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A Perceptual Pathway to Bias: Interracial Exposure Reduces Abrupt Shifts in Real-Time Race Perception That Predict Mixed-Race Bias

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Abstract
In two national samples, we examined the influence of interracial exposure in one's local environment on the dynamic process underlying race perception and its evaluative consequences. Using a mouse-tracking paradigm, we found in Study 1 that White individuals with low interracial exposure exhibited a unique effect of abrupt, unstable White-Black category shifting during real-time perception of mixed-race faces, consistent with predictions from a neural-dynamic model of social categorization and computational simulations. In Study 2, this shifting effect was replicated and shown to predict a trust bias against mixed-race individuals and to mediate the effect of low interracial exposure on that trust bias. Taken together, the findings demonstrate that interracial exposure shapes the dynamics through which racial categories activate and resolve during real-time perceptions, and these initial perceptual dynamics, in turn, may help drive evaluative biases against mixed-race individuals. Thus, lower-level perceptual aspects of encounters with racial ambiguity may serve as a foundation for mixed-race prejudice.

Keywords
social perception, social cognition, prejudice, face processing, visual perception

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The population of mixed-race individuals in the United States is growing faster than any other racial group (Humes, Jones, & Ramirez, 2011), yet understanding of how individuals resolve racial ambiguity is limited. Previous studies have focused on how categorization of racially ambiguous faces is susceptible to cognitive and motivational biases, such as hypodescent (Ho, Sidanius, Levin, & Banaji, 2011; Peery & Bodenhausen, 2008), social dominance (Ho, Sidanius, Cuddy, & Banaji, 2013), stereotypes (Freeman, Penner, Saperstein, Scheutz, & Ambady, 2011; Hugenberg & Bodenhausen, 2004), essentialism (Chao, Hong, & Chiu, 2013), labeling (Tskhay & Rule, 2015), political and economic factors (Krosch & Amodio, 2014; Krosch, Berntsen, Amodio, Jost, & Van Bavel, 2013), and motivation to control prejudice (Chen, Moons, Gaither, Hamilton, & Sherman, 2014). However, very few studies have examined how people's exposure to individuals of different races (i.e., interracial exposure) affects the way they perceive racially ambiguous individuals, and such studies have relied on explicit outcome-based measures and mostly focused on short-term perceptual adaptations to certain races (Halberstadt, Sherman, & Sherman, 2011; Webster, Kaping, Mizokami, & Duhamel, 2004). Moreover, to date, no research has explored how naturalistic, long-term interracial exposure across the United States might affect the underlying process of resolving racial ambiguity as well as its downstream evaluative consequences.

Intergroup exposure has long been studied with respect to biased processing of racial out-group faces, as occurs in the cross-race effect (Meissner & Brigham,

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2001). Outside the domain of face perception, decades of research on intergroup contact has consistently found that exposure to racial out-group members can decrease both explicit and implicit bias (for a review, see Pettigrew, Tropp, Wagner, & Christ, 2011). One mechanism underlying such bias reduction is the effect of interracial exposure on the cognitive structure of group representations, which leads to less differentiated ingroup and out-group representations. Accordingly, central to numerous models of bias reduction is the notion that bias will be reduced as groups are perceived to possess greater similarity and overlapping characteristics (Allport, 1954; Dovidio, Gaertner, & Kawakami, 2003). The implication is that the less differentiated "us" and "them" become at a conceptual level, evaluative differentiation should follow suit.

If representations of race categories are conceptually more differentiated with less interracial exposure, such cognitive structuring could impact even the initial perception of another person's race—well before any evaluative biases have a chance to take place. Indeed, neuroimaging work has shown representational patterns for White and Black categories in face-perception regions to be more or less differentiated depending on social-cognitive factors, such as implicit racial bias (Brosch, Bar-David, & Phelps, 2013). In the case of perceiving a racially ambiguous face, the amount of differentiation between White and Black category representations could change the process by which race is initially perceived. According to the *dynamic interactive model* (Freeman & Ambady, 2011), the mixture of racial cues inherent to racially ambiguous faces triggers a dynamic competition between simultaneously active race categories (e.g., White and Black) that must be resolved over hundreds of milliseconds (Freeman, Pauker, Apfelbaum, & Ambady, 2010). This is because social-category representations are reflected by distributed patterns of neuronal activity, and race categorization thus involves dynamic changes in a neuronal pattern. Early in processing, representations of race would reflect a rough sketch of facial information and be partially consistent with multiple categories. As bottom-up processing of facial information continues, conceptual knowledge and stereotypes begin to activate, and these exert their own top-down effects on the categorization process. Driven by these parallel bottom-up and top-down forces, neuronal activity gradually sharpens into an increasingly complete White or Black representational pattern, while other coactivated representations are pushed out, until a final race categorization is produced (Freeman & Ambady, 2011).

