Developmental differences in face recognition by face race and emotion expression: An examination of the cross-race effect

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DEVELOPMENTAL DIFFERENCES IN FACE RECOGNITION BY FACE RACE AND EMOTION EXPRESSION: AN EXAMINATION OF THE CROSS-RACE EFFECT

Abstract

The current research tested children memory for emotional and neutral African-American and Caucasian-American male and female faces. The results revealed a three-way interaction with race, sex, and expression, demonstrating a developmental sensitivity to numerous social factors and the integration of multiple streams of facial information (e.g., race, sex, and emotion). Follow-up analyses revealed a more accurate identification of White faces than Black faces, regardless of emotional expression, by 8-year-olds, but not younger children or young adults. Adults, but not children, had a more accurate identification of happy faces than angry faces, regardless of race.

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Introduction

A variety of social factors, including culture, race, and age, affect our most fundamental psychological processes (Chiao & Ambady, 2007), including social cognitive tasks like remembering faces and decoding emotional expressions (Eberhardt, 2005; Freeman, Schiller, Rule, & Ambady, 2010). In adults, the cross race effect (CRE), the tendency to remember faces of one's own race with more accuracy than faces of other races, has been well documented (Ambady & Weisbuch 2011; Meissner & Brigham 2001). One possible explanation for the CRE is that individuals attend more to individuating characteristics of same race faces, but not other race faces (Hugenberg, Young, Sacco, & Bernstein 2011).

In children, there is mixed evidence for the cross race effect. Pezdek, Blandon-Gitlin, and Moore (2003) found a CRE at kindergarten, 3rd grade, and young adults. However, White children at age 6-8 are more accurate than older children in recognizing out-group faces (Chance, Turner, & Goldstein, 1982).

Importantly, in addition to unchanging properties of the face like race, situationally sensitive properties such as the emotion expressed by a face influence recognition accuracy. For example, memory is enhanced for positive expressions later in adulthood while memory is enhanced for negative expressions earlier in adulthood; specifically, older, but not younger, adults remember faces with higher accuracy if the face showed a happy expression rather than an angry or sad expression (Mather & Cartensen 2003). Moreover, short-term memory is enhanced for angry relative to happy or neutral faces in young adults (Jackson, Wu, Linden, & Raymond, 2009). While the influence of emotional expressions of adult face memory is therefore understood, less work has been done in children, For instance, a study of children and adolescents with and without major depressive disorder (MDD) found that memory for fearful, but not happy or angry, faces was impaired in individuals with MDD (Pine, Lissek, Klein, Mannuzza, Moulton, Guardino, & Woldehawariat 2004), but this work employed a clinical sample, leaving unexplored how non-depressed, typically developing children's face memory is modulated by emotional expressions.

The influence of expressions on face memory is of theoretical interest. There is debate whether facial expression and facial identity are perceived through two separate processes. The influential model proposed by Bruce and Young (1986) has some evidence from more recent brain imaging studies. In a review, Jackson et al. (2009) cites evidence for independent routes, based on studies suggesting the fusiform face area is involved in face identification while the superior temporal sulcus, amygdala, and orbital frontal cortex are involved in emotion perception. Evidence also comes from ERP and behavioral data that reaction time for identifying faces of different emotional expressions is similar (Eimer, Holmes, & McGlome 2003; Haxby, Hoffman, & Gobbini 2002). Conversely, evidence against independent processes also comes from brain imaging data that the fusiform face area and inferotemporal cortex are also involved in perceiving emotional expression (Jackson et al. 2009). There is also behavioral evidence that faces with happy expressions are identified with higher accuracy (Gallegos & Tranel 2005). Several findings also demonstrate the influence of identity on emotion recognition. For example, happiness is perceived more readily in women and anger is perceived more readily in men (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007). Additionally, happiness is perceived more readily in White faces and negative expressions are perceived more readily in Black faces (Hugenberg 2005).

As a consequence, further research exploring the bi-directional relation between the processing of static and dynamic aspects of the face is necessary. Moreover, exploring the integration of dynamic and static features in the context of children's face memory represents an important opportunity to understand how these different streams of face information are integrated across development. For example, children may process dynamic and static aspects of faces in a more clearly distinct manner than adults, perhaps because immature face processing makes simultaneous processing of these streams of information challenging. Alternatively, the ability to incorporate both static and dynamic facial information may be well developed early in childhood, as both skills appear well formed (i.e., children are skilled at face memory and emotion decoding separately and thus may be able to integrate these two informational streams in a similar manner as adults.)

