

The Impact of Childhood Experience on Amygdala Response to Perceptually Familiar Black and White Faces

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Abstract

■ Given the well-documented involvement of the amygdala in race perception, the current study aimed to investigate how interracial contact during childhood shapes amygdala response to racial outgroup members in adulthood. Of particular interest was the impact of childhood experience on amygdala response to familiar, compared with novel, Black faces. Controlling for a number of well-established individual difference measures re-

lated to interracial attitudes, the results reveal that perceivers with greater childhood exposure to racial outgroup members display greater relative reduction in amygdala response to familiar Black faces. The implications of such findings are discussed in the context of previous investigations into the neural substrates of race perception and in consideration of potential mechanisms by which childhood experience may shape race perception. ■

INTRODUCTION

The amygdala responds to a range of biologically relevant and/or highly arousing stimuli (Adolphs, 2010; Whalen & Phelps, 2009; Phelps & LeDoux, 2005; Hamann, Herman, Nolan, & Wallen, 2004; Adams, Gordon, Baird, Ambady, & Kleck, 2003; Dolan & Vuilleumier, 2003; Whalen, 1998; LeDoux, 1996; Morris et al., 1996), including both negatively (Whalen et al., 2004; Zald, 2003; Morris et al., 1996) and positively evaluated conspecifics (Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002; Breiter et al., 1996). In the context of race perception, when no additional salient information is provided about the targets (such as group relevance or familiarity; e.g., see Van Bavel, Packer, & Cunningham, 2008; Phelps et al., 2000), the amygdala has been shown to preferentially respond to the perception of outgroup members, that is, Black individuals for White perceivers (Wheeler & Fiske, 2005; Hart et al., 2000; see also the 30-msec condition in Cunningham et al., 2004). It has been suggested that negative evaluations of Black individuals by White perceivers account for the preferential recruitment of the amygdala (Ronquillo et al., 2007; Wheeler & Fiske, 2005; Hart et al., 2000; for reviews, see Kubota, Banaji, & Phelps, 2012; Eberhardt, 2005). However, preferential amygdala response to Black faces has been demonstrated even for Black perceivers (Telzer, Humphreys, Shapiro, & Tottenham, 2013; Lieberman, Hariri, Jarcho, Eisenberger, & Bookheimer, 2005), suggesting that cultural associations with negativity or threat (rather than outgroup status) may contribute

to this effect. Indeed, a large body of work consistently suggests that White perceivers often evaluate Blacks negatively and that threat is a particularly salient dimension of the Black stereotype (Donders, Correll, & Wittenbrink, 2008; Trawalter, Todd, Baird, & Richeson, 2008; Correll et al., 2007; Eberhardt, Goff, Purdie, & Davies, 2004; Dovidio & Gaertner, 1986, 1998). These factors may promote preferential amygdala activity in response to Black targets, which tends to be apparent in perceivers with more prejudicial attitudes (Brosch, Bar-David, & Phelps, 2013; Cunningham et al., 2004; Phelps et al., 2000).

It is important to note, however, that the preferential amygdala response to Black faces disappears when participants have reason to consider the individual characteristics of outgroup members. The process of individuation is thought to reduce prejudicial attitudes toward these specific targets. For example, perceivers who are asked to consider individual characteristics of unfamiliar faces show no amygdala bias (Wheeler & Fiske, 2005), and participants with egalitarian attitudes and motivations seem to down-regulate spontaneous amygdala activity to Black faces when possible (Cunningham et al., 2004). In addition, when participants view familiar exemplars (e.g., Denzel Washington, Harrison Ford), Black faces do not induce greater amygdala activity, even in prejudiced individuals (Phelps et al., 2000). It seems that aspects of face processing, which typically characterize the perception of the ingroup (perceptual individuation, positive affective associations, or availability of person-knowledge), may thus override an otherwise preponderant amygdala response to outgroup faces (see Correll, Lemoine, & Ma, 2011; Cunningham & Van Bavel, 2009). This interpretation

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echoes the long-standing idea that perceiving others in terms of their unique characteristics rather than social categories may minimize prejudice (Fiske & Neuberg, 1990; Brewer, 1988).

One intriguing implication of this idea is that interracial contact may itself promote individuated processing and thus minimize prejudice. Research on Allport's (1954) contact hypothesis convincingly shows that contact reduces prejudice across a wide range of conditions (e.g., Pettigrew & Tropp, 2006; Brown & Hewstone, 2005; Olsson, Ebert, Banaji, & Phelps, 2005; Allport, 1954). A recent study provides initial evidence of neural mechanisms through which childhood experience may impact bias, showing that exposure to racial diversity attenuates children's amygdala response to Black faces (Telzer, Humphreys, et al., 2013). We are interested in the possibility that effects of childhood exposure reflect, at least in part, the fact that contact leads perceivers to more successfully individuate familiar members of the outgroup (Dovidio & Gaertner, 1999). In line with this possibility, research shows that perceptual individuation training reduces prejudice and that this effect is mediated by improvements in cross-race face processing (Lebrecht, Pierce, Tarr, & Tanaka, 2009). Given that contact alters the development of neural, perceptual, and evaluative response to the outgroup (Telzer, Humphreys, et al., 2013; Kinzler, Shutts, & Correll, 2010), the present research examines the possibility that childhood contact with outgroup members influences the neural correlates of the perception of familiar racial outgroup members.

In addition to examining childhood contact, the current study involves a controlled manipulation of perceptual familiarity. Very few studies have directly examined how simple perceptual familiarity, a central aspect of face-based individuation, impacts race perception. In contrast, previous studies have often presented faces for which person-knowledge is available (e.g., famous faces; Phelps et al., 2000; see also Cloutier, Kelley, & Heatherton, 2011), thus potentially confounding perceptual familiarity ("I know Denzel Washington's face") with the availability of knowledge about biographical information or information learned through previous experience ("Denzel won an Oscar," "Denzel plays tough characters"). In the current study, White participants were asked to perceptually individuate several White and Black faces (Lebrecht et al., 2009), allowing us to experimentally manipulate familiarity with a particular set of faces. Participants then viewed these familiar faces (along with novel faces) while we recorded BOLD activity in the brain. To our knowledge, this is the first fMRI investigation to experimentally induce familiarity during race perception, which allows us to identify the impact of perceptual familiarity. In line with previous literature, we expected that presentation of novel Black faces would lead to greater amygdala activity than novel Whites (H_1). More importantly, we predicted that this preferential response to Blacks would be attenuated for the familiar faces, reflecting the capacity of perceptual familiarity to attenuate prejudice (H_2). Finally, we

predicted that the effect of familiarity on response to Black faces (i.e., a reduction in amygdala response to perceptually individuated Black faces) would be particularly pronounced among participants with high levels of interracial contact (H_3).

