Chapter 12

An Experience-Based Holistic Account of the Other-Race Face Effect

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Variations between human populations in face structure and the concept of "face race" C12.S1

Since populations of the modern human race left Africa around 100,000 years ago and settled in different continents, their body morphology, including the face, has been transformed in response to different natural selection pressures (i.e. different environments;[1] e.g. Katzmarzyk and Leonard, 1998; Ruff, 1994, 2002). Consequently, despite the extremely high genetic similarity between different human populations (e.g. Altshuler et al., 2005; Cavalli-Sforza and Cavalli-Sforza, 1994), there are important and clearly visible differences between their faces, both in terms of the bone structure and the reflectance of light on the skin (surface reflectance, i.e. color and texture) (Bruce and Young, 1998; see Figure 12.1). For instance, sub-Saharan Africans have a darker skin and wider, more bulbous noses than Asians or Western Europeans, the latter being characterized by the thinnest pointy noses (see Choe et al., 2004; Farkas, 1994; Le et al., 2002; Porter, 2004; Porter and Olson, 2001).

The term of "race," and the concept it traditionally refers to, namely genetically different human populations in the world, is one of the most intellectually and emotionally charged in society, and in science as well. While some scientists claim that there is no biological reality to racial categories in the human population, others argue that different human groups can be distinguished based on genetic factors (see e.g. Edwards, 2003; Jorde and Wooding, 2004, Risch et al., 2002; and the whole special issue of *Nature Genetics*, volume 36, 2004). Even though one has to acknowledge that the genetic borders between human populations are fuzzy, that there is no point in trying to define a number of different human races on earth, and that the variance in genetic diversity can be much greater within a given population than between populations (Lewontin, 1972; Witherspoon et al., 2007) if the genes are considered in isolation (rather than collectively; see Edwards, 2003), a substantial part of the variance in the skin color and texture, as well as in the bone structure of the face (and the whole body) (e.g. Rosenberg et al., 2002), is at least accounted for by genetic differences between human populations. In short, biologically, race is real, though it involves superficial traits and fuzzy categories. In this chapter, we will focus on how human beings recognize individual faces of their own versus another "racial group," and we will use the term "face race" in the context of visual recognition, as traditionally done in this scientific literature.

[1] Some traits of the body and face may also have, as Darwin (1871) suggested, spread through sexual selection (e.g. an arbitrary preference for blue eyes).

C12.F1 **Fig. 12.1** Illustration of the variations of the human face between a few populations. Top row, left to right: the (2009) leaders of Malawi, Bolivia, France, and Laos; second row: Slovenia, China, Nigeria, and Egypt; third row: Lebanon, Senegal, Sweden, and Japan; fourth row: North Korea, Germany, Israel, and Rwanda; fifth row: Cambodia, Mongolia, Ecuador, and US.

The "other-race" face effect

C12.S2

Race is in the face. We first notice it there. And we notice it particularly quickly when the person belongs to another racial group. By means of both shape and surface reflectance information (Hill et al., 1995), an observer is able to distinguish between two faces belonging to two different races (e.g. a Western European versus a sub-Saharian African) accurately and rapidly (e.g. Caldara et al., 2004; Levin, 1996, 2000; Valentine and Endo, 1992).

Within a given human race, identifying specific individuals from their face is more complex, since it requires us to perceive much subtler variations of shape and surface-based properties among faces (O'Toole et al., 1999), both at the level of local distinct facial features (e.g. eyes, eyebrows, nose, mouth, ears, etc.) and at the global level of the face (e.g. head shape, relative distances between features such as the eyes and the mouth; Rhodes, 1988). Despite this complexity of individual face recognition, normal adult human observers are quite accurate at making differences between distinct individual unfamiliar faces, and in particular at recognizing previously seen individuals from their face (e.g. Bahrick et al., 1975; Bruce and Young, 1998).

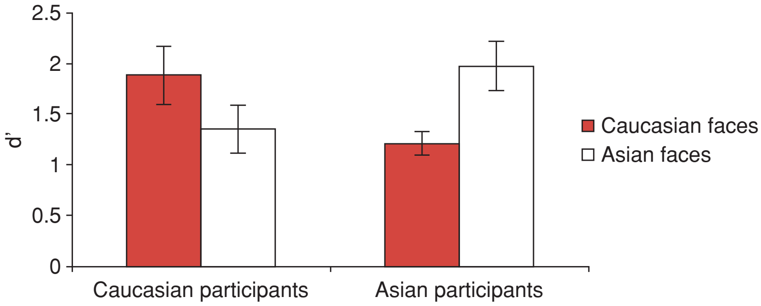
However, this expertise holds only if the individual faces are from the same racial group that the observer encounters regularly in his/her environment, i.e. generally his/her own racial group. In contrast, people are not that good at individualizing faces belonging to another racial group and may find that faces from other races "all look alike," whereas faces of one's own race appear easily distinguishable (Feingold, 1914).

Using a face recognition task, Malpass and Kravitz (1969) reported the first empirical demonstration that observers perform significantly better with their own-race as compared to other-race faces. Since this first demonstration, this "other-race effect" (ORE, also called "own-race bias," "cross-race effect," and "cross-racial facial identification effect" in the scientific literature) has been replicated in numerous studies, with different racial groups (see Meissner and Brigham 2001).

In most empirical studies, the ORE is demonstrated through a standard recognition paradigm, in which participants have to discriminate between faces encoded during a (incidental or explicit) learning phase (targets) and novel faces (distractors). The ORE is classically reflected by a crossover interaction between the race of participants and the race of faces in discrimination accuracy (Figure 12.2). In some studies, a response time advantage for same-race (SR) relative to other-race (OR) faces has also been found in old/new recognition tasks (e.g. Chance and Goldstein, 1987; Michel et al., 2006b; Valentine, 1991).

In some studies guided by an applied research concern—i.e. the understanding of the psychological factors affecting eyewitness identifications, a context in which the phenomenon is currently largely acknowledged (e.g. Brigham and Wolfskeil, 1983; Brigham et al., 1999; Deffenbacher and Loftus, 1982; Kassin et al., 1989), the ORE has also been demonstrated in more forensically relevant paradigms. These paradigms include lineup identification (e.g. Berger, 1969; Brigham et al., 1982; Doty, 1998; Fallshore and Schooler, 1995; Platz and Hosch, 1988), facial reconstruction tasks (Ellis et al., 1979), and photo lineup construction by law enforcement officers (Brigham and Ready, 1985). Finally, the ORE has also been observed in perceptual matching tasks with unfamiliar faces (e.g. Lindsay et al., 1991; Malpass et al., 1988; Sangrigoli and de Schonen, 2004; Walker and Hewstone, 2006; Walker and Tanaka, 2003), even though it is not always found, and never as large as in an old/new recognition paradigm (see Papesh and Goldinger, 2009).

The results of these numerous studies conducted in adult human observers have been reviewed in several meta-analyses (Anthony et al., 1992; Bothwell et al., 1989; Lindsay and Wells, 1983; Shapiro and Penrod 1986), the most recent one (Meissner and Brigham 2001) reviewing over 30 years of research on the ORE, with nearly 5000 participants involved. Overall,



C12.F2 **Fig. 12.2** A typical other-race effect as observed in an old/new face recognition task. In this study (Michel et al., 2006a), participants were first presented with 20 faces of each race one by one (3-s duration, ISI 1-s) to encode in memory. Then, they performed an old/new recognition task on 40 faces (20 learned, 20 new) presented individually, for same- and other-race faces separately. Each face was presented until the participant's response, or for a maximum of 2 s. Participants did not know the ratio of old and new faces, and did not receive any feedback for their responses. The order of presentation for the blocks of same- and other-race faces was counterbalanced across participants. The other-race effect is reflected by the cross-over interaction between the race of participants and the race of faces in discrimination accuracy, participants of both groups performing better at recognizing their own-race than other-race faces. Errors bars represent standard errors of the mean.

these meta-analyses confirm the robust nature of the ORE. The advantage of recognizing SR faces is consistent across different experimental paradigms and racial groups, even though it is not always reflected by a perfect cross-over interaction (Anthony et al., 1992; Meissner and Brigham, 2001).

