

Neural Basis of Prejudice and Prejudice Reduction

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ABSTRACT

Social prejudices, based on race, ethnicity, gender, or other identities, pervade how we perceive, think about, and act toward others. Research on the neural basis of prejudice seeks to illuminate its effects by investigating the neurocognitive processes through which prejudice is formed, represented in the mind, expressed in behavior, and potentially reduced. In this article, we review current knowledge about the social neuroscience of prejudice regarding its influence on rapid social perception, representation in memory, emotional expression and relation to empathy, and regulation, and we discuss implications of this work for prejudice reduction interventions.

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In psychological research, prejudice is an individual-level attitude toward a group and its members that creates or maintains hierarchical status relations between groups (1). Together with stereotypes, which are culture-specific attributes associated with a group and its members, prejudice guides social judgments and actions that contribute to discrimination (2), both explicitly and implicitly (3).

Research on the neural basis of prejudice seeks to illuminate the mechanisms through which prejudice is formed, represented in the mind, expressed in behavior, and reduced (4–7). Here we describe what neuroscience has taught us so far about the neural basis of prejudice and its implications for cognition and behavior. We begin by describing how race and group membership influence social perception and how intergroup bias, a term encompassing prejudice and stereotypes, is represented in neural systems of learning and memory. We then discuss implications for how it may be regulated and reduced.

Like most social processes, prejudices and stereotypes operate in particular sociocultural contexts, and the nature of prejudice on one dimension, such as ethnicity, often differs from that on other dimensions, such as gender or sexuality. Therefore, a consideration of context is essential. Most research on the social neuroscience of prejudice has been conducted in the United States with a focus on White participants' responses to Black compared with White individuals, and while some findings may generalize across contexts, others may not.

PREJUDICE AFFECTS THE EARLIEST STAGES OF PERCEPTION

Social identity is detected rapidly in the brain: Neural processing of a person's group membership, based on race, ethnicity, gender, or even arbitrary social categories, begins immediately upon viewing their face (5,8). Research using event-related potentials (ERPs)—patterns of electroencephalographic (EEG) activity linked to a stimulus (e.g., face) or action—reveals a series of processes that unfold over a few

hundred milliseconds to encode a person's identity (9) (Figure 1). In this section, we describe the neural processes of group-based categorization and perception and how they may contribute to prejudice.

Bottom-up Attention to Race

A person's race can be detected within ~100 ms after viewing their face. In an ERP study of social categorization, Ito and Urland (10) recorded White American participants' EEG signals while they viewed pictures of White and Black male and female faces (shown in grayscale and equated for luminance). Regardless of whether participants were instructed to classify faces by gender or race, ERP measures revealed larger responses to outgroup Black than ingroup White faces in the N100 (or N1), an ERP component observed over occipitoparietal regions which reflects early orienting and bottom-up attention processing (11). Functional magnetic resonance imaging (fMRI) studies corroborate this bottom-up interpretation, such that race can be decoded from patterns of activity in early visual cortex in the occipital lobe as participants view Black and White faces (12,13).

Goal-Directed Early Attention to Race

Goal-directed, top-down processing of social identity occurs ~180 to 200 ms following face presentation, as indicated by the P200 (or P2) ERP component (14,15). In studies of race classification, the P200 is typically larger in response to Black than White faces among White participants (10,14,16–18) as well as Black participants (15), a pattern that, during race classification tasks in White-dominant American academic contexts, may reflect participants' vigilance to minority race cues (14,19).

Race-Based Conflict and Classification

Depending on the task, early attentional activations may be followed by the N200 (or N2; ~260 ms), which is associated

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with conflict processing and response selection and generated in the dorsal anterior cingulate cortex (dACC) (20). In American participants, N200 responses are larger to White or Black faces depending on the task (21–23) and are associated with increased control of bias (16). Classification behaviors are often accompanied by the P300 (or P3; ~450–600 ms), reflecting the rapid evaluation of one's race-related response (5,24).

Neural Categorization of Intersectional Identities

People typically belong to multiple social categories (e.g., race/ethnicity, gender, nationality, occupation) (25), and fMRI research on perceiving intersectional identities reveals interacting top-down and bottom-up processes (26). This work shows that as a face is perceived, preexisting representations of social categories in the anterior temporal lobe (ATL) and orbital frontal cortex converge in the fusiform cortex with bottom-up visual inputs through a rapid iterative process to shape the perception of social category (27).

