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Cross-cultural perceptions of facial resemblance between kin

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Humans use facial comparisons to identify their relatives and adjust their behavior accordingly. However, the mechanisms underlying the assessment of facial similarities are poorly known. Here, we investigate the role of exposure to particular faces for the detection of facial similarities by asking judges to detect parent–child pairs using faces from different origins. In a first phase, French and Senegalese judges assessed facial resemblance in French and Senegalese families. In a second phase, Senegalese judges who had immigrated to France, as well as French and Senegalese stationary judges, were asked to rate a second set of Senegalese and French families. The judges showed no differences in their ability to detect parent–child pairs in French and Senegalese families in both the first and second phases. For judges who changed their country of residence, the answer time and duration of stay in the new country were not associated with correct assignment rates. Our results suggest that exposure has a limited role in the ability to process facial resemblance in others, which contrasts with facial recognition processing. We also discuss whether processing facial similarities is a by-product of the facial recognition system or an evolved ability to assess kinship relationships.

Keywords: face recognition, learning, plasticity

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Introduction

Evidence that individuals recognize their kin and regulate their behavior accordingly has been documented in a variety of social species including insects, birds, fishes, mammals, and primates (reviewed in Chapais & Berman, 2004; Hepper, 1991; Holmes & Sherman, 1983). The ability to recognize kin can be extended to third party relationships, that is, relatedness among other individuals. Monkeys, for instance, are able to categorize kinships among others (in baboons, Bergman, Beehner, Cheney, & Seyfarth, 2003; in vervet monkeys, Cheney & Seyfarth, 1980; and in java monkeys, Dasser, 1988). This capacity could be a by-product of the selective pressure to detect one's own kin. However, it could also result from

selection acting directly on the recognition of kinship relationships among other individuals. This capacity may have evolved in social species: when alliances are common, it could be beneficial to detect the relatedness among other individuals to predict alliances (Cheney & Seyfarth, 2004). For example, individual macaques recruit allies that are not related to their opponent during agonistic interactions (Schino, Tiddi, & Di Sorrentino, 2006). In most human societies, political structures have been dominated by coalitions of related males (fraternal kinship groups), and the ability to identify third party relationships would have been critical for individuals to choose allies (Rodseth & Wrangham, 2004).

This capacity to identify relatedness among individuals may rely on environmental or phenotypic cues. The environmental cues could be the familiar other's peri-

natal association with the individual's biological mother and the duration of coresidence (i.e., shared experience; Lieberman, Tooby, & Cosmides, 2007), or the rate of association between individuals (i.e., associative learning, Hepper, 1991). These mechanisms, however, require that environmental cues are reliable indicators of relatedness, which is not always the case (such as when illegitimate children are frequent). Thus, in this context, individuals may rather rely on phenotypic cues, which are produced directly by the individuals. The recognition of kin may then be achieved through phenotype matching, a mechanism by which a target phenotype is compared to a "template" phenotype (Hauber & Sherman, 2001; Hepper, 1991; Lacy & Sherman, 1983). This "template" phenotype may refer to those of its familiar kin or its own phenotype (i.e., the "armpit effect," Mateo & Johnston, 2000).

A large body of evidence suggests that humans use facial resemblance as a relatedness cue and subsequently adjust their behavior. Individuals exhibit more trust (DeBruine, 2002, 2004, 2005; Platek, Krill, & Wilson, 2009; Platek & Thomson, 2007), altruism (DeBruine, Jones, Little, & Perrett, 2008), and decisions of paternal investment toward self-resembling faces (Alvergne, Faurie, & Raymond, *in press*; Apicella & Marlowe, 2004; Platek et al., 2003, 2004, 2005; Volk & Quinsey, 2002). In addition, facial resemblance to self decreases the attractiveness of the opposite sex (DeBruine, 2005), which reinforces the idea that perception of facial resemblance is associated with behavioral decisions pertinent to kin selection, kinship detection allowing inbreeding avoidance or adjustment of pro-social behaviors. Interestingly, there is some recent evidence that kin detection is performed using self-referent phenotype matching (Bressan & Zucchi, 2009; Platek & Kemp, 2009). For instance, self-resembling faces activate similar neural substrates than actual kin faces (Platek & Kemp, 2009). Overall, there is converging evidence that humans possess evolved cognitive abilities to differentiate kin from non-kin on the basis of facial resemblance, using a particular combination of existing neurocomputational architecture (Platek & Kemp, 2009; Platek et al., 2008, 2009).

