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Face cognition in humans: Psychophysiological, developmental, and cross-cultural aspects

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Investigators are finding increasing evidence for cross-cultural specificity in face cognition along with individual characteristics. The functions on which face cognition is based not only are types of general cognitive functions (perception, memory) but are elements of specific mental processes. Face perception, memorization, correct recognition of faces, and understanding the information that faces provide are essential skills for humans as a social species and can be considered as facets of social (cultural) intelligence. Face cognition is a difficult, multifaceted set of processes. The systems and processes involved in perceiving and recognizing faces are captured by several models focusing on the pertinent functions or including the presumably underlying neuroanatomical substrates. Thus, the study of face-cognition mechanisms is a cross-disciplinary topic. In Russia, Germany, and China there are plans to organize an interdisciplinary cross-cultural study of face cognition. The first step of this scientific interaction is conducting psychological and psychophysiological studies of face cognition in multinational Russia within the frame of a grant supported by the Russian Science Foundation and devoted to "cross-cultural tolerance". For that reason and in the presence of the huge diversity of data concerning face cognition, we suggest for discussion, specifically within the psychological scientific community, three aspects of face cognition: (1) psychophysiological (quantitative data), (2) developmental (qualitative data from developmental psychology), and (3) cross-cultural (qualitative data from cross-cultural studies). These three aspects reflect the different levels of investigations and constitute a comprehensive, multilateral approach to the problem. Unfortunately, as a rule, neuropsychological and psychological investigations are carried out independently of each other. However, for the purposes of our overview here, we assume that the main factors that could influence the developmental, individual psychophysiological, and cross-cultural differences in face cognition are not only biological but also social and cultural. One of the principal tasks of this article

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is to draw the attention of psychologists to the physiology of face processing and to draw the attention of neuroscientists to the psychology of face cognition. Thus, the main goal of the article is to instigate a discussion among social psychologists, psychophysiologists, and neuroscientists about the mechanisms of face cognition, which, as in a mirror, reflect the basic, fundamental "psychophysical" problem of psychophysiology.

Keywords: face cognition, social psychophysiology, development, other-ethnicity effects, brain mechanisms

Psychophysiological aspects of face cognition

The functional architecture and neural basis of the face-selective system in the human brain

Since the 1990s, brain mechanisms for face processing have been an area of high interest within psychophysiology and neuroscience. In the ever-growing body of research are the anatomical and physiological organization of the mechanisms underlying face perception and memory; the brain algorithms for detecting and identifying faces; the neural basis of face perception in humans and animals; the congenital and acquired disorders of face perception; and the brain mechanisms of cross-cultural differences in face perception and emotion recognition.

According to contemporary psychophysiological data (neuroimaging, electroencephalography, behavioral and clinical evidence), processing of faces can be divided into perceptual processing (detection of faces) and conceptual processing (identity of faces and facial expression) (De Haan, 2011; Tsao & Livingstone, 2008). In humans, a distributed neural network, involving the subcortical pathway (SP) and cortical areas (CAs), mediates these processes.

The SP (retina, superior colliculi, pulvinar of the thalamus, amygdala) is believed to process the basic features of faces quickly and automatically — that is, preattentively and unconsciously (for a review, see De Haan, 2011).

According to the widely known and cited functional model of the distributed human neural system for face processing, proposed by Haxby and Gobbini (2011), the face-selective CAs are divided into the Core System (CS) and the Extended System (ES). The CS includes the inferior occipital gyrus (occipital face area, OFA), the middle-lateral fusiform gyrus (fusiform face area, FFA), and the face-selective parts of the superior temporal sulcus (fSTS) and the superior temporal gyrus (fSTG). There is evidence that the FFA supports analysis of the invariant (static) components of faces (recognition/discrimination of individuals), while the STS and the STG are involved in the interpretation of changeable (dynamic) aspects of face processing (perception of facial expression, eye gaze, lip movements). Via forward and backward routes, the ES communicates with both the SP and the CS. It encompasses the amygdala, hippocampus, inferior frontal gyrus, medial orbitofrontal cortex, and anterior cingulate cortex (De Haan, 2011; Haxby & Gobbini, 2011). The networks of the ES are involved in the conscious interpretation of emotional states and the intentions of others in order to control and plan behavior in social situations.

As revealed by studies with functional magnetic resonance imaging (fMRI), the face-selective brain areas are activated more when humans are viewing human faces than when they are viewing other visual objects — letter strings, textures, flowers, houses, hands. The most robust face-selective activation is found in the FFA, which maximally responds to a wide variety of face stimuli: photos of familiar and unfamiliar faces, schematic faces, cartoon faces, animal faces, as well as faces presented in different sizes and locations, and from different viewpoints (Kanwisher & Dilks, 2013; Tsao & Livingstone, 2008). Although viewing faces evokes bilateral activation within all face-responsive regions, stronger responses have been found in the right hemisphere (Ishai, 2008).

