The Neural Basis of Ideological Differences in Race Categorization

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Multiracial individuals are often categorized as members of their "socially subordinate" racial group—a form of social discrimination termed hypodescent—with political conservatives more likely than liberals to show this bias. Although hypodescent has been linked to racial hierarchy preservation motives, it remains unclear *how* political ideology influences categorization: Do conservatives and liberals see, feel, or think about mixed-race faces differently? Do they differ in sensitivity to Black prototypicality (i.e., skin tone darkness and Afrocentric features) or racial ambiguity (i.e., categorization difficulty) of Black/White mixed-race faces? To help answer these questions, we collected a politically diverse sample of White participants and had them categorize mixed-race faces as Black or White during functional neuroimaging. We found that conservatism was related to greater anterior insula activity to racially ambiguous faces, and this pattern of brain activation mediated conservatives' use of hypodescent. This demonstrates that conservatives' greater sensitivity to racial ambiguity (rather than Black prototypicality) gives rise to greater categorization of mixed-race individuals into the socially subordinate group and tentatively suggests that conservatives may differ from liberals in their affective reactions to mixed-race faces. Implications for the study of race categorization and political psychology are discussed.

Keywords: Race categorization, hypodescent, political ideology, neuroimaging, anterior insula, ambiguity

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Introduction

Individuals of mixed-race heritage are often categorized as members of their "socially subordinate" racial group—a form of bias termed *hypodescent*. Throughout history, hypodescent has been employed to bolster the social and economic status of White Americans and subjugate minorities (e.g., through the notorious "one drop rule" in the U.S.) and continues to enhance vulnerability to discrimination and exacerbate existing racial inequalities [1,2]. White Americans' use of hypodescent is often motivated by a desire to preserve the status quo racial hierarchy with Whites on top (e.g., [3–5]), and political conservatives tend to engage in hypodescendant categorization more strongly than liberals [6]. Although recent work has identified an ideological asymmetry in the use of hypodescent, it remains unclear whether conservatives and liberals actually see, feel, or think about mixed-race individuals differently—and how these processes give rise to downstream categorization biases.

Consistent with the theme of this issue, we adopt a *political neuroscience* approach (e.g., [7,8]) to examine the neurocognitive processes underlying hypodescent. Traditional behavioral methods cannot fully disentangle how and why conservatives categorize multiracial individuals as members of their most subordinate racial group. For example, mixed-race faces[1] vary on at least two critical dimensions: Do conservatives and liberals differ in their sensitivity to the racial *content* or racial *ambiguity* of such faces*?* And does ideology primarily operate on race categorization through perceptual, affective, or cognitive processes? Such questions are difficult to separate in behavioral investigations but might be critical to understanding the link between ideology and hypodescent. To overcome these limitations, we used functional neuroimaging (fMRI) and examined the role of neural mediators of political ideology and the categorization of Black/White mixed-race faces as Black (i.e., according to hypodescent).

Individuals of Black and White mixed-race heritage tend to differ from mono-race faces (e.g., Black *or* White) on two dimensions that might trigger different responses from conservatives and liberals: *Black prototypicality* (i.e., skin tone darkness and Afrocentric features) and racial *ambiguity* (i.e., categorization difficulty). One possibility is that conservatives might be more sensitive than liberals to the Black prototypicality of a face—or any perceived

[1] We use the terms "mixed-race" and "mono-race" to refer to individuals with parents of different or the same races, respectively, while acknowledging that the racial categories that parents and offspring belong to are socially constructed and that mixed-race individuals are not always racially ambiguous, difficult to categorize, or seen as mixed-race.

deviation from the White majority prototype—and this could drive their greater categorization of mixed Black/White faces as Black. Indeed, people with conservative ideologies typically display greater implicit and explicit negative attitudes and affect toward Black Americans than their more liberal counterparts [9–13] and the extent to which people evaluate Black people more negatively predicts categorization of mixed-race faces as Black [14,15]. By this account, conservatives' stronger tendency to categorize mixed-race faces as Black (compared to liberals) could be explained by sensitivity to increases in the Black prototypicality of mixed-race faces, and the desire to maintain a strict boundary around definitions of Whiteness.

Another possibility is that conservatives might categorize mixed-race faces as Black because of a greater sensitivity to racial ambiguity. While conservatives show stronger aversion to general ambiguity than liberals [16], *racial* ambiguity might be particularly aversive to conservatives. Conservatives tend to be more sensitive to racial hierarchy challenges [17], and racial ambiguity can be seen as visual evidence of the threat that racial "mixing" poses to the status quo racial hierarchy with Whites on top [18–21]. Indeed, a growing body of research implicates hierarchy-stabilizing (or system-justifying) motives in ideology-based categorization of mixed-race individuals as Black [3–6]. Thus, conservatives might be especially sensitive to individuals they have trouble categorizing as Black or White (regardless of individuals' Black prototypicality). By this account, conservatives' stronger tendency to categorize mixed-race faces as Black might be explained by sensitivity to the ambiguity of mixed-race faces. Rather than reflecting anti-Black prejudice per se, conservatives' greater use of hypodescent might reflect a reaction—and perhaps an aversion—to racial mixing more generally.

Prior research revealed a significant effect of political ideology on categorization of racially ambiguous faces [6]. Participants self-reported their political ideology and performed a race categorization task in which they saw a series of faces, ranging from 100% Black to 100% at varying degrees of ambiguity, and simply indicated whether they thought the face was Black or White. As expected, self-identified conservatism (vs. liberalism) was consistently associated with a stronger tendency to categorize mixed Black and White faces as Black (i.e., according to hypodescent). This relationship was (partially) explained by participants' opposition to equality. However, the potentially separable effects of face Black prototypicality and visual ambiguity on categorization were impossible to disentangle using a behavioral task alone in these studies. This led us to conduct the current research designed to disentangle these processes.