In this work, we attempted to rule out several possible alternative interpretations. Our foremost concern was that people with more positive attitudes toward Blacks would either seek more contact or artificially inflate their estimates of contact. If so, observed effects of contact could actually be driven by prejudice. To distinguish effects of contact from those of prejudice, we controlled for a battery of well-established measures of interracial attitudes related to prejudice and motivation. In addition to helping identify the effect of contact, inclusion of these measures allows us to test a number of interesting ancillary hypotheses. For example, it could be expected that prejudiced participants or participants with low motivation to respond without prejudice would fail to individuate members of the outgroup, perhaps reflecting a tendency to view Blacks in more categorical terms.

METHODS

Participants and Design

Forty-seven participants were recruited from the greater Chicago area for monetary compensation (\$50). One participant was excluded from the study because of excessive movement during the scanning session, and one was excluded because of incomplete questionnaires. The remaining 45 participants were between the ages of 19 and 34 years (24 women; $M_{\text{age}} = 24.2$ years, $SD = 4.28$ years), had normal or corrected-to-normal visual acuity, and reported right-handedness and no significant abnormal neurological history. All participants self-identified as White American (one participant indicated both White and Latino identity). Participants provided informed consent in accordance with the guidelines set by the University of Chicago Institutional Review Board.

All participants completed (a) an evaluative priming (EP) task, (b) a familiarization task designed to familiarize them with 10 Black and 10 White faces, (c) a scanning procedure during which we presented Black and White faces, half of which were novel and half of which were familiar—having been presented during the familiarization task, and (d) a set of questionnaires, including a measure of contact with Black people during childhood and explicit measures of prejudice and motivation to respond without prejudice. These tasks are described in greater detail below. For the purposes of the primary fMRI analysis, this ultimately yielded a 2 (Race: Black vs. White) \times 2 (Familiarity: Novel vs. Familiar) within-participant design, with continuous between-participant measures of interracial contact during childhood and four covariates (implicit and explicit prejudice, internal and external motivation).

Stimuli

Forty male faces (50% Black) from the Chicago Face Database were used as the stimuli for the fMRI component of the study. All the stimuli displayed a neutral facial expression, were wearing gray shirts, and were superimposed on a white background. The faces were equated on attractiveness, masculinity, and perceived threat. Twenty faces (50% Black) were introduced during the familiarization task and later served as the familiar faces in the scanning session; the remaining 20 faces (50% Black) were never presented before the scanning session and thus served as the novel faces during the scanning session. The particular set of faces in each condition was counterbalanced across participants. Stimulus presentation and data collection were programmed using E-Prime 2.0 (www.pstnet.com/eprime). A back-projection system was used to present stimuli in the scanner.

Procedure

EP Task

After participants provided informed consent and were screened for their eligibility to participate in an fMRI study, they completed an EP task to assess implicit racial bias. Participants were presented with a series of trials in which a Black or a White male face was displayed on the screen, followed by a target word that was either negative or positive (see Fazio, Jackson, Dunton, & Williams, 1995). The task included 140 trials. Each trial started with a 500-msec fixation, followed by a 200-msec face prime (Black or White). A positive or a negative word then appeared at the center of the screen for 1500 msec, and participants were instructed to categorize the word based on its valence by pressing one of two buttons on the keyboard as quickly as possible (face stimuli for this task were taken from the NimStim stimulus set [Tottenham et al., 2009] and were not used in any other component of the study).

Familiarization Task

Next, participants completed a familiarization task (adapted from Lebrecht et al., 2009). In this task, each of the 20 faces (50% Black) was associated with a particular letter in the alphabet. Participants were instructed to memorize the association between the face and the letter. Each block consisted of one training phase and one testing phase. Each combination of face and letter was presented three times in the training phase, and the participants' memory for the face-and-letter combination was tested afterward. They were not allowed to proceed to the next block until they had achieved 100% accuracy. Participants were required to complete four blocks but had the option to complete an additional block to solidify their memory of the faces and corresponding letters. At the end of the familiarization task, participants' memory of the face-and-letter associations was tested again with time constraint.

In this instance, participants were asked to respond as fast as possible (i.e., within 2 sec) to further evaluate the strength of the associations between the faces and letters. After successfully recalling all the associations between faces and letters with 100% accuracy, participants proceeded to the fMRI session.

fMRI Session

After being given explicit instructions and practice trials, participants were scanned in an event-related fMRI session while performing a 1-back task: They were asked to press two buttons (using both of their index fingers) when two faces of the same identity were sequentially presented. Across three runs, 40 unique faces (20 familiar, 20 novel) were presented four times in a pseudorandom fashion (two faces from each condition were presented five times to introduce four task-relevant trials for the 1-back task). Each trial consisted of a face presented for 1100 msec followed by a fixation cross that was presented for 1100 msec, resulting in a trial lasting 2200 msec. Each repetition time (TR) was set to be 2200 msec, corresponding to the duration of each trial. Specifically, although we synchronized the onset of each trial with the beginning of TR, each stimulus face was only presented for the first half of the TR. Null events consisting of a fixation cross for 2200 msec were pseudorandomly interspersed to introduce jitter into the fMRI time series to create inter-trial intervals of either 1100, 3300, 5500, or 7700 msec. Pictures were presented in the center of a back-projected screen measuring 240 mm × 180 mm (with pictures of faces averaging 120 mm × 90 mm). While performing the 1-back task, participants were instructed to form impressions of the faces based on their gut reactions.

Questionnaires

Participants completed a series of questionnaires designed to assess explicit attitudes about racial outgroups. Questionnaires included an interracial contact measure assessing individual differences in exposure to members of different racial groups before age 18. Items instructed participants to report the racial and ethnic makeup of their social networks during three separate stages of childhood (0–6, 6–12, and 12–18 years), once for adults in their network and once for peers (e.g., “Not including your family, what percentage of the children you knew (friends, classmates) belonged to each of the following categories? Asian, Black, Latino, etc.”). A variable reflecting each participant's contact with Black adults and peers at all stages of childhood was computed by averaging the reported percentage of Blacks in each of the six contact items (adult and peers at ages 0–6, 6–12, and 12–18). This index thus reflects the average proportion of Black people in each participant's social network throughout childhood. Participants were also asked to complete the Modern Racism Scale (MRS; McConahay, 1988). The six-item MRS is

designed to measure subtle forms of racism that are prevalent in the United States today and includes questions that indirectly relate to racial attitudes. Participants were asked to indicate to what extent they agreed with each statement on a 5-point Likert scale. The scale was used to access participants' explicit attitudes toward Black individuals. Participants also completed the internal and the external motivation to respond without prejudice scales on a 9-point Likert scale (IMS and EMS; Plant & Devine, 1998). Following completion of the questionnaires, participants were thanked, debriefed, and compensated.

