The neural correlates of race

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Behavioral analyses are a natural choice for understanding the wide-ranging behavioral consequences of racial stereotyping and prejudice. However, studies using neuroimaging and electrophysiological research have recently considered the neural mechanisms that underlie racial categorization and the activation and application of racial stereotypes and prejudice, revealing exciting new insights. Work that we review here points to the importance of neural structures previously associated with face processing, semantic knowledge activation, evaluation and self-regulatory behavioral control, enabling specification of a neural model of race processing. We show how research on the neural correlates of race can serve to link otherwise disparate lines of evidence on the neural underpinnings of a broad array of social-cognitive phenomena; we also consider the implications for effecting change in race relations.

New frontiers in the study of race and social cognition

Brain imaging and electrophysiological methods have emerged as important new tools for scholars of race. In particular, research using functional brain imaging (e.g., fMRI) and electrocortical responses (such as event-related brain potentials (ERPs) and electroencephalography (EEG)) is providing unparalleled access to how race is processed in the brain, as well as new insights into how race influences perceptions and behaviors (Box 1). Several recent models explicate the neural structures involved in particular aspects of social cognition, such as judging mental states [1,2], perceiving faces [3] and activating attitudes [4]. Although such models are crucial for understanding specific social-cognitive constructs, in vivo social perception also draws on multiple, overlapping social cognitive processes. Race perception enables examination of how these and related systems interact to inform judgments and behaviors.

Here, we review recent research investigating the neural systems associated with race processing. On the basis of this work, we put forward an initial model of the neural correlates of race that could serve as a basis for future research aimed at understanding the interacting systems involved in race processing and its downstream cognitive, affective and behavioral consequences.

Race perception, categorization and the putative face-processing network

Racial categorization can occur based on facial features, which means that race perception often begins with the perception of a face. Consequently, we begin here by considering research on the neural structures supporting face processing. Although work on face perception often focused on mechanisms that differentiate faces from non-faces and on how personal identity is retrieved (e.g. Ref. [3]), research is now showing that even basic aspects of face perception are affected by race and that sensitivity to race occurs in a fast and seemingly automatic fashion.

Fusiform gyrus and posterior cingulate cortex

Race effects have been observed in two brain areas traditionally associated with face perception, the lateral fusiform gyrus and posterior cingulate cortex (PCC), with greater activity in response to racial ingroup than outgroup members in both areas [5–8] (Box 2). Lateral fusiform activity has been linked to encoding of the visual appearance of the face. Modulation of this process by race could reflect greater experience with racial ingroup members, as other research shows an increase in fusiform activity with expertise [9]. Motivation might also have a role, as suggested by a study in which Caucasian participants were told that they had been randomly assigned to one of two competing, racially diverse teams [10]. Participants first learned to recognize members of both teams, then viewed pictures of team members’ faces. Activity in the bilateral fusiform gyrus was sensitive to team designation, showing greater activity to own than competing team members, regardless of their race. Therefore, the motivational significance conferred by status as a fellow team member modulated recruitment of face-processing mechanisms, suggesting that prior race effects reflect inherent motivations to attend more deeply to ingroup members. Regardless of the cause, race effects on fusiform activity have downstream consequences; greater activity in left fusiform to ingroup than outgroup faces also correlates with an ingroup memory advantage [5].

PCC activity generally is enhanced during retrieval of information about familiar versus unfamiliar individuals [3]. However, enhanced PCC activity to ingroup faces has been obtained with faces that are unknown to the participants, suggesting that a more general sense of group-based familiarity also affects PCC activity. In sum, work examining race effects on face processing both informs understanding of race categorization and suggests that motivational factors (e.g. those relevant to ingroup–outgroup distinctions) influence recruitment of face-processing mechanisms, thereby enhancing current understanding of this fundamental component of social cognition.

Electrocortical responses to race

Whereas fMRI has revealed the neural structures affected by race during face processing, studies using ERPs have...
elucidated mechanistic aspects of race perception and categorization, such as its time course and malleability. In an initial investigation, participants viewed pictures of Black and Caucasian individuals (targets) while ERPs were recorded [11]. Modulations as a function of target race occurred as early as the N100 ERP component, peaking 122 ms after face onset. Race effects also were observed in the subsequent P200, N200 and P300 components (Figure 1). Numerous subsequent investigations have replicated these findings [12-18] (Table 1). These components are generally sensitive to attentional and categorization processes [19], suggesting that the race effects reflect automatic encoding of, and orienting toward, racial category information. Importantly, sensitivity to race occurs regardless of whether participants are explicitly attending to race, to another social dimension (gender), or making person-based, individuating judgments [14], indicating that attention to race is obligatory.