The size of the ORE varies across studies. While we have found quite large OREs in our own studies with an old/new recognition paradigm (Figure 12.2), other authors have referred to the ORE as a fairly weak effect (Meissner and Brigham, 2001). However, the ORE has been replicated numerous times and is one of the few reliable empirical phenomena in the face recognition literature. The small size of the effect—relative to interindividual variability in face recognition performance—in an experimental context may have more to do with the limitations of the paradigms to capture a phenomenon that can nevertheless be dramatic in one's real life experience (Feingold, 1914). Moreover, the large majority of researchers who study the ORE perform their experiments with participants raised in largely multiracial societies (e.g. North America, Australia) in which the ORE may be smaller than when it is assessed in populations living in fairly homogenous racial societies (e.g. Africa, Western Europe, or East Asia).

C12.S3 Proposed explanations of the ORE

Different explanations have been proposed to account for the ORE. They will simply be mentioned in this section without expanding (for details, see e.g. Meissner and Brigham, 2001).

1 A *difference of intrinsic discriminability* between different populations of faces (e.g. Malpass and Kravitz, 1969): there would be less physiognomic variability between individual faces within one race than within another race.

2 A *lack of contact* or visual experience with OR faces, as initially proposed by Feingold (1914, p.50): "it is well known that, other things being equal, individuals of a given race are distinguishable from each other in proportion to our familiarity, to our contact with the race as a whole."

3 A *difficulty in processing OR faces holistically or configurally* (e.g. Rhodes et al., 1989): OR faces would be treated using a more piecemeal, and less efficient process.

4 A *differential depth of encoding* for SR versus OR faces: SR faces would be encoded deeply in memory while OR faces would be encoded in a shallow way (Chance and Goldstein, 1981).

5 *Prejudiced racial attitudes*: observers, particularly those with more prejudiced racial attitudes, would not be motivated to differentiate members of another race, which would result in a weaker memory for OR faces (e.g. Berger, 1969; Galper, 1973).

6 An *emphasis on visual information specifying race* for OR faces: observers would limit their encoding of OR faces at a superordinate level of categorization, focusing on race-specifying features ("It's a Chinese person") at the expense of individuating information (e.g. Anthony et al., 1992; Levin, 1996, 2000).

7 A *differential coding of OR and SR faces in a multidimensionally organized face- space* (Valentine, 1991): individual faces encountered would be organized in a multidimensional face-space in memory. The dimensions of the face-space would be the most diagnostic for discriminating own-race faces. Individual faces from another race would be densely clustered in the space, and thus easily confused.

8 An inherent difference in the most diagnostic cues for individualization of SR and OR faces which would lead to *a reduced sensitivity to diagnostic features for OR faces* (e.g. Furl et al., 2002): the utility of the facial dimensions for individualization, which would include both features and the relative distances between these features (Rhodes, 1988), would vary between races. For example, eye color could be less useful for discriminating Asian than Caucasian faces. The observer's sensitivity to these diagnostic dimensions would develop through visual experience (generally limited to SR faces). As a result, sensitivity to diagnostic features would be lower for OR than SR faces.

The only account that is usually rapidly dismissed in reviews of the ORE is the difference of intrinsic discriminability between different populations of faces, because the ORE can be observed in participants of many different races (e.g. Byatt and Rhodes, 2004; Chance et al., 1975; Luce, 1974; O'Toole et al., 1994; Valentine and Endo, 1992). However, one should remain aware that there *are* probably real intrinsic differences in the potential discriminability of individual faces from different populations of the world. For instance, Africans differ among each other genetically far more than other races do (Cavalli-Sforza and Cavalli-Sforza, 1994), since the African's DNA continued to diversify after the ancestors of Australian aboriginals, Europeans, and Asians left Africa. Hence, there is certainly much more variance in the face (and body) morphology within the African population than within the Caucasian or Aboriginal populations. In other words, for an "ideal observer," individual faces of a given population considered as a single race may in fact be more heterogeneous than individual faces of another race. Therefore, at least for that reason, one should not expect a perfect cross-over ORE in any given study, even if experience with OR faces and all other factors were perfectly controlled.

As for the other accounts of the ORE, they are not always situated at the same level of explanation, and are not all mutually exclusive. Here we will argue in favor of an experience-based holistic account of the ORE, as an integrated theoretical proposal.

C12.S4 An experience-based holistic account of the ORE

C12.S4.1 The necessity of experience

At the highest level of explanation, the ORE *has to* be due to the *differential visual experience* one has with a group of faces sharing a certain given morphology, generally one's own facial morphology, as compared to a group of faces sharing another kind of morphology, the other-race faces. The only alternative account would be that the human face processing system is genetically prespecified to an extreme degree of precision such that one is only able to efficiently individualize faces of his/her own racial group. This latter account can be definitely dismissed by recent results observed in human adults who have been adopted at a young age (3–9 years old) into another racial group: they present an advantage at processing these other-race faces over their own-race faces (Sangrigoli et al., 2004), a finding that could not be explained by a genetic account. The role of visual experience in the ORE is further supported by developmental studies indicating that although 3-month-old Western European infants can discriminate faces within four different racial groups (faces of their own racial group, sub-Saharan Africans, Middle Eastern, and Chinese faces), 9-month-old infants can only discriminate own-race faces (Kelly et al., 2007). Together, these studies show that visual experience early in life with one racial group of faces tunes the face recognition system to the characteristics that allow individualizing faces of this group. However, the face recognition system remains flexible for years at least, since the ORE can be reversed in large part (de Heering et al., in press), or even completely (Sangrigoli et al., 2004), if one is exposed to another racial group throughout development.

The experience-based account of the ORE, or "contact hypothesis," is sometimes questioned because the ORE does not always go away, or even get smaller with experience (e.g. Ng and Lindsay, 1994; Wright et al., 2003) or training (e.g. Malpass et al., 1973; Lavrakas et al., 1976). However, the claim that experience does not affect the ORE (e.g. Levin, 2000) is not always correct (e.g. Chiroro and Valentine, 1995; Cross et al., 1971; Dunning et al., 1998; Hancock and Rhodes, 2008; Rhodes et al., 2009; see also the training studies of Tanaka and Pierce, 2009; for a review, see McKone et al., 2007). Most importantly, this is an entirely different issue: whether, *in adulthood*, *after* one's face recognition system has been tuned to individualize SR faces efficiently during development, it is still possible to learn to individualize OR faces as efficiently as SR faces. Irrespective of the answer to this latter question, which is still unresolved, it remains clear that, at the highest level of explanation, the differential visual experience with SR versus OR faces *during development* of the face recognition system accounts for the ORE.

C12.S4.2 An experience-based holistic account

Face perception is a high-level visual process, i.e. it results from the interaction of the incoming information and internal representations (Cavanagh, 1991; Gregory, 1997). Therefore, it is necessary to understand the nature and characteristics of this interaction to explain it. With early and extensive exposure to a set of visual stimuli sharing a common structure, the face recognition system appears to build what Goldstein and Chance (1980) referred to as a "schema." The schema can be considered as a generic face representation derived from visual experience with a rapidly growing number of exemplars early in life. Importantly, this generic representation is a *global* face configuration, also called a *holistic* representation (Galton 1883; Sergent 1984, 1986; Tanaka and Farah, 1993).