Data Analysis

fMRI Data Acquisition and Analysis

Anatomical and functional imaging was performed on a 3T Philips Achieva Quasar scanner at the University of Chicago Brain Research Imaging Center. High-resolution structural images were acquired in the sagittal plane using a T1-weighted 3D Turbo Field Echo (TFE/MP-RAGE) anatomical scan with the following parameters: TR = 8.5 msec, echo time = 4.0 msec, field of view = 240 × 228 mm, 1.0 mm slice thickness, no gap, 240 × 228 mm matrix, 1.0 × 1.0 × 1.0 mm voxel size. Functional images were collected in three functional runs of 144 TRs each, using pulse sequence parameters including TR/echo time = 2200/28 msec, flip angle = 79°, contiguous slices with 3.28 mm thickness, gap = 0.72 mm, field of view = 210 × 210 mm, approximately 64 × 64 mm matrix.

fMRI data were analyzed using the SPM8 (Wellcome Department of Cognitive Neurology, London, UK). Before analysis, data were preprocessed to remove sources of noise and artifacts. Functional data were realigned within and across runs to correct for head movement and transformed into a standard anatomical space (3 mm isotropic voxels) based on the ICBM 152 brain template (Montreal Neurological Institute) and approximates the Talairach and Tournoux atlas space (Talairach & Tournoux, 1998). Normalized data were then spatially smoothed (8 mm FWHM) using a Gaussian Kernel to increase the signal to noise ratio and reduce the impact of anatomical variability not corrected for by stereotaxic normalization.

For each participant, general linear model was constructed to examine brain activity for each condition (i.e., familiarity vs. novelty, Black vs. White). This general linear model, incorporating task effects and covariates of no interest (a session mean, a linear trend to account for low-frequency drift, and six movement parameters derived from realignment corrections), was convolved with a canonical hemodynamic response function and used to compute parameter estimates (β) and contrast images (containing weighted parameter estimates) for each condition at each voxel. Contrast images of interests for each subject, comparing novel versus familiar Black faces, novel versus familiar White faces, novel Black versus novel White faces, and familiar Black versus familiar White faces,

were entered into a second-level random effects analysis with the participant treated as the random effect.

Amygdala ROI Analysis

An ROI analysis was conducted to identify the hypothesized impact of childhood exposure on amygdala response to novel Black, novel White, familiar Black, and familiar White faces. ROI analyses were conducted for both the left and right amygdala. The 4-mm spherical ROI for the left amygdala (MNI: -24, -3, -21) was functionally identified based on a peak activation resulting from the contrast of all combined conditions versus baseline. The 4-mm spherical ROI for the right amygdala (MNI: 24, -3, -21) was based on the ROI identified for the left amygdala, as no peak activation within the cluster responding to all combined conditions versus baseline was identified. To examine how childhood interracial contact relates to amygdala response while partitioning out prejudice, parameter estimates for each condition were extracted and submitted to an offline analysis examining the effect of childhood exposure to Black individuals on amygdala response in the contrasts-of-interest while controlling for the impact of prejudicial attitudes (i.e., EP, MRS, IMS, and EMS).

Exploratory Whole-brain Analysis of the Impact of Familiarity on Race Perception

A second-level whole-brain analysis was performed to identify the impact of the familiarity on race perception. Brain responses associated with each contrast image of interests (novel vs. familiar Black faces, novel vs. familiar White faces, novel Black vs. White faces, familiar Black vs. White faces) significant at a threshold of $p < .001$ (uncorrected) with a cluster extent of 15 voxels are reported in Table 1.

Exploratory Whole-brain Analysis of the Impact of Childhood Exposure

A second-level whole-brain regression analysis was also performed to identify the impact of the perceivers' level of childhood exposure, while controlling for the effect of prejudicial attitudes measured by the MRS, on brain responses associated with each contrast image of interests (novel vs. familiar Black faces, novel vs. familiar White faces, novel Black vs. White faces, familiar Black vs. White faces). Regions significant at a threshold of $p < .001$ (uncorrected) with a cluster extent of 15 voxels are reported in Table 2.

RESULTS

Behavioral Results

The mean contact score with Black individuals was 9.30% ($SD = 10.49$, $\alpha = .90$), suggesting that Blacks made up roughly 10% of the average participant's social network during childhood. The means for MRS, IMS, EMS, and

Table 1. Identification of BOLD Signal as a Function of Familiarity and Race

<i>Brain Region</i>			<i>k</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>z</i>
<i>White > Black</i>							
BA 18	R	Cuneus	257	4.62	9	-99	15
BA 19	R	Ventral temporal cortex	461	4.33	21	-69	-12
BA 37	L	Ventral temporal cortex		4.22	-30	-57	-3
BA 31	R	Posterior cingulate gyrus	15	4.15	15	-39	39
BA 25	L	Ventral striatum	27	4.04	-3	9	-9
BA 7	R	Precuneus	45	3.91	6	-72	30
<i>Novel White > Novel Black</i>							
BA 11	R	Orbitofrontal cortex	30	4.20	12	45	-18
<i>Familiar White > Familiar Black</i>							
BA 18	R	Lingual gyrus	1775	5.90	12	-81	-6
BA 37	R	Ventral temporal cortex		4.86	24	-45	-15
BA 18	L	Lingual gyrus		4.78	-24	-78	-15
BA 19	L	Cuneus		4.71	-3	-78	30
<i>Black > White</i>							
BA 17	L	Inferior occipital cortex	31	4.16	-21	-99	-9
<i>Novel Black > Novel White</i>							
None							
<i>Familiar Black > Familiar White</i>							
BA 17	L	Inferior occipital cortex	21	4.02	-21	-102	-9
<i>Novel > Familiar</i>							
BA 17	R	Lingual gyrus	5337	7.90	21	-90	-6
BA 37	R	Ventral temporal cortex		6.36	36	-54	-18
BA 17	L	Lingual gyrus		5.94	-15	-96	-6
BA 37	L	Ventral temporal cortex		5.66	-36	-57	-15
	R	Amygdala		5.39	21	-6	-21
	L	Hippocampus		4.79	-24	-18	-15
BA 3	L	Postcentral gyrus	2011	6.12	-42	-21	60
BA 41	L	Posterior insula		5.60	-42	-27	0
BA 41	R	Posterior insula		5.19	33	-6	-6
	L	Putamen/thalamus	76	5.36	-12	-27	-3
BA 4	R	Precentral gyrus	337	4.87	48	-6	48
BA 42	L	Postcentral gyrus	25	4.25	63	-9	12
BA 20	R	Anterior inferior temporal gyrus	35	4.23	24	-3	-48
<i>Novel White > Familiar White</i>							
BA 37	R	Ventral temporal cortex	703	5.53	36	-54	-18
BA 6	L	Paracentral lobule	128	4.98	0	-21	69
	L	Hippocampus	129	4.74	-27	-18	-15
BA 19	L	Inferior occipital gyrus	246	4.61	-33	-81	-12

