

Research Article

Separable Neural Components in the Processing of Black and White Faces

William A. Cunningham,¹ Marcia K. Johnson,¹ Carol L. Raye,¹ J. Chris Gatenby,² John C. Gore,² and Mahzarin R. Banaji³

¹Department of Psychology, Yale University; ²Institute of Imaging Science, Vanderbilt University; and ³Department of Psychology, Harvard University

ABSTRACT—*In a study of the neural components of automatic and controlled social evaluation, White participants viewed Black and White faces during event-related functional magnetic resonance imaging. When the faces were presented for 30 ms, activation in the amygdala—a brain region associated with emotion—was greater for Black than for White faces. When the faces were presented for 525 ms, this difference was significantly reduced, and regions of frontal cortex associated with control and regulation showed greater activation for Black than White faces. Furthermore, greater race bias on an indirect behavioral measure was correlated with greater difference in amygdala activation between Black and White faces, and frontal activity predicted a reduction in Black-White differences in amygdala activity from the 30-ms to the 525-ms condition. These results provide evidence for neural distinctions between automatic and more controlled processing of social groups, and suggest that controlled processes may modulate automatic evaluation.*

For almost 100 years, psychologists have studied attitudes and preferences by asking people to report on the good and bad attributes of people, things, and events (Eagly & Chaiken, 1993). However, recent evidence shows that people also spontaneously evaluate social objects along a good-bad dimension, without necessarily being aware that they are doing so (Bargh, Chaiken, Gvender, & Pratto, 1992; Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Given such findings, models of social attitudes suggest at least two modes of evaluation: one that in-

volves conscious and controlled modes of thinking and another that involves relatively automatic processes that operate without deliberate thought or sometimes without conscious awareness (Greenwald & Banaji, 1995; Nisbett & Wilson, 1977). Furthermore, an evaluation following more controlled processing may differ from an evaluation based only on more automatic processing. On indirect or implicit measures that tap automatic associations, many White participants show negativity toward Blacks, the elderly, or foreigners compared with Whites, the young, or Americans, yet they report unbiased attitudes on questionnaires that allow more controlled or conscious evaluations of the same groups (Cunningham, Nezlek, & Banaji, in press; Devine, 1989; Nosek, Banaji, & Greenwald, 2002).

Rather than being absolute categories, automatic and controlled can be thought of as relative terms used as shorthand for referring to differences in the nature, number, or complexity of cognitive operations engaged (e.g., Johnson & Reeder, 1997). That is, automatic processes are said to require fewer cognitive resources or involve less intent or conscious experience (or some combination of these factors) than controlled processes (see Bargh, 1996, for a review). Furthermore, cognitive operations that are thought to involve intentions, more complex operations, or the retrieval of more complex information take more time than more automatic or less complex processes (e.g., Johnson, Kounios, & Reeder, 1994; Neely, 1977). Therefore, in the current study, by manipulating the amount of time that stimuli were presented, we contrasted conditions that varied the opportunity for conscious perception (e.g., Cheesman & Merikle, 1986; Marcel, 1983) and the opportunity for reflective or controlled processing of the stimuli (Murphy & Zajonc, 1993). Differences in responses evoked by stimuli that are presented for a very short interval presumably reflect differences arising from relatively automatic perceptual and associative operations, whereas differences in responses evoked by stimuli that

Address correspondence to William A. Cunningham, Department of Psychology, University of Toronto, 100 St. George St., Toronto, ON M5S 3G3; e-mail: cunningham@psych.utoronto.ca.

	P S C I	7 6 0	B	Dispatch: 28.9.04	Journal: PSCI	CE: Blackwell
	Journal Name	Manuscript No.		Author Received:	No. of pages: 8	PE: Chris/Saravana

are clearly visible should be more likely to reflect controlled cognitive operations as well (see Draine & Greenwald, 1998, regarding the use of briefly presented stimuli to investigate automatic evaluative processes).

In this study, we integrated a behavioral examination of automatic and controlled evaluation with an investigation of the neural systems that may underlie these processes. We posed two primary questions: First, are common brain areas involved in the automatic and controlled processing of social-group members, or do different brain areas contribute to these seemingly distinct processes? Second, if relatively controlled and relatively automatic processing of members of social groups recruit different brain regions, is there evidence that more controlled processing can modulate the activity resulting from automatic processing?

Prior findings suggest that the amygdala is responsive to the emotionality of stimuli (Davis & Whalen, 2001; Isenberg et al., 1999; LeDoux, 1996). Also, the amygdala responds to emotion (e.g., responds more to fearful than to neutral facial expressions) whether stimuli are presented at durations long enough for the stimuli to be consciously seen (Morris et al., 1996) or more briefly (33 ms and masked; Whalen et al., 1998). Given the strong evidence for White participants' negative evaluations of Black compared with White individuals on measures of automatic evaluation (Cunningham et al., in press; Nosek et al., 2002; Wittenbrink, Judd, & Park, 1997), one might expect greater amygdala activation for Black faces than for White faces. To date, however, neuroimaging studies using presentations of Black and White faces have not found this expected pattern (Hart et al., 2000; Phelps et al., 2000). Although Hart et al. showed that amygdala activity habituated more quickly for same-race faces than for other-race faces, there was no overall difference in activation. In addition, although Phelps et al. found that the difference in amygdala activity for Black relative to White faces correlated with indirect measures of prejudice, there was no overall difference in average amygdala activation to Black and White faces.