Race Effects on Face Encoding

Race also influences the initial visual encoding of an individual's face. In an fMRI study of face recognition, ingroup faces recruited greater fusiform cortex activity than outgroup faces, which in turn related to better memory for ingroup faces (28). ERP studies reveal that this effect occurs ~170 ms following face onset, indicated by the N170 component, a negative-polarity signal at temporal-occipital sites with neural sources in the fusiform and inferior occipital cortices (29). Studies of the effect of race on the N170 isolate social causes of perceptual bias by controlling for lower-level effects, such as by equating different-race images for luminance and contrast (30,31) and presenting images at consistent fixations. By doing so, one may infer that race effects on the N170 reflect the influence of social goals on attention and visual encoding.

Although early reports of race effects on the N170 were mixed (32–37), these effects are now understood to depend on a perceiver's task goals and social motivations (38,39). When race is relevant to one's goal, configural processing of goal-relevant group members is enhanced. For example, in contexts in which outgroup faces pose a threat and are thus more relevant, the N170 to outgroup faces is larger (30,31); in cases where ingroup faces are more relevant, the N170 to ingroup faces is larger (38). When identity is not relevant, group effects are not observed.

Multiple social factors can influence the effect of race on configural face encoding, such as categorization goals (32), social power (31), economic scarcity (40), implicit prejudice (41), intergroup anxiety (30), perceiver race (42), group identity (43), and intergroup contact (34). Although most of these findings were observed in the American context, similar patterns have been found in Canadian, Chilean, Chinese, Israeli, Japanese, Korean, and Swiss contexts [e.g., (37,44)]. Increased configural processing, as indicated by the N170 or fMRI measures of fusiform cortex activity, has also been observed for ingroup members of novel and arbitrary groups (38,45), university ingroup members (46), and sex-typical faces relative to sex-atypical faces (47), and an fMRI study using multivoxel pattern analysis found that face-specific activity in

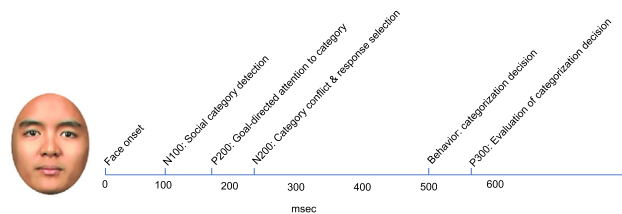


Figure 1. Event-related potentials component responses to a face and their putative functions in race categorization tasks, showing the typical timing and interpretation of each component, as well as the timing of a typical behavioral categorization response.

the fusiform cortex could distinguish between ingroup faces but not outgroup faces (48). Collectively, these findings demonstrate an effect of social identity on the earliest stages of face processing.

What are the implications of race effects on face perception? The impaired configural encoding of racial minority faces has been proposed as a very literal form of dehumanization (49), dubbed perceptual dehumanization (50). In research on how economic factors influence perception of racial minority individuals (40), White American participants' brain activity was recorded while they viewed faces of Black and White individuals, believed to be other study participants. Participants made money allocations to individuals in a condition of either perceived scarcity or a control condition. Face images were equated for luminance and contrast. Using EEG, an initial study revealed a delay in the N170 to Black compared with White faces in the scarcity condition, but no difference in the control condition—a pattern suggesting a selective impairment of Black face encoding under scarcity. A second study, using fMRI, showed a reduction in face-selective fusiform cortex activity, based on a functional localizer, to Black compared with White faces under scarcity, but no difference in the control condition (Figure 2), replicating the pattern observed with EEG. In both studies, the race effect on face encoding predicted the extent to which participants allocated less money to Black than White faces, consistent with the idea that perceptual dehumanization may be engaged strategically, and perhaps implicitly, to facilitate discriminatory actions.

Collectively, research on intergroup categorization and perception reveals that social identities such as race, ethnicity, and gender are detected extremely quickly, likely prior to conscious processing. Moreover, it demonstrates the sheer pervasiveness of prejudice—its effects begin the moment we encounter a group member—and the challenges of responding without it.