Race and Emotional Expression

Given that the processing of face identity and emotion displays appears to share some overlap, it is likely that race and emotion might influence face memory, both in children and adults. First, emotion-specific stereotype information may bias memory for faces that fit that stereotype; for example, enhanced memory for angry Black faces in White perceivers (e.g. Ackerman, Shapiro, Neuberg, Kenrick, Becker, Griskevicius, Maner, & Schaller 2006). More broadly, the social relevance of a face may contribute to the CRE. A fearful face of a racial in-group member may be more meaningful in signaling danger than a fearful face of an out-group member. The heightened emotional arousal of seeing the fearful in-group member's face may lead to better memory for that face.

Several studies provide evidence that race interacts with facial expression for emotion perception, face identification, and face memory. Fear differentially activates amygdala activation in response to own- and other-race faces (Chiao, Iidaka, Gordon, Nogawa, Bar, Aminoff, Sadato, & Ambady 2008). In an experiment where perceivers rated the anger of a face morphed to have facial features along a spectrum of increasingly prototypical anger expression, White adults rated more gradations of anger expressions as "angry" for Black faces as compared to White faces (Hugenberg & Bodenhausen 2003). White participants also were more accurate in a face identification memory task in identifying White smiling faces and Black angry faces than they were in identifying White angry faces and Black smiling faces (Corneille, Hugenberg, & Potter 2007).

Less work has been done in children's memory for faces of different races displaying different emotional expressions. Young children remember "mean" neutral faces with higher accuracy than "nice" neutral faces where race was held constant by using 50% White and 50% Black face morphs (Kinzler & Shutts 2008), which leaves unaddressed how unambiguous manipulations of target race interact with expressions to influence face memory in children.

The current study: Same- vs. other-race emotion memory in children vs. adults

The current study addresses the question whether race interacts with emotion in White children's and adults' memory for faces. This study provides information on developmental changes in integration of the trait cue of race and state cue of emotion. As stated previously, young adults have higher accuracy for remembering negative expressions over positive expressions (Jackson, Wu, Linden, & Raymond, 2009), children remember "mean" over "nice" faces with higher accuracy (Kinzler & Shutts 2008), and Whites have higher accuracy for remembering angry Black male faces than angry White male faces (Ackerman et al. 2006). Therefore the hypothesis is that White children will remember angry Black faces with the highest accuracy (based on Ackerman et al. 2006), angry White faces with the next highest accuracy (based on Kinzler & Shutts 2008), neutral White faces with the next highest accuracy, and neutral Black faces with the lowest accuracy (based on research on the CRE).. Additionally, older children will perform more like adults in their memory biases.

Methods

Participants

Participants were White children ages 5-8 recruited at the Museum of Science, Boston, and White adults 18-24 recruited at Tufts University. Child participants received a sticker as compensation for their participation, and undergraduates received course credit. The age composition was: 5-year-olds: 12 (7 female), 6-year-olds: 12 (6 female), 7-year-olds: 11 (3 female), 8-year-olds: 16 (6 female). Adults 18-year-olds: 31 (23 female), 19-year-olds: 18 (9 female).

Materials

Faces were chosen from the NimStim face database (Tottenham, Tanaka, Leon, Mccarry, Nurse, Hare, Marcus, Westerlund, Casey, & Nelson 2009) and an in-house face database. Due to fewer Black females available in the NimStim and less range of emotional expressions in the database, NimStim were used as targets and both NimStim and the other face database was used to fill in foils. All faces had a direct rather than averted gaze, closed mouth, and wore a gray shirt or the photographs were digitally altered to wear a gray shirt. All faces were presented in equal size display on the screen and presented in color, with a white background.

Procedure

The encoding task used 8 angry and 8 happy faces in random order for a total of 16 encoding phase faces, followed by a 2-minute distraction, and a final recall task with 32 neutral faces (16 foils). Order of presentation of faces was randomized in both encoding and recall phase. Additionally, conditions were counterbalanced so that an individual displayed an angry face in one condition and a happy face in the other.

Two additional pilot studies were run: (1) emotion labeling to assess whether children perceive the happy and angry stimuli in the study as happy and angry, and (2) a neutral face condition to compare a baseline to the happy vs. angry condition. In the neutral control condition pilot study, methods were identical to the methods just described, using the same individuals from the NimStim and in-house face database with neutral expressions in place of angry and happy expressions. Analysis of gender of target was also conducted, though the number of stimuli available to divide analyses into race, emotion, and gender bins was limited, and therefore results must be interpreted with caution. The results of the pilot studies are in the appendix.