If White and Black category representations are more differentiated with less interracial exposure, the competition process needed to resolve racial ambiguity would unfold quite differently. For individuals in which White and Black representations are more similar (high-exposure perceivers), coactivation of both categories when a racially ambiguous face is encountered would lead to a smooth-competition process that gradually settles into one category. However, for individuals in which White and Black representations are more differentiated (low-exposure perceivers), coactivation of the two categories would result in a more unstable process because of the dynamic conflict between bottom-up visual processing of the face (pushing the White and Black category activations closer together) and top-down conceptual knowledge (strongly pulling the White and Black category activations further apart). In other words, a racially ambiguous face creates instability for the perceptual system of a low-exposure perceiver because visual processing attempts to bring together two race categories that conceptual knowledge is trying to rapidly pull apart (Fig. 1).

In the present work, we first confirmed the above predictions of the dynamic interactive model through a computational simulation study that detailed the process of resolving racial ambiguity for low- and high-exposure perceivers (Fig. 1). Then, we used a mouse-tracking technique with human participants to index such unstable categorization dynamics during perceptions of racially ambiguous faces. Other methods traditionally used to index the categorization process, such as reaction time measures, indicate only overall difficulty and how long it takes to go from stimulus to response, but they cannot reveal the abrupt category-shifting effects unfolding during categorization and unstable dynamics that we predicted. We tested in Study 1 whether low-exposure perceivers experience uniquely unstable dynamics when confronting racial ambiguity.

Critically, we argue that if more unstable dynamics manifest in the initial perception of racially ambiguous targets, this may bear evaluative consequences. Past research has shown that within-category featural variation influences evaluations independent of group membership itself. For example, features typical of another race (e.g., Afrocentric cues on a White face) trigger "hidden" race-category activations (Freeman et al., 2010) that predict automatic evaluative responses (Livingston & Brewer, 2002) and criminal sentencing (Blair, Judd, & Chapleau, 2004). However, with respect to evaluations of genuinely ambiguous (rather than less prototypical) targets, results of prior studies have been mixed, with racially ambiguous, relative to racially unambiguous, individuals judged to be more attractive in some studies (Halberstadt & Winkielman, 2014), while less warm and competent in other studies (Sanchez & Bonam, 2009).

Recent work suggests that aspects of perceptual experience, such as processing fluency, may influence a variety of evaluations (Lick & Johnson, 2015), including the