The failure to find differences in amygdala activation for Black versus White faces could be the result of conflict between automatic and more controlled processes. Presumably, automatic and controlled responses to fearful faces do not differ (both negative). In contrast, automatic and controlled evaluations of social groups do sometimes differ. If more positive controlled processing can moderate more negative automatic processing, this could account for the absence of clear differences in amygdala responses to Black and White faces in previous studies. That is, previous studies may have failed to detect differences in amygdala activity because of the simultaneous activation of discrepant positive (more reflective) and negative (more automatic) evaluation processes (Greenwald & Banaji, 1995; Johnson & Multhaup, 1992).

In this study, we directly compared two perceptual conditions that varied the opportunity for controlled processing of race by

presenting photographs of Black and White faces either for very short durations (30 ms—barely a flash on the screen) or at durations long enough for the faces to be clearly visible (525 ms). Differences in activation for Black and White faces presented at short duration reflect relatively automatic processing compared with differences in activation for faces that participants can clearly see, and therefore have more opportunity to process reflectively.

METHOD

Participants

Twenty White participants were paid for their participation. The data from 4 participants were omitted because of excessive head movement (> 2 mm); we also excluded the data from 3 participants who when asked reported that they may have seen facelike stimuli in the 30-ms presentations. The final 13 participants (4 females) had a mean age of 27.

Task

During functional magnetic resonance imaging (fMRI), participants pressed one of two buttons with their right hand to indicate whether a visual stimulus appeared to the left or right of a fixation cross. Stimuli were projected onto a clear screen at the base of the MRI bore. From the participants' point of view, the stimuli were abstract pictures, white squares, or emotionally neutral human faces. The six trial types presented short-duration Black faces, long-duration Black faces, short-duration White faces, long-duration White faces, and short- and long-duration white squares (filler trials). Short-duration stimuli were presented for 30 ms, and long-duration stimuli for 525 ms. All stimuli were preceded and followed by an abstract picture, which masked the 30-ms images. The duration of the second mask image held the overall amount of visual information constant—the second abstract picture was presented for 525 ms on short-duration trials and 30 ms on long-duration trials. Thus, on short-duration trials, participants reported seeing and judging the position of an abstract picture (no participant included in the analysis reported seeing the 30-ms faces). A cross appeared for 1,300 ms between trials. So that faces were always separated by 12 s, each face presentation was followed by five white-square trials, each randomly presented as a short- or long-duration trial such that the intervals between faces were, on average, identical for short- and long-duration trials. Four runs of data were collected. Each run contained six presentations of each critical trial type (short-duration Black faces, short-duration White faces, long-duration Black faces, and long-duration White faces) in random order. The same eight Black faces and eight White faces were presented in the short- and long-duration conditions.

Scanning

A GE 1.5-T MRI scanner at the Yale Magnetic Resonance Research Center was used for scanning. Eighteen coronal slices (slice thickness = 6 mm, skip = 2 mm) were prescribed perpendicular to the anterior commissure–posterior commissure line, with the ninth slice centered on the amygdala. Functional images were acquired using a single-shot gradient echo-planar pulse sequence (TE = 60 ms, TR = 2,000 ms, in-plane resolution = 3.125×3.125 mm, matrix size = 64×64).

Preprocessing

Data were corrected for slice-acquisition time and motion using SPM99 (Friston et al., 1995), then co-registered to in-plane anatomical images and transformed to conform to the SPM99 standard T1 MNI (Montreal Neurological Institute) brain interpolated to $3 \times 6 \times 3$ mm. Functional data were smoothed using a 9-mm FWHM (full-width-half-maximum) kernel, and default SPM99 high- and low-pass filters were applied.

Group Contrast Analyses

For each subject, we used SPM99 to generate statistical contrast maps from the average fMRI blood-oxygen-level-dependent (BOLD) signal for Black compared with White faces in both the short- and long-duration conditions. To characterize the neural response for short- and long-duration presentations of Black and White faces, we regressed the fMRI signal reflecting brain activity for the Black-face trials and for the White-face trials onto a canonical hemodynamic response and a secondary time derivative that allowed for differences in hemodynamic onset. To generate group statistical contrast maps, we conducted a random effects analysis using the contrast maps of individual subjects as input. For analyses of the amygdala, an anatomical mask was created to reduce the opportunity of Type I error in this a priori region of interest. For whole-brain analyses, significant areas of activity were defined as those in which the activity of at least 13 contiguous voxels differed for Black and White faces at a significance level greater than $p < .005$ ($t > 3.05$) in the short- or long-duration condition. The choice of significance threshold and cluster size was determined by a Monte Carlo simulation that took into consideration the original acquisition voxel size, resliced voxel size, and smoothing kernel to obtain a corrected alpha level of $p < .05$. Using the SPM ROI Toolbox (Poldrack, n.d.), we plotted time courses from voxels that differed in either the 30-ms or the 525-ms Black-White contrast.