In most societies, people's visual experience during development is limited to faces that share a certain morphology, i.e. faces of a certain racial group. Hence, with increasing experience, the holistic representation, originally *broadly tuned*, becomes more fine-grained, or *finely tuned* for a certain racial group of faces (Kelly et al., 2007). That is, it becomes centered around the physical characteristics of these SR faces (e.g. a relatively large eye-eyebrow distance as in Eastern Asian faces). The holistic representation is also optimally tuned to take into account the *variations* of these features in the population of faces encountered (e.g. how variable is the distance between the eye and eyebrow within the population). The representation of a given facial attribute (e.g. nose width, interocular distance) within this face schema is thus finely (small variance) or rather broadly (large variance) specified, around an average value.

In this context, let us consider the perception of a face belonging to another race. The OR face input differs substantially from the observer's experience-based holistic representation, on multiple morphological aspects. For instance, the interocular distance of the OR face may be very small, and so out of range of the variations encountered before. As a result, this OR face input does not fit well the experience-based holistic template of the observer. Consequently, the new OR face is not—or less well—encoded and represented holistically. Rather, the OR face has to be analyzed feature-by-feature, i.e. analytically. Fine-grained information can of course be extracted from the new morphological input (OR face), and the individual face can be encoded in the system, but it requires a greater amount of resources, at the expense of speed and accuracy.

Such a relatively simple proposal, inspired by Goldstein and Chance's (1980) early proposal and encompassing more recent data (see below) and concepts from the face recognition literature, can form the basic theoretical account of the ORE. This view is particularly interesting because, as we will explain below, it could account for the ORE even if the *variance* between facial features in two sets of faces—and thus their diagnosticity—from different races was strictly identical.

This experience-based holistic (EBH) account is based on the reduced holistic/configural processing mode observed for OR faces (Michel et al., 2006a,b; Tanaka et al., 2004) and can account for its consequences (the reduced sensitivity to feature-based properties and relative distances between features; Hayward et al, 2008; Rhodes, et al, 2006). It can incorporate, as we will discuss below, the notion of face-space (Valentine, 1991), and is not incompatible with the idea of a differential depth of encoding (Chance and Goldstein, 1981), which is rather seen as a consequence of a lack of holistic processing. This account can also predict, to some extent, the inverse relationship between the ability to individualize OR faces and race-categorization judgments (Levin, 2000) without the need to call upon the social notions of stereotypes towards "outgroup" members as causes of the ORE (see section 'The sociocognitive account of the ore: a brief critical review').

This theoretical proposal is, however, fundamentally incompatible with the view that the ORE is caused exclusively, or even to a large extent, by motivational, attentional, or more generally by sociocognitive factors (e.g. Hugenberg et al., 2007; Levin, 1996, 2000; Sporer, 2001). It does not deny that sociocognitive factors can greatly influence face identification, and thus the ORE, in experimental or ecological contexts (see Hugenberg et al., Chapter 13, this volume), or that these studies are of great interest in order to understand social cognition. However, according to the EBH account, modulatory sociocognitive factors are not at the root of the ORE, which we propose primarily results from the way the human brain perceives and represents faces.

Some clarifications and evidence for the EBH account C12.S5

Holistic processing of individual faces C12.S5.1

There is considerable evidence that individual faces are represented holistically or configurally, even though there is much less agreement on what this exactly means (e.g. Farah et al., 1998; Galton, 1883; Goldstein and Chance, 1980; Peterson and Rhodes, 2003; Rossion, 2008, 2009; Tanaka and Gordon, Chapter 10, this volume). Here, as in early studies in this area, the terms "holistic" and "configural" are used as synonyms (Sergent, 1984; Tanaka and Farah, 1993; Young et al., 1987). Importantly, "holistic/configural" refers to both a way of *representing* faces and a *perceptual process*: it is by matching the incoming visual face-stimulus to an internal holistic representation that this face can be *perceived* holistically (see Rossion, 2009; Rossion and Boremanse, 2008).

The empirical evidence in favor of the holistic view of face perception shows essentially that facial features are *interdependent* during face processing: the processing of a facial feature (e.g. eyes, nose, mouth, etc.) is affected by identity or position alterations of one or several other facial feature(s) (e.g. Farah et al., 1998; Homa et al., 1976; Mermelstein et al., 1979; Sergent, 1984; Suzuki and Cavanagh, 1995; Tanaka and Farah, 1993; Tanaka and Sengco, 1997; Young et al., 1987). This interdependency of facial features during face processing is nicely illustrated by the "composite-face illusion," adapted from the "composite-face effect" (Young et al., 1987): identical attended top halves of faces tend to be perceived as being different if they are aligned (but not if they are spatially misaligned) with distinct unattended bottom parts (Figure 12.3), illustrating that the parts of a face (here the two halves) cannot be perceived independently (for empirical demonstrations in face matching tasks; e.g. Goffaux and Rossion, 2006; Hole, 1994; Le Grand et al., 2004; Rossion and Boremanse, 2008).

What is "holistic" in this framework is the *perception* of the face, as indicated by the perceptual nature of the composite-face illusion (Figure 12.3), the fact that the locus of this illusion lies

C12.F3 **Fig. 12.3** Illustration of the composite-face illusion. Identical attended top halves of faces tend to be perceived as being different when they are aligned with distinct unattended bottom parts. Here, the top half of a face is aligned with six different bottom halves (first row: example for a Western European face; third row: example for an Eastern Asian face). The illusion disappears if the two halves of the face are spatially misaligned (second and forth row). It has been demonstrated that the composite-face illusion is stronger for same- than for other-race faces, leading to a larger face-composite effect for the former (Michel et al., 2006b, 2007).

primarily in high-level visual areas sensitive to faces, such as the right "fusiform face area" (Schiltz and Rossion, 2006), and that it occurs at about 160 ms over the visual occipitotemporal cortex (Jacques and Rossion, 2009) (for an alternative view, with a locus of holistic processing at a decisional level, see Richler et al., 2008; Wenger and Ingvalson, 2002). The perception is holistic because the incoming face-stimulus has to be matched to the holistic internal *representation* of the face (Tanaka and Farah, 1993), *derived from experience*, for the stimulus to by fully perceived. This view has been indirectly supported by showing, for instance, that if the exact same face input deviates from the usually seen upright orientation (i.e. an inverted face), holistic face perception breaks down (e.g. Tanaka and Farah, 1993; Young et al., 1987). This phenomenon is best illustrated by the fact that the composite-face illusion vanishes if faces are presented upside down. In addition, this loss of holistic face perception in the composite face effect is abrupt, taking place between 60 and 90 degrees of angle of face rotation, rather than being linearly related with the angle of rotation of the face (Rossion and Boremanse, 2008; see also McKone, 2004; Murray et al., 2000, 2003). This observation suggests that the face input is perceived by means of an experience-based internal face representation (i.e. we are used to seeing faces upright and tilted up to a certain angle, but almost never from 90 degrees to 180 degrees).

This holistic representation is applied to *all* information that is potentially diagnostic to individualize the face: both the local facial features *and* the relative distances between these features, without giving any special representational status to the latter (sometimes referred to as "configural," "configurational," or "second-order relational" cues in the literature, e.g. Carey, 1992; Maurer et al., 2002) (Rossion, 2008, 2009; Tanaka and Farah, 2003). Nevertheless, some kinds of facial information (i.e. diagnostic cues that are used to individualize the face) may be more dependent on holistic processing than other cues. For instance, large-scale information, conveyed by lower spatial frequency ranges, such as global head shape, relative distance between eyes and mouth, may be more dependent on holistic processing than local details or fine-grained variations of texture, contained in higher spatial frequency ranges (Goffaux and Rossion, 2006; Sergent, 1986).