Another portion of data, pertaining to the specificity of the face-selective CAs, comes from studies that used transcranial magnetic stimulation (TMS) to examine face processing. Pitcher, Walsh, and Duchaine (2011) used TMS to disrupt CAs implicated in the recognition of faces: the OFA, the face area in the right somatosensory cortex, and the STS. While stimulating the OFA, they discovered a temporally discrete impairment window from 60 to 100 ms. The TMS data that provide evidence that the OFA processes faces in a discrete temporally early period correspond closely to time-locked features of the face-sensitive N170 component of evoked response potential (ERP). The N170 is an ERP peaking 170 ms after stimulus onset; the response is stronger to faces than to objects (Eimer, 2011). This 170-ms face-selective time window may be formed as follows: detection and crude affective categorization occur rapidly, from 100 ms post-stimulus onset, with fine-grained cortical representations necessary to recognize identity and to discriminate between basic emotional expressions computed within an additional 70 ms (Palermo & Rhodes, 2007).

Feature-based and holistic-based algorithms for face cognition

The fundamental question in modern research on face processing is how the brain extracts and interprets the various facial properties from a single visual image. At present feature-based or holistic-based algorithms for the identification of individual faces are being discussed most actively (Sokolov, 2013; Tsao & Livingstone, 2008). The feature-based algorithm starts with identification of the fiducial face points (eyes, mouth, nose) in order to compute various geometric ratios. In a holistic algorithm, the entire face is matched to memory templates ("face-filters") without isolating specific features or parts. The first algorithm is robust in regard to position and scale variations, and the advantage of the second is that all parts of the face are used, and no information is discarded. Extensive psychophysiological evidence now shows that face processing uses both feature-based and holistic-based algorithms. For example, the FFA exhibits sensitivity to differences in face identity for upright but not inverted faces and sensitivity to holistic information in upright but not inverted faces; it thus favors the gestalt-based algorithm (Kanwisher & Barton, 2011; Kanwisher & Dilks, 2013). From another side, FFA responses show some invariance across changes in stimulus position and image size, and thus they reveal the advantages of the feature-based approach (Kanwisher & Barton, 2011). The face-selective neurons ("gnostic neurons") in human amygdala appear to represent perceptual information about face shape in a fashion invariant to image changes — that is, in a holistic way (see the "neuron-detector of Bill Clinton" in Kreiman, Fried, & Koch, 2002).

Do face cognition and objects' processing involve different visual networks in the brain?

Although the CS and the ES show the strongest activation in response to faces, they also respond to nonface objects (houses, chairs, tools), thus ruling out their status as "face modules" (Ishai, 2008; Tsao & Livingstone, 2008). In this connection, two alternative hypotheses are now being discussed. According to the first, the expertise hypothesis (EH), the FFA is engaged not in processing faces per se but rather in processing any sets of stimuli that share a common shape and about which the subject has gained substantial expertise (Tarr & Gauthier, 2000). The second hypothesis, the distributed-coding hypothesis (DCH), argues that objects and faces are coded via the distributed profile of neuronal activity across much of the ventral visual pathway (Haxby & Gobbini, 2011). The numerous results of fMRI, single-cell recording, TMS, and neuropsychology, taken together, make the argument that faces are "special" because of the tight clustering of face-selective neurons and thus they argue against EH. Moreover, these results indicate dissociations not only between faces and objects in general but also specifically between faces and other parts of the body (head, hands). The most effective pro-DCH argument came from a neuropsychological case study: Moscovitch, Winocur, and Behrmann (1997) described a striking agnosia of a patient who was severely impaired in regard to object recognition but nonetheless was 100% normal in regard to face recognition. Such a pattern of deficits indicates that in the visual hierarchy face processing is a completely different pathway that branches away from object recognition early (for a discussion, see Jansari et al., 2015). From another side, it has been compellingly shown that expertise, attention, visual imagery, emotion, contexts of whole bodies, emotional voices, and natural scenes modulate activation of the FFA (de Gelder & Van den Stock, 2007; Palermo & Rhodes, 2011). Thus, the results of the research projects briefly reviewed here appear conflicting, and there does not seem to be a simple answer as to whether the EH or the DCH is true.