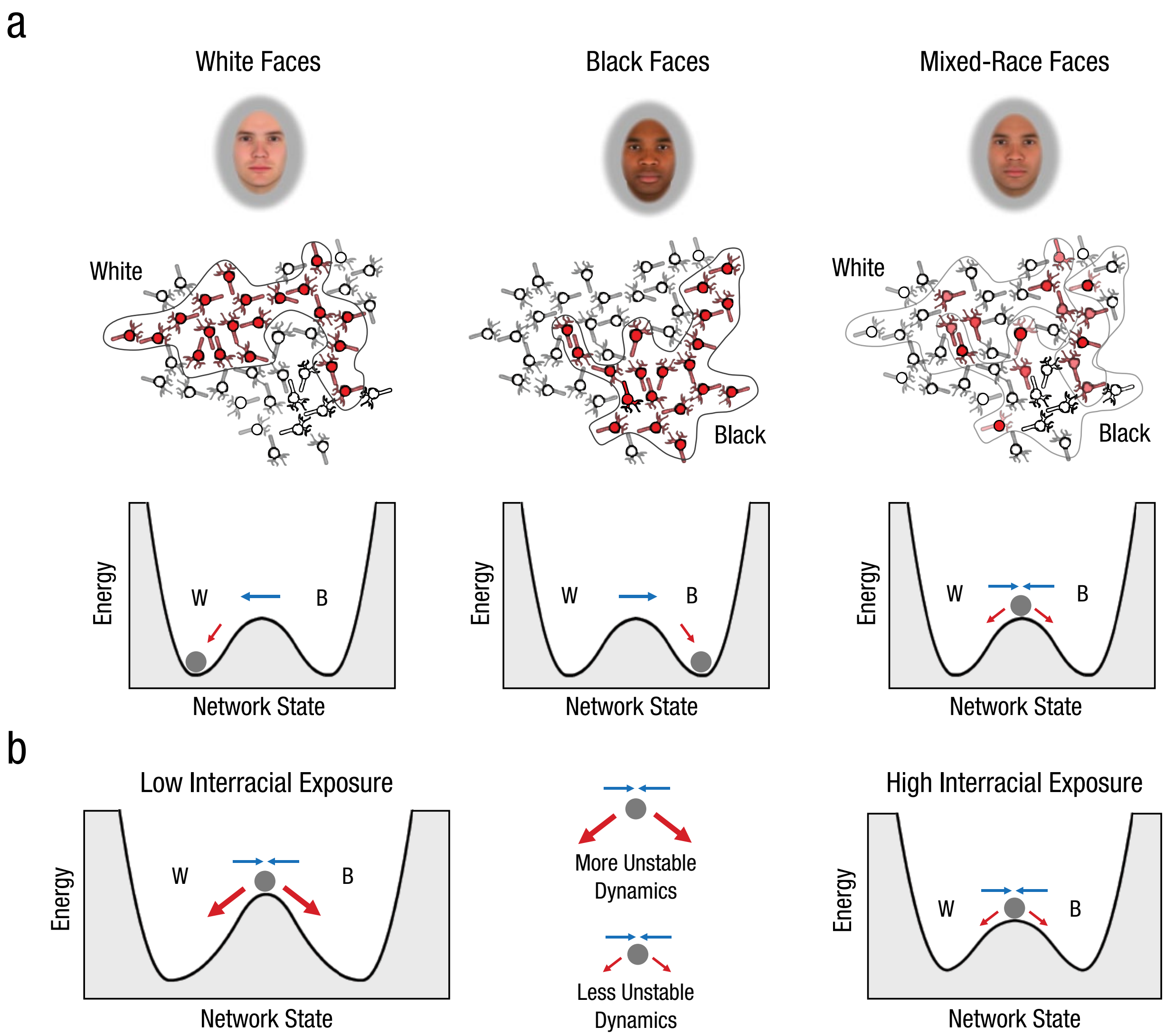

Fig. 1. Schematic illustrations of how the perceptual system resolves racial ambiguity, according to the dynamic interactive model, in which two simultaneous forces drive race categorization: visual processing (blue arrows) and conceptual knowledge (red arrows). The diagrams in (a) show hypothetical neural states associated with finalized categorizations of White and Black faces, as well as with not-yet-finalized categorizations of mixed-race faces early in processing. In response to a face, the neural network is attracted to settle into patterns associated with White and Black categories, and the associated network states are highly stable and therefore have low energy. The mixed-race pattern and associated network state are unstable and therefore have higher energy. The network seeks to settle into stable, lower-energy attractor states (White or Black) formed by learned conceptual knowledge, similarly to the way in which a ball is compelled to roll down a hill. At the same time, dynamic visual processing of mixed-race cues creates bottom-up pressure that works against the natural descent of the system (pushing White and Black activations closer together and driving the system toward the ridge between the attractors), which creates instability. The diagrams in (b) show hypothetical neural states associated with not-yet-finalized categorizations of mixed-race faces for low- versus high-exposure perceivers. Because patterns for White (W) and Black (B) categories are more differentiated in low-exposure perceivers (with deeper and more distant attractors, creating a steeper descent), the system experiences a stronger "pull" to descend into the categories, while visual processing of mixed-race cues "pushes" the system up against the attraction, which causes more unstable dynamics. (See the Supplemental Material for further details.)

attractiveness of racially ambiguous faces (Halberstadt & Winkielman, 2014). For example, gay and lesbian targets were rated less favorably than heterosexual individuals largely because categorizing them by gender involved more disfluency (Lick & Johnson, 2013). Here, we proposed that an unstable race-categorization process—unique to perceivers with low interracial exposure—may operate as a form of perceptual disfluency that results in more negative evaluations of mixed-race targets. Thus, we predicted that less interracial exposure would be associated with a more unstable perceptual experience of racial ambiguity, and this greater initial instability may help explain a greater prejudice against mixed-race individuals. We tested this prediction in Study 2.