Of primary interest was a specific neural region—the insula—because of its relevance in independent investigations of ideology, race, and ambiguity. Tucked deep in the lateral sulcus,

the insula plays a key role in emotional processing, with posterior regions linked to interoception and anterior regions linked to emotional experience and the integration of affective information into cognitive re-representation [22–24]. Based on a large body of previous research, we reasoned that the insula might be associated with political ideology and hypodescent.

Political ideology has been associated anatomically with individual differences in insula gray matter volume [25,26] and functionally to insula activity in response to political outgroup members [27], information about ingroup politicians [28], reactions to disgusting images [29], and risky decisions [30]. Furthermore, the anterior insula has been implicated in the learning of political allyship [31,32] and White decision makers exhibit stronger insula activity when processing Black (vs. White) faces [33–36].

To our knowledge, no neuroimaging studies of Black prototypicality have implicated the insula, but these previous studies (e.g., [36,37]) utilized face stimuli of mono-racial individuals who were unambiguously categorized as Black or White. In the current research, we sought to examine insula activity in response to racial ambiguity using artificially morphed mixed-race faces that were of maximal ambiguity and therefore difficult to categorize based on race. Outside the race domain, the anterior insula is commonly associated with processing of ambiguity (for review see [10]), is shown to underpin uncertainty in political evaluations [38], and individuals with higher intolerance of uncertainty (a trait frequently associated with political conservatism [39]) have the greatest bilateral anterior insula activation in affectively ambiguous tasks [40].

Together, these three streams of research findings make the anterior insula a prime region of interest for our investigation of the influence of ideology on the racial categorization of mixed-race ambiguous faces. We additionally conducted whole-brain analyses to examine whether ideology is also related to activity in neural regions tied to face perception (e.g., OFA, FFA) and social cognition (e.g., STS, mPFC, rTPJ) when processing mixed-race faces. Examination of these regions could help us to begin to determine if the relationship between political ideology and racial categorization is related to social perceptual, affective, and/or cognitive processes. In doing so, we aimed to help clarify the neurocognitive processes underlying hypodescent.

Current Research

In the present research, we presented an ideologically diverse group of White individuals with faces that ranged from 100% White to 100% Black (at 10% increments) and examined their categorization decisions while undergoing neuroimaging. This allowed us to independently model changes in brain activity as a function of the Black prototypicality and ambiguity of face stimuli. We then examined how these separable neural responses varied for liberals and conservatives in regions related to perceptual, affective, and cognitive processes to discover how neural sensitivity mediates the effect of ideology on racial categorization.

Materials and Methods

(a) Participants

Forty-six self-identified White undergraduate psychology students at New York University participated in exchange for course credit. Our sample size was determined as the number of scanning participants we were able to run in a single semester. Participants were recruited from across the full political spectrum by oversampling conservatives. Political ideology was assessed in a mass-testing session several weeks prior to the neuroimaging session; based on these responses, we invited an ideologically heterogeneous sample of respondents to participate in the neuroimaging session. Participants were pre-screened such that none reported a history of neurological problems, and all had normal or corrected-to-normal vision, were right-handed, and were native English speakers. One participant was excluded from analysis because the imaging data could not be recovered from the servers, and four others were excluded because they failed to identify 100% White faces as "White" or 100% Black faces as "Black." Following these exclusions, our final sample for analysis included 41 participants (M_{Age} = 19.15, SD = 1.20; 24 identified as female, 17 as male). We report how we determined our sample size and all data exclusions, manipulations, and measures in the study. Summary data, analysis code, and materials are available at: https://osf.io/a4jtd.

(b) Procedure

Participants self-reported their political ideology on an 11-point scale ranging from "extremely liberal" to "extremely conservative" in a mass-testing session at the beginning of the semester. Because of the liberal skew of the university population, we oversampled politically conservative and moderate participants to ensure ideological heterogeneity. The mean level of ideology was therefore moderate in our study *(M* = 5.34; *SD* = 2.60). The experimenter was blind to participants' ideology and participants were not aware they were selected based on their

ideology. This helped ensure that the experimenter would not express any behaviors that could influence participants' responses.

Before entering the scanner, participants provided informed consent in accordance with the university committee on activities involving human subjects and completed a metal screening checklist. Participants were informed they would see a series of faces, and that although some faces were of mixed-race heritage, they should use the racial label (Black or White) they felt most closely reflected the person's race. Once in the scanner, participants viewed faces in a randomized, sequential order and categorized each face as "Black" or "White" using their index and middle fingers (see Figure 1A). Race/finger assignment was counterbalanced across participants to control for handedness, which did not influence results and is therefore excluded from analysis. Upon exiting the scanner, participants completed demographic and individual difference measures,[2] were debriefed, thanked, and assigned course credit.