Analysis Plan

Participants' d-prime scores were calculated from hit rates and false alarm rates. Scores of 0% accuracy and 100% accuracy were corrected using the formula suggested by Snodgrass & Corwin (1988). A higher d-prime score indicates a higher ratio of hits relative to false alarms, and a lower d-prime score indicates a lower ratio of hits relative to false alarms. Put another way, a higher d-prime score indicates less overlap in signal and signal-plus-noise, and a lower d-prime score indicates more noise. D-prime scores for overall hits and false alarms, as well as hits and false alarms separated by race, separated by emotion, and separated by race-emotion combination (e.g. happy White males) were compared in a repeated measures ANOVA. Mixed ANOVAs were used to analyze the between-subjects age effect, the within-subjects face race and emotion expression effects, and the interactions between these variables.

Results

Cross-race effect and age

There was a significant interaction for age of participant and d-prime scores for White vs. Black target faces, $F(6,103)=4.275$, $p<0.001$. Follow-up analyses revealed a significant difference between d-prime scores for White and Black faces, regardless of emotion, for 8-year-olds, $F(1,15)=8.268$, $p<0.05$, such that memory for White faces was greater than memory for Black faces (Figure 1, Table 2).

Cross Race Effect for Face Memory in 8-year-olds but not other age cohorts

Analyzing the CRE within age cohorts, there were no significant differences between d-prime scores for White and Black faces, regardless of emotion, in 4-year-olds ($F(1,9)=0.083$, $p=0.780$), 5-year-olds ($F(1,11)=0.186$, $p=0.186$), 6-year-olds ($F(1,11)=0.010$, $p=0.923$), 7-year-olds ($F(1,10)=0.001$, $p=0.971$), 18-year-olds ($F(1,30)=2.467$, $p=0.127$), or 19-year-olds ($F(1,17)=3.342$, $p=0.085$). However, there was a significant difference between d-prime scores for White and Black faces, regardless of emotion, for 8-year-olds, $F(1,15)=8.268$, $p<0.05$, such that memory for White faces was greater than memory for Black faces.

Emotion and race interaction

Analysis of d-prime scores for race and emotion using a repeated measures ANOVA revealed no significant within-subject effects (all ps<0.70) (Figure 2, Figure 3).

Among adults (ages 18-19 grouped together), there was a significant main effect for emotion, $F(1,48)=4.133$, $p<0.05$, such that memory for happy faces was greater than memory for angry faces (Figure 2, Figure 3, Table 1). There was no significant interaction of emotion and race ($F(1,48)=0.111$, $p=0.741$).

Within age groups, there were no significant main effects (all *p*s<0.80) or interactions (all *p*s<0.80) among any of the child groups. There was a non-significant trend for emotion in 8-year-olds, $F(1,15)=4.480$, $p=0.051$, such that memory for happy faces was greater than memory for angry faces.

Discussion

At age 8, White participants showed a higher d-prime score for White faces than Black faces (Figure 1). Only the 8-year-old cohort showed a significant discrepancy between d-prime scores for White and Black faces (Table 2).

Why would the 8-year-olds show a stronger cross race effect in face memory than other groups? Children are aware of racial differences at age 8, though less aware of the social implications of race (Apfelbaum, Pauker, Ambady, Sommers, & Norton 2008). It is possible that race is learned as a meaningful category around age 8 and becomes more salient. The lack of CRE in face memory for adult participants is more puzzling. It is possible that emotion was more salient than race to adults in this task, or that the ease of the task or demand characteristics influenced adults' perceptions. However, though the task may have been relatively easy for adult participants, accuracy scores for adults were not near ceiling.

There was no race by emotion interaction in memory for faces as predicted. It may be that encoding a face as angry does not enhance recall when the individual's expression is then neutral. It is a unique and challenging task to recognize the identity of a neutral face when previously only presented with expressive faces. It is adaptive to encode emotional faces of others, but perhaps the emotion is encoded more strongly than the identity. The study raises questions as to how emotion information that is encoded is or is not called upon by retrieval when the target face has a different expression at encoding and at retrieval. The study shows a null finding in short-term (after about approximately two minutes) recall. Effects on longer-term recall remain to be tested, as the current study is not equipped to study long-term recall, but could potentially have more real-world relevance, for example, if an eyewitness views an individual with an angry or fearful expression at a crime scene and has poor recall of the individual in the police lineup when he or she later has a neutral expression. Several other possibilities for the lack of race by emotion interaction include the small range of stimuli (16 encoding faces) or low power from small participant sample sizes.