Humans are also able to use facial resemblance to detect kinship relationships among other individuals. People asked to assess facial pictures of unfamiliar individuals are able to detect resemblance between children and parents (reviewed in Alvergne, Faurie, & Raymond, 2007; but see also Alvergne et al., *in press*) and also among siblings, whether the stimuli depict child faces (Maloney & Dal Martello, 2006) or adult faces (DeBruine et al., 2009). Interestingly, external judgments about facial resemblance (i.e., "social mirror") are potentially used by individuals when making behavioral decisions. For instance, the frequency of spouse and child abuse perpetrated by men is negatively related to how often

others have told them that the children looked like them (Burch & Gallup, 2000). The cognitive processes associated with the detection of facial resemblance among others have, however, received little attention to date. In particular, it is not known whether this ability is a by-product of facial recognition as such or if it rather implies different cognitive abilities.

There is now good evidence that facial recognition operates early in life, with infants showing an innate face-oriented cognitive mechanism (Farroni et al., 2005; Johnson, Dziurawiec, Ellis, & Morton, 1991). Facial recognition is not, however, species-specific until 6 months of age, after which infants cannot discriminate between other primates' faces (Pascalis, de Haan, & Nelson, 2002). This phenomenon, called "perceptual narrowing," is perhaps the result of the cortical specialization that occurs with exposure to faces (Nelson, 2001). The importance of exposure for recognizing faces is further supported by a large number of studies showing an "other-race effect," which is defined as a greater capacity to recognize faces of one's own cultural group as compared to faces from other cultural groups (reviewed in Meissner & Brigham, 2001). However, between 3 and 9 years of age, this effect may be reversible when children are exposed to new types of faces (Sangrigoli, Pallier, Argenti, Ventureyra, & de Schonen, 2005). It is thus widely thought that facial recognition of individuals is specialized in adulthood, and increased expertise in facial processing is assumed to increase the ability to process relational information between facial features (such as nose, mouth, and eyes); this cognitive ability is referred to as configural processing (see Farah, Wilson, Drain, & Tanaka, 1998).

However, the effect of exposure to particular types of faces on the ability to detect kinship in other individuals' relationships is currently unknown. It is possible that the processing of facial similarities is simply a by-product of facial recognition and, thus, also highly sensitive to exposure. However, it could also be an independent mechanism utilizing distinct facial information. Some studies have shown that humans are able to detect facial resemblance between kin in chimpanzees, gorillas, and mandrills (Alvergne et al., 2009; Vokey, Rendall, Tangen, Parr, & de Waal, 2004), which suggests that exposure is not the only determinant of the kinship detection capacity.

In this study, we investigated whether the detection of facial similarities among unfamiliar pairs of parents and children is associated with an "other-race effect." Individuals born and still living in a given country (France and Senegal) were asked to infer kinship among faces from their own country or from the other country. Additionally, we compared Senegalese judges who had changed their country of residence with people who had stayed in their natal country to evaluate whether or not kinship detection capacity depends on exposure.

Methods

Facial pictures (mothers, fathers, and children)

Pictures of families (mothers, fathers, and children) from France (two sets, F1 and F2; $N_{F1} = 34$, $N_{F2} = 17$) and Senegal (two samples, S1 and S2, $N_{S1} = 39$, $N_{S2} = 24$) were either obtained from previous studies (F1) or taken specifically for the purpose of this study (other samples; see Table 1 for details on child age, sex repartition, and origin of pictures for each sample). Note that the actual paternity was not controlled (DNA data are not available) thus introducing a possible noise for the assessment of paternal resemblance. Nevertheless, the proportion of illegitimate children in our samples is likely to be very low (the median rate of non-paternity worldwide is ~3.9%; Anderson, 2006).

For each sample, color pictures were taken in a front view of the person at a distance of approximately 1 m using a digital camera (Canon EOS 20D); the same general settings were used for all photos. Subjects were asked to express a neutral face and look directly at the camera. All photographs were processed using Adobe Photoshop 7 to normalize the contrast and luminosity and to turn all backgrounds into white (Senegalese pictures) or black (French pictures). All families participated in the study on a voluntary basis and gave their consent after being informed about the general research project. The study received the approval of both the French National Committee of Information and Liberty (CNIL) and the Senegalese National Council of Health and Research.