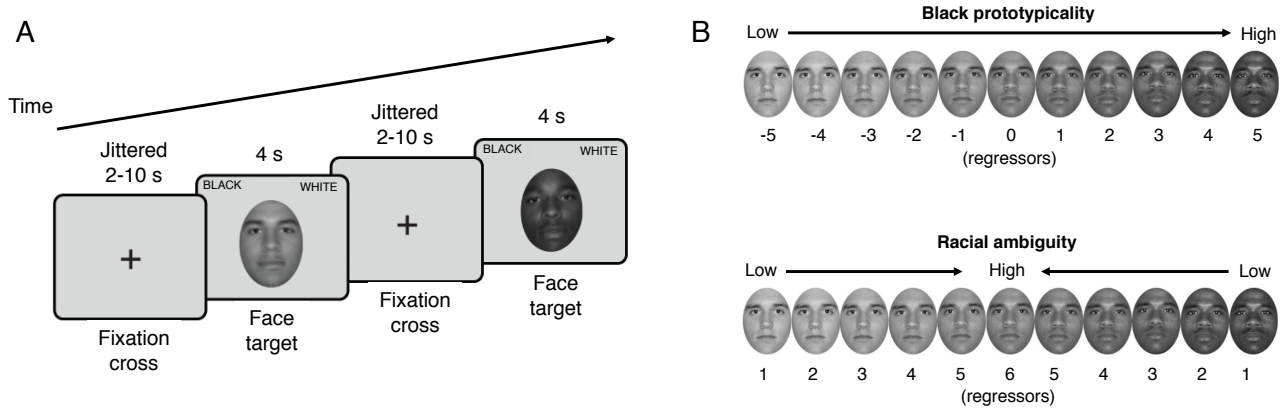

Figure 1. Schematic of the experimental task and sample stimuli. (A) On each trial, a fixation cross appeared for a jittered time period between 2 and 10 seconds, followed by a face, which appeared on the screen for 4 seconds, during which time participants registered their categorization of the face as "Black" or "White." (B) Sample continuum of faces morphed from a White to Black "parent" face, at 10% increments. Parametric regressor weights associated with increasing Black "parent" face content (i.e., Black prototypicality; top) and increasing racial ambiguity (bottom). A single face from each continuum was used on each trial.

[2] Participants also underwent structural scanning and performed a mind perception task as part of two unrelated studies [26] that also assessed participants' ethnic heritage and identity, system justification, voting behaviors, right-wing authoritarianism, need for structure and closure, resistance to change, BIG-5 personality, disgust sensitivity, and religiosity. These measures were not analyzed for this paper.

(c) Stimuli

To create each stimulus face, we combined two unique "parent" faces from a large subset of faces from the Eberhardt Laboratory Face Database and varied the degree to which each parent face was represented using morphing software (Morph Age Express 4.1, Creaceed Software, 2011). Selected faces were of individuals identified as male and as either Black or White with neutral expressions, and they were matched for facial structure and facial hair. We presented male faces because previous research has observed that the effects of hypodescent are more readily observed with respect to male than female faces [41]. Eight face images were created for each of 11 subcategories that ranged from "100% Black" (i.e., containing no White "parent" face content) to "100% White" (i.e., containing no Black "parent" face content) at 10% increments (i.e., containing some Black and some White parent face content). Faces were presented once in an upright fashion and once inverted for a total of 176 trials. Final images were presented in grayscale on a gray background halfway between the average mean luminance for Black and White faces. Faces were cropped and resized so that the 293 x 400 pixel oval images excluded hairstyles, necks, and ears. In light of null effects observed for inversion and inversion x ideology interactions on categorization [6], we combined responses to upright and inverted faces in our analyses.

Importantly, our design ensured the degree of Black to White face content was orthogonal to the degree of racial ambiguity of faces (see Figure 1B). This allowed us to model these two factors as independent regressors and to examine their neural correlates and independent associations with political ideology and race categorization threshold.

(d) Functional magnetic resonance imaging acquisition

fMRI data were collected using the 3T Siemens Allegra head-only scanner at the New York University Center for Brain Imaging with the Siemens standard head coil. Anatomical images were acquired using a T1-weighted protocol (256 x 256 matrix, 176 1-mm sagittal slices), along with a field map and short TE EPI scan to improve functional-to-anatomical coregistration. Functional images were acquired using a multiecho EPI sequence (TR time = 2,000 ms; echo time = 15 ms; field of view = 240 mm, flip angle = 82 degrees, bandwidth = 4,166 Hz/Px, and echo spac- ing = 0.31 ms), obtaining 34 contiguous oblique-axial slices (3 mm x 3 mm x 3 mm voxels) + 20 degrees parallel to the anterior commissure–posterior commissure line. Fixation scans acquired at the start of each run were dropped from analysis to allow for magnet equilibrium. Responses were collected using a Rowland USB 5-button box. Data were

preprocessed and analyzed in SPM12 (Wellcome Department of Cognitive Neurology, London, United Kingdom), coregistered to structural images, corrected for slice acquisition time and motion, transformed to conform to the default EPI Montreal Neurological Institute (MNI) brain interpolated to 3mm x 3mm x 3mm, smoothed using a 6-mm full-width/half-maximum kernel, corrected for artifacts, and de-trended.

(e) Behavioral Analysis

To obtain an index of participants' race categorization, we computed each participants' threshold for categorizing a mixed-race face as Black, their *Point of Subjective Equality* (PSE). To estimate PSE we fit each participants' categorical judgments of Black and White to a cumulative normal function and calculated the point at which the curve crossed 0.5 on the y-axis, which represented the point on the continuum (i.e., x-axis) at which participants had an equal probability of categorizing a face as Black or White [see 42]. Lower PSEs suggest that a face required less Black face content to be categorized as "Black"—i.e., a lower threshold for categorizing a face as Black.