Interestingly, in adults, d-prime scores showed a higher hit to false alarm ratio for happy faces of both races, and a lower hit to false alarm ratio for angry faces of both races. Happy faces may be more pleasant to direct attention toward, or be more attractive, influencing length of encoding time. Eyetracking studies would provide further information on the relationship between time spent looking at different emotional expressions and retrieval.

Conclusion

The current research tested adult’s and children’s memory for emotional and neutral Black and White-American faces. The results reveal a developmental sensitivity to race and emotion and the integration of multiple streams of facial information.

Appendix A

Pilot data: Neutral faces pilot memory study, (N=8 participants, 7 White, 6 with useable data)

Participant	Age	Race	Gender	d Black	d White	Overall d'
A	3	White	male	0.83171	0	0.39837
B	4	White	female	1.468989	0.993129	1.205786
C	5	White	female	1.593219	0.83171	1.37681
D	6	White	female	0	0.993129	0.488776
E	10	White	female	1.468989	0.637279	0.993129
F	12	White	female	2.300699	1.824839	2.037496

No significant differences between d-prime for Black and White neutral faces.

Appendix B.

Pilot data: Emotion labeling study (N=12 participants, 7 female).

Participant	Age	Race	Gender	Happy_Accuracy	Angry_Accuracy
AA	4	w	f	100.00%	75.00%
BB	4	w	f	100.00%	87.50%
CC	4	w	m	100.00%	62.50%
DD	4	w	f	87.50%	75.00%
EE	4	w	m	87.50%	87.50%
FF	4	w	m	100.00%	62.50%
GG	4	w	m	100.00%	50.00%
HH	5	w	f	100.00%	75.00%
II	5	w	f	87.50%	75.00%
JJ	6	w	f	100.00%	87.50%
KK	6	w	f	87.50%	50.00%
LL	7	w	m	100.00%	75.00%
		Average Accuracy		95.83%	71.88%

Summary: From pilot data from 12 participants, young children labeled the happy faces as “happy’ 95.83% of the time and labeled angry faces as “angry” 71.88% of the time. Most common other responses for the angry faces were “sad”, “surprised”.

Figure 1. Average d-prime scores for White (in blue) vs. Black (in red) faces for each age cohort.

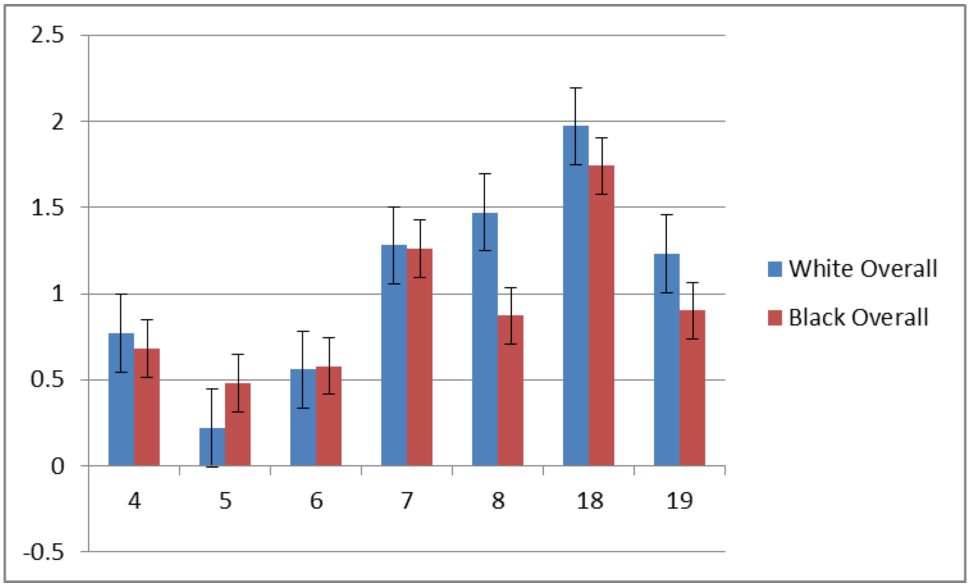

Figure 2. Average d-prime scores for happy (in blue) vs. angry (in red) expressions in White faces for each age cohort.