Facial resemblance assessment

To assess parent–child facial similarities, the general procedure described in Alvergne et al. (2007) was used. Resemblance was assessed by asking judges to identify the true parent among a set of three adults of the same sex (Figure 1). The other two adults presented, in addition to the true parent, were randomly selected among parents of children who were not examined by a given judge. For each child, the resemblance to the father and the mother



Figure 1. Example of facial recognition test using pictures of mother–child pairs from Senegalese families. Judges from both France and Senegal were asked to (1) look at the face of the child presented below and to (2) choose which picture was most likely to portray its mother among the pictures proposed above. The order of children, the position of correct mothers, as well as the choice of false mothers were randomized. Each picture was seen only once by a given judge. Here, the correct choice is the middle picture.

was evaluated independently by the same judges. The judges were volunteers who did not know the families presented in the photographs. The judges' sex, age, number of children, and birth order were recorded. Judges were unaware of the purpose of the study when assessing resemblance. A computer program (written in Delphi, version 7) was used to randomize and assist each part of the test. Each picture was seen by a given judge only once, except those displaying children (viewed both in the mothers' test and the fathers' test). For each child in a given test, the judge's score was recorded as 0 for failure or 1 for success. The expected proportion of correct matches from all judges for one child varies between 1/3 (no resemblance) and 1 (perfect resemblance).

The study was divided into two phases. In the first part (Phase 1), judges from France and Senegal were asked to rate the resemblance of children to both their mothers and

Sample name	Source	Sample size			Child age (years)	
		Total	Girls	Boys	Min–Max	Mean ± SD
F1	Alvergne et al. (2007)	34	18	14	2–6	3.9 ± 2.3
S1	Present study	39	18	21	2–6	4.0 ± 1.2
F2	Present study	17	8	9	4–6	5.1 ± 0.6
S2	Present study	24	14	10	4–6	5.1 ± 0.7

Table 1. Sample size, age, and sex of children according to their cultural group. F1: French families tested in Phase 1; S1: Senegalese families tested in Phase 1; F2: French families tested in Phase 2; and S2: Senegalese families tested in Phase 2.

their fathers (in a randomized order) in the F1 and S1 samples. In the second part (Phase 2), we used new judges from France and Senegal, as well as Senegalese judges living in France (residents for 5.1 ± 3.4 years; recruited in Montpellier). They were asked to rate the resemblance of children to their mothers in samples F2 and S2.

The judges were told to spend as much time as they needed to look at the pictures. In Phase 2, the answer time was recorded for each assessment to control for potential effects of the time spent looking at faces on the accuracy of the detection. The judges were asked to rate the resemblance for one sample only (either F1 or S1 for Phase 1, and either F2 or S2 in Phase 2). Details of the judges' composition (sample size, age, and sex) are shown in Table 2.

Statistical analysis

To compare recognition rates to those expected by chance for each parent, a general linear mixed model (GLMM) with cross random effects was built to take into account the structure of the data (Crawley, 2007), where one judge assessed several children and one child was evaluated by several judges. The response variable (each judge's score for each child) was modeled as binary. The 95% confidence intervals around the predicted value of the mean were then compared to the rate expected by chance.

Next, a mixed model was built for each cultural group of the judges to investigate the effect of the cultural origin of the tested faces on the facial detection of kin. The models include the variables associated with the judge, the child characteristics (age, sex), and the sex of the tested parent (for Phase 1). The models also incorporated all meaningful interactions, which were entered into the model as fixed effects to control for potential sources of variations. Variables with significant effect in this full model were used as confounding variables in a second model, which was specifically designed to test the effects of family cultural group (and, in Phase 2, the effect of answer time). The model was not reduced to avoid false positives

(Whittingham, Stephens, Bradbury, & Freckleton, 2006). Then, according to Bates and Sarkar (2007), P -values were computed using a sample generated after 10,000 simulations from the posterior distribution of the parameters of the fitted model, using Markov Chain Monte Carlo (MCMC) methods.