Table 1. (continued)

Brain Region			<i>k</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>z</i>
	L	Thalamus	22	4.43	-12	-24	0
BA 24	L	Middle cingulate gyrus	43	4.31	-6	-12	45
BA 37	L	Ventral temporal cortex	80	4.05	-39	-45	-21
BA 18	L	Cuneus	16	3.85	-18	-99	-6
	R	Putamen	21	3.61	30	-6	-6
Novel Black > Familiar Black							
BA 18	R	Lingual gyrus	2699	6.30	24	-84	-9
BA 18	L	Lingual gyrus		5.07	-21	-87	-9
BA 37	R	Ventral temporal cortex	402	5.37	21	-51	-12
	L	Amygdala	103	5.16	-24	-3	-21
	L	Hippocampus		3.70	-24	-21	-18
BA 3	L	Postcentral gyrus	541	5.02	-51	-18	54
	R	Amygdala	72	4.98	18	-6	-21
BA 3	R	Postcentral gyrus	156	4.43	63	-15	48
BA 22	L	Posterior insula	79	4.40	39	18	3
BA 22	R	Posterior insula	42	4.14	45	-15	0
BA 24	L	Middle cingulate gyrus	42	4.02	-9	3	39
BA 22	L	Superior temporal gyrus	23	3.87	-51	-3	-6
BA 24	R	Middle cingulate gyrus	16	3.78	9	6	39
BA 6	R	Superior frontal gyrus	18	3.72	18	-3	75
BA 6	R	Supplementary motor area	20	3.71	6	-6	60
<i>Familiar > Novel</i>							
BA 23	L	Posterior cingulate gyrus	225	7.01	-9	-24	27
BA 7	L	Precuneus	436	6.62	-9	-72	30
BA 40	L	Inferior parietal lobule	518	6.57	-36	-66	42
BA 40	R	Inferior parietal lobule	105	5.24	39	-63	39
BA 9	L	Middle frontal gyrus	65	5.07	-42	18	36
Familiar White > Novel White							
BA 7	L	Precuneus	596	6.70	-9	-72	30
BA 40	L	Inferior parietal lobule		5.84	-36	-63	39
BA 31	L	Posterior cingulate gyrus	36	3.79	-6	-39	27
Familiar Black > Novel Black							
BA 7	L	Inferior parietal lobule	363	5.15	-33	-66	42
BA 23	L	Posterior cingulate gyrus	84	4.30	-3	-30	30
BA 40	R	Inferior parietal lobule	98	4.23	39	-63	39
BA 7	L	Precuneus	82	4.07	-9	-69	30
BA 8	L	Middle frontal gyrus	15	4.01	-45	18	36
BA 46	L	Inferior frontal gyrus	26	3.79	-39	45	6

Activations determined to be significant (threshold = $p < .001$, uncorrected; clusters = 15 voxels; actual values are reported in the table). BA = approximate Brodmann's area location. Coordinates are from the MNI atlas. Locations of the activations are determined based on the functional responses superimposed on averaged anatomical MRI images.

EP were 11.27 ($SD = 4.54$, $\alpha = .87$), 35.98 ($SD = 9.04$, $\alpha = .91$), 23.07 ($SD = 9.60$, $\alpha = .85$), and 22.15 ($SD = 46.50$), respectively.

For the EP task, we computed a simple index reflecting prejudice. We excluded RTs deviating more than 3 SD s from each participant's individual mean RT (5.6% of trials) and trials for which participants made an incorrect response (e.g., classifying a negative word as positive; 4% of trials). For each cell of the 2 (Race: Black vs. White) \times 2 (Valence: Positive vs. Negative) within-participant design, we computed the mean RT for the remaining trials and submitted them to a repeated-measures ANOVA. The Race \times Valence interaction was significant, $F(1, 44) = 10.208$, $p = .003$. An index reflecting this interaction was calculated: EP Bias = $(RT_{\text{white_neg}} - RT_{\text{black_neg}}) - (RT_{\text{white_pos}} - RT_{\text{black_pos}})$. Higher scores on this index indicate that participants responded more quickly when Black faces were paired with negative words and White faces were paired with positive words, suggesting a relative bias against Blacks, resulting either from greater negativity toward Black targets or greater positivity toward White targets.

fMRI Results

Mean Level Effects

A 2 (Race: Black vs. White) \times 2 (Familiarity: Novel vs. Familiar) \times 2 (Amygdala Localization: Left vs. Right) repeated-measures ANOVA was performed. A main effect of Familiarity was found, $F(1, 44) = 21.290$, $p < .001$, suggesting that the perception of familiar faces was associated with reduced amygdala response ($M = .287$, $SE = .094$) as compared with that of novel faces ($M = .728$, $SE = .103$). No main effect of Race or Amygdala Localization and no two-way interaction were found, $|F|s < 2.05$. Critically, however, a significant three-way interaction between Race, Familiarity, and Amygdala Localization was found, $F(1, 44) = 7.841$, $p = .008$.