Behavioral Measures

The Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) and all self-report questions were administered on a computer after scanning. For the IAT, a face or a word was presented on each trial. In one block of trials, participants

pressed one key for Black faces and words with good meanings and another key for White faces and words with bad meanings. In another block of trials, participants classified the Black faces and bad words with one key and the White faces and good words with another. Implicit attitude was defined as the average difference in response latency between these two conditions, with higher scores reflecting more difficulty pairing Black with good than with bad. Faces used for the IAT and the brain-imaging part of the study were identical.¹

After the IAT, the Modern Racism Scale (a self-report scale measuring racial prejudice; McConahay, 1986) and the Motivation to Respond Without Prejudice Scale (a self-report scale measuring motivations to think and behave without prejudice; Plant & Devine, 1998) were presented in random order on the computer. From the Motivation to Respond Without Prejudice Scale, we used the Internal Motivation subscale, which measures participants' desires to think, feel, and respond without prejudice for personal reasons. Participants responded to each item with a rating from 1 to 6, with 1 indicating strong disagreement with the statement and 6 indicating strong agreement with the statement. The Modern Racism Scale and Internal Motivation to Respond Without Prejudice Scale were combined into a single self-reported prejudice index. Higher scores reflect more positive attitudes toward Black Americans and a personal desire to act without prejudice toward them. For this index, we subtracted the midpoint of the scale, so that positive scores indicate agreement with nonprejudiced items and disagreement with prejudiced items, and negative scores indicate the reverse.

In addition, we created an index of implicit-explicit conflict that conceptually reflects the discrepancy between automatic and controlled attitudes. Attitude conflict was operationalized as the product (see Botvinick, Braver, Barch, Carter, & Cohen, 2001) of the IAT and prejudice index, and higher scores reflect greater conflict: The more a participant both reported positive attitudes on the self-report measures and showed negativity toward Blacks relative to Whites on the IAT, the higher the participant's conflict score.

RESULTS

Behavioral Data

All participants (13 out of 13) disagreed with prejudiced statements, agreed with nonprejudiced statements, and reported having motivation to respond without bias (see Table 1). Yet, on average, participants showed automatic negative associations toward Black relative to White faces on the IAT. Response times (851 ms) from blocks pairing Black faces with bad words

¹One reason why we selected the IAT to measure implicit associations is that the IAT is among the most statistically reliable implicit measures available (see Cunningham, Preacher, & Banaji, 2001). Also, research has indicated that amygdala activation for Black relative to White faces correlates with IAT scores (Phelps et al., 2000), indicating that the IAT may be a predictor of emotional processing.

TABLE 1
Behavioral Attitude Measures

Measures	<i>M</i>	<i>SD</i>	Minimum	Maximum
IAT ^a	160.17	154.14	-101	465
Combined prejudice index ^b	1.35	0.28	0.85	1.79
Modern Racism Scale	2.15	0.31	1.71	2.57
Internal Motivation	4.82	0.51	4.20	6.00
Implicit-explicit conflict	4.88	5.13	-3.48	15.57

^aScores on the IAT (Implicit Association Test) were calculated by subtracting average response latency on trials pairing Black faces with good words and White faces with good words from average response latency on trials with the reverse pairings. ^bThis index was computed by averaging scores on the Internal Motivation subscale of the Motivation to Respond Without Prejudice Scale with reversed scores on the Modern Racism Scale and then subtracting the scale midpoint (3.5).

and White faces with good words were significantly shorter than response times (1,011 ms) from blocks pairing Black faces with good words and White faces with bad words, $t(11) = 3.6$, $p < .01$, indicating Black-bad and White-good associations were stronger than Black-good and White-bad associations.

fMRI Data

We assessed the differential neural response to faces by contrasting the fMRI signal for Black and White faces in the 30-ms and 525-ms conditions (see Table 2). The 30-ms contrast

showed a significant difference in an area of right amygdala extending into ventral pallidum, $t(12) = 4.26$, $p < .001$. As can be seen in Figure 1, relative to nonface trials, amygdala activity for 30-ms presentations increased on trials with Black faces and decreased on trials with White faces. With more liberal thresholds, this activation spread into more ventral parts of the amygdala. This pattern suggests that at relatively automatic levels of processing, more emotional processing occurs for Black than for White faces.

