framework was built among other things on the observation that children and adolescents living in segregated neighbourhoods show a larger ORE than children and adolescents living in integrated neighbourhoods (e.g. Cross *et al.*, 1971; Feinman & Entwhistle, 1976) while mixed results characterize the reversal or levelling of the ORE in adulthood (Elliott, Wills & Goldstein, 1973; Goldstein & Chance, 1985; Malpass, Lavigueur & Weldon, 1973; but see Furl *et al.*, 2002; Levin, 2000; Meissner & Brigham, 2001).

These results also emphasize the importance of the length of exposure to the new face race to stabilize recently acquired face representations. Indeed Asian adopted adults' long experience with Caucasian faces (23 years on average) was large enough to reverse their ORE (see Sangrigoli *et al.*, 2005). On the contrary, Asian adopted children's limited experience (6 to 14 years) with this face race appears as insufficient to erase totally Asian face representations acquired earlier and to reverse significantly their performance on Caucasian faces, even if they were already at that time slightly better with this face category than with Asian faces. This finding is compatible with the observation that almost 10 years of experience are necessary for teachers to be better at processing children's faces than adult faces holistically, which indicates more generally that even in adulthood the face processing system can be modulated by prolonged visual experience with a specific face category (i.e. children's faces) (de Heering & Rossion, 2008).

To summarize, our observations indicate that face representations remain plastic enough to be modified or incorporate faces from another race (i.e. other-race faces) at least if being confronted with the new population of faces starts when the face processing system is still evolving (Carey *et al.*, 1980) and if a certain amount of experience is acquired with the new face race. Yet, 6 to 14 years of exposure to Caucasian faces are not sufficient to erase fully the own-race face representations acquired during infancy (Kelly *et al.*, 2007b; Sangrigoli & de Schonen, 2004b). This phenomenon is clearly reflected in Figure 2, illustrating Asian adopted participants' tendency to score more negatively than age-matched Caucasian participants when considering their accuracy ratios (i.e. $(C - A)/(C + A)$).

Several questions related to the question of the role of experience in shaping the ORE remain as yet unresolved and deserve future investigation. For instance, if children's face recognition system is plastic during development, it should be able to handle different races of faces efficiently, and consequently show a wider tuning to face morphology when exposed to several races of face than when exposed to a single race. This could be tested with children raised in multicultural societies. Moreover, children whose face recognition system is still plastic should show increased effects of training with other-race faces, as well as a deficit in holistic processing for other-race faces (Michel *et al.*, 2006a, 2006b; Tanaka *et al.*, 2004) that could be erased much faster than in adults.

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