Importantly, this holistic mode of processing faces, which is already present in 4 to 6-year-old children (Carey and Diamond, 1994; de Heering et al., 2007; Pellicano and Rhodes, 2003; Tanaka et al., 1998), and perhaps even in 7-month-old infants (e.g. Bhatt et al., 2005; Cohen and Cashon, 2001), is *functional*, in the sense that it allows efficient encoding of an individual face, i.e. as a single representation, with all its diagnostic cues being encoded at once. The importance of the holistic mode of face processing is supported by evidence that acquired prosopagnosia, the inability to recognize and discriminate individual faces following brain damage (Bodamer, 1947), is related to an inability to process faces holistically (e.g. Levine and Calvanio, 1989; Sergent and Villemure, 1989; see Ramon et al., 2010 for a review).

Other-race faces are processed less holistically/configurally than same-race faces C12.S5.2

Four studies have shown directly that OR faces are processed less holistically than SR faces. Using the "whole-part advantage" effect (i.e. the fact that it is easier to recognize a facial feature when it is presented within the whole context of the face than when it is presented in isolation; Tanaka and Farah 1993; see Tanaka and Gordon, Chapter 10, this volume), Tanaka and colleagues (2004) showed that Western Europeans (Germany), who had been living in a largely unicultural society and had minimal experience with Asian faces, processed Caucasian (SR) faces, but not Asian (OR) faces, holistically. Michel and colleagues (2006a) replicated this finding in Belgian participants, who presented a strong ORE as measured in a preliminary face recognition task. Interestingly, in both studies, the Eastern Asian participants (Chinese), who had experience with

Caucasian faces (for their entire life in the study of Tanaka et al., 2004; for a year on average in the study of Michel et al., 2006a), showed holistic face processing for both races of faces (Caucasians and Asians), suggesting that visual experience may lead to, or increase, holistic processing for OR faces.

In a subsequent study (Michel et al., 2006b), Caucasian participants presented a composite-face effect (i.e. a difference in performance between misaligned and aligned face-stimuli in a composite-face matching task) in accuracy rates for Caucasian faces exclusively (Figure 12.4). These Caucasian participants presented a composite face effect for both race of faces in response times. Interestingly, in this study, Eastern Asian participants, who had no significant experience with Caucasian faces, showed a significant composite-face effect for Caucasian faces in accuracy rates, but marginally smaller than the composite-face effect exhibited for Asian faces (Figure 12.4). Moreover, their composite effect was also significantly smaller for Caucasian than for Asian faces in response times. These results showed that more holistic processing for SR than OR faces is found also for Asian observers. They also showed that holistic processing can be applied to OR faces (to a lesser extent than SR faces) even when observers do not have visual experience with these OR faces, an observation which is valid also for Caucasian observers presented with Asian faces (Michel et al., 2007).

In summary, there is direct evidence from two well-validated experimental paradigms measuring the interdependence between facial features, a marker of holistic face processing, that SR faces are processed, i.e. perceived, more holistically than OR faces. There is also indirect evidence in favor of this view: the decrease of performance for processing inverted faces (Farah et al., 1995; Rossion, 2008, 2009), an indirect marker of holistic processing, is larger for SR than OR faces (Hancock and Rhodes, 2008; Rhodes et al., 1989, 2006; Sangrigoli and de Schonen, 2004; see also Murray et al., 2003), at least when SR and OR faces are tested under the same conditions (unlike in Valentine and Bruce, 1986, where OR faces were given an advantage by being presented for a longer time). A lack of verbal overshadowing effect, the phenomenon that describing verbally a previously seen face impairs recognition of this face, for OR faces is also generally taken in support of the view that these faces are not or less processed holistically (Fallshore and Schooler, 1995).

C12.S5.3 A theoretical framework

The experience-based holistic account of the ORE outlined above is reasonably simple, and in agreement with many different proposals and observations about the ORE, as we will try to explain below.

C12.S5.3.1 PC analysis of SR and OR faces, and global components

Several studies have applied principal components analysis (PCA) to face images to extract the main dimensions that account for variance in a face set (e.g. Kirby and Sirovich, 1990; Turk and Pentland, 1991). PCA does a good job of accounting for some aspects of human memory performance with SR and OR face images (e.g. O'Toole et al., 1994; O'Toole, Chapter 2, this volume). Most interestingly, the PCs (or "eigenfaces") that account for most of the variations within races of faces are not only different for different races—indicating that there are distinct diagnostic features to individualize faces in different races—but they are *global*: they are identifiable at the level of the whole face and do not correspond to common sense local cues such as the size of the nose, or the thickness of the eyebrows for instance (O'Toole et al., 1994). This observation suggests that in order to accurately and rapidly identify an individual face within a given race, observers should ~~c~~consider many elements covarying together. Note that in a PC analysis of faces, the early components can carry information about subordinate-level categorization (sex,