Support for the suggestion that this differential amygdala activation is part of an automatic evaluation process comes from correlating the mean difference in fMRI signal in the amygdala voxels found to be significant ($p < .005$) in the 30-ms Black-White contrast with the IAT scores. To the extent that amygdala activity reflects processing associated with relatively automatic evaluations of social groups, individual differences in this activity should correlate with individual difference indices assumed to measure automatic biases. This analysis indicated that amygdala activity was significantly correlated with participants' IAT scores, $r(11) = .79$, $p < .01$. That is, the more implicit negativity toward Blacks relative to Whites that participants showed on the IAT, the greater their amygdala activity for Black relative to White faces in the 30-ms condition.

Although participants showed a greater amygdala response to Black compared with White faces presented for 30 ms, research has suggested that many White individuals are motivated to

TABLE 2
Areas of Significant Blood-Oxygen-Level-Dependent Activation

Size (number of significant words)	Area	BA	Hemisphere	\pm statistic	MNI coordinates		
					<i>x</i>	<i>y</i>	<i>z</i>
Greater response to Black than to White faces (30-ms condition)							
11	Amygdala	—	Right	4.26	18	-6	-12
32	Superior frontal sulcus	9	Left	4.79	-21	30	39
27	Superior temporal cortex	36	Right	4.88	30	-6	-33
27	{ Supplementary motor	6	Left	4.56	-3	0	66
	{ Supplementary motor	6	Left	4.05	-48	-6	54
Greater response to Black than to White faces (525-ms condition)							
77	{ Anterior cingulate	32	Left	5.82	-6	36	24
	{ Anterior cingulate	32	Left	4.52	-9	18	33
	{ Anterior cingulate	32	Right	4.34	3	18	33
13	Ventrolateral PFC	47	Right	4.04	57	30	-12
37	{ Dorsolateral PFC	9	Right	4.88	27	48	24
	{ Dorsolateral PFC	9	Right	4.85	33	48	36
15	Dorsolateral PFC	10	Right	5.22	24	60	27
20	Supplementary motor	6	Left and Right	4.12	0	0	72
Greater response to White than to Black faces (525-ms condition)							
23	Dorsolateral PFC	44	Left	5.64	-57	18	36
16	Hippocampus	—	Right	4.91	33	-24	-18

Note. The reported brain areas with significant activation show local maxima that are greater than 8.00 mm apart within each cluster. The *x*, *y*, and *z* coordinates are in MNI (Montreal Neurological Institute) space. No areas showed greater response to White than to Black faces in 30-ms condition. BA = Brodmann's Area; PFC = prefrontal cortex.

a: Amygdala Contrast Map **b: Amygdala Timecourses**

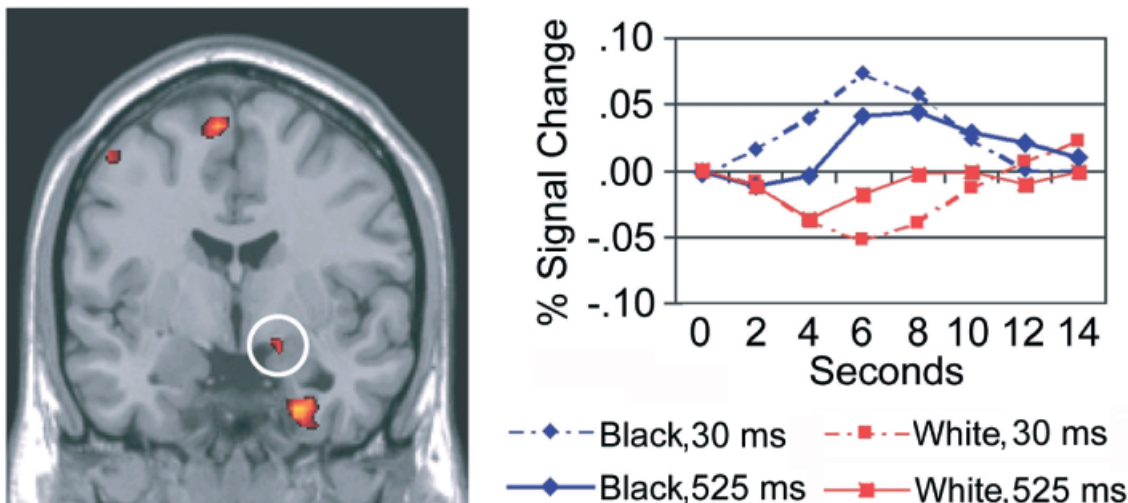


Fig. 1. Activation in right amygdala. The coronal map (a) shows areas that a random effects analysis identified as exhibiting greater response to Black than to White faces in the 30-ms condition ($p < .005$). The circled area is the amygdala. Areas with significant activation are in color, with yellow indicating a higher level of significance than red. The graph of signal change over time (b) shows the amygdala response to Black and White faces generated from these significant voxels separately for the 30-ms and 525-ms conditions.

regulate or control unwanted feelings toward particular social groups. All participants in this study fell into this category: Despite showing more positive associations to Whites than Blacks on the IAT, all participants reported internalized desires to respond without prejudice. Results for the 525-ms duration were consistent with this regulatory motivation: In contrast to the 30-ms condition, the 525-ms condition showed no significant amygdala difference in the Black-White contrast. Moreover, a direct comparison of amygdala activation for Black compared with White faces in the short- and long-duration conditions resulted in a significant interaction. As can be seen in Figure 1b, the Black-White difference in activation observed

in the 30-ms condition was significantly reduced in the 525-ms condition, when presumably automatic attitudes were counteracted by more positive controlled attitudes, $F(1, 12) = 5.25$, $p < .05$.