Just as face-processing areas appear sensitive to ingroup–outgroup distinctions, effects of race on ERP components reflect distinctions between ingroup and outgroup members. Dickter and Bartholow [12] recorded ERPs as Black and Caucasian perceivers viewed pictures of Black and Caucasian targets in a gender categorization task. Results for Caucasian perceivers replicated previous work (e.g. Refs [11,14,15]), showing larger P200 amplitude to Black than to Caucasian targets and larger N200 amplitude to Caucasian than to Black targets. However, the pattern was reversed among Black perceivers, with larger P200s to Caucasian targets and larger N200s to Black targets. Willadsen-Jensen and Ito [17] reported similar findings with Asian participants. These results, coupled with the fMRI face-processing data, suggest that neural differentiation of race operates at the level of broader social distinctions (ingroup versus outgroup).

Box 2. Race effects in the N170 electrocortical index of face processing

The N170 ERP component is a negative-going deflection maximal over lateral temporal areas that is larger to faces than to non-faces [60]. Its sensitivity to race has been equivocal, with support obtained for three mutually exclusive hypotheses. First, the N170 has been argued to reflect structural face encoding, sensitive only to global features that differentiate faces from non-faces, but not to features of individual faces [60,61]. This perspective implies that race should not modulate N170 responses, a pattern obtained in several studies [18,62,63].

Other research indicates that N170 amplitude is also increased to non-face stimuli with which participants are expert [64]. This suggests the N170 reflects a more general expertise mechanism that is sensitive to faces, about which humans are normally expert, and to other stimuli about which individuals are idiosyncratically expert. This perspective predicts that N170 amplitude should be greatest in response to racial ingroup members because perceivers typically have more experience interacting with ingroup members. This also converges with source localization data implicating the fusiform gyrus in the generation of the N170 [65], and the greater fusiform activity in response to racial ingroup faces observed in fMRI studies [5,6]. To date, however, only one study has obtained this N170 pattern [14].

Finally, N170 amplitude is increased by manipulation that disrupts the configural processing typically applied to faces [66]. Racial outgroup faces are often less familiar, and might be processed in a less configural manner [67]. Consequently, the prediction can be derived that N170s should be larger to racial outgroup faces, a pattern obtained in several studies [68-70].

These conflicting findings suggest that features other than simple physical and/or structural differences influence N170 responses to faces. One possibility is that motivational factors that make race more or less salient to perceivers modulate this neural response. Consistent with this view, all studies producing larger N170s in response to racial outgroups have made identity salient (e.g. by having participants detect when two consecutively presented faces match or trying to remember the faces) whereas none of the studies obtaining other patterns have. Given assumptions that the N170 reflects structural face encoding, and that perceivers typically process racial outgroup faces in a less, configural shallower manner (e.g. as reflected in poorer memory for outgroup faces), tasks that require attention to identity might selectively increase recruitment of face-processing mechanisms to racial outgroup members. However, further research is needed to clarify these seemingly contradictory patterns of N170 to racial outgroup and ingroup targets.
Blacks with threat and behavioral expression of racial bias. Moreover, ERP effects mediated the relation between self-reported endorsement of stereotypes linking Caucasians. These beliefs (i.e. stereotypes) then influence reactions toward, and judgments about, the individual. To date, few studies have sought to identify brain areas associated with racial stereotyping (Box 3) but ERPs have been used to investigate rapidly unfolding neural responses to stereotype activation and violation. In studies examining person perception, N200s are larger to more familiar individuals [61,72]. Race effects showing orientation of considerable semantic knowledge and, therefore, are hypothesized to engage this system, reflecting either updating of existing content or a motivated attempt to resolve the inconsistent information.

Subsequent research investigated spontaneous stereotype activation in a task that required no explicit trait inferences [25]. Participants categorized the race of centrally presented Black and Caucasian faces (targets) flanked on four sides by trait words that were either stereotype consistent (e.g. a Black face with ‘violent’) or stereotype inconsistent (e.g. a Black face with ‘safe’) with respect to the target’s race. Strictly speaking, the flanker words were task irrelevant and required no attention. However, categorization responses were slower to faces flanked by stereotype-inconsistent words, indicating that participants implicitly activated racial stereotypes associated with the faces and were affected by their congruence.