Face processing in social cognition and social communications

Brain areas for face processing, along with other modalities, are actively involved in social cognition and social communications (Chernorizov, Asmolov, & Schechter, 2015; Zinchenko & Pervichko, 2013). They derive information about a person's identity and emotional state, gender and age, array of verbal and nonverbal (gestural) social signals, eye-gaze processing in face-to-face situations, capacity to understand people's intensions and desires, and impressions of others' attractiveness and trustworthiness (Bate & Bennett, 2015; Rolls, 2011; Soto & Wasserman, 2010). A large number of psychophysiological studies suggest that social cognition and communication strongly engage such parts of the brain as the amygdala, insula, fSTS, FFA, and OFC (Adolphs & Birmingham, 2011; Haxby & Gobbini, 2011). For example, information about a facial expression that is conveyed unconsciously via SP to the amygdala may be sufficient only to discriminate emotional (more arousing) from unemotional (less arousing) faces (Palermo & Rhodes, 2007). In modern social neuroscience a new line of research is evolving that focuses on how human beings recognize individual faces of their own race versus faces of individuals in another "racial group." This research centers on the brain mechanisms of the well-known phenomenon that people have greater difficulty distinguishing and recognizing individual faces from a different human population (the "other-race effect") than from their own ("in-group favoritism"). Some fMRI and ERP studies suggest that the expertise-dependent development of holistic processing of the FFA, from infancy through childhood, plays an important role in the recognition of familiar and unfamiliar faces of our own race and of other races (Jakobsen, Umstead, & Simpson, 2016; Rossion & Michel, 2011).

Developmental aspects of face cognition

General psychological findings from studies of the specificity of face cognition in adulthood

Face cognition — the ability to perceive and discriminate, to memorize and to correctly and rapidly recognize faces, and to understand the diverse information that faces provide — is one of the most valuable sets of skills for humans as social beings.

Since the days of Francis Galton, psychologists have been aware that a face is not identified by recognition of its isolated features but by the integration of these features into a perceived whole (Tanaka & Gordon, 2011). This face-specific strategy has been called holistic processing. According to models of face cognition (Bruce & Young, 2012) face perception starts with structural encoding — that is, extracting pictorial and structural codes from faces and maintaining them for a short period of time for subsequent recognition.

Psychological, clinical, phylogenetic, and neuroimaging studies have demonstrated that face cognition is a specific process and is connected more with social intelligence than with general cognitive processes (Bruce & Young, 2012; Wilhelm et al., 2010). Hildebrandt, Wilhelm, Schmiedek, Herzmann, and Sommer (2011) showed that this differentiation between general cognitive abilities and face cognition persists into old age. But what about the development of face processing?

The development of face cognition

The development of face cognition in childhood and adolescence is of interest to many researchers today. However, there are still many unresolved controversies. Already newborn infants show a preference for moving, schematic faces (Goren, Sarty, & Wu, 1975). One proposed explanation is a preference of the immature visual system for (top-heavy) patterns with an emphasis in the upper visual hemifield (Simion, Valenza, Cassia, Turati, & Umilta, 2002). Quinn, Yahr, Kuhn, Slater, and Pascalis (2002) found a preference in infants for the faces of wild cats, which the authors explain through the same mechanisms that supposedly drive the preference for female human faces (cats faces have some feminine traits). This mechanism is based on the early preference of infants for their mothers' faces. Infants are able to recognize their mothers' faces from different perspectives and to process the configuration of their faces (Rose, Feldman, Jankowski, & Van Rossem, 2008).

Because of many difficulties in the organization of the investigation of the development of face cognition, there are different interpretations of experimental findings. In the following sections, we discuss some major controversies in theories about the development of face cognition.

Controversies in research on the development of face cognition

Early versus late maturity of qualitative development. In discussing the qualitative development of face cognition, it is important to recall the classical encoding-switch hypothesis of Carey and Diamond (1977). Their main thesis is that face cognition matures late — during late adolescence — and this process is related to social experiences.

These initial suggestions about the late maturation of face cognition were strongly criticized. One of the points was connected with "own-age bias" — that is, it is easier to recognize persons from one's own age group (Anastasi & Rhodes, 2005). In Flin's work (1985) faces of classmates of children were used, and performance was much higher than in classic studies. This finding was crucial for changing views on the development of face cognition.

The current position is based on experimental evidence (psychological, clinical, phylogenetic, neuroimaging) of the specificity of face cognition and holds that it is possible to observe specific mechanisms already in early childhood, but these mechanisms continue to mature until late adolescence. Alternative positions are based on a theory of general development; proponents claim the early maturity of face cognition already at 4–5 years and relate this process to general cognitive abilities (Crookes & McKone, 2009).