At the same time, areas of increased activity for Black faces relative to White faces in the 525-ms condition (Fig. 2) were observed in right ventrolateral prefrontal cortex (PFC; Brodmann's Area, BA, 47), $t(12) = 4.04$, $p < .005$; right dorsolateral PFC (BA 9), $t(12) = 4.88$, $p < .001$; and anterior cingulate (BA 32), $t(12) = 5.82$, $p < .001$. We subtracted the magnitude of the Black-White difference in amygdala activation in the 525-ms condition from the corresponding difference in the

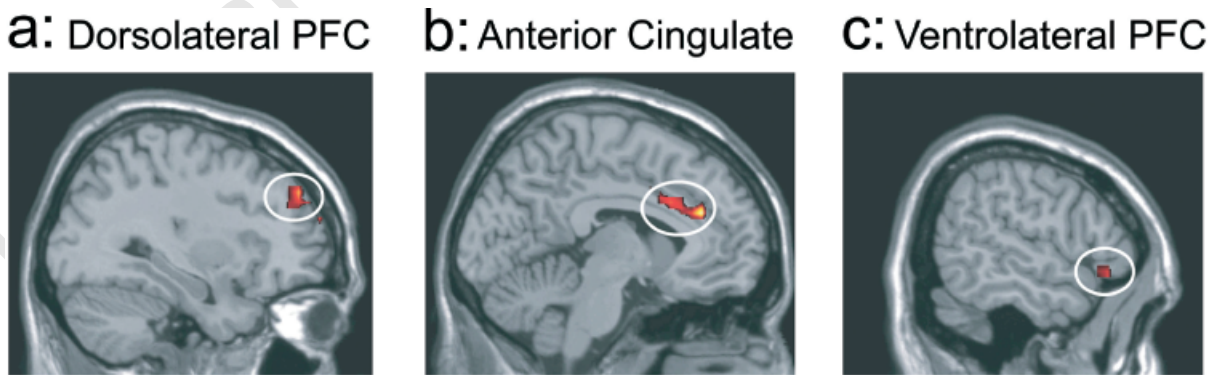


Fig. 2. Prefrontal activations in the 525-ms condition. Areas with greater response to Black than to White faces ($p < .005$) were found in (a) dorsolateral prefrontal cortex (PFC), (b) anterior cingulate, and (c) ventrolateral PFC. The maps are in sagittal orientation to show the extent of activation. Areas discussed in the text are circled. Areas with significant activation are in color, with yellow indicating a higher level of significance than red.

30-ms condition to generate an index of amygdala modulation. Correlations between this modulation index and participants' Black-White contrast maps (voxel by voxel) for the 525-ms condition indicated that the modulation of amygdala activation was associated with increases in activation in dorsolateral PFC, $t(12) = 3.07$, $p < .005$; MNI: $x = 33$, $y = 48$, $z = 36$, and anterior cingulate, $t(12) = 2.98$, $p < .01$; MNI: $x = 3$, $y = 6$, $z = 33$. Consistent with previous research showing that these areas are associated with regulation and executive function (Beauregard, Levesque, & Bourgouin, 2001; MacDonald, Cohen, Stenger, & Carter, 2000; Ochsner, Bunge, Gross, & Gabrieli, 2002), these results suggest that controlled processing can moderate, and even override, activity that would otherwise arise from automatic processing (Moskowitz, Gollwitzer, Wasel, & Schaal, 1999).

In previous work, we showed that evaluations marked by ambivalence are associated with activity in ventrolateral PFC (Cunningham, Johnson, Gatenby, Gore, & Banaji, 2003). In the present study, to examine the role of PFC in attitudinal ambivalence arising from differences between automatic and controlled attitudes, we calculated a discrepancy index of attitudinal conflict (the product of participants' IAT scores and prejudice scores; Table 1). Correlating this index with fMRI results in the 525-ms condition indicated that greater attitude ambivalence was significantly correlated with greater activation for Black relative to White faces in an area of ventrolateral PFC adjacent to that identified in the 525-ms Black-White comparison, $t(11) = 3.14$, $p < .005$; MNI: $x = 42$, $y = 20$, $z = -9$. Moreover, when predicting response to faces in the 525-ms condition from the discrepancy index and the IAT simultaneously, we found that the IAT was a significant predictor of amygdala activation, $t(11) = 3.87$, $p < .01$. In the 30-ms condition, the IAT correlated directly with differential Black-White amygdala activity, and in the 525-ms condition, the IAT correlated with differential Black-White amygdala activity after controlling for discrepancies between indirect and self-report measures of racial attitudes.