DIFFERENT FORMS OF PREJUDICE ARE ROOTED IN MULTIPLE MEMORY SYSTEMS

Prejudiced attitudes are traditionally thought to include affective, cognitive, and conative components (1,51). Social neuroscience research suggests that these components correspond to distinct underlying neurocognitive systems for learning and memory, including Pavlovian, semantic, and instrumental processes (Figure 3) (4,52). A consideration of these memory systems, as well as their interplay and behavioral expressions, has advanced our understanding of how

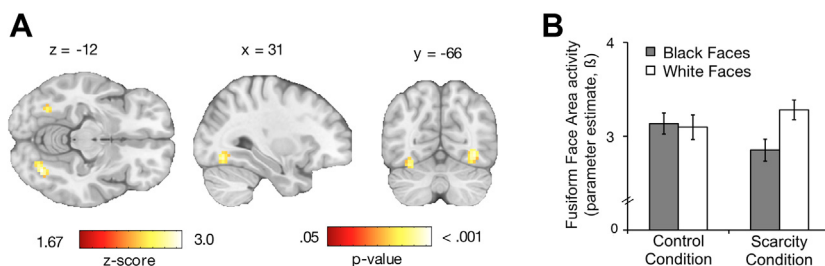


Figure 2. Face-selective activity in the fusiform cortex (A) was reduced among White participants when they viewed faces of Black relative to White recipients in a money sharing game under conditions of scarcity (B) (40).

prejudice is learned, represented, and expressed in both implicit and explicit responses.

Pavlovian Aversive Conditioning: An Affective Form of Prejudice

Early social neuroscience studies proposed that implicit prejudice is represented by Pavlovian aversive conditioning and amygdala function (53,54). Indeed, prejudice is often imbued with emotions such as fear, anger, and disgust, but at its root is threat (55–57), a response associated with aversive conditioning and the amygdala (58,59). Located bilaterally in the temporal cortices, the amygdala receives direct or nearly direct input from all sensory structures and, via central nucleus

activity and cascading noradrenergic effects in the brain and hypothalamic-pituitary-adrenergic axis, initiates a rapid defensive response to a perceived threat (60). These characteristics correspond to multiple aspects of implicit prejudice in intergroup situations, including heightened autonomic arousal and anxiety (61,62), increased vigilance and attention to group-based threat cues (e.g., race cues) (30,63,64), behavior perceived as awkward or unfriendly (65–68), social distancing from a racial outgroup member (69–71), and impaired cognitive control (61,72,73). Consistent with an amygdala substrate of affective prejudice, research using Pavlovian aversive conditioning tasks suggests that, for White participants, threat associations are facilitated for Black faces compared with White

Neural bases of prejudice and prejudice reduction, relevant functions, and intergroup group correlates

Neural bases of prejudice				
	Neural structure	Relevant functions	Intergroup correlates	Selected references
	Fusiform gyrus	Configural face encoding	Group-biased face processing, perceptual dehumanization	28, 39, 30, 40, 41, 48
	Amygdala	Pavlovian aversive conditioning, threat processing, defensive response	Implicit affective bias, avoidance, social distance, awkward/unfriendly nonverbals	54, 74, 79
	Anterior temporal lobe	Semantic memory, representation of social concept knowledge	Conceptual associations of stereotype content and valence	13, 84
	Striatum	Instrumental learning, reward value, habit	Choice behavior, implicit choice preferences	93, 102
	Insula	Representation of body states, visceral negative affect (e.g., disgust)	Negative intergroup affect, intergroup empathy	124, 125
Neural bases of prejudice reduction				
	Anterior cingulate cortex	Response evaluation, conflict monitoring, empathy	Detection of group-biased tendency, intergroup empathy	124, 125, 23, 134
	Lateral prefrontal cortex	Response selection, cognitive control	Implementation of intended (e.g., unbiased) response	14, 135, 139
	Medial prefrontal cortex	Mentalizing, impression formation	Prosocial engagement, perspective taking	89, 90, 113

Figure 3. Neural structures associated with prejudice and prejudice reduction, their psychological functions, and their intergroup effects.

faces (74) and are more resistant to reversal (75). For White participants, Black faces also conveyed stronger aversive signals than White faces during reinforcement learning (76).