This controversy remains unresolved. Several studies have returned to the postulate about the late maturity of face cognition. For example, Meinhardt-Injac, Persike, and Meinhardt (2014) have shown that although object perception by 14-to-16-year-old adolescents is on the same level as that of adults, face perception in this age group is not completely mature. To sum up, the trajectory of qualitative changes in the development of face cognition remains unclear; this path leads to other open questions — about the trajectory of quantitative changes in the development of face cognition and about factors that might influence this process.

Early versus late maturity of quantitative development. This controversy is based on the one about the qualitative development of face cognition and includes the same phases of changes of views on this question. In the classic studies of Carey and Diamond (1977) within the framework of the encoding-switch hypothesis but also in more recent studies (for example, Bruce et al., 2000), the trajectory of the quantitative development of face cognition was viewed as a linear increase with a slight decline at early puberty.

An alternative position starts from the theory of general development and postulates that 4-to-5-year-old children can already show as high a level of performance as adults if the procedure is organized in such a way that other cognitive functions are included in the decision process for the task. For example, Mondloch and colleagues (Mondloch, Dobson, Parsons, & Maurer, 2004; Mondloch, Le Grand, & Maurer 2002) found faster development in face-discrimination tasks that used a sequential presentation of faces; this result may be explained by the larger contribution of general memory. Based on the idea of Betts, Mckay, Maruff, and Anderson (2006) that psychometric-task performance in young children is characterized by a lack of sustained attention, Lundy, Jackson, and Haaf (2001) used stimuli with a larger size to better focus the children's attention. Indeed, in children, this procedure diminished the "paraphernalia-effect", the obstruction of face memory by irrelevant details like wearing a hat.

In order to decide between these positions, it is important to return to the first controversy by finding the trajectory of the qualitative development of face cognition and to clarify the question about the specificity of the development of this process.

Nature versus nurture. As mentioned above, in the framework of the classic encoding-switch hypothesis, Carey and Diamond (1977) noted that the maturity of face cognition in adolescence is highly related to social experiences and high motivation to communicate as adolescents try to find new friends. Further research on the development of face cognition with different designs and different age groups of children led to the position that face cognition is congenital and genetically determined. This position is supported by studies with babies, psychogenetic studies, studies about congenital prosopagnosia, and comparative studies with monkeys (McKone, Crookes, Jeffery, & Dilks, 2012).

Even though genetics has an important role in the normal development of face cognition, experience also makes contributions to this development. Le Grand, Mondloch, Maurer, and Brent (2004) found that, even after effective treatment, patients with a bilateral congenital cataract, who therefore were deprived of structured visual input during the first months of life, may continue to have difficulties when they have to compare faces. Many studies by Gauthier showed the importance of experience for the performance of tasks with visual stimuli and also in face tasks (Gauthier et al., 2014). Another argument in favor of experience is the decrease of the other-race effect (difficulties in recognizing the faces of people of other ethnicities) with increasing experiences with people of the corresponding ethnicity (Tanaka, Kiefer, & Bukach, 2004). Finally, Sommer, Hildebrandt, Kunina-Habenicht, Schacht, and Wilhelm (2013) have shown that high social activity is meaningful for the normal functioning of face memory until old age.

In addition, both genetic factors and social experience are imperative for the normal and healthy development of face cognition.

Cross-cultural aspects of face cognition

Other-ethnicity effects in face-processing efficiency

Cross-cultural communication is becoming increasingly common and frequent. Face perception is usually the first way for people to get information from each other. Although most facial information is universal, there are also some cultural and ethnic differences that lead to differences in processing faces of one's own ethnicity and other-ethnic faces. Such a phenomenon was first pointed out by Feingold (1914), who revealed the tendency of people to more easily mix/confuse persons with other ethnicity than persons of their own ethnicity. Since then, many researchers have conducted studies on this topic. Some different terms were used to describe this mass of phenomena — for example, other-race effect, own-race bias, cross-race effect, own-race effect. Some authors use the word *ethnicity* or *culture* instead of the word *race*. And there are more general terms — for example, *in-group effect* and *out-group effect*. Here we adopt the term *other-ethnicity effect*. The other-ethnicity effects revealed in previous studies can be grouped into two styles. One style is presented as the difference between face-processing efficiency when looking at the faces of people of one's own ethnicity and versus looking at the faces of people of other ethnicities; the other style is the cognitive bias in face processing.

In studying processing efficiency, the indices of response time and accuracy are usually taken as the dependent variables. Both advantages and disadvantages of other-ethnicity face processing have been reported; they are modulated by the task. In a face-recognition task (Meissner & Brigham, 2001) people are usually better at processing faces of their own ethnicity than faces of other ethnicities; this is the other-ethnicity disadvantage. However, when the task is to classify the ethnicity of faces, people are usually quicker to categorize other-ethnicity faces (Caldara, Rossion, Bovet, & Hauert, 2004; Levin, 1996, 2000); this is the other-ethnicity advantage. And there is a negative correlation in response time between the own-ethnicity advantage in face recognition and the other-ethnicity advantage in ethnicity-based categorization (Ge et al., 2009).