DISCUSSION

In summary, we found greater amygdala activation for Black than White faces when faces were presented for only 30 ms (a duration at which participants reported seeing only the mask stimulus). This difference in amygdala activation was stronger the higher participants' racial bias on the IAT. These results, combined with previous investigations of intergroup attitudes, suggest that implicit negative associations to a social group may result in an automatic emotional response when encountering members of that group. Yet when participants had the opportunity to process Black and White faces for 525 ms (and reported seeing the faces), we observed activity differences not in the amygdala, but in areas of PFC (BA 47 and 9) and anterior cingulate (BA 32)—areas associated with inhibition, conflict,

and control (Beauregard et al., 2001; MacDonald et al., 2000; Ochsner et al., 2002). Furthermore, activation in the ventrolateral PFC was correlated with attitudinal ambivalence, and activations in dorsolateral prefrontal and anterior cingulate cortices were correlated with an index of the modulation of amygdala activity when participants had opportunity to reflectively process the faces.

Such a pattern is consistent with a suggestion by Richeson et al. (2003) that activation in dorsolateral PFC and anterior cingulate is associated with attempts to control unwanted prejudicial responses to Black faces. Richeson et al. found that people who had the strongest race bias on the IAT (and thus the most to control) had the largest degree of activation in these regions to Black relative to White faces. The regions Richeson et al. identified as underlying the control of prejudice were nearly identical to the regions identified in this study as being associated with modulation of automatic evaluations. The present study provides strong evidence about the functions of these regions by showing that the reduction in Black-White differences in amygdala activation in the long- compared with the short-duration condition was correlated with activity in dorsolateral PFC and anterior cingulate. Thus, our findings are consistent with the idea that it is possible to control spontaneously activated negative attitudes and point to neural circuits that may be involved in this control.

These results suggest that previous neuroimaging research has failed to find robust evidence of greater amygdala activation for Black faces relative to White faces in White participants because more controlled processing can modulate more automatic processing. Greater Black-White difference in amygdala activation in the 30-ms condition than in the 525-ms condition is consistent with the idea that unwanted prejudicial responses are most likely to occur under conditions of distraction or cognitive overload, when reflective cognitive processes that might modulate an automatically activated evaluation are otherwise engaged (Pendry & Macrae, 1999). Furthermore, Richeson et al. (2003) found that presumed greater response regulation while viewing Black faces was associated with poorer subsequent performance on a task that required cognitive control (i.e., the Stroop task).

Such mental distraction may partially explain why a significant direct correlation between the IAT and amygdala activity for Black relative to White faces was found by Phelps et al. (2000), who used a 2-s presentation time, but not in the 525-ms condition of the current study. Whereas participants in the present study made left/right judgments about the location of each stimulus, Phelps et al. directed attention toward the faces on each trial using an n-back task. Thus, their participants engaged in intentional memory encoding operations and memory judgments and may have been less able to regulate their responses than were participants in the present study. Furthermore, Phelps et al. used a blocked design in which multiple Black or White faces were presented sequentially,

whereas we used an event-related design in which Black and White faces were presented randomly. If control of prejudiced responses usurps cognitive resources (e.g., Richeson et al., 2003), then a task with repeated Black faces may be more demanding than one in which Black and White faces are interspersed.²

One potential contributor to amygdala activity is the ease with which stimuli can be processed and discriminated. Golby, Gabrieli, Chiao, and Eberhardt (2001) showed that same-race faces activate the fusiform gyrus—an area associated with perceptual expertise (Gauthier, Tarr, Anderson, Skudlarski, & Gore, 1999)—more than other-race faces do. This result suggests that same-race faces may have an advantage in early visual processing. Our results are consistent with this idea in that we found that participants' IAT scores correlated significantly with greater bilateral fusiform activation for White relative to Black faces in the 30-ms condition. Additionally, the degree of Black relative to White amygdala activity correlated with left fusiform activity in the 30-ms condition.³ Thus, the greater White participants' race biases, the more superficially they may process Black faces relative to White faces; this difference in perceptual processing may result in a relatively undifferentiated early visual signal that triggers an emotional response (e.g., Johnson & Multhaup, 1992).

Together, the present data provide new evidence about the neural correlates of automatic and more controlled processing of stimuli that have conflicting valence. The data show neural differences between more automatic and more controlled processing of social groups, and suggest that reflective processes may interact with and modulate evaluations arising more automatically during perceptual processing.

Acknowledgments—This research was supported by National Institute of Mental Health Grant MH-75672, National Science Foundation Grant SBR-9709924 (to M.R.B.), and National Institute of Health Grant MH-62196 (to M.K.J.). For helpful comments on this article, we thank Geoff Cohen, Brian Scholl, Peter Salovey, Antonio Freitas, Chuck Sanslow, Greg Walton, Eric Uhlmann, Jason Mitchell, Joe Bates, Karen Mitchell, and Christy Marshuetz.