It is notable that fMRI evidence for the amygdala's role in prejudice is mixed, a pattern that is possibly due to the use of small samples and inchoate methods in early reports (4). Research conducted more recently, in the context of current methodological and statistical practices, has not found consistent support for an amygdala response to race or its correlation with implicit prejudice measures (77). Instead, this more recent work suggests that the amygdala response to outgroup members depends on social contexts and perceiver goals, consistent with broader functions of the amygdala (78), and thus supports complex adaptive responses to intergroup threat (77,79,80).

Evaluative Associations and Stereotypes in Semantic Memory

Conceptual knowledge about people and groups (e.g., character judgments, stereotypes) is represented in cortical structures that support semantic memory, including the temporal lobes and inferior frontal regions (81). Converging evidence from research using multiple methods (e.g., EEG, fMRI, transcranial magnetic stimulation) suggests that social concepts, such as knowledge about groups and individuals, are represented in the ATL (82). In studies of intergroup bias, ATL activity has been associated with group-based evaluations (i.e., associations with positive- or negative-valence concepts) and stereotypes that refer to specific trait concepts (e.g., uneducated, athletic, criminal) (13,83–86). The ATL also supports the formation of group-based evaluations through repeated exposure to positive or negative group descriptions (84).

These findings bolster and refine the longstanding idea that cognitive forms of intergroup bias, which include evaluative beliefs and stereotype content, are distinguishable from affective forms of bias (e.g., a threat response associated with the amygdala) (53,87). They further suggest that behavioral assessments of implicit prejudice, typically measured in terms of reaction time to classify evaluative words, represent semantic rather than affective processes.

Although stereotypes and evaluative associations are both represented as concepts in semantic memory, they serve different functions and may be expressed through different neurocognitive pathways. For example, stereotype-based judgments have been linked to activation in the medial prefrontal cortex (PFC) (13,88), which is involved in impression formation and mentalizing (89,90), whereas group-based evaluative judgments have been linked to activity in the orbitofrontal cortex (13), a region involved in choice preferences (91).

Instrumental Learning: Prejudice in Behavior and Social Interaction

Relatively little research in social psychology has examined the conative component of prejudice, in part because the field has lacked a theoretical model of how attitudes may be formed and represented via action. However, recent work has proposed that this behavioral component of prejudice corresponds to an instrumental learning mechanism (92,93).

Instrumental learning concerns the formation of reward-based associations through action and feedback. In contrast to Pavlovian or semantic learning, instrumental learning is expressed most directly in choice preferences and approach/avoidance actions.

Research on the instrumental learning of social attitudes has leveraged contemporary paradigms of reinforcement learning and computational modeling (94,95). These studies reveal that people incrementally update their attitudes about individuals (96) and groups (93,97) through choice and feedback in a manner predicted by reinforcement models (98). Consistent with reinforcement learning in nonsocial contexts (99), the updating of reward associations with individuals (i.e., prediction error) has been associated with activity in the ventral striatum, and reward-based social decisions are represented in the ventral PFC (100–102). Similar activations have been observed in studies of intergroup bias in economic decisions, suggesting a basis in instrumental processes (103), and behavioral studies have shown, via instrumental learning, that group-level prejudice can form through interactions with group members (93).

An implication of intergroup instrumental learning is that it may transform into a habit, an automatic response that forms when a previously-rewarded action persists in the absence of reward (104,105). Automatic expressions of prejudice have long been likened to a habit (106,107), and social neuroscience research has refined this idea to refer more specifically to the expression of bias in actions. Consistent with this prediction, Hackel *et al.* (93) found that reward-based choice preferences for social groups persisted, in a habit-like manner, when such choices were no longer rewarded.

Interactive Memory System Effects

Although memory systems support different modes of learning, representation, and expression, they typically operate in concert to support complex social and behavioral processes (52,108). That is, during experiences with outgroup members, people may form attitudes and stereotypes through multiple processes simultaneously. In other cases, existing representations in one memory system may shape learning in another system, such as when stereotypes (in semantic memory) modulate the encoding of a group member's reward feedback in instrumental learning [e.g., (109)].

Interactive memory systems may also contribute to more complex expressions of prejudice, for example, when threat or instrumental responses are contextualized by stereotypes and integrated with current goals in the PFC [e.g., (101)]. For example, an initial affective response could be modified by a group's stereotype to produce a specific emotion, such as disgust, anger, contempt, or pity, and to guide goal-consistent responses, such as avoidance (following disgust) or harm (following contempt) (56).