(f) Neuroimaging Analyses

Individual participants' BOLD responses were modeled at the first-level as a function of a canonical hemodynamic response function (HRF) with a 128 s high-pass filter, using a general linear model (GLM) that modeled face onset, parametrically modulated by face Black prototypicality (from -5 to 5), face ambiguity (from 1 to 6). We turned off SPM default serial orthogonalization of parametric regressors to assess independent effects of ambiguity and Black prototypicality without prioritizing either dimension assigning variance. First-level contrasts for Black prototypicality and ambiguity were generated and entered into a second level random effects analysis that regressed Black prototypicality and ambiguity onto whole-brain activity to determine the extent to which these dimensions were tracked by brain regions associated with perceptual, cognitive, and affective processes. We corrected whole-brain analyses for multiple comparisons using an arbitrary height threshold of $p < .001$ and a cluster extent of $k = 33$ to maintain a family-wise error (FWE) rate of $p < .05$, calculated using Monte Carlo simulation in AlphaSim. We then extracted individual participants' average mean parameter estimates (beta

values) within each significant brain region using Marsbar to correlate them with ideology and race categorization (i.e., PSE) and to submit them to mediation analyses.[3]

In light of our *a priori* hypothesis regarding anterior insula activity, we also examined activity across bilateral anterior insula regions of interest using maps from [45]. We analyzed neural activity in these ROIs by extracting mean parameter estimates (beta values) associated with the Black prototypicality and ambiguity predictors averaged from all voxels separately within each ROI and compared them to a baseline of 0 (reflecting no association between predictors and insula activity) using one-sample *t*-tests, then examined those parameter estimates' association with ideology and PSE.

As a complement to analyses correlating ideology with extracted neural activity in response to Black prototypicality and ambiguity, we also performed an analysis with ideology as a covariate and searched the whole-brain for regions that were sensitive to the interaction of Black prototypicality x ideology and ambiguity x ideology and replicated our main findings using this alternative method (see supplement).

Results

(a) Conservatives exhibited a lower threshold for seeing mixed-race faces as Black

To first test for ideological differences in threshold for categorizing mixed-race Black/White faces as Black, we examined the correlation between participants' political ideology and PSE. Replicating previous research [6], ideology marginally predicted PSE scores, $r(39) = -0.29$, 95% CI [-0.55, 0.02], $t = 1.87$, $p = .07$, such that increased conservatism was moderately associated with a decreased threshold for categorizing mixed-race faces as Black (see Figure S1).[4] Although this relationship did not reach traditional levels of statistical significance, the trend and magnitude were consistent with previous findings in a larger overall sample [6].

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[3] Because racially ambiguous faces typically take longer to categorize than racially prototypical ones (e.g., [43]), we also conducted a GLM adjusting for response time and correlated the adjusted Black prototypicality and ambiguity betas with ideology and PSE (see supplemental text and Table S2). These analyses yielded identical patterns of significance, suggesting that activity to ambiguity reflects differential (rather than longer) engagement of neural processes among conservatives and liberals. That is, our effects do not merely reflect "time-on-task" effects [44].

[4] It is conceivable that conservatives' lower PSE reflects greater "ingroup overexclusion" (i.e., a higher threshold for categorizing as face as in-group [46]) rather than hypodescent (i.e., a greater tendency to categorize faces as their "socially subordinate" race), and our task alone cannot tease these two possibilities apart. It is worth pointing out, however, that (a) previous research indicates that ingroup overexclusion is linked to ingroup identification (e.g., [47,48]), and yet (b) White identification failed to mediate the association between ideology and PSE in previous research using the same task [6]. Thus,

(b) Conservatism tracked neural sensitivity to ambiguity

Next, we examined neural activity to faces across the whole-brain as a function of their ambiguity and Black prototypicality. As anticipated, increasing ambiguity was related to a network of brain regions typically associated with salience processing and the explicit resolution of ambiguity: bilateral anterior insula, sensory-motor/dorsal anterior cingulate cortex, and inferior frontal regions [49,50] (See Table 1 and Figure 2). Furthermore, increasing ambiguity was associated with greater activity in the occipital cortex, a region that is also implicated in the resolution of perceptual ambiguity [51] and greater activity in the right fusiform gyrus, which is typically associated with configural face encoding [52–54]. No regions showed significant associations with increasing Black prototypicality at our whole brain thresholds (see Table S1 in the supplement for neural activity in response to decreasing ambiguity and increasing White prototypicality).

Table 1. Brain regions that parametrically tracked Black prototypicality and Ambiguity

Contrast	Anatomical Region	Hemisphere	Volume (voxels)	MNI peak coordinates (mm) (x,y,z)	Maximum z score
Increasing Ambiguity	Anterior Insula	R	568	36, 18, 0	6.31
	Anterior Insula	L	249	-30, 18, 6	6.02
	FFA	R	66	36, -54, -12	4.60
	Occipital	R	171	33, -90, -3	5.96
	Occipital	L	79	-30, 87, 0	6.12
	Inf Frontal	L	112	-36, 9, 33	4.79
	SMA/dACC	-	506	-3, 15, 60	6.45
Increasing Black prototypicality	No regions				

although ingroup overexclusion could be involved in conservatives' racial categorizations, it seems unlikely that it could fully explain the pattern of behavioral results.

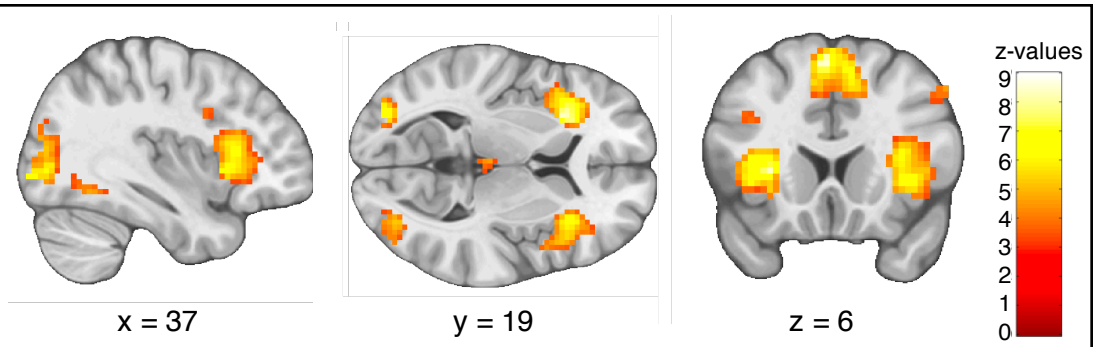

Figure 2. Neural activity associated with increasing racial ambiguity.