Results

Facial resemblance assessment

For French judges, the detection rates of French families (0.53) and Senegalese families (0.53) were significantly ($P_{MCMC} < 0.001$) above the rate expected by chance (0.33). Similarly, for Senegalese judges, the detection rates of French families (0.45) and Senegalese families (0.46) were significantly ($P_{MCMC} < 0.001$) above the rate expected by chance (0.33). Overall, both the French and Senegalese judges were able to recognize parent–child pairs through facial pictures in families belonging to their own cultural groups, as well as in families from different origins.

Effect of the cultural origin of the families tested

The scores obtained by French judges were not associated with the age of the judge ($P = 0.22$), the age of the child ($P = 0.96$), the sex of the judge ($P = 0.10$), the interaction between the sex of the judge and the sex of the child ($P = 0.44$), or the interaction between the sex of the parent and the sex of the judge ($P = 0.77$). However, the French judges' scores were related to the interaction between the sex of the child and the sex of the parent ($P < 0.001$).

Similarly, the scores of the Senegalese judges were not related to the age of the child ($P = 0.66$), the age of the judge ($P = 0.13$), the sex of the judge ($P = 0.25$), the

Judges' cultural group	Total	Men	Women	Age min–max, mean \pm SD	Mean number of judges \pm SD per child	
					F1	S1
<i>Phase 1</i>						
French	170	91	79	13–76, 29.0 \pm 12.6	53.0 \pm 1.8	45.6 \pm 8.2
Senegalese	192	75	117	14–70, 29.4 \pm 12.9	36.5 \pm 4.8	57.6 \pm 13.3
<i>Phase 2</i>						
French	80	34	46	13–63, 28.7 \pm 10.3	53.0 \pm 6.1	27.5 \pm 4.1
Senegalese	81	35	46	13–63, 32.4 \pm 13.2	41.0 \pm 0.0	22.6 \pm 3.1
Senegalese living in France	74	33	41	19–29, 26.0 \pm 4.1	39.0 \pm 0.0	39.0 \pm 0.0

Table 2. Judges' details according to their cultural group. Sample size, age, and sex are indicated, as well as the number of judges per child for each set of family pictures in both phases of the study (F1: French families, S1: Senegalese families, F2: French families, and S2: Senegalese families; see text for details).

interaction between the sex of the judge and the sex of the child ($P = 0.39$), or the interaction between the sex of the parent and the sex of the judge ($P = 0.39$). However, the Senegalese judges' scores were associated with the interaction between the sex of the child and the sex of the parent ($P < 0.001$).

Next, we controlled for significant effects, including the cultural origin of the families and all meaningful interactions. We observed that facial resemblance assessment depended on the sex of the parent, the sex of the child, and the cultural group of the families and their interactions for both the French and the Senegalese judges (see Tables 3A and 3B for estimates and P -values). Interestingly, the picture that emerged from these results is that daughters resembled their mothers more than their fathers, while the converse was true for boys.

To disentangle the interaction effects, the same analysis was performed for each cultural group of judges and each

(A) French judges	Estimate	Std. error	z-value	Pr(> z)
Intercept	0.4220	0.1340	3.150	<0.01
Type of test ^M	-0.3266	0.1010	-3.232	<0.01
Child sex ^G	-0.5762	0.1800	-3.201	<0.01
S1	-0.3494	0.1797	-1.944	0.06
Type of test ^M : Child sex ^G	0.6229	0.1383	4.503	<0.001
Type of test ^M : S1	0.2263	0.1427	1.586	0.11
Child sex ^G : S1	0.6748	0.2426	2.782	<0.01
Type of test ^M : Child sex ^G : S1	-0.4263	0.2009	-2.122	0.04
(B) Senegalese judges	Estimate	Std. error	z-value	Pr(> z)
Intercept	-0.09669	0.10669	-0.906	0.36
Type of test ^M	-0.31987	0.09105	-3.513	<0.001
Child sex ^G	0.03680	0.14076	0.261	0.79
F1	-0.31218	0.16869	-1.851	0.06
Type of test ^M : Child sex ^G	0.40608	0.13032	3.116	<0.01
Type of test ^M : F1	0.30343	0.15103	2.009	0.04
Child sex ^G : F1	0.27846	0.22223	1.253	0.21
Type of test ^M : Child sex ^G : F1	-0.19059	0.21076	-0.904	0.36

Table 3. Model outputs: (A) French judges; (B) Senegalese judges. Mixed models that incorporated the identity of the child and the identity of the judges as cross random effects were used. The response variable (score) is modeled as binary. The intercept corresponds to the scores obtained for the father test with boys and families of the judge's own cultural group. ^M is the variation of the effect of the second modality of the test (mother test) as compared to the intercept. ^G is the variation of the effect of the second modality of child sex (girls) as compared to the intercept. The “:” indicates an interaction effect between two variables. Significant (<0.05) P -values are in bold.