For the paradoxical phenomena of the other-ethnicity effects, the Categorization-Individuation Model (CIM) (Hugenberg, Young, Bernstein, & Sacco, 2010) provides a good explanation. This model indicates two different types of face processing. Categorization refers to the process of classifying examples into a group along shared dimensions, and identity refers to discrimination among category examples. The CIM suggests that the other-ethnicity effect results from the asymmetric experience and motivation of own-ethnicity and other-ethnicity faces in categorizing or individualizing. The CIM postulates a tendency to selectively identify or diagnose characteristics (for example, to configure information) among own-ethnicity faces (individuation) but to attend to category-diagnostic features (for example, skin tone) in other-ethnicity faces (categorization). Most perceivers have extensive experience in individuation with own-ethnicity faces but not necessarily with faces from another ethnicity. Therefore, if the task is to categorize the ethnicity of stimuli, it is suitable for other-ethnicity face processing, whereas recognition tasks lead to own-ethnicity advantages.

The CIM also admits that, in some cases, perceivers are motivated to process more individuation information in the face; such processing will overcome the basic tendency to categorize other-ethnicity faces. Emotion in facial expression might change the observer's motivation to process faces. For example, a study reported that the other-ethnicity disadvantage disappears when the face is angry; such mechanisms allow differentiation between out-group members to identify those who pose the greatest threat (Ackerman et al., 2006) When the task is to directly categorize the emotion of facial expression, the other-ethnicity effect is modulated by the type of emotion expression. In a review, Elfenbein and Ambady (2002) concluded that the other-ethnicity disadvantage is weakest — that is, agreement is best — for happiness and anger. However, this conclusion is not consistent if we carefully compare the previous studies. The amount of other-ethnicity effect on an emotional expression depends not only on the characteristic of this expression per se but also on the characteristics of the other expressions presented in the experiment. Therefore, the results reasonably change among previous studies with different settings.

The other-ethnicity effect in facial-expression recognition is also modulated by the intensity of the expression. For example, in a study by Zhang, Parmley, Wan, and Cavanagh (2015) American and Chinese participants classified angry, sad, and happy expressions of Caucasian and Chinese face stimuli at subtle-, low-, and moderate-intensity levels. Other-ethnicity effects were present only for expressions of anger at low and moderate intensity, and for sadness expressed at moderate intensity.

However, a study (Johnson & Fredrickson, 2005) revealed that positive emotion elicited by unrelated videos also reduces the own-ethnicity advantage in facial recognition. The authors explained that possible mechanisms might include improvements in holistic processing and promotion of a common in-group identity because of positive emotions.

Other-ethnicity effects in face-processing bias

In studies of other-ethnicity effects, besides having the reaction time and the accuracy as the behavior-dependent variables, qualitative and quantitative evaluation has also been used. With evaluation tasks, the other-ethnicity effects might present as cognitive bias — that is, people might tend to give a special evaluation to the other-ethnicity faces in contrast to their own. We refer to this as the other-ethnicity effect in face-processing bias. Such bias could present in evaluating characteristics of other-ethnicity face stimuli, as well as in people's feeling for and attitude toward the faces.

This aspect of other-ethnicity effects has not been studied as much as the other-ethnicity effects in face-processing efficiency. For example, Russell (1994) and Elfenbein and Ambady (2002) suggested examination of cultural variability not only for specific, discrete emotions but also for broad dimensions of affect. However, Russell (1991) also thought that the broad dimensions of affect (for example, arousal and valence) might be easier to identify and interpret across cultures. There are, in fact, quantitative differences for rating emotional stimuli along these dimensions across cultures as well. For example, facial expressions of European posers were rated lower in intensity by Asian than by European participants (Ekman et al., 1987). In a study with Japanese and Americans as observers and posers, the American observers gave higher intensity ratings than did the Japanese observers to all emotions regardless of the poser's ethnicity, except for disgust posed by Japanese (Matsumoto & Ekman, 1989). Although these studies reported some cultural specificity in the ratings of emotion intensity, these specificities were not bi-directionally present across cultures, precluding more general conclusions about other-ethnicity effects in emotion-intensity ratings.