Table 1. ERP components sensitive to racial ingroup/outgroup status.

<table>
<thead>
<tr>
<th>ERP component</th>
<th>Typical effect</th>
<th>Typical mean peak latency</th>
<th>Functional significance</th>
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<tbody>
<tr>
<td>N100</td>
<td>Larger in response to racial outgroup members [11,12,14,15]</td>
<td>120 ms</td>
<td>N100 and P200 amplitude generally reflects attentional deployment. In the context of race, the effects suggest early orientation to more novel targets. Effects could be thought of as a form of coarse, rapidly occurring vigilance</td>
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<tr>
<td>P200</td>
<td>Larger in response to racial outgroup members [11,12,14–17]</td>
<td>180 ms</td>
<td>N200 amplitude is also sensitive to attentional deployment.</td>
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<tr>
<td>N200</td>
<td>Larger in response to racial ingroup members [11–18,71]</td>
<td>250 ms</td>
<td>Race effects showing orientation of greater attention to racial ingroup members in this component have been interpreted as reflecting the spontaneous direction of deeper levels of attention to more familiar (ingroup) individuals (following initially greater attention to outgroup members in the N100 and P200). The anterior scalp distribution of the N200 is broadly consistent with the role of the MPFC in making mental state inferences</td>
</tr>
<tr>
<td>P300</td>
<td>Larger in response to targets whose race differs from preceding individuals [11–14,16,17]</td>
<td>540 ms</td>
<td>The P300 has been associated with a broadly distributed network involving the locus-coeruleus norepinephrine system that responds to motivationally significant events. Increased P300 amplitude in response to individuals who differ in race from preceding individuals has been interpreted as reflecting contextual updates along inherently motivationally relevant dimensions</td>
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with the covertly attended flankers. Moreover, the amplitude of an ERP component associated with response conflict was enhanced on stereotype-inconsistent trials, indicating that the presence of stereotype-inconsistent information enhanced response conflict during racial categorization. Consistent with this idea, the lateralized readiness potential showed evidence of competing response activations in the motor cortex on inconsistent (but not consistent) trials. This work underscores the fact that stereotypic beliefs influence even simple perceptual judgments about race, and that the extent to which stereotypes influence these perceptual judgments can be determined by whether neural activation of motor responses is controlled. In the next section, we highlight the importance of conflict and control processes in regulating race-based responding.

**Race perception, evaluation and regulation of intergroup behavior**

In addition to stereotypic beliefs, negative feelings about the group (i.e. prejudice) are often activated following racial categorization. Moreover, these spontaneous evaluations have important implications for behavioral responses. From this perspective, it makes sense to look for links between the neural circuits that are important for evaluation and those that are involved in regulation of intergroup behavior. Considerable evidence points to overlap between these systems, particularly involving the amygdala, anterior cingulate cortex (ACC) and dorsolateral and ventrolateral prefrontal cortex (DLPFC and VLPFC, respectively) [4].

**Amygdala**

Consistent with amygdala involvement in the arousal of negative affect [26], numerous studies have found greater amygdala activity elicited by racial outgroup than by ingroup members [6,27–31]. Moreover, indirectly assessed race bias responses indicating negativity toward Blacks correlate with enhanced amygdala activity to Black than to Caucasian faces [32,33]. These effects were initially interpreted as reflecting the implicit activation of racial outgroup bias.

This pattern typically has occurred when participants are engaged in perceptual encoding of faces or making social category judgments. Such conditions maintain the natural salience of race, leading to the implicit activation of prejudice. However, this activation can be attenuated by factors that direct attention away from race or engage the perceiver’s motivation to control bias. Similarly, the amygdala responds flexibly as a function of current goals [34]. Consistent with these findings, amygdala activation in response to racial group membership is modulated by processing goals. In one study, the tendency toward greater amygdala activity in response to racial outgroup than to ingroup faces was eliminated when participants made either nonsocial judgments or individuation judgments about the individuals [27].

Features of the target individuals can also moderate amygdala activity in response to race. One study found greater amygdala activity in response to Black than to Caucasian faces among Caucasian participants when the targets were gazing at the perceivers, but not when the targets’ eyes were averted or closed [30]. The authors argued that averted or closed eyes signal a low potential for threat, and so attenuate racial differences in amygdala activity. Also, greater amygdala activity in response to racial ingroup than to outgroup faces has been reported, but only with faces displaying fearful expressions [35]. Together, the results indicate that, although amygdala activity is sensitive to more than just outgroup antipathy, it is responsive to evaluative reactions based on race, with the specific nature of those reactions sensitive to a range of contextual features.