	Cultural group of the tested families	
	F1	S1
<i>French judges</i>		
Fathers–sons	0.61	0.53 ($P = 0.16$)
Fathers–daughters	0.46	0.53 ($P = 0.22$)
Mothers–sons	0.52	0.51 ($P = 0.90$)
Mothers–daughters	0.53	0.57 ($P = 0.48$)
<i>Senegalese judges</i>		
Fathers–sons	0.39 ($P = 0.12$)	0.48
Fathers–daughters	0.48 ($P = 0.98$)	0.47
Mothers–sons	0.40 ($P = 0.70$)	0.41
Mothers–daughters	0.53 ($P = 0.63$)	0.50

Table 4. Variations in correct parent–child assignments by French and Senegalese judges in the same and different cultural groups based on combinations of parent and child sexes. For each combination, P -values correspond to the deviation associated with kin recognition in the other cultural group as compared to kin recognition in the same cultural group. Significant (<0.05) P -values are indicated in bold. Facial kin recognition performed by judges was equivalent whether or not the tested faces were of the same cultural group as the judges.

possible combination of parent and child sexes (father–son, father–daughter, mother–son, and mother–daughter). Estimated detection rates and P -values associated with the deviation between the same and other cultural groups are indicated in Table 4. Notably, the scores obtained by Senegalese judges are lower overall than those obtained by French judges on all samples tested. Nevertheless, in all cases, facial kin recognition was equivalent regardless of the cultural origin of the families tested.

Plasticity of the kin assessment ability

During Phase 2, family samples (F2 and S2) that were distinct from those used in Phase 1 (F1 and S1) were used. Additionally, Senegalese judges living in France displayed resemblance scores significantly higher than expected by chance (see Figure 2). They were thus able to recognize kin facially in families of both the same and other cultural groups.

The scores obtained by French judges were not associated with the age of the judge ($P = 0.50$), the sex of the judge ($P = 0.29$), the sex of the child ($P = 0.34$), the age of the child ($P = 0.11$), or the interaction between the sex of the judge and the sex of the child ($P = 0.14$). However, the scores were negatively associated with the age of the mother ($P = 0.03$). The scores obtained by Senegalese judges were not associated with the sex of the judge ($P = 0.99$), the age of the mother ($P = 0.94$), or the interaction between the sex of the judge and the sex of the child ($P = 0.55$). However, their scores were associated with the age of the judge ($P < 0.01$), the sex of the child ($P = 0.06$), and the age of the child ($P < 0.01$).