Simulation

Method

First, to illustrate how more unstable dynamics during the processing of racial ambiguity are a natural by-product of a perceptual system containing more differentiated race-category representations (as in low-exposure perceivers), we developed a new instantiation of the dynamic interactive model and conducted a series of computational simulations (see the Supplemental Material available online). The model has a recurrent connectionist architecture with stochastic activation. It simulates the process of perceiving a face's race depending on a number of perceiver factors, including one's conceptual knowledge and interracial exposure. Two neural networks (low exposure and high exposure) were developed, with the single difference between them being that the high-exposure network's White and Black categories were conceptually more similar and had more overlapping characteristics than the low-exposure network's race categories (Fig. S1 and Table S1 in the Supplemental Material), as is characteristic of greater interracial exposure (Allport, 1954; Dovidio et al., 2003). As theoretically predicted (Fig. 1), when there were less overlapping conceptual associations between the White and Black categories (low-exposure network), the two category representations (attractors) were more differentiated, that is, further apart and deeper (Fig. S2 in the Supplemental Material).

Results

Across 6,000 simulations, in both the low-exposure and high-exposure networks, we found that the presentation of racially ambiguous faces increased both the overall amount of category competition ($p < .0001$) and the number of abrupt shifts between the White and Black categories ($p < .0001$). Critically, however, this effect of racial ambiguity on abrupt category shifts was significantly larger in the low-exposure than in the high-exposure network ($p = .003$), even though the overall amount of competition was identical for both networks ($p = .32$; see the Supplemental Material for full details). In the studies that followed, we corroborated such findings with human participants.

Study 1

In Study 1, we predicted that all participants would experience the same overall difficulty and competition in categorizing a racially ambiguous face, but lack of interracial exposure would lead the process of resolving this ambiguity to unfold in a more unstable fashion.

Method

To examine the race-categorization process, we used mouse tracking, a well-validated measure of how multiple social categories activate and resolve over hundreds of milliseconds (Freeman & Ambady, 2010). Previous studies have shown that as racial ambiguity increases, mouse trajectories become increasingly attracted toward the opposite race category before settling into the selected response (Freeman et al., 2010). Such results provide evidence of continuous, smooth competition between two coactivated social categories settling into a single categorization over time (e.g., Freeman, Ambady, Rule, & Johnson, 2008). Beyond such smooth-competition effects, mouse tracking may also reveal abrupt shifts during race categorization, which manifest as discrete reversals in direction from one response toward the other. Such discrete changes would reflect rapid, unstable shifting between White and Black category activations, and previous hand-tracking studies have revealed such abrupt shifts in the context of a variety of cognitive processes (e.g., Dale & Duran, 2011; Freeman, 2014).

We predicted that, overall, participants' mouse trajectories would become increasingly attracted toward the category opposite of the one finally chosen as racial ambiguity (and other types of ambiguity, such as color ambiguity) increased. This attraction would provide an index of category competition, consistent with prior work (Freeman et al., 2010). However, we predicted that participants with lower interracial exposure would exhibit more abrupt category shifts as racial ambiguity (but not other types of ambiguity) increased, even though participants with both low and high interracial exposure would exhibit the same amount of overall competition. These shifts would manifest as abrupt reversals in mouse trajectories toward the two possible race-category responses (Fig. 2a).

Participants. Participants ($N = 235$) were recruited through Amazon Mechanical Turk for monetary compensation. Only participants who used a mouse (rather than a trackpad or touch screen) were allowed to participate. The sample size was based on our previous mouse-tracking study, which used a national sample also obtained via Mechanical Turk (Hehman, Carpinella, Johnson, Leitner, & Freeman, 2014). That study involved a similar categorization task and obtained robust effects. Given the focus on White-Black interracial exposure, only participants who self-identified as White were included in analyses ($n = 194$; 112 female, 82 male; age: $M = 40.1$ years, $SD = 13.7$). Including non-White