Following the three-way interaction, we performed separate 2 (Race: Black vs. White) \times 2 (Familiarity: Novel vs. Familiar) repeated-measures ANOVAs on the left and right amygdala ROIs. A main effect of Familiarity was found for left amygdala, $F(1, 44) = 17.063$, $p < .001$, as well as for right amygdala, $F(1, 44) = 18.134$, $p < .001$, such that the perception of familiar faces was associated with reduced activity (left amygdala: $M = .306$, $SE = .106$; right amygdala: $M = .268$, $SE = .101$), as compared with that of novel faces (left amygdala: $M = .743$, $SE = .113$; right amygdala: $M = .713$, $SE = .116$). The main effect of Race was not significant for left amygdala, $F(1, 44) = 0.247$, $p = .622$, or for right amygdala, $F(1, 44) = 0.043$, $p = .836$. However, we observed an interaction between Familiarity and Race on left amygdala, $F(1, 44) = 5.127$, $p = .029$ (Figure 1A), which was absent for right amygdala, $F(1, 44) = 0.021$, $p = .884$. The simple-effects tests reported below therefore focus on the left amygdala.

The difference in left amygdala response to novel Black versus novel White faces was marginally significant, $t(44) = 1.823$, $p = .075$. Although this difference is not quite significant, it echoes past work (Ronquillo et al., 2007; Lieberman et al., 2005; Wheeler & Fiske, 2005; Hart et al., 2000; for reviews, see Kubota et al., 2012; Eberhardt, 2005) and offers tentative support for H_1 : Novel Black faces ($M = .88$, $SE = .13$) were associated with marginally greater amygdala activity than novel Whites ($M = .60$, $SE = .14$). The difference between familiar Black and familiar White faces was also marginally significant, but in the opposite direction, such that familiar White faces ($M = .40$, $SE = .13$) induced marginally greater activity than familiar Blacks ($M = .21$, $SE = .11$), $t(44) = -1.767$, $p = .084$.

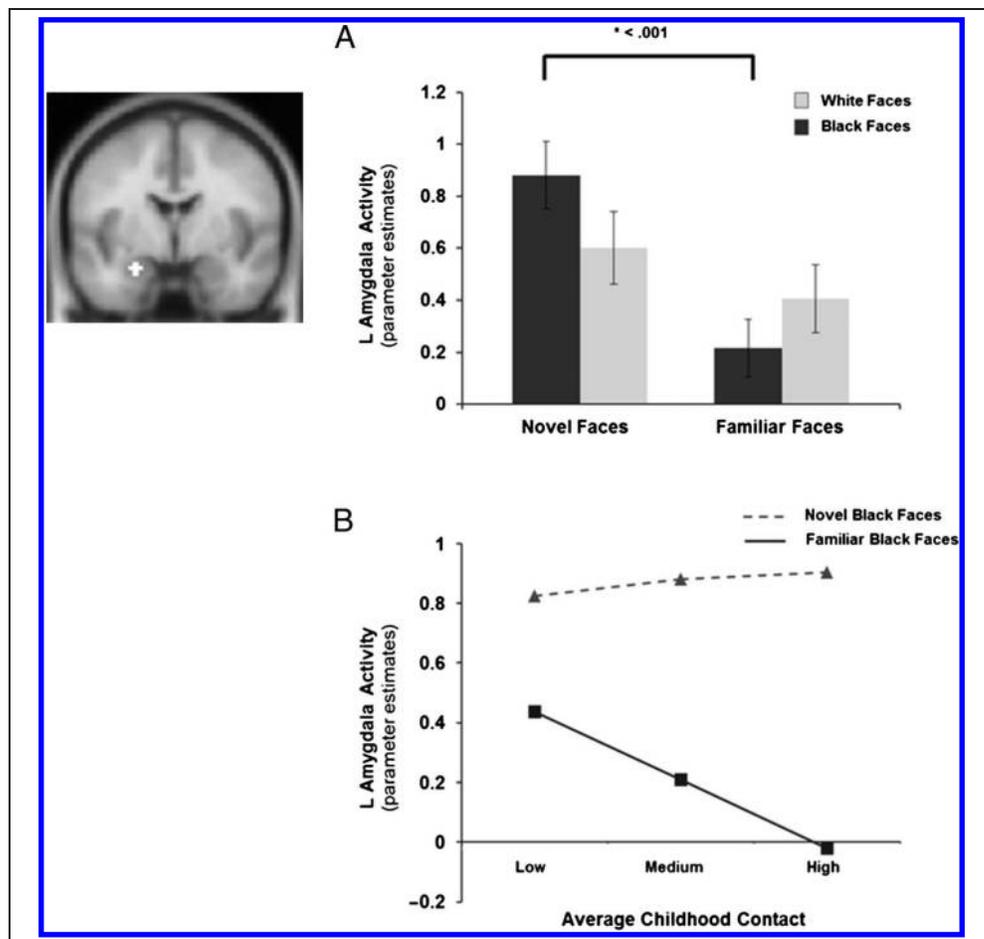
Importantly, familiar Black faces were associated with less left amygdala activity than novel Black faces, $t(44) = -5.327$, $p < .001$. This result offers strong support for H_2 , which predicted that familiarization with outgroup faces would attenuate amygdala response. Amygdala activity to novel and familiar White faces did not differ, $t(44) = -1.181$, $p = .244$.

Table 2. Identification of BOLD Signal of the Exploratory Whole-brain Regression Analysis as a Function of Average Childhood Contact with Black Individuals When Controlling for MRS

Brain Region	k	t	MNI Coordinates			
			x	y	z	
<i>Novel Black > Individuated Black</i>						
L hippocampus	36	5.02	-30	-18	-12	
L amygdala	32	4.56	-24	-6	-24	
<i>Familiar White > Familiar Black</i>						
BA 38	R temporal pole	15	5.39	36	9	-30

Activations determined to be significant (threshold = $p < .001$, uncorrelated; clusters = 15 voxels; actual values are reported in the table). BA = approximate Brodmann's area location. Anatomical locations were determined based on peak coordinates localization in the MNI Brain Atlas. No suprathreshold regions were found for novel White versus familiar White or novel White versus novel Black.

Figure 1. (A) Effect of familiarity on L amygdala response to Black and White faces. Familiar Black faces elicited significantly less amygdala activity than novel Black faces, supporting our H₂. (B) Relationship between childhood interracial contact and L amygdala response to familiar (solid line), as compared with novel (dash line), Black faces, controlling for well-established individual differences related to race perception (i.e., implicit and explicit prejudice, internal and external motivation to respond without prejudice). Higher childhood interracial contact predicted attenuated amygdala response to familiar Black faces, supporting our H₃. Note that although childhood contact was a continuous variable in data analysis, it was presented as a categorical variable in B to generate the regression plot between childhood diversity and amygdala response while controlling for MRS.