Implications for Implicit and Explicit Prejudice

Implicit prejudice is widely documented in behavioral research, yet its psychological basis and means of expression remain poorly understood. Moreover, the term "implicit" itself is often unclear—does this mean it is unconscious? Unintentional? Both? By linking aspects of prejudice to different underlying systems of learning and memory, neuroscience research may

help to illuminate the nature of implicit bias (92) and elucidate function beyond a focus on awareness (110).

A memory systems approach reveals that implicit expressions of bias in behavior may reflect more than one underlying process. Pavlovian threat-based associations can be activated rapidly, likely without awareness or intention, experienced as affect, and influence nonverbal behaviors in ways that are consistent with several behavioral studies of implicit bias in social interactions [e.g., (65)]. But because Pavlovian learning does not encode concepts, it is unlikely to drive responses on word-classification-based implicit measures, such as the implicit-association test. In contrast, responses on such tasks reflect associations with conceptual valence in semantic memory or in the case of implicit stereotyping, with stereotype concepts. Although these semantic associations with social groups may be activated automatically and influence decisions that are difficult to control, the extent to which they operate without awareness is still being debated (111).

Recent work on instrumental learning and habit in the context of social cognition has revealed yet another kind of implicit bias. Past neurological studies have shown that striatal-dependent instrumental learning can form without explicit knowledge of this learning (e.g., in people with amnesia) (112). Similarly, healthy participants can form and express instrumental associations with group members independent of their explicit attitudes (93).

Together, neuroscience research on prejudice reveals that implicit prejudice is not one thing; it could reflect one or more distinct forms of learning. Furthermore, as we described in this section, a consideration of these different underlying mechanisms can clarify how and under what conditions implicit prejudice is expressed.

NEURAL BASIS OF INTERGROUP COGNITION, EMPATHY, AND PROSOCIAL BEHAVIOR

The tendency to mentalize (i.e., infer another's perspective) and empathize more strongly with ingroup members is reflected in patterns of neural activity while people view and think about ingroup or outgroup members. According to a meta-analysis of fMRI studies (113), viewing ingroup members elicits greater medial PFC activity, a correlate of mentalizing and trait inference (89,90), relative to viewing outgroup members, whereas viewing outgroup members elicits greater activity in the insula [e.g., (114,115)], a region linked to disgust and visceral discomfort (116). This pattern, suggesting reduced mentalizing and increased disgust toward outgroups, has been noted to correspond with cognitive and emotional components of dehumanization, respectively (115).

In studies of intergroup pain perception, empathy toward another is characterized by increased attention to the pain recipient and to one's own experience of physical discomfort. Findings from fMRI studies on pain perception suggest a pattern of ingroup empathy involving greater activity in the ACC and the anterior insula toward ingroup compared with outgroup members in pain, and this pattern has been related to participants' reported empathic concern (117–119). Research using transcranial magnetic stimulation observed increased sensorimotor resonance when perceiving racial ingroup versus outgroup members in pain, as indexed by perceivers' lower

corticospinal excitability (120), suggesting another neural expression of ingroup empathy. By contrast, *schadenfreude*, or feeling pleasure at another's misfortune, is greater toward outgroup members and is related to activity in the ventral striatum, a region linked broadly to reward processing (121–123).

The neural activation patterns underlying ingroup mentalizing and empathy offer insight into their effects on judgment, choice, and action; for example, when a person is lacking in empathy, reduced ACC and anterior insula activations may help to explain the lack of awareness about another's plight and reluctance to help (117). These findings also help to explain the neural and psychological processes through which interventions increase empathy (124,125), such as through perspective taking (126) and cross-group identity (127).

REGULATION OF PREJUDICE: NEURAL MECHANISMS OF COGNITIVE CONTROL

Because prejudices and stereotypes can be activated automatically, self-regulation is often needed to respond without bias (106). Neuroscience models of cognitive control suggest that this involves two processes: an evaluative (or monitoring) process, supported by the dACC, which detects conflict between a biased tendency and one's response goal, and a regulative process, supported by the lateral PFC, which implements an intended response (128–130). The regulative process may involve inhibiting the unwanted response, associated with the right inferior frontal gyrus (131), or selecting an intended response, supported by the left dorsolateral PFC (132). Both processes are involved in the regulation of prejudice (79).