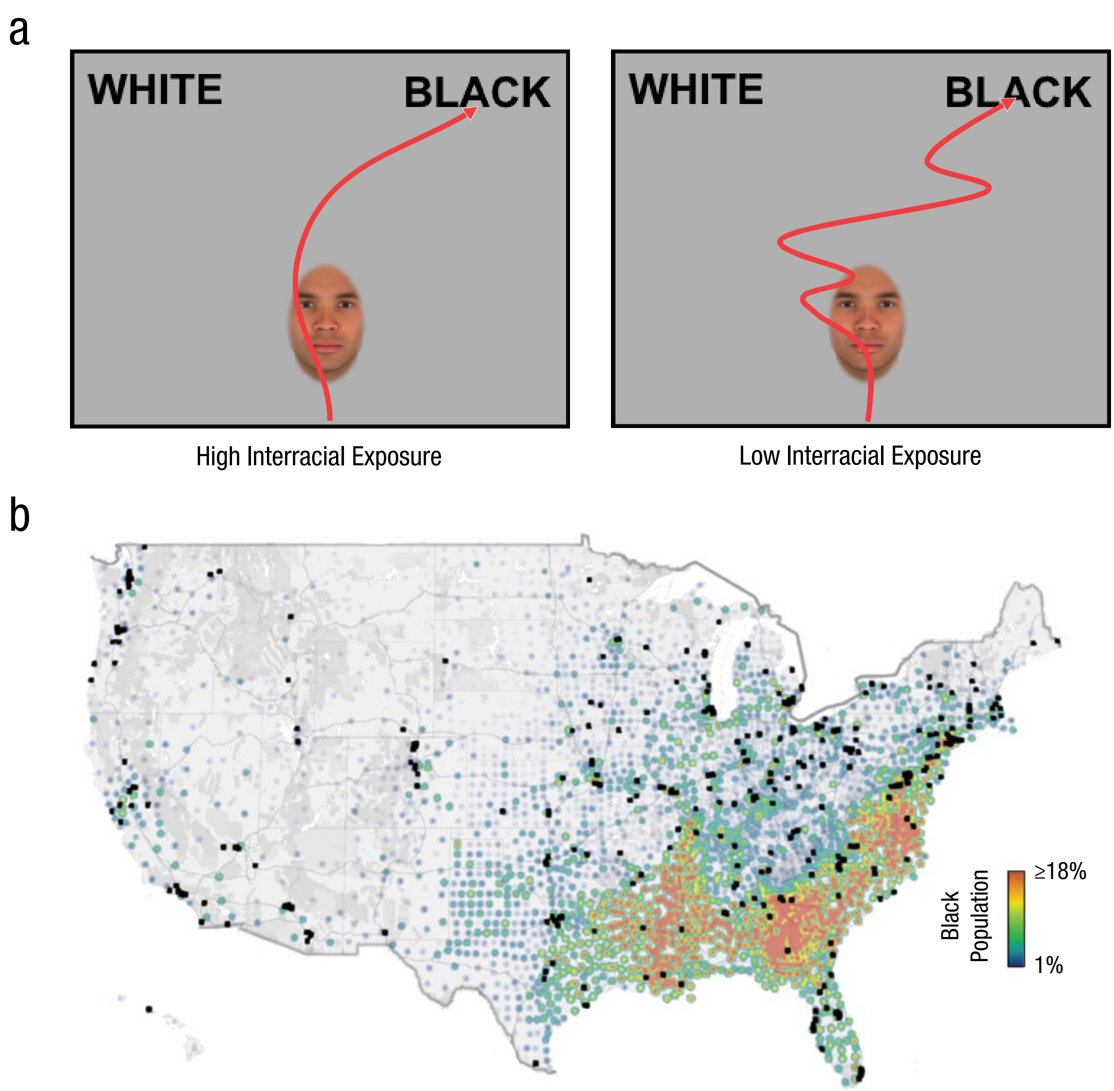

Fig. 2. Mouse-tracking paradigm and participants' interracial exposure. Participants' mouse trajectories (a) were tracked as they categorized a series of faces as White or Black. We predicted that when participants were presented with racially ambiguous stimuli, their mouse trajectories would show evidence of overall coactivation between the White and Black categories, reflected by an attraction to the alternate category on the opposite side of the screen. More critically, we predicted that participants with high interracial exposure would exhibit a more stable coactivation process (smoother and more continuous mouse trajectories), compared with participants with low interracial exposure, who would exhibit a more unstable coactivation process (trajectories shifting more abruptly between the two categories). The U.S. map (b) depicts the geographical distribution of White participants from Studies 1 and 2 (total $N = 343$) with black dots. The color overlay indexes local interracial exposure by illustrating the percentage of Black population, based on U.S. Census Bureau data (Humes, Jones, & Ramirez, 2011).

participants (n = 41; 24 female, 17 male; self-identified race: 10 Black, 14 Asian, 8 Latino/Hispanic, 9 mixed-race/other) did not substantially change the results.