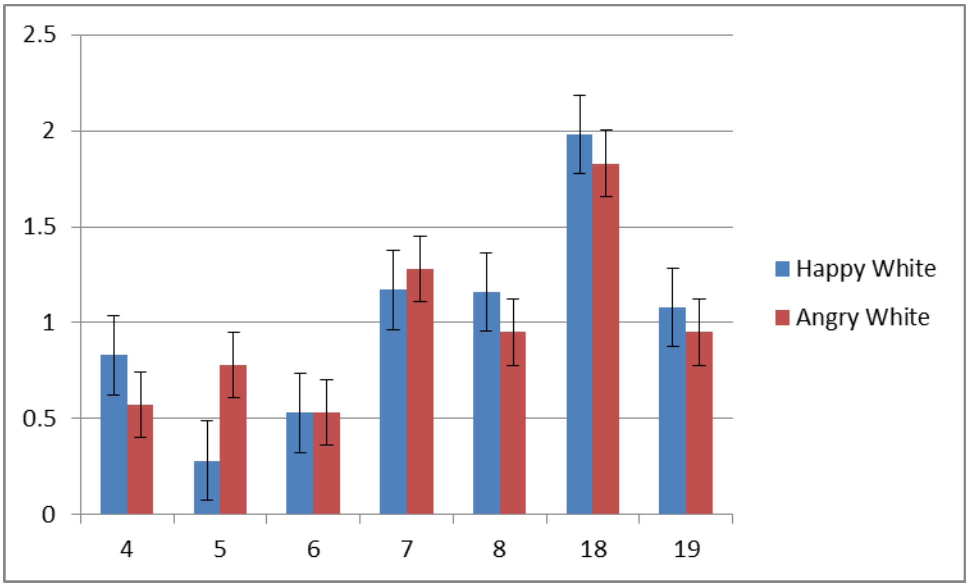

Figure 3. Average d-prime scores for happy (in blue) vs. angry (in red) expressions in Black faces for each age cohort.

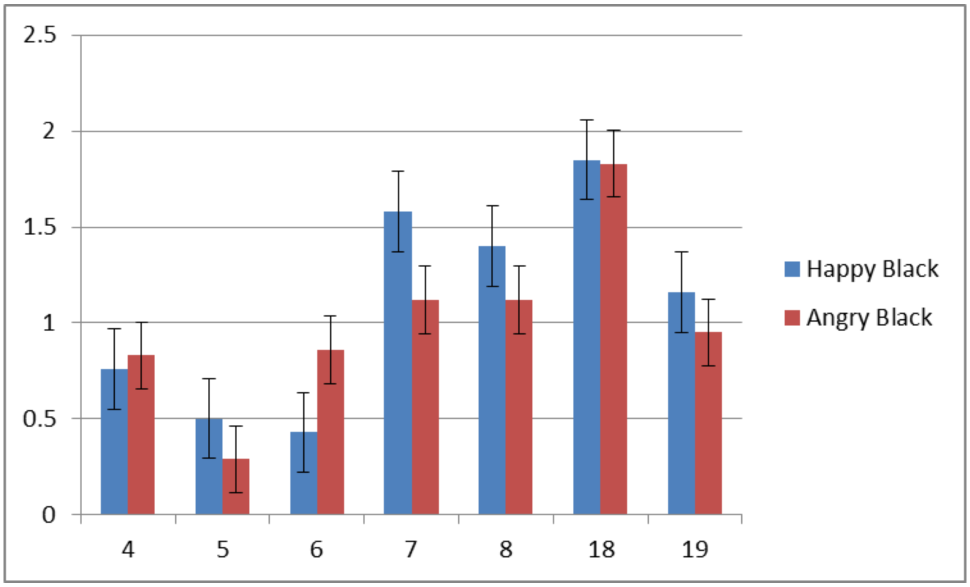

Table 1
Descriptive Statistics: D-prime scores for 18-19 year olds as a group.

	Mean	Std. Deviation	N
d White happy	1.65	1.489	49
d Black happy	1.60	1.469	49
d White angry	1.50	1.504	49
d Black angry	1.51	1.448	49

Table 2

Descriptive statistics: D-prime scores for 8-year-olds as a group.

	Mean	Std. Deviation	N
d White	1.47	0.790	16
d Black	0.87	0.501	16

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