Next, we inspected correlations between neural sensitivity to ambiguity and political ideology. Consistent with previous accounts linking conservatism to insula sensitivity and our *a priori* interest in insula activity, ideology was only correlated with sensitivity to ambiguity in the bilateral insula, $r(39) = 0.42$, 95% CI [0.13, 0.64], $t = 2.88$, $p = .006$ (all other p's > .16; Bonferroni corrected α = .008 to protect against multiple comparisons), see Figure 3. Similarly, when activity in these regions was simultaneously regressed onto political ideology, only bilateral insula activity emerged as a significant predictor, b = 0.79, SE = 0.28, $t = 2.81$, CI [0.21, 1.36], $p = .008$. Together, this reveals a relationship between political ideology and insula activity to racial ambiguity such that conservatives showed greater insula sensitivity to increasing racial ambiguity.

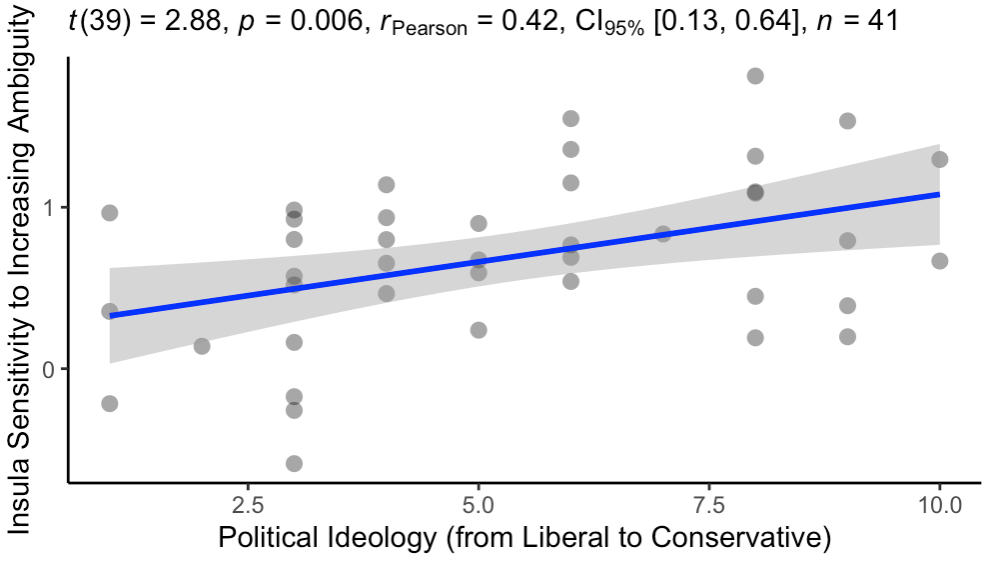

Figure 3. Conservative participants showed greater bilateral anterior insula sensitivity to increasing facial ambiguity, compared to liberal participants.

To further corroborate these observations, we investigated activity across the anterior insula ROI masks. Results revealed that bilateral insula ROI parameter estimates (beta values) associated with the ambiguity predictor were significantly different from a baseline of zero: M = 0.42, SE = 0.07, $t(40) = 6.30$, $p < .001$, 95% CI [0.29, 0.56] and that once again ideology was correlated with this brain activity, $r(39) = 0.40$, 95% CI [0.10, 0.63], $t = 2.72$, $p = .01$, such that conservatives showed greater insula sensitivity to increasing racial ambiguity.

Parameter estimates associated with the Black prototypicality predictor differed marginally from zero: $M = 0.009$, $SE = 0.005$, $t(40) = 1.86$, $p = .07$, 95% CI [-0.001, 0.02] and were not related to ideology, $r(39)= 0.19$, 95% CI [-0.13, 0.47], $t = 1.19$, $p = .24$. Along with the whole-brain results (and alternative analyses in the supplement), this suggests a robust insula sensitivity to racial ambiguity, but not face Black prototypicality, which was strongest among political conservatives.

(c) Ideological differences in race categorization were mediated by insula sensitivity to ambiguity

To examine whether ideological differences in race categorization were attributable to conservatives' stronger insula sensitivity to the ambiguity of faces, we conducted a bootstrapping mediation analysis [55] using the mediate function of the "Mediation" R package with 10,000 iterations (see Figure S2 in the supplement for zero-order correlations). This analysis yielded a significant indirect effect such that insula sensitivity to ambiguity mediated the effect of conservatism on thresholds for categorizing a face as Black (A x B cross product = -0.14, $SE = 0.01$, 95% CI [-.34, -.01], $p < .05$ (see Figure 4).[5,6]

[5] Following recent concerns about such use of a single index of mediation and resulting Type I error inflation [56], we also used a "component" approach to provide convergent evidence for indirect mediation using the JSmediation R package. Specifically, we found that the a-path was significant (a point estimate = 0.42, $SE = 0.14$, $t = 2.88$, $p = .006$) the b-path was significant (point estimate = -0.33, $SE = 0.16$, t = 2.02 $p = .05$), and our indirect effect was significant (point estimate = -0.14, 95% CI [-0.34, -0.004], 5,000 Monte Carlo iterations), corroborating the findings from the bootstrapping analysis.

[6] This effect was driven most strongly by right anterior insula sensitivity to ambiguity (see supplement for separate analyses). Both left and right anterior insula have been implicated in the integration of interoception with cognitive and motivational information, but the right anterior insula is believed to serve a more dominant role (e.g., [9]).