Stimuli. Stimuli for the race-categorization task were eight computer-generated male face identities that were each morphed along a 9-point race continuum, from White (morph −4) to Black (morph +4), using FaceGen (Blanz & Vetter, 1999). This software uses a 3-D morphing algorithm based on anthropometric parameters of human population, in which a continuum from White to Black race category can be manipulated while holding other extraneous cues constant. A color-categorization task involving various shapes was used as a control. Shape stimuli for this control task consisted of eight shape forms that were each morphed along a 9-point color continuum, from red (morph −4) to blue (morph +4) using photo-editing software. This resulted in a total of 72 stimuli for the race-categorization task and 72 stimuli for the color-categorization task.

Procedure. Participants completed the race- and color-categorization tasks in counterbalanced order using an in-house JavaScript-based implementation of Mouse-Tracker (Freeman & Ambady, 2010), which can capture participants' mouse trajectories through their Internet browser (e.g., see Hehman et al., 2014). To begin each trial, participants clicked on a "Start" button located at the bottom center of the screen, which was then immediately replaced by the face stimulus (race task; see Fig. 2a) or shape stimulus (color task). Targets were presented in a randomized order, and participants categorized them by clicking either a "White" or "Black" response (race task) or a "Red" or "Blue" response (color task), which were located in the top corners of the screen (which response was on the left and which on the right was randomized across participants). During this process, we recorded the streaming *x, y* coordinates of the mouse cursor (sampling rate ≈ 70 Hz) unbeknownst to participants. To ensure trajectories were on-line and capturing participants' actual decision process, we encouraged participants to begin initiating movement early. As in previous research (e.g., Freeman et al., 2010), if the mouse was not moved within 400 ms of the start of a trial, a message appeared after participants made their response. This message encouraged them to start moving earlier on future trials even if they were not yet fully certain of their response. Further details about analytic techniques for mouse-trajectory data can be found in Freeman and Ambady (2010). Participants completed 72 trials for each task (i.e., one for each stimulus).

Following the categorization tasks, participants provided demographic information, including their current zip code (see Fig. 2b). We estimated the percentage of Black population in the local areas of the participants based on their zip code, using the most current race/ethnicity population data from the U.S. Census Bureau (Humes, Jones, & Ramirez, 2011). This provided a real-world index of how much interracial exposure is typically experienced in our participants' local environment, tailored to the target stimuli of interest (i.e., Black-White ambiguity). A low percentage Black population implies that participants have little interracial exposure, whereas a high percentage Black population implies they have high interracial exposure (we provide support for this measure by additionally assessing interracial exposure directly in Study 2). We also collected participants' political orientation (on an 11-point scale from *extremely liberal* to *extremely conservative*) for use as a covariate.

Data preprocessing. All mouse trajectories were rescaled into a standard coordinate space (top left: [−1, 1.5]; bottom right: [1, 0]) and normalized into 100 time bins using linear interpolation to permit averaging of their full length across multiple trials. For comparison, all trajectories were remapped rightward. To obtain a by-trial index of the degree to which the mouse was attracted toward the unselected response, we computed *maximum deviation*: the maximum perpendicular deviation between the observed trajectory and an idealized response trajectory (a straight line between the trajectory's start and end points), as is typically used in mouse-tracking studies (Freeman & Ambady, 2010). To measure abrupt category shifts and back-and-forth wavering between responses, we calculated *x*-flips, which are the number of switches along the *x*-axis (the axis of decision), in accordance with prior research (e.g., Dale & Duran, 2011; Dale, Roche, Snyder, & McCall, 2008; Freeman, 2014). Specifically, *x*-flips were calculated using the following formula:

$$\sum H\left[-(x_t - x_{t-1})(x_{t-1} - x_{t-2})\right],$$

where x represents the x-axis coordinate at time t, and H represents a Heaviside threshold function. The function multiplies −1 by a three-step comparison along the x-axis, yielding a value of 0 (no x-flip) or 1 (x-flip) when there is a change in direction. For example, if x was increasing from $t - 2$ to $t - 1$ but then began decreasing from $t - 1$ to t, the product of such differences would always be −1, which using the multiplier of −1 returns a 1 (x-flip). This analysis was done across the entire time course of the trajectory and summed, which provided a count of the number of directional changes. For calculating these x-flips, the x-coordinate time series was first smoothed using a sliding five-window average that rendered the measure more sensitive to larger-scale directional changes rather than small perturbations in movement.