²Another difference between the current study and the one by Phelps et al. is that they found bilateral amygdala activation correlated with IAT scores, whereas in this study we found right amygdala activation did. It is unclear what might account for such a difference. Findings suggest that amygdala laterality varies as a function of gender (Canli, Desmond, Zhao, & Gabrieli, 2002) or personality variables (Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002).

³Participants with the strongest White-good and Black-bad associations had the greatest activation to White relative to Black faces in both the right and the left fusiform gyrus—right fusiform: $t(12)=4.26$, $p < .001$; MNI: $x=51$, $y=-42$, $z=-24$; left fusiform: $t(12)=4.21$, $p < .001$; MNI: $x=-45$, $y=-42$, $z=-21$. Similarly, degree to which amygdala activity was greater for Black than for White faces in the 30-ms condition correlated with differential White-Black fusiform activity: left fusiform— $t(12)=4.66$, $p < .001$; MNI: $x=-30$, $y=-36$, $z=-21$.

REFERENCES

- Bargh, J.A. (1996). Automaticity in social psychology. In E.T. Higgins & A.W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 169–183). New York: Guilford Press.
- Bargh, J.A., Chaiken, S., Govevender, R., & Pratto, F. (1992). The generality of the automatic attitude activation effect. *Journal of Personality and Social Psychology*, *62*, 893–912.
- Beauregard, M., Levesque, J., & Bourgouin, P. (2001). Neural correlates of conscious self-regulation of emotion. *Journal of Neuroscience*, *21*, RC165: 1. Retrieved XXXX 200X from
- Botvinick, M.M., Braver, T.S., Barch, D.M., Carter, C.S., & Cohen, J.D. (2001). Conflict monitoring and cognitive control. *Psychological Review*, *103*, 624–652.
- Canli, T., Desmond, J.E., Zhao, Z., & Gabrieli, J.D. (2002). Sex differences in the neural basis of emotional memories. *Proceedings of the National Academy of Sciences, USA*, *99*, 10789–10794.
- Canli, T., Sivers, H., Whitfield, S.L., Gotlib, I.H., & Gabrieli, J.D. (2002). Amygdala response to happy faces as a function of extraversion. *Science*, *296*, 2191.
- Cheesman, J., & Merikle, P.M. (1986). Distinguishing conscious from unconscious perceptual processing. *Canadian Journal of Psychology*, *40*, 343–367.
- Cunningham, W.A., Johnson, M.K., Gatenby, J.C., Gore, J.C., & Banaji, M.R. (2003). Neural components of social evaluation. *Journal of Personality and Social Psychology*, *85*, 639–649.
- Cunningham, W.A., Nezlek, J.B., & Banaji, M.R. (in press). Implicit and explicit ethnocentrism: Revisiting the ideologies of prejudice. *Personality and Social Psychology Bulletin*.
- Cunningham, W.A., Preacher, K.J., & Banaji, M.R. (2001). Implicit attitude measures: Consistency, stability, and convergent validity. *Psychological Science*, *12*, 163–170.
- Davis, M., & Whalen, P.J. (2001). The amygdala: Vigilance and emotion. *Molecular Psychiatry*, *6*, 13–34.
- Devine, P.G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology*, *56*, 5–18.
- Draine, S.C., & Greenwald, A.G. (1998). Replicable unconscious semantic priming. *Journal of Experimental Psychology: General*, *127*, 286–303.
- Eagly, A.H., & Chaiken, S. (1993). *The psychology of attitudes*. Fort Worth, TX: Harcourt Brace.
- Fazio, R.H., Sanbonmatsu, D.M., Powell, M.C., & Kardes, F.R. (1986). On the automatic activation of attitudes. *Journal of Personality and Social Psychology*, *50*, 229–238.
- Friston, K.J., Holmes, A.P., Worsley, K.J., Poline, J.P., Frith, C.D., & Frackowiak, R.S.J. (1995). Statistic parametric maps in functional imaging: A general linear approach. *Human Brain Mapping*, *2*, 189–210.
- Gauthier, I., Tarr, M.J., Anderson, A.W., Skudlarski, P., & Gore, J.C. (1999). Activation of the middle fusiform 'face area' increases with expertise in recognizing novel objects. *Nature Neuroscience*, *2*, 568–573.
- Golby, A.J., Gabrieli, J.D., Chiao, J.Y., & Eberhardt, J.L. (2001). Differential responses in the fusiform region to same-race and other-race faces. *Nature Neuroscience*, *4*, 845–850.
- Greenwald, A.G., & Banaji, M.R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review*, *102*, 4–27.
- Greenwald, A.G., McGhee, D.E., & Schwartz, J.L.K. (1998). Measuring individual differences in implicit cognition: The Implicit