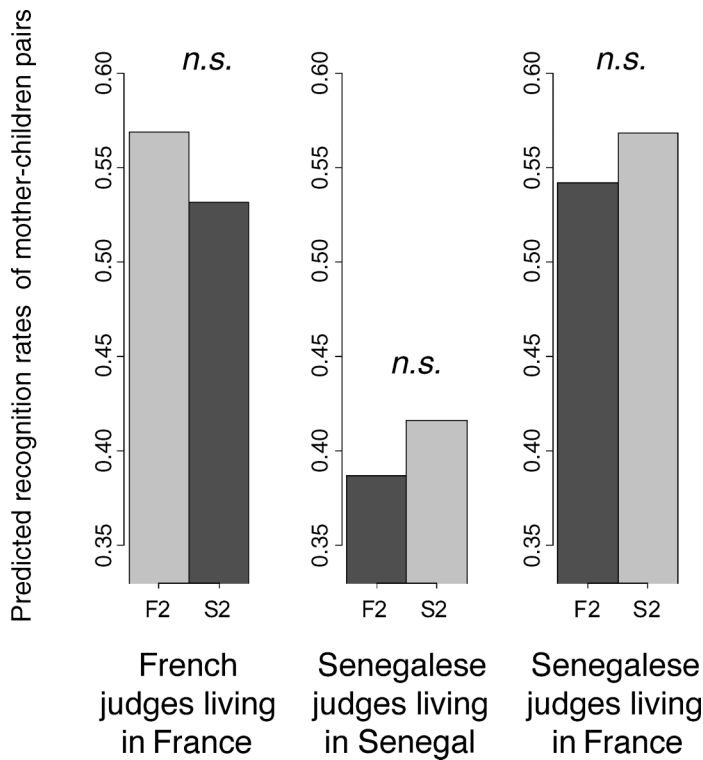


Figure 2. Predicted facial recognition rates of mother–child pairs according to the type of judge and the cultural group of the tested families (F2: France; S2: Senegal). The rate expected by chance is 0.33. The light gray bar corresponds to the recognition of pairs from the same cultural group; the dark gray corresponds to the recognition of pairs from the other cultural group. Whatever the cultural origin of judges, facial recognition of mother–child pairs was higher than expected by chance and was not influenced by the cultural origin of families. *n.s.*: non-significant ($P > 0.05$).

For Senegalese judges living in France, their scores were not associated with their age ($P = 0.46$), their sex ($P = 0.74$), the sex of the child ($P = 0.14$), the age of the child ($P = 0.19$), the age of the mother ($P = 0.12$), or the interaction between the sex of the child and the sex of the judge ($P = 0.24$).

After controlling for significant effects, all groups of judges were equally successful in facially detecting mother–child pairs from either France or Senegal ($P = 0.19$ for French judges, $P = 0.49$ for Senegalese judges, and $P = 0.69$ for Senegalese living in France, Figure 2). As in Phase 1, the scores obtained by Senegalese judges were lower overall than those obtained by other judges. The effect of time spent looking at a set of pictures was not related to the score obtained by either the French ($P = 0.49$) or the Senegalese judges ($P = 0.39$), but it was negatively correlated with the score obtained by Senegalese judges living in France ($P = 0.03$). In addition, the interaction between the time spent looking at faces and the origin of faces was non-significant for all judges ($P =$

0.47, $P = 0.35$, $P = 0.28$, for French, Senegalese, and Senegalese living in France, respectively). This result suggests that the time spent looking at faces did not vary regardless of whether faces are from the same or other cultural groups and that duration of stimuli either does not affect the accuracy of the detection (for stationary judges) or decreases it (for judges having immigrated). Finally, the scores obtained by the Senegalese judges who immigrated were associated with neither the number of years they have spent in France ($P = 0.76$), nor the interaction between this variable and the cultural origin of the pictures ($P = 0.18$). These results confirm those results that were obtained in Phase 1, namely that the judges were equally able to detect kin facially in their own and other cultural groups. Moreover, the results suggest that an exposure to a particular type of faces does not influence the accuracy of the detection.

Discussion

The assessment of facial resemblance is not culture-specific

Judges from France and Senegal did not differ in their ability to detect kinship when looking at either French or Senegalese faces; this effect was observed independently in two replicates with relatively large sample sizes. An intriguing result was the ability to more accurately detect same-sex resemblance (father–son and mother–daughter pairs) in same- versus other-race faces. This result may be a by-product of the ability to detect sex-related traits in faces, which was found to be more accurate for same- than other-race faces (O’Toole, Deffenbacher, Valentin, & Abdi, 1994). When all combinations are taken together, however, the present results suggest that facial recognition of parent–child pairs shows no other-race effect.

The absence of an other-race effect in the facial detection of kin may result from a shared experience between French and Senegalese individuals, due to migration between these two countries. Shared experience could not, however, account for the recognition ability observed in the Senegalese judges, as they were recruited in rural areas where the contact rate with white people is low (<1%). The absence of an other-race effect is also not likely to result from the amount of time judges spent looking at the facial pictures; the time spent looking at faces did not vary among groups of judges whether they looked at same- or other-race faces. The limited role of exposure to different face types is furthermore suggested by the result obtained with immigrant judges. Similar to the stationary judges, the judges who immigrated were equally able to detect mother–child pairs using faces from either their own or their new culture. Moreover, the time spent in the new cultural environment did not affect the

ability to detect kin. This result suggests that the ability to detect kin facially is not dependent on exposure to that particular type of faces.

Note that the Senegalese judges who immigrated were overall more accurate than the stationary judges, whatever the cultural origin of the faces. The difference observed here is likely to be a bias due to the differential computer experience between the two samples. Indeed, while most of the immigrant judges were from and currently lived in urban areas, stationary judges were recruited from rural areas where access to computers is rather limited and exposure to images is restricted. However, even though judges from rural Senegal were overall less successful at computer tasks as compared to judges from urban areas (French judges and Senegalese judges living in France), they were also equally able to assess facial resemblance in same- and other-race faces.