Results and discussion

Participants exhibited a sizable range of local interracial exposure (0–94.1% Black population; M = 8.2%, SD = 12.4). For multiple regression models, a multilevel generalized-estimating-equation (GEE) regression approach was used, which can incorporate nested data while accounting for the intracorrelations in repeated measures designs. For simple-slope decomposition, continuous variables were analyzed at ±1 standard deviation of the mean. Trials in which participants took excessively long to respond (> 2,000 ms) were discarded from analysis (3.8% of all trials). The inclusion of participant age and political orientation as covariates did not change the significance of the results.

Race-categorization responses. Though our main interest was mouse-trajectory dynamics, we first regressed race categorizations (0 = White, 1 = Black) onto morph level (−4 = most White, 4 = most Black), local interracial exposure, and their interaction using GEE logistic regression. As a face's morph level became more prototypically Black, the likelihood of a Black categorization correspondingly increased, $b = 1.75$, $Z = 22.00$, $p < .0001$. However, there was no effect of interracial exposure, $b = 0.107$, $Z = 1.32$, $p = .19$, nor an interaction between morph level and interracial exposure, $b = -0.0477$, $Z = -0.93$, $p = .35$. When examining only trials on which race was most ambiguous (morph levels: 0, ±1), we still found no effect of exposure, $b = 0.0229$, $Z = 0.50$, $p = .62$.

To determine each participant's point of subjective equality (PSE)—the morph level at which there was a 50-50 likelihood of a White or Black categorization—we fit response data to logistic psychometric curves. Because morph levels ranged from −4 to 4, a PSE of 0 represented a lack of bias. Consistent with an extensive literature on hypodescent (the tendency to assign mixed-race individuals to the lowest status group), the PSE was significantly shifted from 0 in the direction of Black categorization ($M = 0.32$, $SE = 0.05$), one-sample $t(193) = 6.34$, $p < .0001$. However, consistent with the regression analyses, there was no correlation between participants' PSE and their level of interracial exposure, $r(192) = .020$, $p = .77$.

Only a few prior studies have examined the effect of interracial exposure on race categorizations (Halberstadt et al., 2011; Webster et al., 2004). While there is some evidence that longer-term interracial exposure may shift the perceptual category boundaries of race (Webster et al., 2004), other research has found that interracial exposure is not related to categorizations of racially ambiguous faces (Chen et al., 2014). Halberstadt et al. (2011) found support for the effect of participants' learning histories (i.e., what order they learned faces) on categorization responses. However, our White participants presumably all had similar learning histories, such that they were likely exposed to more White faces early on in their lifetime (unless they grew up in a racially integrated area of the United States). Past research has been unable to clarify how interracial exposure interacts with this learning history and whether interracial exposure should affect categorization outcomes. In the present work, we focused on the underlying race-categorization process.

Category competition. Numerous studies have found that as a face's gender, race, age, or emotion category becomes more blended with another category within that dimension (e.g., a male face becomes more blended with the female category), mouse trajectories' parallel attraction toward that alternate category response increases in categorization tasks, as indexed by maximum deviation. We expected maximum deviation to have a curvilinear (quadratic) relationship with morph level: As a face's race (or a shape's color) approaches the middle of the morph continuum and becomes more ambiguous, mouse trajectories should show stronger competition and parallel attraction during categorization, which would be manifested in greater maximum deviation. However, because we predicted that all participants would experience the same overall competition and difficulty as a face became more racially ambiguous, we did not expect this measure to be influenced by local interracial exposure. Instead, we predicted that the qualitative nature of that competition would vary by interracial exposure (which we tested later).