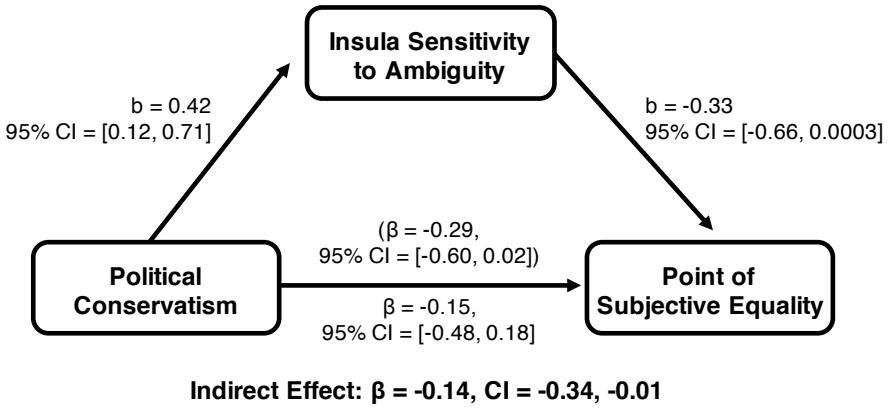

Figure 4. Mediation model illustrating how the negative effect of conservatism on the threshold for categorizing faces as Black (Point of Subjective Equality) was mediated by conservatives' greater insula sensitivity to the ambiguity of faces. Parameter estimates are standardized coefficients.

Discussion

We examined the ideological origins and neural substrates of hypodescent—the categorization of mixed-race individuals according to their "socially subordinate" race. We found that activity in the bilateral anterior insula was associated with the racial ambiguity of a face. Importantly, White political conservatives showed stronger insula sensitivity to racial ambiguity than liberals, and this helped to explain their lower threshold for categorizing an ambiguous face as Black (i.e., hypodescent). These results suggest that ideological differences in race categorization may not necessarily be driven by racial animus against Black targets, but rather reactions to deviations from either the White *or* Black prototype. In other words, hypodescent may stem from ideological differences in the intolerance of racial ambiguity.

In addition to advancing our understanding of the role of ideology in race categorization, this finding also underscores the usefulness of neuroimaging in disambiguating the processes underlying complex behavior—such as racial categorization—that can be difficult to disentangle using behavioral paradigms alone. That ideological differences arose in a region often associated with affective processing suggests that racially ambiguous faces could give rise to different emotional reactions in conservatives vs. liberals. That is, rather than visually perceiving or thinking about mixed-race faces differently, conservatives might maintain a stricter boundary around Whiteness (compared to liberals) because of the way they feel about racial ambiguity. Specifically, the anterior insula is thought to be involved in the integration of external sensory information with internal emotional and bodily state signals [50]. Our findings raise the intriguing possibility that conservatives may *experience* racial ambiguity as more arousing or aversive, especially given the role of the insular cortex in disgust sensitivity [57], interoceptive awareness [58], and pain detection [59]. Indeed, a we conducted an analysis using Neurosynth to help

quantify the likelihood of this relationship based on the existing literature on the insula and affective processing (see [60]). Our analysis revealed that the terms *aversive*, *disgust*, *interoception*, and *pain* had 58%, 50%, 62%, and 66% probabilities (respectively) of appearing in published reports of right anterior insula activation (MNI coordinates 36, 18, 0).

Thus, we speculate that an aversive state may lead conservatives to resolve race categorization challenges quickly and in the most culturally accessible or hierarchy-affirming way—that is, according to hypodescent. Consistent with this account, conservatives made faster categorization decisions than liberals (b = -0.12, p = .006), and these faster decisions were associated with an increased likelihood of Black categorization (b = -0.03, p = .003). In other words, ideological differences were evident not only in racial categorization but also in how fast people made their judgments. Further corroborating this account, other research has found that conservatives are more likely to evaluate racially ambiguous faces negatively, independent of their Black prototypicality [61]. Given known links between affective arousal and evaluation (e.g., [62]) and between increased anterior insula activity and negative evaluation of stimuli (e.g., [63,64]), these findings provide additional evidence that an aversive state might underpin conservatives' processing and resolution of racial ambiguity.

However, the current study cannot rule out other plausible explanations for conservatives' heightened anterior insula activity to racial ambiguity. Beyond affective processing, the anterior insula has also been implicated in cognitive and perceptual processing (e.g., [24,65,66]) and indeed a Neurosynth analysis revealed our coordinates' association with non-affective terms like *response selection*, *switch*, *load*, and *working memory* (with probabilities 72%, 71%, 64%, and 61%, respectively). Thus we must exercise caution when inferring affective processes from anterior insula (i.e., making a reverse inference; see [67]). For example, previous research suggests that anterior insula activity tracks psychological conflict and/or difficulty, both of which are likely to arise when categorizing ambiguous stimuli and could be modulated by ideology. Although the relationship between ideology and PSE through anterior insula activity was robust to response time controls—and conservatives actually made *faster* race categorizations than liberals (suggesting *less* decision conflict)—we cannot rule out ideological differences in other cognitive or perceptual processes. Indeed, affective, perceptual, and cognitive processes are not mutually exclusive, and a single study relying on a reverse inference cannot determine which psychological processes are most responsible for race categorization.

We hope that future research will employ both neuroscience and behavioral measures to (a) provide convergent evidence for the role of affect in racial categorization, and (b) take an iterative approach by using such behavioral evidence to constrain neuroscientific interpretations, and vice versa (see [8]). An additional benefit of such an approach is the new *behavioral* hypotheses it spawns, for example, that conservatives categorize more mixed-race faces as Black than liberals because of a visceral reaction to racial ambiguity. Future research would do well to examine conservatives' subjective experiences of arousal, aversion, and disgust in response to racially ambiguous individuals to understand how these processes relate to categorization and evaluations of individuals and groups. Furthermore, researchers might consider attempting to block or assuage negative emotional responses or inducing positive emotional responses during categorization to reduce hypodescent. We would also recommend conceptual replications using different stimuli, more representative participant and stimuli samples with regard to age and race, and an extension of these ideas to other contexts (e.g., categorizations based on gender, sex, sexual orientation, or minimal groups).