Furthermore, people might give different explanations for the same facial expression because of the variability of cultures. For example, although the reaction time and accuracy of identifying the smile expression bears little other-ethnicity effect (Elfenbein & Ambady, 2002), and it is assumed to be culturally universal that smiling individuals are usually perceived more favorably than nonsmiling ones — they are judged as happier, more attractive, competent, and friendly — a study showed that the perception of smiling individuals is culturally diversified and that, in some cultures, this generally positive nonverbal signal may have negative associations (Krys et al., 2015).

Conclusion

Face cognition is a rather contradictory area of investigation. In future studies it will be important to clarify questions about the qualitative development of face cognition and about qualitative characteristics like holistic processing. From the developmental point, it is still not clear at which age this characteristic ability reaches full maturity. Cultural factors are also an important aspect influencing the functions of face cognition. Finally, research on the brain mechanisms of face processing will continue to be an important domain for our understanding of general issues in social neuroscience and social psychology.

Taken together, data from neurobiological, psychological, and cross-cultural research demonstrate the close connections of face processing with special organized brain activity, the individual nature of a person, and the cultural specificity of social relations. In this combination of nature and nurture factors psychologists tend to consider experience as the leading driving force for the formation of face cognition. But an increasing number of behavioral and neurophysiological findings challenge this view and argue that the role of experience in the development of the mechanisms of face processing has been overestimated. The emerging picture is that the mechanisms supporting face cognition mature at the earliest ages (3–5 years of age and, even, infancy) and are driven by everyday social contacts and also by innate brain factors. Thus, to fully understand the mechanisms of face processing, the "approach from mind" and the "approach from brain" should complement each other. Such a complex psychophysiological approach will be implemented in the framework of the wide-scale research on interethnic relations in multinational and multicultural Russia.

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References

Ackerman, J. M., Shapiro, J. R., Neuberg, S. L., Kenrick, D. T., Becker, D. V., Griskevicius, V., & Schaller, M. (2006). They all look the same to me (unless they are angry): From out-group homogeneity to out-group heterogeneity. *Psychological Science, 17*(10), 836–840. doi: 10.1111/j.1467-9280.2006.01790.x

Adolphs, R., & Birmingham, E. (2011). Neural substrates of social perception. In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 543–561). New York: Oxford University Press. doi: 10.1093/oxfordhb/9780199559053.013.0029

Anastasi, J. S., & Rhodes, M. G. (2005). An own-age bias in face recognition for children and older adults. *Psychonomic Bulletin and Review*, *12*, 1043–1047. doi: 10.3758/BF03206441

Bate, S., & Bennett, R. (2015). The independence of expression and identity in face processing: Evidence from neuropsychological case studies. *Frontiers in Psycho*logy, *6*, Article 770, 1-7. doi: 10.3389/fpsyg.2015.00770

Betts, J., Mckay, J., Maruff, P., & Anderson, V. (2006). The development of sustained attention in children: The effect of age and task load. *Child Neuropsychology*, *12*, 205–221. doi: 10.1080/09297040500488522

Bruce, V., Campbell, R. N., Doherty-Sneddon, G., Import, A., Langton, S., McAuley, S., & Wright, R. (2000). Testing face processing skills in children. *British Journal of Developmental Psychology*, *18*(3), 319–333. doi: 10.1348/026151000165715

Bruce, V., & Young, A. (2012). *Face perception.* London: Psychology Press.

Caldara, R., Rossion, B., Bovet, P., & Hauert, C.A. (2004). Event-related potentials and time course of the “other-race” face classification advantage. *Neuroreport, 15*, 905–910. doi: 10.1097/00001756-200404090-00034

Carey, S., & Diamond, R. (1977). From piecemeal to configurational representation of faces. *Science*, *195*, 312–314. doi: 10.1126/science.831281

Chernorizov, A. M., Asmolov, A. G., & Schechter, E. D. (2015). From physiological psychology to psychological physiology: Postnonclassical approach to ethnocultural phenomena. *Psychology in Russia: State of the Art*, *8*(4), 4–22. doi: 10.11621/pir.2015.0401

de Gelder, B., & Van den Stock, J. (2011). Real faces, real emotions: Perceiving facial expressions in naturalistic contexts of voices, bodies, and scenes. In A. Calder, G. Rhodes, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 510–524). New York: Oxford University Press. doi: 10.1093/oxfordhb/9780199559053.013.0027

De Haan, M. (2011). Neurodevelopment of face perception. In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 685–704). New York: Oxford University Press. doi: 10.1093/oxfordhb/9780199559053.013.0038

Eimer, M. (2011). The face-sensitive N170 component of the event-related brain potential. In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 327–341). New York: Oxford University Press. doi: 10.1093/oxfordhb/9780199559053.013.0017

Ekman, P., Friesen, W. V., O’Sullivan, M., Chan, A., Diacoyanni-Tarlatzis, I., Heider, K., & Tzavaras, A. (1987). Universals and cultural differences in the judgments of facial expressions of emotion. *Journal of Personality and Social Psychology*, *53*, 712–717.

Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion recognition: A meta-analysis. *Psychological Bulletin, 128*, 203–235. doi: 10.1037//0033-2909.128.2.203

Feingold, C. A. (1914). The influence of environment on identification of persons and things. *Journal of Criminal Law and Police Science, 5,* 39–51.

Flin, R. H. (1985). Development of face recognition: An encoding switch? *British Journal of Psychology*, *76*, 123–134.

Gauthier, I., McGugin, R. W., Richler, J. J., Herzmann, G., Speegle, M., & Van Gulick, A. E. (2014). Experience moderates overlap between object and face recognition, suggesting a common ability. *Journal of Vision*, *14*, 1–12.

Ge, L., Zhang, H., Wang, Z., Quinn, P. C., Pascalis, O., Kelly, D., & Lee, K. (2009). Two faces of the other-race effect: Recognition and categorization of Caucasian and Chinese faces. *Perception, 38*, 1199–1210.

Goren, C. C., Sarty, M., & Wu, P.Y.K. (1975). Visual following and pattern discrimination of face-like stimuli by newborn infants. *Pediatrics*, *56*, 544–549.

Haxby, J., & Gobbini, M. (2011). Distributed neural systems for face perception. In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 114–129). New York: Oxford University Press.

Hildebrandt, A., Wilhelm, O., Schmiedek, F., Herzmann, G., & Sommer, W. (2011). On the specificity of face cognition compared with general cognitive functioning across adult age. *Psychology and Aging*, *26*, 701–715.

Hugenberg, K., Young, S. G., Bernstein, M. J., & Sacco, D. F. (2010). The Categorization-Individuation Model: An integrative account of the other-race recognition deficit. *Psychological Review, 117*, 1168–1187. doi: 10.1037/a0020463

Ishai, I. (2008). Let us face it: It is a cortical network. *Neuroimag*e, *40*, 415–419.

Jakobsen, K. V., Umstead, L., & Simpson, E. A. (2016). Efficient human face detection in infancy. *Developmental Psychobiology*, *58*, 129–136.

Jansari, A., Miller, S., Pearce, L., Cobb, S., Sagiv, N., Williams, A. L., … Hanley, J. R. (2015). The man who mistook his neuropsychologist for a popstar: When configural processing fails in acquired prosopagnosia. *Frontiers in Human Neuroscience*, *9*, Article 390, 1–16.

Johnson, K. J., & Fredrickson, B. L. (2005). "We all look the same to me": Positive emotions eliminate the own-race in face recognition. *Psychological Science*, *16,* 875–881.

Kanwisher, N., & Barton, J. (2011). The functional architecture of the face system: Integrating evidence from fMRI and patient studies. In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 130–147). New York: Oxford University Press.

Kanwisher, N., & Dilks, D. (2013). The functional organization of the ventral visual pathway in humans. In L. Chalupa & J. Werner (Eds.), *The new visual neurosciences* (pp. 733–746). Cambridge, MA: MIT Press.

Kreiman, G., Fried, I., & Koch, C. (2002). Single-neuron correlates of subjective vision in the human medial temporal lobe. *PNAS*, *99*, 8378–8383.

Krys, K., Vauclair, C.-M., Capaldi, C. A., Lun, V. M.-C., Bond, M. H., Domínguez-Espinosa, A., … Yu, A. A. (2015). Be careful where you smile: Culture shapes judgments of intelligence and honesty of smiling individuals. *Journal of Nonverbal Behavior*, *40*(2), 101–116.

Le Grand, R., Mondloch, C. J., Maurer, D., & Brent, H. P. (2004). Impairment in holistic face processing following early visual deprivation. *Psychological Science*, *15*, 762–768.

Levin, D. T. (1996). Classifying faces by race: The structure of face categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22*, 1364–1382.

Levin, D. T. (2000). Race as a visual feature: Using visual search and perceptual discrimination tasks to understand face categories and the cross-race recognition deficit. *Journal of Experimental Psychology: General, 129*, 559–574.

Lundy, B. L., Jackson, J. W., & Haaf, R. A. (2001). Stimulus properties, attentional limitations, and young children's face recognition. *Perceptual and Motor Skills*, *92*, 919–929.

Matsumoto, D., & Ekman, P. (1989). American-Japanese cultural differences in intensity ratings of facial expressions of emotion. *Motivation & Emotion, 13*, 143–157.

McKone, E., Crookes, K., Jeffery, L., & Dilks, D. D. (2012). A critical review of the development of face recognition: Experience is less important than previously believed. *Cognitive Neuropsychology*, *29*, 1–39.