Assessment of facial resemblance differs from facial recognition

It is intriguing that the detection of kinship relationships through facial comparisons was not influenced by the cultural origin of the faces since individual facial recognition is. Indeed, a number of studies have shown that facial recognition of individuals is a highly specialized cognitive system that optimizes recognition of same-group faces (Goodman et al., 2007; Kelly et al., 2007; Lindsay, Jack, & Christian, 1991; Meissner & Brigham, 2001; O'Toole et al., 1994).

The absence of an other-race effect for facial comparisons could result from an experimental bias that underestimated the role of some memory processes. The faces to be compared were presented concomitantly in the present study, while two different pictures of the same face are generally presented sequentially in facial recognition tests. The absence of a recall-like process in the task used here may account for a failure to show an other-race effect for facial comparisons (Meissner, Brigham, & Butz, 2005). A similar experiment using a delayed match to sample task (the child and the related individuals presented in two successive sequences) could help assess the influence of this memory process on the ability to assess facial resemblance across different cultural groups.

The absence of other-race effect for the detection of facial resemblance could also be due to a relatively limited specialization of the cognitive process involved. It would be the case if an inability to recognize relationships among others implied only a low fitness cost (weak selection pressure). Under this hypothesis, the other-race effect observed in facial recognition would be the expression of a highly specialized cognitive process designed to respond appropriately to same-group faces, because of high potential costs of inappropriate behaviors. Interestingly, there is some evidence that the recognition

of familiar individuals is highly specialized and requires several cognitive functions other than face perception (e.g., emotion and theory of mind areas; Gobbini & Haxby, 2007). Additionally, individuals are more distressed (as shown by increased brain activation) by social exclusion (in a virtual game) when being excluded by same-race or self-resembling individuals than by other-race individuals (Krill & Platek, 2009), suggesting that in-group individuals may potentially impose severe costs. Whether the detection of facial resemblance among others is a less specialized mechanism associated with lower costs remains to be investigated, for example using neuro-imaging techniques.

Finally, it is also possible that the cues used to detect facial resemblance differ from those allowing facial recognition. Recognizing facial identity requires processing both the shape of individual features (such as eyes, mouth, or nose) and the configuration among features (such as distance between the eyes). Studies suggest that expertise in recognizing faces may result from configural processing ability and that the other-race effect in facial recognition results from a lower ability to process configural information in other races than in same-race faces (reviewed in Meissner & Brigham, 2001). Thus, the lower sensitivity to exposure in processing facial similarities could result from a relatively low use of relational information between features when making facial comparisons. There is some evidence that the facial detection of kinship is not processed using overall spatial information (e.g., ratio of the distance between eyes on the distance between nose and mouth). Indeed, when judges assess kinship relationships through facial comparisons, the performance in the “full-face” condition (full faces are presented to the judges) is not better than performance resulting from combining the two “masked” conditions (either the upper or the lower half of the faces is presented to the judges; Dal Martello & Maloney, 2006).

A preferential use of featural information to process facial comparison may reflect a by-product of the general facial processing system, as featural processing is present in newborns. This hypothesis implies that selective pressures on the use of spatial information for processing facial similarities were likely to be insufficient. It could be so if the detection of kinship relationships in social settings is achieved by mechanisms not involving facial comparisons (such as associative learning and/or diffusion of social information). The preferential use of featural information may also result from a higher reliability of this cue compared to configural information when assessing facial resemblance. A possibility is that features are more heritable or less sensitive to environmental factors than spatial relations between them, thus making features more relevant to detect kinship than facial configuration. There is some evidence that all parts of the face are not equally relevant to kinship judgments: for instance, sibling recognition through facial comparisons is reduced by only 5.3% when the lower half of the face is masked (while it is

reduced by 65% when the upper half is masked), which is interpreted as a confirmation that the lower part of children's faces, highly sensitive to growth during childhood and puberty, is not a reliable kinship cue (Dal Martello & Maloney, 2006).

To our knowledge, however, information on the mechanisms and cognitive processes underlying facial resemblance assessment between individuals is not yet available, and further studies are needed to decipher the proximate and ultimate causes.

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