Conclusion

Our findings illustrate the promise of a political neuroscience approach to illuminate psychological mechanisms that may otherwise be difficult to disentangle when it comes to judgment and behavior [7,8]. They also help to explain how and why multiracial individuals are often categorized of as members of their most subordinate racial group—a phenomenon that enhances their vulnerability to discrimination and exacerbates existing racial inequalities. Given the myriad societal consequences of minority-group categorization and the large number of people who are potentially vulnerable to biased categorization, understanding the processes by which ideology reinforces the racial status quo is critically important.

Author Contributions. All authors designed the research. ARK analyzed the data with guidance from JJVB. ARK wrote the original manuscript draft. JJVB and JTJ reviewed and edited the manuscript and gave final approval for publication.

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SUPPLEMENT

The Neural Basis of Ideological Differences in Race Categorization

by Amy R. Krosch, John T. Jost, & Jay J. Van Bavel

Philosophical Transactions of the Royal Society B

Alternative Ideology Covariate Analyses

We performed additional analyses with ideology as a covariate and searched the whole-brain for regions sensitive to the interaction of Black prototypicality x ideology and ambiguity x ideology. We used a relaxed height threshold of $p < .005$ and a cluster extent of $k = 20$. Replicating our main results with this alternative analysis, we found only two significant clusters: Bilateral insula activity tracked the interaction of ambiguity and ideology. Additionally, Black prototypicality x ideology was tracked by small clusters in right caudate and inferior, mid, and superior frontal areas.

Insula Asymmetry Effects

Right insula activity to ambiguity was correlated with ideology ($r = 0.38$, $p = .01$) and PSE ($r = -0.40$, $p = .01$) and a bootstrapping mediation analysis yielded a significant indirect effect such that right insula sensitivity to ambiguity mediated the effect of conservatism on PSE (A x B cross product = -0.16, $SE = 0.02$, 95% CI = [-0.38, -0.01], $p < .05$. Left insula activity to ambiguity was correlated with ideology ($r = 0.38$, $p = .02$) but less strongly with PSE ($r = -0.18$, p = .27) and left insula sensitivity to ambiguity did not mediate the effect of conservatism on PSE (A x B cross product = 0.06, $SE = 0.01$, 95% CI = [-0.09, 0.25], $p > .05$

Analyses Adjusted for Response Time

We re-ran all imaging analyses including response time (RT) as a parametric regressor to rule out that insula activation to racial ambiguity reflects 'time on task effects' (see [44]). After adjusting for RT, racial ambiguity was still related to greater bilateral anterior insula activity ($r = .39$, $p = .01$), greater bilateral anterior insula activity was still related to lower PSE ($r = .35$, $p = .03$), and a mediation analysis revealed a significant indirect effect such that insula sensitivity to ambiguity mediated the effect of conservatism on thresholds for categorization a face as Black (A x B cross product = -0.12, $SE = 0.01$, 95% CI [-.30, -.01], $p < .05$ (see Fig. 5). Conducting the analyses both with and without RT as a covariate and finding nearly identical patterns of neural

activity to ambiguity and identical relationships with ideology and PSE strengthens our conclusion that activation differences between liberals and conservatives reflect differential engagement of the anterior insula rather than *longer* engagement of the same processes (see [44]). See Table S2 for all brain regions that parametrically tracked increasing and decreasing ambiguity and Black and White prototypicality, adjusting for reaction time (along with the neural correlates of response time).

Table S1. Brain regions that parametrically tracked White prototypicality and decreasing ambiguity

Contrast	Anatomical Region	Hemisphere	Volume (voxels)	MNI peak coordinates (mm) (x,y,z)	Maximum z score
Decreasing Ambiguity	Temporal Mid	L	294	-57, -60, 6	5.21
	Frontal Mid	L	135	-27, 27, 51	5.17
	Precuneus	-	97	-9, -42, 45	4.55
	Temporal Mid	L	252	51, -45, 3	4.52
	Cuneus	-	42	3, -81, 33	3.93
Increasing White prototypicality	Calcarine	-	1810	12, -66, 15	7.28

Table S2. Brain regions that parametrically tracked increasing and decreasing Ambiguity and increasing Black prototypicality and White prototypicality, *adjusting for Response Time* (i.e., including a RT covariate).

Contrast	Anatomical Region	Hemisphere	Volume (voxels)	MNI peak coordinates (mm) (x,y,z)	Maximum z score
Increasing Ambiguity	SMA/ACC		125	12, 21, 45	5.12
	Insula	R	83	33, 21, 15	4.51
	Ins/Inf Front	R	38	48, 27, 24	4.39
	Insula	L	46	-33, 15, 9	4.14
Decreasing Ambiguity	Frontal Mid	L	148	-27, 27, 48	6.22
	Temporal Mid	L	69	-60, -51, 0	4.63
	Occipital Mid	L	54	-39, -75, 30	4.44
	Calcarine		342	12, -69, 6	3.71
Increasing Black prototypicality	No voxels				
Increasing White prototypicality	Calcarine		1823	-9, -72, 9	7.68
Longer RTs	Insula	L	1064	-30, 24, 6	13.27
	Supp Motor		616	-6, 15, 57	7.69
	Insula	R	744	36, 21, 6	7.30
	Thalamus		222	6, -24, 0	6.22
	Supp Parietal	L	687	-24, -66, 42	6.06
	Temp Inf	X	588	48, -57, -9	6.21
	Parietal Sup	R	50	27, -54, 57	5.31
	Caudate	R	44	9, 9, 12	4.92
	Caudate	L	56	-6, 9, 12	4.86
	Calcarine	L	73	-18, -66, 12	4.78
	Frontal Sup	R	34	24, 0, 57	4.14
Shorter RTs	Putamen	L	1058	-30, -15, 9	5.94
	Inf Parietal	L	293	-60, -36, 45	5.12
	Temporal Mid	R	418	39, -51, 27	4.71
	Supp Motor		66	3, -18, 51	4.08
	Paracentral	R	35	15, -36, 51	3.84