**ACC and PFC**

People often attempt to control or override negative race-based reactions, and several contemporary models of race bias emphasize the role of conflict between responses driven by automatic negative evaluations and those reflecting egalitarian goals in determining the extent of bias...
expressed toward outgroup members (e.g. Ref. [36]). Electro
cortical and fMRI research on cognitive control has identified a network involving the ACC (conflict monitor-
ing) and PFC (regulative control) as important for regulat-
ing responses under conditions of conflict [37,38]. Findings
reviewed here converge on the suggestion that the same
mechanisms are engaged to override racially biased
responses.

In a recent study of Caucasian participants reporting
strong motivation to control prejudice [32], greater amyg-
da activity was elicited by Black than by Caucasian faces
only when faces were shown too briefly to be consciously
detected (for 30 ms) (see also Ref. [28]). By contrast, no
racial difference in amygdala activity was observed when
faces were shown for 525 ms. Instead, Black faces pre-
sented for this longer duration elicited greater activity
in the ACC and right VLPFC and DLPFC (Figure 2),
presumably reflecting enhanced control over implicit nega-
tive evaluations. Other studies similarly have found
greater ACC and DLPFC activity when participants need
to override responses based on negative associations with
racial outgroup members [39,40].

ACC involvement in the control of racially stereotypic
responding is further supported by research using the
error-related negativity (ERN), a response-related ERP
component generated in the ACC and thought to reflect
conflict [38] and/or distress related to error commission
[41]. In several studies, mistakenly categorizing a tool as a
gun following a Black face prime elicits larger ERNs than
do similar errors following Caucasian face primes, particu-
larly among participants highly motivated to control prejudice
Black. Black faces are more active in response to Black than to Caucasian faces
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in the ACC and right VLPFC and DLPFC (Figure 2),
substantiating that motivational factors
come together in service of processing
higher-order social construct. Figure 3 presents a
ting race perception. Also included are areas
associated with other aspects of social cognition but as
yet not reported to be sensitive to race, to indicate potential
directions for future research.

Race perception begins with categorization, often based
on physical characteristics of faces. ERP research shows
that extracting race information begins as early as one-
tenth of a second following initial perception of faces, and
fMRI and ERP source localization data indicate that
racial processes identified in these other models interact,
highlighting that theoretically separable aspects of social cog-
nition (e.g. face perception, evaluation and semantic
person knowledge) come together in service of processing
this higher-order social construct. Figure 3 presents a
model of the distributed brain areas identified as being
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Following the quick processing of racial information,
networks associated with three interacting processes
might be activated. The first involves affective evaluation.
To date, differential responses to racial ingroup and
outgroup members have been obtained primarily in the
amygdala. However, areas such as the orbitofrontal cortex
and insula are also involved in evaluative processing
cf. Ref. [4]) and, in some cases, have shown sensitivity
to race [39,45]. Because interracial interactions are so
imbed with evaluation (including the retrieval of
group-based evaluations and valenced-stereotypical
beliefs) it is proposed that activity in a widely distributed
network of brain areas subsuming evaluative processing
is important for race perception.

**A proposed model of race processing and its
implications for social cognition**

The research summarized here underscores the import-
ance of several neural structures in the processing of race
and the regulation of race-related responding. There are
several points of convergence between the areas identified
here and those featured in recent models of the neural
foundations of several social-cognitive phenomena [1,3,4].
Therefore, the study of race perception is intriguing
because it underscores the extent to which the neural
processes identified in these other models interact,
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![Trends in Cognitive Sciences Vol.13 No.12](image-url)

**Figure 2.** Increase in activity in areas of the PFC associated with cognitive control when Caucasian participants view Black as compared to Caucasian faces under conditions that enable more reflective processing. Specifically, areas in the DLPFC (a), the ACC (b) and VLPFC (c) are more active in response to Black than to Caucasian faces presented above the conscious threshold (for 525 ms). This differential activation is not observed when faces are shown below conscious awareness (for 30 ms), which would eliminate the ability to engage more controlled processes. Reproduced, with permission, from Ref. [32].
This demonstrates that race not only carries meaning on its own, but can also serve as a contextual influence that moderates other ongoing processes.