Individual Difference Effects

A primary goal of this research was to examine how childhood contact relates to the perceptual individuation of Black faces (H₃). To help distinguish the effects of contact from other individual differences (e.g., prejudice), we also included a battery of covariates in our primary multiple regression. We therefore analyzed responses to novel and familiar Black faces as a function of childhood contact, MRS, EP, IMS, and EMS. Before proceeding to the test of H₃, we report the effects of these covariates to clarify their impacts on amygdala response during the perception of novel versus familiar faces. Given the significant difference in left amygdala activity to familiar versus novel Black faces, which is absent in right amygdala, our analysis thus focuses on left amygdala.

Analysis of the covariates. Although there was, on average, a pronounced reduction in left amygdala activity to familiar (rather than novel) Black faces, higher prejudice (as measured by the MRS) attenuated this effect, $b = -.083$, $SE = .040$, $t(40) = -2.057$, $p = .046$. In other words, more prejudiced participants did not distinguish between familiar and novel Black faces to the same extent as less prejudiced participants. Although prejudice is not

the focus of this work, this finding suggests that prejudiced participants were less willing or less able to individuate the Black faces they had previously viewed, treating all outgroup members more similarly.

Somewhat surprisingly, the implicit measure of prejudice (performance on the EP task) had little influence on amygdala response. It did not predict the magnitude of the difference between novel and familiar Black faces, nor the difference between novel White and novel Black faces. Even when we reestimated a model excluding the (conceptually similar) explicit measure of prejudice, EP had no observable effect ($|t| < .3$). The motivation scales IMS and EMS were not significant predictors in the model ($|t|s < .9$). As discussed in the Introduction, these measures were included in our analyses to control for the possibility that egalitarian-minded participants might seek out more contact and/or inflate estimates of interracial contact in an effort to appear more egalitarian. However, if the nonsignificant covariates (EP, IMS, EMS) are removed from the model, the effects of MRS remain significant (in fact effects of MRS become slightly stronger).

Effects of interracial contact during childhood. The primary focus of the current study (H₃) concerns the

possibility that interracial contact during childhood impacts how perceivers individuate outgroup faces, as reflected by amygdala response to the familiar, compared with novel, Black faces. To address this question, we examined differential amygdala activity to novel versus familiar Black faces using multiple regression and treating interracial contact and all covariates (EP, MRS, IMS, and EMS) as simultaneous predictors. To be consistent with the previous analysis, we again focused on the relationship between contact and activity in the left amygdala. However, these effects hold if treating the combination of left and right amygdala activity as our dependent variable.

As predicted, childhood exposure to Black individuals was associated with reduced activity in left amygdala to familiar Black faces (relative to novel Black faces), $b = .027$, $SE = .013$, $t(39) = 2.107$, $p = .042$, controlling for the set of covariates. In other words, more extensive interracial contact was associated with a particularly pronounced decrease in amygdala activity to familiar faces, suggesting that these perceivers were differentially individuating members of the outgroup. It is important to note that contact with Latinos and Asians (treated separately or as a set) did not similarly affect the processing of Black faces, $|t|s < 0.6$.

This contact-dependent sensitivity to familiar faces was also exclusive to the processing of Black or outgroup faces. Interracial contact was not associated with a similar familiarity effect for White faces (i.e., differential processing of familiar and novel Whites), $b = -.004$, $SE = .019$, $t(39) = -0.216$, $p = .830$, controlling for the covariates. We also analyzed the relationship between interracial contact and the familiarity effect for Black faces, while controlling for the White familiarity effect (and the covariates). This analysis aimed to determine whether the effect of contact emerges for Black faces over and above similar familiarity-based effects for White faces. Strikingly, childhood contact still predicted differential amygdala response to novel and familiar Black faces, $b = .027$, $SE = .013$, $t(38) = 2.080$, $p = .044$.¹ By contrast, there was still no evidence of a relationship between childhood

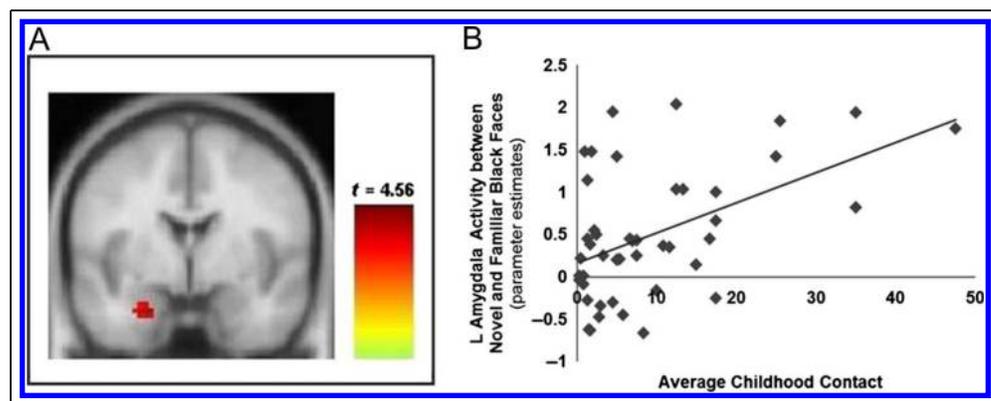
contact and the familiarity effect for White faces when controlling for the covariates and an index of the Black familiarity effect, $b = -.004$, $SE = .020$, $t(38) = -0.213$, $p = .833$.²

We also examined the impact of childhood interracial contact at different ages. In all of these analyses, we control for the set of covariates and the White Familiarity Effect. Similar to the effect of average childhood contact, exposure to Black individuals before age 6 was associated with reduced activity in left amygdala to familiar, relative to novel Black faces, $b = .028$, $SE = .012$, $t(38) = 2.260$, $p = .030$. Exposure to Black individuals between the age of 6 and 12 was also associated with reduced activity in left amygdala to familiar, relative to novel Black faces, $b = .023$, $SE = .011$, $t(38) = 2.148$, $p = .038$. However, childhood exposure to Black individuals between the age of 13 and 18 was not significantly associated with reduced activity in left amygdala to familiar as compared with novel faces, $b = .014$, $SE = .013$, $t(38) = 1.077$, $p = .288$.³