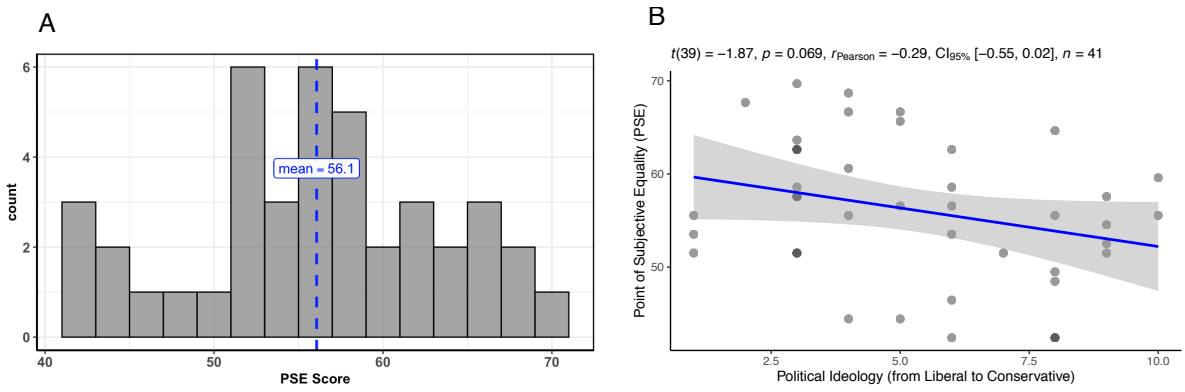

Figure S1. PSE distribution (A) and correlation between ideology and PSE (B).

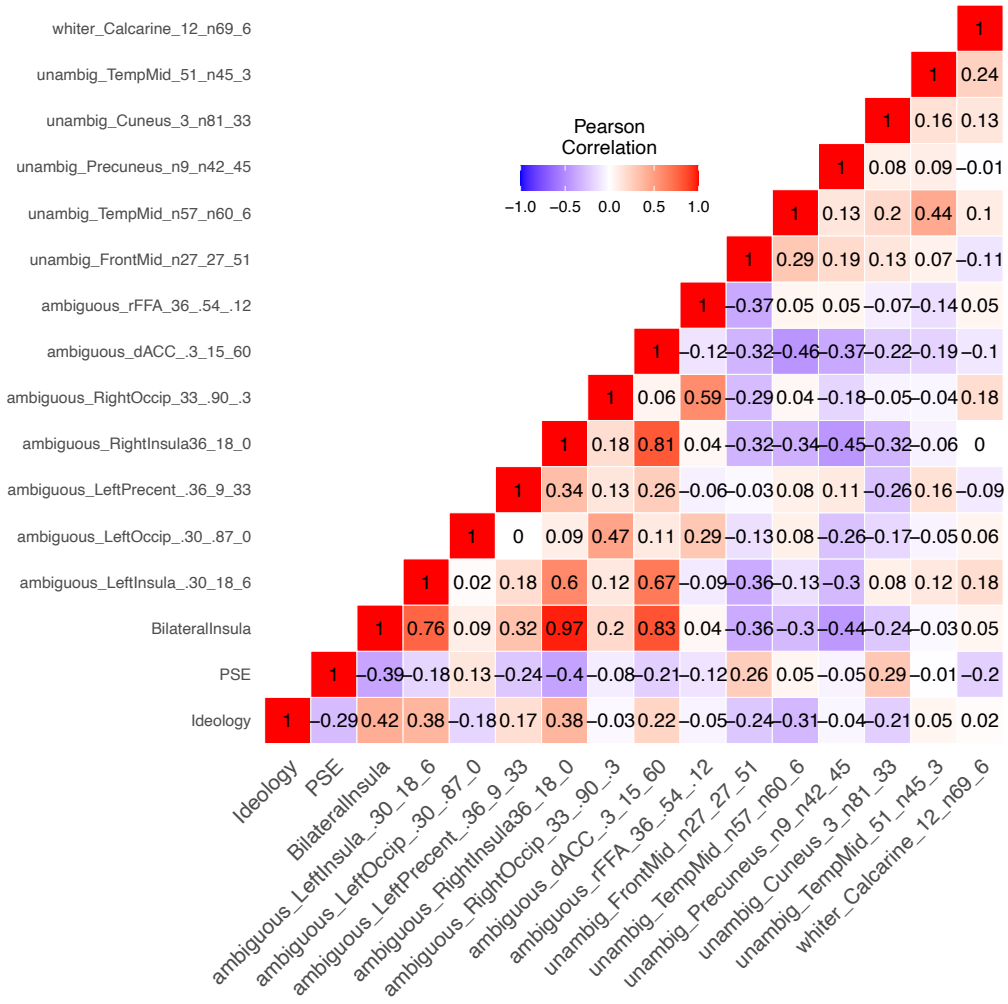

Figure S2. Correlation between Ideology, PSE, and Neural Activity to Increasing and Decreasing Ambiguity and White prototypicality