Meinhardt-Injac, B., Persike, M., & Meinhardt, G. (2014). Development of visual systems for faces and objects: Further evidence for prolonged development of the face system. *PLoS ONE, 9*(6): e99942, doi: 10.1371/journal.pone.0099942

Meissner, C. A., & Brigham, J. C. (2001). Eyewitness identification: Thirty years of investigating the own-race bias in memory for faces: A meta-analytic review. *Psychology, Public Policy, & Law, 7*, 3–35.

Mondloch, C. J., Dobson, K. S., Parsons, J. & Maurer, D. (2004). Why 8-year-olds cannot tell the difference between Steve Martin and Paul Newman: Factors contributing to the slow development of sensitivity to the spacing of facial features. *Journal of Experimental Child Psychology*, *89*, 159–181.

Mondloch, C. J., Le Grand, R., & Maurer, D. (2002). Configural face processing develops more slowly than featural face processing. *Perception*, *31*, 553–566.

Moscovitch, M., Winocur, G., & Behrmann, M. (1997). What is special about face recognition? *Journal of Cognitive Neuroscie*nce, *9*, 555–604.

Palermo, R., & Rhodes, G. (2007). Are you always on my mind? A review of how face perception and attention interact. *Neuropsychologia, 45*, 75–92.

Pitcher, D., Walsh, V., & Duchaine, B. (2011). Transcranial magnetic stimulation studies of face processing. In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 362–378). New York: Oxford University Press.

Quinn, P. C., Yahr, J., Kuhn, A., Slater, A. M., & Pascalis, O. (2002). Representation of the gender of human faces by infants: A preference for female. *Perception*, *31*, 1109–1121.

Rolls, E.T. Face neurons (2011). In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 51–75). New York: Oxford University Press.

Rose, S. A., Feldman, J. F., Jankowski, J. J., & Van Rossem, R. (2008). A cognitive cascade in infancy: Pathways from prematurity to later mental development. *Intelligence*, *36*, 367–378.

Rossion, R., & Michel, C. (2011). An experience-based holistic account of the other-race face effect. In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 223–248). New York: Oxford University Press.

Russell, J. A. (1991). Culture and the categorization of emotions. *Psychological Bulletin, 110*, 426–450.

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin, 115,* 102–141.

Simion, F., Valenza, E., Cassia, V. M., Turati, C., & Umilta, C. (2002). Newborns' preference for up-down asymmetrical configurations. *Developmental Science*, *5*, 427–434.

Sokolov, E. N. (2013). *The psychophysiology of consciousness*. New York: Oxford University Press.

Sommer, W., Hildebrandt, A., Kunina-Habenicht, O., Schacht, A., & Wilhelm, O. (2013). Sex differences in face cognition. *Acta Psychologica, 142*, 62–73.

Soto, F. A., & Wasserman, E. A. (2010). Comparative vision science: Seeing eye to eye? *Comparative Cognition and Behavior Reviews*, *5*, 148–154.

Tanaka, J. W., & Gordon, I. (2011). Features, configuration, and holistic face processing. In G. Rhodes, A. Calder, M. Johnson, & J. Haxby (Eds.), *Oxford handbook of face perception* (pp. 149–176). New York: Oxford University Press.

Tanaka, J. W., Kiefer, M., & Bukach, C. M. (2004). A holistic account of the own-race effect in face recognition: Evidence from a cross-cultural study. *Trends in Cognitive Sciences*, *11*, 8–15.

Tarr, M. J., & Gauthier, I. (2000). FFA: A flexible fusiform area for subordinate-level visual processing automatized by expertise. *Nature Neuroscience*, *3*, 764–769.

Tsao, D. Y., & Livingstone, M. S. (2008). Mechanisms of face perception. *Annual Review of Neuroscience*, *31*, 411–437.

Wilhelm, O., Herzmann, G., Kunina, O., Danthiir, V., Schacht, A., & Sommer, W. (2010). Individual differences in perceiving and recognizing faces — One element of social cognition. *Journal of Personality and Social Psychology*, *99*, 530–548.

Zhang, F., Parmley, M., Wan, X., & Cavanagh, S. (2015). Cultural differences in recognition of subdued facial expressions of emotions. *Motivation and Emotion*, *39*, 309–319. doi: 10.1007/s11031-014-9454-x.

Zinchenko, Y. P., & Pervichko E. I. (2013). Nonclassical and postnonclassical epistemology in Lev Vygotsky's cultural-historical approach to clinical psychology. *Psychology in Russia: State of the Art, 6*, 43–56. doi: 10.11621/pir.2013.0104

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