Lastly, we analyzed each cell of the design separately. That is, we performed four distinct analyses, one for novel Black trials, one for familiar Black trials, one for novel White trials, and one for familiar White trials. In each analysis, amygdala activity was modeled as a function of interracial contact and the set of covariates. Greater childhood contact was associated with a reduction in left amygdala response to familiar Black faces, $b = -.022$, $SE = .011$, $t(39) = -2.021$, $p = .050$, but not to any of the other conditions (Figure 1B).⁴

Exploratory whole-brain analysis. Brain regions recruited as a function of Race and Familiarity are reported in Table 1. Notably, corroborating the laterality obtained in the ROI analyses, the left amygdala exhibited greater activity to novel than to familiar Black faces. In addition, although not the primary goal of the current study, ventral temporal cortex (VTC) was found to display greater activity to familiar White than to familiar Black faces as well as to novel than to familiar faces. These findings

Figure 2. (A) A whole-brain regression analysis confirming that difference in L amygdala activity to novel, as compared with familiar, Black faces was significantly associated with childhood interracial contact controlling for prejudice (MRS). Specifically, higher childhood interracial contact was associated with greater difference in amygdala response to novel versus familiar Black faces, further supporting our H₃. (B) The scatterplot demonstrates greater amygdala activity to novel, as compared with familiar Black faces, as a function of increased childhood interracial contact. Note that, contrary to the reported ROI analyses, this scatterplot is based on coordinates obtained from the whole-brain analysis.



partially corroborate the results of previous studies suggesting that individuals preferentially recruit VTC when perceiving same-race as compared with other-race faces (Golby, Gabrieli, Chiao, & Eberhardt, 2001) and that novel faces elicit greater VTC response than familiar faces (Cloutier et al., 2011; Gobbini & Haxby, 2007; Rossion, Schiltz, & Crommelinck, 2003). Interestingly, OFC, a region associated with reward responses during person perception (Haxby, Hoffman, & Gobbini, 2002), was found to be the sole region showing greater activity to novel White than to novel Black faces. This result converges with previous studies demonstrating preferential OFC activity to positively evaluated individuals (Cloutier, Heatherton, Whalen, & Kelley, 2008; O'Doherty, 2004; Singer, Kiebel, Winston, Dolan, & Frith, 2004) as well as to novel ingroup relative to novel outgroup faces (Van Bavel et al., 2008).

An exploratory whole-brain regression analysis was also performed to identify all brain regions activated as a function of average childhood contact with Black individuals (Table 2). Strikingly, in accordance with results of the ROI analysis reported before, differential left amygdala activity to novel versus familiar Black faces was significantly correlated with childhood contact while controlling for MRS, $t(42) = 4.56, p < .001$ (Figure 2). In other words, the greater childhood contact with Black individuals one has, the more likely one is to demonstrate a reduction in amygdala response to familiar, compared with novel, Black faces in adulthood.⁵ Furthermore, few other brain regions were found to be activated as a function of childhood contact. Contrasts of interest are reported in Table 2.

DISCUSSION

With the current research representing the intersection of critical lines of thought from developmental psychology, social cognition, and social neuroscience, we examined the impact of childhood experience on the neural substrates of racial outgroup face processing. Centrally, this work examines the impact of familiarity through perceptual individuation (the process of differentiating between members of an outgroup), which has long been considered critical for reducing prejudice (Fiske & Neuberg, 1990; Brewer, 1988). To investigate this process, we focus on the amygdala, a brain region that responds to biologically and socially salient stimuli (Adolphs, 2010; Whalen & Phelps, 2009; Hamann et al., 2004; Adams et al., 2003; Whalen, 1998), which is also thought to reflect evaluative biases toward outgroup members (Krill & Platek, 2009; Ronquillo et al., 2007; Wheeler & Fiske, 2005; Cunningham et al., 2004; Hart et al., 2000; but see Van Bavel et al., 2008). In accordance with our expectations, our findings demonstrate that perceptual familiarity reduces preferential amygdala activity to members of the outgroup (see H₂), lending strong support to social cognitive models of person perception and highlighting the role of the amyg-

dala as part of a neural process by which individuation may reduce evaluative bias. The degree to which this process depends on MRS reinforces this interpretation: highly prejudiced participants were less likely to differentiate familiar Black faces from faces they had never seen before (Forbes, Cox, Schmader, & Ryan, 2012).

Of particular relevance, we show that the effect of familiarity on amygdala activity depends critically on the participants' exposure to Black individuals during childhood (see H₃). Indeed, we believe that this study represents the first effort to characterize how childhood experience shapes the neural substrates of race perception in adulthood. Our data show that interracial contact magnifies the effect of familiarity, leading to an especially pronounced reduction in amygdala response to familiar Black faces. Moreover, by controlling for an extensive battery of established measures, we demonstrate that this effect cannot easily be explained by attitudes or motivational processes previously shown to impact race perception (see Cunningham et al., 2004; Phelps et al., 2000). Interracial contact during childhood thus seems to powerfully moderate the effects of individuation on neural response to the outgroup.

Interestingly, childhood interracial contact before age 12 particularly predicts the impact of familiarity training on race perception, as demonstrated by reduced amygdala response to familiar compared with novel Black faces. In other words, greater exposure to Black individuals early in life contributes to the efficiency of familiarity training. This finding is consistent with a previous study suggesting that early deprivation of interracial exposure results in heightened amygdala response to outgroup members (Telzer, Flannery, et al., 2013). In contrast, interracial contact between the age of 13 and 18 is not reliably associated with greater reduction of amygdala response to familiar faces. Given that adolescents display greater recruitment of amygdala when perceiving Black versus White faces than younger children (Telzer, Humphreys, et al., 2013), and adolescents tend to exhibit overall greater amygdala activity to fearful faces when compared with individuals from other age groups (Tottenham & Sheridan, 2009; Guyer et al., 2008; Hare et al., 2008; Monk et al., 2003), it is possible that the impact of interracial contact during adolescence is overridden by the saliency of negative evaluations culturally associated with Black individuals.