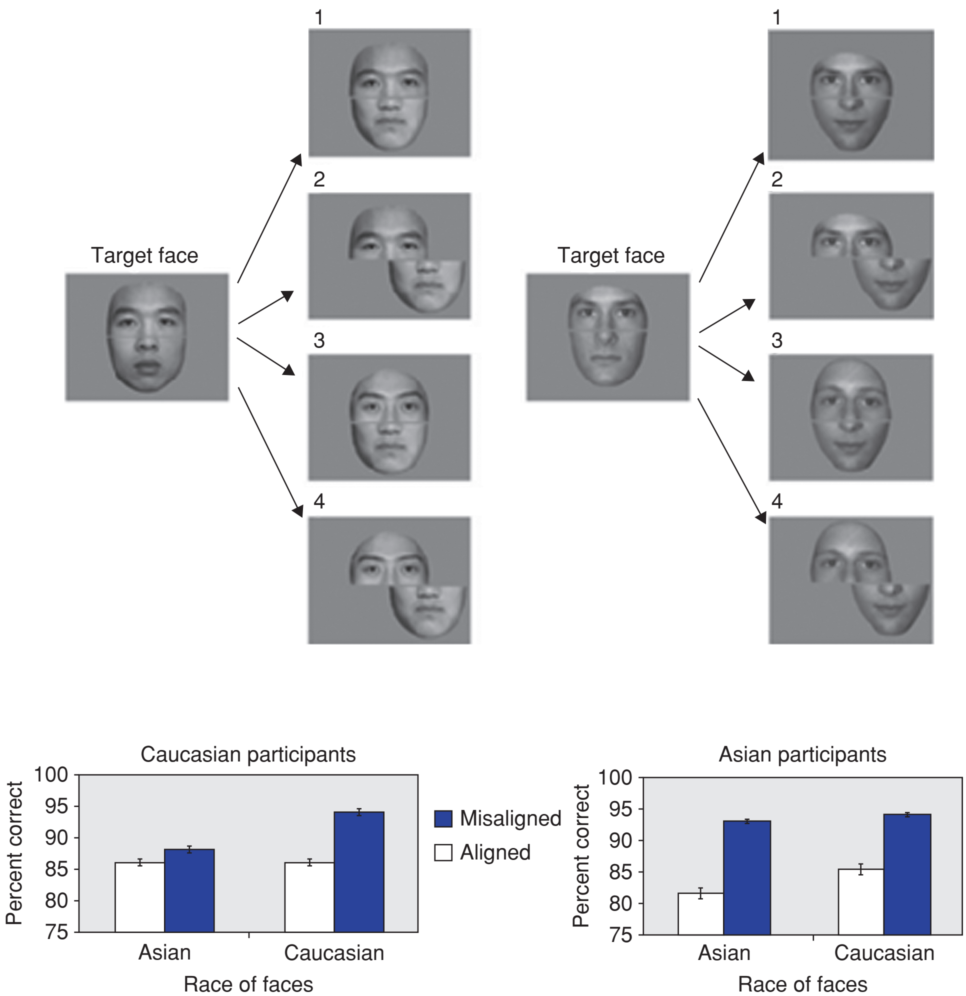


Fig. 12.4 Top: examples of Asian (on the left) and Caucasian (on the right) original (target) and composite faces used in the experiment of Michel et al. (2006b). The target face could be followed by a composite face with (1) the same top part aligned with a different bottom part, (2) the same top part misaligned with that different bottom part, (3) a different top part aligned with that different bottom part, or (4) a different top part misaligned with that different bottom part. For each pair of faces, participants were required to judge if the top parts were "same" or "different," ignoring the lower parts. Bottom: the composite-face effect in accuracy rates showed by Caucasian and Asian participants for Asian and Caucasian faces in the experiment of Michel et al. (2006b). The effect is reflected by the difference in performance for the trials requiring a "same" response (conditions 1 and 2) between "aligned" and "misaligned" conditions. Caucasian participants presented a composite-face effect for Caucasian faces but not for Asian faces. Asian participants showed a significant composite-face effect for Caucasian faces, but weaker than the composite-face effect exhibited for Asian faces. Errors bars represent standard errors of the mean. From Rossion et al. (2006), reprinted with permission from Wiley-Blackwell. C12.F4

race, etc.; see Abdi et al., 1994; O'Toole et al., 1994) while the later PCs apparently carry finer details, being potentially important for coding identity (O'Toole et al., 1994). However, even these later components are essentially global. This observation is consistent with a coarse-to-fine mode of processing face identity in which an initial global coarse representation is progressively refined, yet remains holistic throughout the processing of the face (Sergent, 1986).

C12.S5.3.2 Distinct diagnostic features for SR and OR faces

As stated above, the PCs accounting for variations within races of faces appear to be different for different races, indicating that there are distinct diagnostic features to individualize faces in different races (O'Toole et al., 1991, 1994). There are other sources of evidence that the main sources of variability between features of faces (i.e. diagnostic information for individualization) are different between races. In an early behavioral study, Ellis and colleagues (1975) found that Africans did not use the same facial features as Caucasians in their verbal descriptions of own-race faces, suggesting that the diagnostic features differ in these two races (see also Shepherd and Deregowski, 1981). Anthropometric studies also report large variations between different human populations, not only in terms of the average size and shape of certain features (allowing race categorization of the faces), but also in terms of their degree of variance within a given population (see Farkas, 1994). Interestingly, members of different racial groups, who may not look at faces the same way during identification (see Blais et al., 2008), appear to rely on different features to discriminate individual faces, irrespective of the race of the face with which they are presented (Ellis et al., 1975; although see Shepherd and Deregowski, 1981).

In principle, if faces from different races differ from each other along different (diagnostic) dimensions, and people rely on information that is diagnostic in their own race when they have to individualize faces, it is not very surprising that our face recognition system has great difficulties in discriminating individual OR faces. Throughout development, people would become particularly sensitive to the facial information that is diagnostic to individualize SR faces (e.g. interocular distance if it varies a lot between individual SR faces). When faced with OR faces, they would tend to rely on the same facial information, without much success because the source of variance in individual OR faces would be different (e.g. interocular distance would not vary a lot between OR faces).

In itself, such an experience-based account would be sufficient to account for the ORE, without the need to call upon the notion of a holistic representation. However, we argue that this account is not fully satisfactory. First, under this account, it is difficult to explain the larger holistic processing effects found for SR than OR faces. Second, Rhodes and colleagues (2006) found a clear ORE for participants of two races tested with stimuli on which *strictly identical* variations of local features or relative distances between features were applied to SR and OR faces. If the ORE was entirely due to naturally differential diagnostic cues for different races, an experiment in which *the exact same variations* were created on a set of SR and OR stimuli should not have led to any ORE. This finding *cannot* be explained by an account of the ORE in terms of differentially diagnostic features across races. Indeed, why would one be more sensitive to featural/relational changes applied on SR than on OR faces if they are identical, and do not respect the normal variations of cues encountered in real life? In contrast, according to the EBH account, participants in that study did not perceive OR faces as holistically as SR faces~~,~~ because, irrespective of the fact that the exact same variations were diagnostic for SR and OR faces, OR faces did not fit well with the observer's holistic template, contrary to SR faces. Therefore, OR faces were not encoded and recognized well. Thus, while there are certainly different diagnostic cues for different races of faces, and this factor probably contributes to the ORE, it is not sufficient.

A more efficient processing of both local features and relative distances between them for SR faces

C12.S5.3.3

Since holistic/configural processing is applied to *all* kinds of information that is potentially diagnostic to individualize the face, the EBH account of the ORE is entirely compatible with the observation that one is less efficient at processing both the local features of OR faces *and* the relative distances between these features (see Hayward et al., 2008; Rhodes et al., 2006, 2009a). However, the EBH account makes an interesting prediction: since the perception of long-range relative distances between features may be the most vulnerable to a loss of holistic perception (Goffaux and Rossion, 2007; Rossion, 2008; 2009; Sekunova and Barton, 2008), if anything, the ORE could be larger when only long-range relative distances between features are manipulated (e.g. eyes-mouth distance) than when diagnostic cues which can be resolved locally (e.g. eyes color, eye-eyebrow distance) are modified. This would be particularly the case in conditions of uncertainty, i.e. when the observer is not told about the nature of the diagnostic cues in a given task (see Rossion 2008, 2009).

OR faces more densely clustered than SR faces in face-space memory

C12.S5.3.4

Valentine (1991) provided an account of the ORE (among other effects) in terms of "face-space." A face would be uniquely represented as a point, or a vector, in a memory-space defined by a number of dimensions along which faces vary. Since the diagnostic facial dimensions would differ between different races, the dimensions of the face-space would be relevant mainly for SR faces. Therefore, OR faces would be more densely clustered in that space, and thus more confusable (Byatt and Rhodes, 2004; Valentine, 1991; Valentine and Endo, 1992). This account is clearly an experience-based account, in the sense that an observer would have developed sensitivity through experience to the different dimensions (i.e. interrelated group of features) characterizing SR faces.

The EBH account is largely compatible with this view, or at least the main aspects of it. The average (SR) face, or "norm," that is supposed to be the centre of the face-space (Valentine, 1991) would be used as a holistic template to perceive an individual face and encode it. The dense cluster of OR faces is merely a way of representing the fact that the aspects coded, i.e. the dimensions of the space (e.g. interocular distance, from small to large), or the range covered by these dimensions, may be inappropriate to encode an OR face (OR faces would thus be all out of range in the space). OR faces would be far from the average because they differ a lot from the template. However, there are a few aspects of Valentine (1991)'s proposal that would differ or need to be specified in an EBH account. First, according to Valentine (1991), the phenomenon essentially reflects a memory problem. However, according to the EBH account, perception and memory of individual faces cannot be disentangled: an internal representation is necessary to perceive the incoming face-stimulus in full: OR faces are *perceived and represented* less holistically than SR faces. Second, obviously, the dimensions that are used to encode a face must be interdependent in the EBH account. Third, the EBH account is more compatible with "norm-based" coding (Rhodes et al., 1987; Rhodes and Leopold, Chapter 14, this volume), i.e. a face being encoded as a vector in the face-space with reference to a central norm calculated as the "average" of the known population of faces, than with exemplar-based coding (Nosofsky, 1986).[2]