Q1

- Association Test. *Journal of Personality and Social Psychology*, 74, 1464–1480.
- Hart, A.J., Whalen, P.J., Shin, L.M., McInerney, S.C., Fischer, H., & Rauch, S.L. (2000). Differential response in the human amygdala to racial outgroup vs. ingroup face stimuli. *NeuroReport*, 11, 2351–2355.
- Isenberg, N., Silbersweig, D., Engelen, A., Emmerich, S., Malavade, K., Beattie, B., Leon, A.C., & Stern, E. (1999). Linguistic threat activates the human amygdala. *Proceedings of the National Academy of Sciences, USA*, 96, 10456–10459.
- Johnson, M.K., Kounios, J., & Reeder, J.A. (1994). Time course studies of reality monitoring and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 20, 1409–1419.
- Johnson, M.K., & Multhaup, K.S. (1992). Emotion and MEM. In S. Christianson (Ed.), *The handbook of emotion and memory: Research and theory* (pp. 33–66). Hillsdale, NJ: Erlbaum.
- Johnson, M.K., & Reeder, J.A. (1997). Consciousness as meta-processing. In J.D. Cohen & J.W. Schooler (Eds.), *Scientific approaches to consciousness* (pp. 261–293). Mahwah, NJ: Erlbaum.
- LeDoux, J.E. (1996). *The emotional brain: The mysterious underpinnings of emotional life*. New York: Simon & Schuster.
- MacDonald, A.W., Cohen, J.D., Stenger, V.A., & Carter, C.S. (2000). Dissociating the role of dorsolateral prefrontal cortex and anterior cingulate cortex in cognitive control. *Science*, 288, 1835–1837.
- Marcel, J.J. (1983). Conscious and unconscious perception: Experiments on visual masking and word recognition. *Cognitive Psychology*, 15, 197–237.
- McConahay, J.B. (1986). Modern racism, ambivalence, and the Modern Racism Scale. In J.F. Dovidio & S.L. Gaertner (Eds.), *Prejudice, discrimination, and racism* (pp. 91–125). Orlando, FL: Academic Press.
- Morris, J.S., Frith, C.D., Perrett, D.I., Rowland, D., Young, A.W., Calder, A.J., & Dolan, R.J. (1996). A differential neural response in the human amygdala to fearful and happy facial expressions. *Nature*, 383, 812–815.
- Moskowitz, G.B., Gollwitzer, P.M., Wasel, W., & Schaal, B. (1999). Preconscious control of stereotype activation through chronic egalitarian goal. *Journal of Personality and Social Psychology*, 77, 176–184.
- Murphy, S.T., & Zajonc, R.B. (1993). Affect, cognition, and awareness: Affective priming with suboptimal and optimal stimulus. *Journal of Personality and Social Psychology*, 64, 723–739.
- Neely, J.H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General*, 106, 226–254.
- Nisbett, R.E., & Wilson, T.D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, 84, 231–259.
- Nosek, B.A., Banaji, M.R., & Greenwald, A.G. (2002). Harvesting implicit group attitudes and beliefs from a demonstration website. *Group Dynamics*, 6, 101–115.
- Ochsner, K.N., Bunge, S.A., Gross, J.J., & Gabrieli, J.D.E. (2002). Rethinking feelings: An fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience*, 14, 1215–1229.
- Pendry, L.F., & Macrae, C.N. (1999). Cognitive load and person memory: The role of perceived group variability. *European Journal of Social Psychology*, 29, 925–942.
- Phelps, E.A., O'Connor, K.J., Cunningham, W.A., Funayama, E.S., Gatenby, J.C., Gore, J.C., & Banaji, M.R. (2000). Performance on indirect measures of race evaluation predicts amygdala activation. *Journal of Cognitive Neuroscience*, 12, 729–738.
- Plant, E.A., & Devine, P.G. (1998). Internal and external motivation to respond without prejudice. *Journal of Personality and Social Psychology*, 75, 811–832.
- Poldrack, R. (n.d.). *SPM TOOLBOX: ROI (Region-of-Interest) Toolbox*. Retrieved June 2002 from <http://spm-toolbox.sourceforge.net>
- Richeson, J.A., Baird, A.A., Gordon, H.L., Heatherton, T.F., Wyland, C.L., Trawalter, S., & Shelton, J.N. (2003). An fMRI investigation of the impact of interracial contact on executive function. *Nature Neuroscience*, 6, 1323–1328.
- Whalen, P.J., Rauch, S.L., Etkoff, N.L., McInerney, S.C., Lee, M.B., & Jenike, M.A. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *Journal of Neuroscience*, 18, 411–418.
- Wittenbrink, B., Judd, C.M., & Park, B. (1997). Evidence for racial prejudice at the implicit level and its relationship with questionnaire measures. *Journal of Personality and Social Psychology*, 72, 262–274.

(RECEIVED 10/24/03; REVISION ACCEPTED 1/14/04)