It is instructive to consider possible explanations for the effect of interracial contact. Childhood contact is likely associated with a number of variables that could conceivably impact participants' ability or motivation to learn about members of the outgroup. For one, interracial contact may promote perceptual expertise, leading to greater differentiation of outgroup members (Lebrecht et al., 2009; Sangrigoli, Pallier, Argenti, Ventureyra, & De Schonen, 2005). Contact is also likely associated with changes in motivations or attitudes toward the outgroup (Pettigrew & Tropp, 2006). Furthermore, it is likely that participants

who grew up in more diverse environments come from families who, on average, also differ on a variety of other dimensions (e.g., parental attitudes about race, political views, and socioeconomic status). Perceptual expertise, motivation, prejudice, and demographics may all affect the way participants respond to novel and familiar Black faces. In fact, our results clearly show that prejudice moderates individuation of the outgroup. Prejudiced participants responded to familiar Black faces in a manner similar to completely novel Black faces (i.e., they failed to treat individuated faces as familiar). In spite of this demonstrable effect, the attitude-based covariates in this study could not account for the effects of contact, suggesting that the process is not simply driven by demand or motivation. Although further research is certainly required to clarify the mechanisms responsible for the effects of childhood exposure, we suggest that the acquisition of perceptual expertise in the processing of racial outgroup members may be a good candidate (cf. Lebrecht et al., 2009). In contrast, individuation processes relying on person-knowledge or preexisting affective associations may be less dependent on perceivers' previous experiences (Cloutier et al., 2011; Phelps et al., 2000). Future research should aim to disentangle the impact of different types of familiarity on race perception. For example, visual familiarity, perceptual individuation, and person-knowledge acquired through social interactions may differentially impact the neural substrates of race perception (Kubota et al., 2012; Cloutier et al., 2011; Cunningham et al., 2004; Phelps et al., 2000). Studies designed to identify networks of regions involved in race perception (e.g., through functional connectivity analysis) or patterns of activity within ROIs (e.g., using multivoxel pattern analysis) would further contribute to these efforts (see Brosch et al., 2013).

It is noteworthy that increased childhood contact had essentially no impact on amygdala response to novel Black faces in this study. Contact decreased amygdala activity only in response to the familiar set of Black faces. It is possible that prejudice against Black individuals masks the impact of childhood interracial contact on amygdala response to novel Black faces. On the other hand, childhood interracial contact may magnify the effect of perceptual individuation training on prejudice reduction. A comprehensive understanding of the nature and quality of childhood interracial contact may clarify the relationship between interracial contact and amygdala response to novel Black faces. For example, participants who actively seek meaningful interactions with Black peers during childhood may spontaneously attempt to perceptually individuate novel Black faces in adulthood. In contrast, individuals who are passively exposed to Black individuals during childhood may not initially be compelled to do so. Nonetheless, in both instances, previous childhood exposure to racial outgroups may predispose perceivers to the benefits of individuation.

The pattern we observed, in which childhood contact failed to reduce the amygdala response to novel Black

faces, does not replicate the recent findings of Telzer, Humphreys, et al. (2013), whose work with children found that interracial contact was associated with reduced amygdala response to unfamiliar outgroup faces. The differences between the results of these studies may reflect (a) differences between the responses of adult and child participants, (b) differences between the manner in which diversity was assessed (e.g., Telzer, Humphreys, et al., 2013, used parental reports of peer and neighborhood diversity, whereas we measured self-report percentage of Black individuals for different ages), (c) differences between the paradigms (e.g., stimuli and task), and/or (d) the fact that Telzer, Humphreys, et al. (2013) analyzed performance as a function of the participants' current level of interracial contact (reported by parents), whereas we based our analysis on retrospective reports of contact. Future studies may benefit from using multiple measures of interracial exposure during childhood to understand these divergent patterns.

The current findings have potentially important implications for prejudice reduction strategies that rely on contact or individuation-based familiarity (Brown, Eller, Leeds, & Stace, 2007; Turner, Hewstone, & Voci, 2007; Allport, 1954). Although contact may reduce prejudice, our results suggest greater benefits for familiar outgroup members (contact had no impact on reactions to novel Black faces). It is also clear from these data that the benefits of familiarity were most pronounced among participants with higher levels of contact. Future research may profitably explore the consequences of the interplay between interracial contact and familiarity for a variety of downstream behavior (e.g., race-based generalizations or discriminatory behavior).

Admittedly, although the current study illustrates the impact of childhood interracial contact on neural response to race perception during adulthood, we did not parse different types of interracial contact. Our measure largely relies on social networks, which should predominantly reflect positive ongoing interaction, but negative forms of interracial contact during childhood may function in a very different way. Consideration of the quality and nature of interactions during childhood may also provide a better understanding of how personal experience influences the processes involved in race perception. In addition, assessing childhood experience based on participants' self-reported memory provides an imperfect measure of interracial contact, potentially subject to demand and social desirability. Further investigations of the impact of childhood experience may benefit from the use of objective measures (e.g., obtaining participants' household registry records for information on racial diversity). Nonetheless, the observed effect of childhood interracial contact on race perception remains significant when controlling for a host of measures related to prejudice, age, and recall performance, giving us greater confidence that our measure of contact is not simply a proxy for pro-Black views.

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Notes

1. Childhood interracial contact becomes a stronger predictor when controlling for age, $b = .030$, $SE = .013$, $t(37) = 2.322$, $p = .026$.
2. We have also assessed the amount of information participants were able to recall before age 6 and between the ages of 6 and 12. Childhood interracial contact remains as a significant predictor for the difference in amygdala activity to novel Black versus familiar Black when controlling for the amount of information people can recall as well as the set of covariates (implicit and explicit prejudice, internal and external motivation to respond without prejudice), $b = .031$, $SE = .014$, $t(35) = 2.218$, $p = .033$. The same pattern remains after controlling for the White familiarity effect (to see whether the effect of contact emerges for Black faces over and above similar familiarity-based effects for White faces), $b = .031$, $SE = .014$, $t(34) = 2.185$, $p = .036$. In addition, interracial contact was not associated with a similar familiarity effect for White faces after accounting for the amount of information that participants recalled ($p > .5$).
3. Contact with Black individuals did not differ across the three age categories, $F(2, 134) = 0.695$, $p = .501$.
4. The bivariate correlations between average childhood contact with Black individuals and left amygdala activity to familiar Black faces, without the inclusion of any covariates, remained significant, $r(44) = -.366$, $p = .013$.
5. A whole-brain analysis conducted with childhood contact alone also revealed significant differential left amygdala activity, although to a lesser extent: $t(43) = 3.96$, threshold set at $p < .001$ uncorrected with a cluster extent of five voxels. Additionally, whole-brain analyses also revealed significant left amygdala differential activity when controlling for all covariates (MRS, IMS, EMS, and EP), $t(39) = 4.14$, and all covariates plus age, $t(38) = 4.40$ (both thresholds set at $p < .001$ uncorrected with a cluster extent of 15 voxels).

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