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[2] With respect to this issue, recent studies have showed that opposite figural aftereffects (see Rhodes and Leopold, Chapter 14, this volume) can be induced simultaneously for faces of different races (Jaquet et al., 2007, 2008). These effects are often interpreted as evidence of different norms for faces of different races but we suspect that these experiments do not allow making such direct inferences about the nature of face

C12.S5.3.5 A perceptual phenomenon: neural measures

According to an EBH account, OR faces are *perceived* less holistically than SR faces. One should thus expect to observe a difference between SR and OR face coding at the level of visual areas of the human brain, in particular the areas of the cortical network that are sensitive to faces (see Haxby et al., 2000; Sergent et al., 1992). Consistent with this suggestion, it has been shown in functional magnetic resonance imaging (fMRI) studies that the "fusiform face area," an area which codes individual faces holistically (Schiltz and Rossion, 2006) responds less well to OR than SR faces (Golby et al., 2001). Note that rather than reflecting an intrinsically lower response to OR than SR faces in this area, these latter results most likely reflect a larger adaptation to facial identity for OR faces (since they all look more alike), which would lead to a decrease of fMRI signal due to adaptation (see Gauthier et al., 2000; Grill-Spector and Malach, 2001; see also the discussion of a related issue about face inversion in Mazard et al., 2006). According to the EBH account, OR faces, which are perceived less holistically, could however recruit part-based processes to a larger extent, perhaps recruiting more general object perception regions such as the lateral occipital cortex (LOC, Malach et al., 1995), as found for faces presented upside-down (e.g. Yovel and Kanwisher, 2005).

Event-related potential (ERP) recordings from the human scalp provide more direct evidence in favor of the perceptual basis of the ORE. The parameters (amplitude, latency, scalp topography) of the face-sensitive N170 component (Bentin et al., 1996; Eimer, Chapter 17, this volume), which is thought to reflect the earliest activation of face representations in the human brain (Rossion and Jacques, 2008), do not vary in a consistent way between OR and SR faces (e.g. Caldara et al., 2004; Ito and Urland, 2003; Stahl et al., 2008). However, most interestingly, there is recent evidence that the release from adaptation to face identity as observed on the N170 amplitude (Jacques et al., 2007) is larger for SR than OR faces (Vizioli et al., 2009). This latter finding supports the view that the ORE is based on a perceptual encoding of individual face representations. Interestingly, the same ERP adaptation paradigm applied with upright and inverted faces, as well as composite faces, indicates that the individual face is encoded holistically during the time range of the N170 (Jacques and Rossion, 2009; Jacques et al., 2007). Altogether, these observations support the EBH account of the ORE.

C12.S5.4 Summary and some implications

To summarize, we propose that the full percept of an individual SR face results from the matching between the face input and an internal generic holistic template, possibly an average face. This matching allows a simultaneous perception of the individual face's deviations from the template, which concern both local and global aspects of the face (e.g. bigger nose, thicker eyebrows, smaller interocular distance, smaller head shape than the template). Depending on its specific deviations, the face could be registered as a vector in a multidimensional space, defined by interdependent, relevant, dimensions. In contrast, an individual OR face cannot fit well with the holistic template because its morphology is beyond the range of morphologies generally encountered in the perceiver's environment. It could then be processed, at least relatively more, by means of analytic, general (i.e. non-face specific) visual recognition mechanisms.

Let us now briefly discuss a few implications of this proposal.

representation. Indeed, if different aftereffects for different races of faces imply different norms, then following this logic, one must also have different norms for upright and inverted faces (Rhodes et al., 2004), male and female faces (Little et al., 2005), or perhaps even different individual faces (Robbins and Heck, 2009).

First, this mode of coding could also account for related phenomena to the ORE, such as the "other-age effect," the reduced ability to recognize faces of another age group, differing substantially in morphology (the "all kids look alike effect"; e.g. Anastasi and Rhodes, 2005; Kuefner et al., 2008; Lamont et al., 2005). Interestingly, it has been recently shown that faces of another age-group are perceived less holistically than same age faces, an effect which can be overturned only with extensive experience with another age group of faces (de Heering and Rossion, 2008; Kuefner et al., 2010).

Second, in this framework, there is only a *single* holistic template.[3] For a given observer, this template is relatively broadly or narrowly tuned to a specific morphology of faces, depending on his/her range of visual experience with faces. If it is finely tuned to SR faces only, OR faces will not be processed holistically. If it is broadly tuned, for instance for an observer who had visual experience with several races of faces, OR faces may also be processed holistically. Importantly, such a broad tuning would make the observer process SR faces *relatively* less holistically than another observer with a representation that is tuned to SR faces only. In other words, trade-offs of holistic effects between SR and OR faces should be observed. Interestingly, there is evidence for such trade-offs in the data of some recent studies that have investigated the other-age face effect. For instance, de Heering and Rossion (2008) found that adult preschool teachers (experts) processed children faces more holistically than adults without visual experience with child faces (novices). However, the data suggested a reverse effect for adult faces, with more holistic processing for child-face novices than experts (see also Kuefner et al., 2010). In the context of SR and OR faces, we predict a similar observation: observers who process OR faces more holistically following experience with OR faces, should process SR faces relatively less holistically than observers who have experience only with SR faces.

In the same vein, a third interesting prediction that can be made from the EBH account concerns observers who are exposed to multiple races of faces during development (e.g. Western European and sub-Saharan African faces). Because their holistic representation would be rather broadly tuned, they would handle more holistically faces of another race never encountered before (e.g. Eastern Asians) as compared to observers who have mainly been exposed to a single race of faces throughout their life.

Fourth, minimal experience may be sufficient to recalibrate the system temporarily (as shown by face adaptation studies; e.g. Webster and MacLin, 1999; Webster et al., 2004), and to be able to process a specific set of OR faces holistically (McKone et al., 2007). However extensive visual experience would be necessary to recalibrate the perceptual face system for the long term and for perceiving unfamiliar OR faces as holistically as SR faces (see de Heering and Rossion, 2008). What "extensive" exactly means cannot be assessed independently of the "quality" of experience, and of the age at which it is acquired. Another important factor to consider would be the degree of morphological difference between the visually experienced regime of faces and the new race of faces. If the latter differs substantially in morphology from the experienced race of faces, as would be the case for faces from another species, the system may take more time to recalibrate. Note also that, according to this view, the ORE would not only concern faces that present quite different morphologies, but should also be observed between different groups of a given human population, in relation to their morphological differences (e.g. Scandinavians and Mediterraneans within the Western European population; see Chiroro et al., 2008).

[3] At least for a given face view, without excluding the possibility of multiple viewpoint dependent representations in the system (Bruce and Young, 1986; Tarr, 1995).

Fifth, if the observer's holistic representation is broadly tuned, he/she may be able to distinguish an OR face from a SR face less efficiently and rapidly than an observer who has a holistic representation tuned only to SR faces. This is because, for the first observer, *both* SR and OR faces could be matched with the internal template and perceived holistically. In contrast, the second observer will categorize the OR face as belonging to another race more easily, since it will not even be encoded holistically. Thus, there may be an inverse relationship between the ability to individualize OR faces, and to categorize these faces as OR faces. Interestingly, the "other-race advantage" observed in race-categorization tasks (i.e. the fact that people are generally faster at categorizing OR than SR faces along their race-dimension; e.g. Caldara et al., 2004; Levin, 1996, 2000; Valentine and Endo, 1992; Zhao and Bentin, 2008), might indeed be inversely related to the ORE in face identification tasks (Levin, 2000). Importantly, this observation can be accounted for by an experience-based holistic account of the ORE without the need to call upon an alternative sociocognitive explanation, to which we will turn in the next section.