Using an ERP approach, Amodio *et al.* (23) demonstrated the dACC's role in rapidly detecting the influence of implicit bias on behavior and demonstrated that this detection process is distinct from the implementation of control. Subsequent work showed that failures to control bias among low-prejudice individuals could be explained by impaired ACC detection as opposed to a lack of motivation (133), suggesting the utility of vigilance-enhancing interventions for such individuals. Other research revealed that bias detection can rely either on internal (personal) cues in the dACC or on external (social) cues in the medial PFC (134) such that both personal and norm-based interventions may enhance the detection of bias.

Regulative control of prejudice has been associated with activity in the left dorsolateral PFC. In EEG studies, greater left PFC activity has been associated with the control of prejudice in both rapid (14) and deliberative (135) responses. Activity in control-related regions has also been observed in several fMRI studies of race perception that did not require control *per se*, suggesting that prejudice control efforts may be activated spontaneously in response to racial cues (136–139). Together, these findings have clarified the process of prejudice control, helped to explain how it fails, and elucidated the kinds of interventions needed to promote it.

IMPLICATIONS FOR PREJUDICE REDUCTION

Neuroscience research has informed prejudice reduction approaches by identifying which kinds of interventions should work better than others. For example, a major takeaway from this work is that prejudice effects on perception and judgment are pervasive, often automatic, and difficult to detect or

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control. Moreover, prejudiced learning is difficult to update because some associations are extremely persistent (e.g., Pavlovian conditioning) and slow to change (e.g., instrumental learning) and because being exposed to biased information in society constantly reinforces prejudice. According to these observations, interventions that rely on the individual to limit or control their bias should be least effective.

Instead, the most effective intervention is one that prevents the activation or expression of bias in the first place with preventive organizational or procedural controls (3). One effective organizational intervention is decision blinding, such as the use of blinded auditions for positions in symphony orchestras in which auditioners perform behind a curtain concealing their identity. This intervention prevents identity cues from being detected in the first place, a practice that dramatically reduced gender disparities in orchestras (140). When identity cues cannot be removed, procedural controls in which clear and concrete decision criteria or interaction scripts are provided and followed can promote fairness by limiting the impact of subjectivity and bias.

When one must rely on the individual to respond without prejudice, interventions that promote successful control may be most effective (141). This work shows that successful control involves both the detection of bias and the implementation of an intended (i.e., fair) response, and thus interventions are most effective when they pair enhanced vigilance for bias with a clear action plan that can be implemented when the cue is encountered (142,143). Furthermore, interventions that enhance empathy, perspective taking, and shared group identities may promote prosocial responses (e.g., helping behavior, empathic concern) and help blur the social boundaries that scaffold intergroup bias (144).

In addition to approaches suggested by the adult literature that have been described here, research on the developmental trajectories of neural substrates of learning and decision making (145), theory of mind (146), and cognitive control (147) may offer clues to how prejudice is formed and expressed across the life span and when certain interventions may be most effective.

LIMITATIONS AND FUTURE DIRECTIONS: CONNECTING INDIVIDUAL-LEVEL BIAS TO SYSTEMIC EFFECTS

A limitation of neuroscience research on prejudice is its near-exclusive focus on individual-level prejudice despite the multilevel nature of social biases such as racism (148,149). Indeed, individual minds are indelibly shaped by the systems in which they operate; therefore, a theory of prejudice focused only on the individual is incomplete.

Social neuroscience has begun to address this issue by examining the effects of large-scale societal factors, such as perceptions of the economy (40) and socioeconomic disparities (150) on individual-level neural functions. Additionally, neural models (e.g., the memory systems model) suggest new hypotheses for how system-level effects, such as cultural stereotypes and societal disparities, can be learned and internalized as individual-level prejudices (109).

Finally, given the concentration of social neuroscience research on prejudice in the United States, findings from this

literature come mainly from White college populations, and most studies have examined White participants' responses to Black people. The lack of diversity on multiple dimensions, including research teams, study participants, and the targets of bias, limits both its generalizability and its ability to fully explain and address prejudice in society.

CONCLUSIONS

Neuroscience research on prejudice has illuminated the neural and cognitive processes that underlie commonly observed forms of prejudice and stereotyping. By advancing basic theories of prejudice, it offers refined predictions about how prejudice is expressed in behavior and new insights into prejudice reduction interventions.

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