This model also has several implications for considering changes in race relations. ERP research indicating that racial category information is processed in an obligatory manner implies that attempts to get people to not ‘see’ race will be relatively ineffective. Moreover, the model suggests that change occurring at the single level of stereotypical or evaluative associations is unlikely to eliminate racially biased behavior because biased responses could still occur through processes mediated by other parts of the neural network. However, although the model generally supports the benefit of improving race relations through strategies that target both semantic and evaluative associations, to the degree that behavior regulation has modulatory effects on other processes, interventions that seek to improve behavior regulation capabilities might be effective in at least reducing the expression of bias. It also suggests that, although race relations will be affected by psychological factors such as social and cultural context might influence race perception (for a relevant discussion, see Ref.[56]).

**Box 4. Outstanding questions**

- Does race influence activity in other brain areas associated with social cognition that have not yet been widely investigated in the context of race perception, such as the MPFC?
- What are the brain mechanisms associated with the storage and retrieval of racial stereotypes? Researchers have examined mechanisms of stereotype activation and regulation of stereotypic responses, as well as structures involved in semantic memory retrieval, but neural structures and/or networks subserving the activation and application of racial stereotypes specifically have yet to be identified.
- What are the psychological mechanisms that produce the race effects reviewed here? Some studies [10,76] support a role for motivational factors in driving differential neural responses to ingroup targets, but differences could also derive from the context of group stereotypes (e.g., that members of a given group are threatening) or from differential familiarity with members of ingroups and outgroups.
- Most (although not all) studies of race perception have tested the reactions of Caucasian perceivers to Caucasian and Black targets. Only a few studies have investigated reactions from more diverse groups of perceivers to targets representing different racial groups. Consequently, more remains to be learned about how factors such as social and cultural context might influence race perception (for a relevant discussion, see Ref. [56]).

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**Figure 3.** A preliminary model of the distributed brain areas involved in race perception. Current research indicates that racial category membership modulates responses in areas previously associated with face perception (labeled ‘Face encoding’), inferences about the storage and retrieval of person knowledge (‘Person knowledge’), arousal of affect and evaluation (‘Evaluation’) and regulation of behavioral responses (‘Behavior regulation’). This model also includes brain areas for which sensitivity to race has not been widely examined, but is expected based on the involvement of these areas with related aspects of social cognition. These areas are denoted with italics.

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This also contains a network of areas supporting processes broadly associated with the storage and retrieval of person knowledge. Of these areas, only the PCC has been shown to date to differentiate as a function of race, but there are strong reasons to expect other areas also will. The medial prefrontal cortex (MPFC), for instance, has been repeatedly implicated in making inferences about others’ psychological states [1,2]. Although we know of no research directly testing race effects on MPFC activity, MPFC activity increases when making inferences about the mental states of similar compared to dissimilar others [46], suggesting that MPFC activity would increase in response to racial ingroup relative to outgroup members. Given the consistently larger medial-frontal responses to ingroup versus outgroup members in ERP studies, it could be that these findings reflect a similar phenomenon; future research could examine whether this ERP activity is generated by the MPFC. In addition, superior and medial temporal lobe structures have been consistently associated with semantic knowledge representations about people [47], which form the foundation of stereotypes.

Finally, activation of stereotypical beliefs and evaluations concerning race engage brain systems involved in behavioral regulation, especially the ACC, DLPFC and VLPFC, to control race-biased responses. Although these areas are distinguished from those associated with evaluation and knowledge activation in Figure 3, they are likely to operate in conjunction. Indeed, evidence indicates that the ACC serves an evaluative function [38,41] and that areas implicated in semantic person knowledge closely interact with those supporting cognitive control (see Ref. [48]).

The results reviewed here support both a bottom-up sensitivity to race cues as well as top-down modulation of other social cognitive processes by race. The former is illustrated most clearly by the quickly occurring and so far unmalleable sensitivity to race seen in ERP responses [14]. The latter can be seen in modulation of amygdala sensitivity to fearful faces depending on target race [35]. This demonstrates that race not only carries meaning on its own, but can also serve as a contextual influence that moderates other ongoing processes.
race-specific beliefs and feelings, the expression of bias will also be determined by an individual’s general regulatory abilities. In sum, race is a multifaceted social variable through which processes such as categorization, knowledge activation and motivation interact in complex yet subtle ways. This review highlights progress made in understanding the neural basis of race perception. Although this research is still relatively new, there are sufficient converging findings to support the model in Figure 3, providing a foundation from which future research on this important construct can be launched (Box 4).

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