Finally, according to this framework, the ability to perceive individual faces holistically is considered as *necessary* for efficient face recognition. Nevertheless, once the individual face has been encoded holistically, a wealth of detailed information, which can enrich its representation and consolidate it in memory, can be accumulated in the face recognition system. Hence, while being able to perceive faces holistically would be *necessary* for efficient face recognition (as shown indirectly by our inability to recognize inverted faces, or by the prosopagnosic patients' recognition difficulties), it is certainly not *sufficient*. It follows that the ability of the face processing system to perceive a face holistically may not be necessarily correlated with the accuracy of face memory in a population of normal individuals. For instance, even though their composite face effect was the largest for SR faces, Asian participants in the study of Michel et al. (2006a) showed holistic processing also for OR (Caucasian) faces. Nevertheless, these Asian participants still showed a substantial ORE as measured in an old/new face recognition task. Moreover, the differential composite effect for SR and OR faces in the study of Michel and colleagues (2006b) was not correlated with the amplitude of the ORE, neither for Asian no Caucasian participants.

To summarize once again, we propose that the full percept of an individual SR face results from the matching between the face input and an internal generic holistic template, possibly an average face. This matching allows a simultaneous perception of the individual face's deviations from the template, which concern both local and global aspects of the face (e.g. bigger nose, thicker eyebrows, smaller interocular distance, smaller head shape than the template). Depending on its specific deviations, the face could be registered as a vector in a multidimensional space, defined by interdependent, relevant, dimensions. In contrast, an individual OR face cannot fit well with the holistic template because its morphology is beyond the range of morphologies generally encountered in the perceiver's environment. It could then be processed, at least relatively more, by means of analytic, general (i.e. non-face specific) visual recognition mechanisms.

C12.S6 The sociocognitive account of the ore: a brief critical review

According to the experience-based holistic account of the ORE, the nature of our face representation and processes would be *constrained* by our perceptual experience with different facial morphologies. That is, visual experience would fine-tune the system such that OR faces would be *perceived* less holistically. However, according to an alternative view, it is largely for social reasons that people are less accurate in recognizing OR faces. For instance, people would have prejudices towards members of another racial group, or would lack motivation/attention to encode OR faces, or would focus on the race of these faces at the expense of their individuality. This proposal is fairly old (see, e.g. Berger, 1969; Galper, 1973) and has several variants, which have received much attention over the past few years (see, e.g. Hugenberg et al., 2007; Levin, 2000; Sporer, 2001).

This sociocognitive account differs fundamentally from the EBH account because, according to the former, the face processing system would remain *broadly tuned*, and thus perfectly *able* in adulthood to deal with a wide variety of facial morphologies from different human populations (or even perhaps beyond human faces, see below). Thus, from a theoretical point of view, the fundamental difference between the sociocognitive and the EBH account is that the latter considers the ORE as a phenomenon occurring at the level of our internal face representation and processes, which are modified by experience and adaptive, whereas the former considers the ORE as a phenomenon that is largely independent from how we represent and process faces. Rather, the ORE would be due to the modulation of face recognition performance by social representations, motivation and/or attentional factors.

In terms of predictions, the difference between the sociocognitive and the EBH account of the ORE is that of a *capability*. According to the EBH account, a human adult observer with no visual experience with OR faces will have more difficulty individualizing these faces than SR faces, *all other factors* (motivation, attention, etc.) *being equal*. According to the sociocognitive account, i.e. if an observer is as motivated and attentive to OR as SR faces and has no prejudicial attitudes towards the OR faces, then he/she should be perfectly *able* to individualize these faces as efficiently as SR faces.

What about the evidence supporting the latter view? The sociocognitive view can in fact be divided into two variants that we will briefly review in turn.

Attention, motivation, and affective factors C12.S6.1

The idea that people would not be *motivated* to encode the individualizing information on OR faces because of prejudiced racial attitudes (e.g. Berger, 1969; Galper, 1973) has not been supported (Brigham and Barkowitz, 1978; Ferguson et al., 2001; Lavrakas et al., 1976; Platz and Hosch, 1988; Slone et al., 2000). Chance and Goldstein (1981)'s proposal, according to which we would not be motivated to encode OR faces *deeply* (irrespective of our racial attitudes), or Malpass' (1990) view, according to which we would not *pay attention to* OR faces' particularities because we would not find it useful to do so, have been either dismissed (Burgess and Weaver, 2003; Devine and Malpass, 1985; see also Rhodes et al., 2009b) or not tested (e.g. Malpass' hypothesis).

However, several recent findings appear to support the sociocognitive account of the ORE. For instance, motivation to individualize OR faces induced by a verbal instruction, a positive emotional state, or a larger functional importance experimentally provided to SR and OR face-stimuli through an angry expression can reduce, or even eliminate the ORE (Hugenberg et al., 2007; Johnson and Fredrickson 2005; Ackerman et al., 2006, respectively). It has also been shown that a pattern of performance similar to the ORE (i.e. one group of faces being more accurately recognized than the other) can be reproduced if one arbitrary group of SR faces is considered as "in-group" and the other as "out-group" (Bernstein et al., 2007; MacLin and Malpass, 2001; Pauker et al., 2009; Shriver et al., 2008).

However, there are a number of issues with these studies and their interpretation. First, participants' differential visual experience with OR faces has not been controlled in any of the above-mentioned studies performed with SR and OR faces, except in that of Rhodes et al. (2009b) who did not observe a significant interaction between condition of encoding and face race.

Second, and more fundamentally, as mentioned above, according to the EBH account of the ORE, a human adult observer has more difficulty individualizing OR faces than SR faces, *all other factors* (motivation, attention, etc.) *being equal.* This account does not state that attentional, motivational, or more generally social factors do not play any role in face recognition memory.

Obviously, they do (e.g. Hugenberg et al., Chapter 13, this volume). If, for reasons provided by the experimenter, an observer becomes *more* motivated to encode OR than SR faces, pays more attention to OR faces, associates these OR faces with particular emotional experiences, etc., he/she may indeed end up being able to recall OR faces equally well or even better than SR faces (see Hugenberg et al., 2007). However, this is an unfair comparison.

In the same vein, telling subjects of an experiment that some faces of a set belong to their own group is likely to increase the attention devoted to these particular faces. Hence, it is not surprising that subjects will recognize these "own group" faces better than the other faces of the set (see Shriver et al., 2008). It is unclear to us how this finding can be relevant for understanding the nature of the ORE.

To understand this issue better, let us make an analogy. It is well known that face recognition performance is massively affected by inversion of the stimulus (Yin, 1969). Even though the nature of the phenomenon is still debated, it is largely believed that upright and inverted faces are not encoded and perceived the same way. According to the most influential view of the face inversion effect, an inverted face cannot be encoded holistically (Farah et al., 1995; Galton, 1883; Rossion, 2008, 2009; Yin, 1969). Now, let us make the hypothesis that people are poor at recognizing inverted faces because of a lack of motivation and attention, or because they have stereotypes towards inverted faces. We design an experiment in which we ask people to encode upright and inverted faces, and ask them to pay particularly attention to the inverted faces "because it is well known that they are harder to recognize." It is likely that the inversion effect will be reduced in these conditions, jus because people would pay much more attention to inverted than upright faces. Could we conclude that motivational and attentional factors explain why we perform poorly with inverted faces in general?

C12.S6.2 Focusing on race rather than individuality for OR faces

According to an old version of the sociocognitive account of the ORE (e.g. Sheperd, 1981), categorical race-specifying information would be more salient in OR than SR faces. Consequently, the observer would focus on this race-specifying information when processing OR faces ("It's Chinese"), at the expense of individualizing information ("It's Fang"). Levin (1996, 2000; Levin and Angelone 2001), provided the strongest evidence for this claim by adapting a visual search paradigm (Treisman and Souther, 1985), in which Caucasian observers detected an OR-target face (Sub-Saharan African) among SR distractor-faces more easily than the reverse (detecting a SR-target face among OR distractor faces). This finding is consistent with the "other-race advantage" observed in race-categorization tasks: observers categorize OR faces according to race faster than SR faces (Caldara et al., 2004; Levin, 1996, 2000; Valentine and Endo, 1992; Zhao and Bentin, 2008). Importantly, Levin (1996, 2000) showed that participants who do not present the ORE in an old/new face-recognition task do not show this OR advantage either in a visual search task, a race-categorization task or both, suggesting that the two phenomena are linked.

However, Levin's (1996, 2000) observations have not always been replicated (see Chiao et al., 2006; Levin, 1996, sixth experiment), and the "OR advantage" observed in a discrimination task in his study conflicts with more recent results (Walker and Hewstone, 2006; Walker and Tanaka, 2003). Moreover, coding race-specifying information for both SR and OR faces does not reduce the ORE, contrary to Levin's hypothesis (Rhodes et al., 2009b). Finally, and most importantly, the OR advantage in a race-categorization task (Caldara et al., 2004; Levin, 1996, 2000; Valentine and Endo, 1992) and its inverted relationship to the ORE (SR advantage) in a face-recognition task (Levin 1996, 2000) do not necessarily imply a sociocognitive explanation. In fact, as indicated at the end of the earlier section "Summary and some implications," this observation would be perfectly compatible with the EBH account outlined here: if the observer's holistic representation is broadly tuned, he/she may be able to distinguish an OR face from a SR face less efficiently and rapidly than an observer who has a holistic representation tuned only to SR faces. This is because, for the first observer, *both* SR and OR faces could be matched with the internal template and perceived holistically. In contrast, the second observer will categorize the OR face as belonging to another race more easily, since it will not even be encoded holistically.

In summary, it may well be that sociocognitive factors that are not concerned directly with the nature of our face representation, such as a reduced attention or motivation, or an overemphasis on race at the expense of individuality for OR faces, play a role in the poorer recognition performance for OR than SR faces observed in real life. However, the experimental evidence in favor of these factors is rather mixed and subject to caution. Moreover, we argue that these factors are certainly not at the heart of the ORE, which rather appears to concern the nature of our face perception mechanisms. We will try to illustrate this point by raising two final, and more general, issues regarding the sociocognitive as opposed to an experience-based holistic account of the ORE.

General issues C12.S6.3

The assumption of a non-adaptive face recognition system, and the under-specification of the sociocognitive account C12.S6.3.1

While the face of all modern humans (*Homo sapiens sapiens*) had the same (African) morphology before human populations came out of Africa and spread on the different continents, the human face and the body have, since then, truly evolved in sometimes dramatically different ways due to environmental pressures (heat, humidity, etc.; Ruff, 1994, 2002). According to the EBH account, the human face recognition system adapts to the regime of faces that one experiences, and becomes finely tuned to the characteristics of these particular faces. In contrast, the sociocognitive view of the ORE depicts a view of our face recognition system that would not have been very adaptive in human evolution: given that human populations have coevolved separately and that multiracial societies are recent, a face recognition system that would have maintained a broad tuning would have been less efficient. In fact, unless one considers that variations in morphology between different world populations are negligible, which is hardly the case (see earlier section "Variations between human populations in face structure and the concept of 'face race'"), there is no reason to expect that the face recognition system would have remained broadly tuned to accommodate all variations of human faces throughout human evolution over the past 100,000 to 200,000 years.

However, let us imagine for one second that the face recognition system remains, as hypothesized by the sociocognitive account of the ORE, broadly tuned. Where does this broad tuning stop? Why do we find it difficult to individualize faces of non-human primates for instance (e.g. Pascalis and Bachevalier, 1998)? Could it be because humans lack the necessary motivation, attention, or because they emphasize the species categorization at the expense of the individualization?

This point illustrates the underspecification of the sociocognitive account of the ORE. Many animal species have faces that resemble those of humans in their configuration (Bruce and Young, 1998). Yet, without extensive experience, humans find it difficult to individualize faces from another species, even of non-human primate faces (see figure 1 in Sergent, 1994; Pascalis and Bachevalier, 1998). It is difficult to believe that this difficulty would be due to social stereotypes or motivational factors, and that by increasing their motivation and positive feelings towards non-human primates or other animal species, humans would be able to discriminate these individuals from their face as well as human faces, without extensive experience training. Yet, this is exactly what would be predicted, in principle, by a sociocognitive account of such an "other-species face effect."

C12.S6.3.2 The relevance of studies testing the ORE in multiracial societies

Another important issue to consider is that many studies claiming to find effects supporting the sociocognitive account are performed in multiracial societies (e.g. North America, Australia). Even though this is understandable—researchers would like to clarify phenomena that are particularly relevant for the community they live in—the generalization of results from these studies to observers living in largely uniracial societies is debatable. Indeed, the tuning to faces with different morphologies is certainly broader in populations of multiracial societies in general than in populations who are exposed almost exclusively to one race of faces. Consequently, in multiracial societies, the ORE is likely to be relatively smaller, and may be eliminated more easily by training participants to individuate other-race faces (McKone et al., 2007; Tanaka and Pierce, 2009) or providing them with an extra-motivation to pay attention to other-race faces (Hugenberg et al., 2007) than in populations who are mainly exposed to a single race of faces. Hence, it may be relatively easy to get rid of the ORE in an experiment performed with participants coming from a multiracial society, and one should be careful in generalizing the outcome of such studies to populations who have never been exposed to OR faces.

C12.S6.4 Conclusion

In conclusion, given the arguments mentioned here, we very much doubt that sociocognitive factors are at the heart of the ORE phenomenon. To be clear, it is extremely important to acknowledge that motivational, attentional, and social factors in general may modulate face recognition performance, and thus may contribute to our difficulty in recognizing OR faces. However, we argue that what is truly at the heart of the phenomenon is the reduced ability to encode OR faces as holistically as SR faces, and that a full understanding of this robust and fascinating phenomenon will go a long way towards a clarification of the nature of our face representation and processes.

C12.S7 Summary and conclusions

There are important and clearly visible differences in terms of bone structure, defining shape, and skin reflectance (color and texture) between faces originating from different human populations of the world. In this chapter, we have reviewed the well-known phenomenon that people have greater difficulty distinguishing and recognizing individual faces from a different human population, or "race," than their own. We integrated a large corpus of data and previous proposals into an experience-based holistic (EBH) account of the ORE. According to this EBH account, an individual face is perceived in full when it matches a holistic representation, a template, derived from visual experience during development. This holistic representation, originally broadly tuned, is refined during development to become tuned to the morphological characteristics of the most common population of faces encountered. Consequently, in adulthood, the individual face belonging to another "racial" group cannot register well with the holistic template. The other-race (OR) face is thus not perceived as holistically as a same-race (SR) face, and is encoded in a more piecemeal, less efficient, fashion. The holistic template is plastic enough to become tuned to OR faces following a reversal of face race experience during childhood, and perhaps during adulthood following extensive experience. We suggest that the EBH account encompasses and extends most other proposals, such as a more densely clustered organization of OR faces in an internal face-space centered on a "norm," and it leads to a number of interesting predictions about the processing of SR and OR faces. In contrast, we argue that while motivational, attentional and sociocognitive factors in general may contribute to lower recognition performance for OR faces, they are not at the heart of the ORE, a phenomenon that is important for understanding the nature of face perception and representation.

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