In separate polynomial regressions for the two categorization tasks, we regressed maximum deviation onto linear and quadratic components of morph level, local interracial exposure, and their interactions using GEE regression. In the race-categorization task, there was a significant linear effect, with maximum deviation decreasing as a face became more prototypically Black, $b = -0.008$, $Z = -2.71$, $p = .007$. More important, there was a strong quadratic effect, with morph levels closer to the middle of the continuum associated with a larger maximum deviation, $b = -0.010$, $Z = -15.74$, $p < .0001$. There was neither a main effect of interracial exposure, $b = 0.0027$, $Z = 0.22$, $p = .83$, nor an interaction of quadratic morph level and interracial exposure, $b = 0.0006$, $Z = 0.88$, $p = .38$. In the color-categorization task, there was no linear effect of maximum deviation, $b = -0.005$, $Z = -1.38$, $p = .17$. More important, there was again a strong quadratic effect, with maximum deviation increasing toward the middle of the continuum, $b = -0.008$, $Z = -10.51$, $p < .0001$. There was neither a main effect of interracial exposure, $b = 0.0041$, $Z = 0.33$, $p = .74$, nor an interaction of quadratic morph level and interracial exposure, $b = 0.0001$, $Z = 0.20$, $p = .84$. These results replicate previous work finding that stimuli bearing cues belonging to multiple categories (e.g., mixed-race faces, blended colors) simultaneously activate those categories, leading to dynamic competition that manifests in increased maximum deviations for mouse trajectories (e.g., Freeman & Ambady, 2011; Freeman et al., 2008).

Abrupt category shifts. The primary hypothesis concerned not the overall amount of competition during race categorization but the nature of that competition. We predicted that as a face became more blended between White and Black categories, participants with less interracial exposure would exhibit more abrupt shifts in race-category activation and unstable dynamics while resolving racial ambiguity. Trajectory *x*-flips were regressed onto linear and quadratic components of morph level, local interracial exposure, and their interactions using GEE Poisson regression (for count data). In the race-categorization task, there was a main quadratic effect of morph level, $b = -0.0024$, $Z = -3.79$, $p = .0001$. As racial ambiguity increased and morph values approached the middle of the continuum, trajectories exhibited increasingly more *x*-flips. Critically, this main effect was qualified by a significant interaction of quadratic morph level and interracial exposure, $b = 0.0011$, $Z = 2.11$, $p = .04$ (Fig. 3). Participants with low interracial exposure (1 *SD* below the mean) showed a highly significant effect of increasing *x*-flips as a face's race became more mixed, simple $b = -0.0036$, $Z = -4.10$, $p < .0001$. Participants with high interracial exposure (1 *SD* above the mean), however, showed no such effect, simple $b = -0.0013$, $Z = -1.66$, $p = .10$. There was no main effect of interracial exposure, $b = -0.0060$, $Z = -0.32$, $p = .75$.

Analyses of the color-categorization task indicated a similar overall quadratic effect of morph level (color ambiguity), $b = -0.0013$, $Z = -2.12$, $p = .03$. Critically, however, the interaction of quadratic morph level and interracial exposure was not significant, $b = -0.0004$, $Z = -0.56$, $p = .58$. These results therefore suggest that while there was an overall tendency for abrupt category shifts as a stimulus becomes more ambiguous, these shifts were exacerbated in participants who live in environments with less interracial exposure, specifically when they were confronted by racial ambiguity (and not other types of ambiguity).

Response times (RTs). Given the interactive effect of exposure on *x*-flips, one might expect a similar effect on overall RT, given that more vacillation should generally lengthen the time required to select a response. That said, we did not have strong predictions regarding RT, given that it is a considerably more indirect measure of the dynamic activation changes of interest here. For instance, higher velocity may be expected to accompany unstable directional changes (*x*-flips) in order to overcome those successive changes. If such an effect were observed, it could cause RTs to be identical for low-exposure and high-exposure perceivers, although the underlying process (as observed via *x*-flips and velocity dynamics) would be considerably different. Nevertheless, for completeness, we examined possible effects on RT.

RTs were regressed onto linear and quadratic components of morph level, interracial exposure, and their interactions using GEE regression, separately for the two tasks. In the race-categorization task, there was a significant linear effect, with RTs decreasing as a face became more prototypically Black, $b = -4.397$, $Z = -4.58$, $p < .0001$. Expectedly, there was a strong quadratic effect, with more ambiguous faces associated with longer RTs, $b = -7.021$, $Z = -19.28$, $p < .0001$. There was no main effect of interracial exposure, $b = 11.283$, $Z = 0.93$, $p = .35$, but the interaction of quadratic morph level and interracial exposure was marginally significant, $b = 0.601$, $Z = 1.81$, $p = .07$. Low-exposure participants showed an effect of increasing RT with racial ambiguity, simple $b = -7.622$, $Z = -15.16$, $p < .0001$, that was slightly larger than the effect for high-exposure participants, simple $b = -6.420$, $Z = -13.33$, $p < .0001$. In the control task, there was no linear effect of RT, $b = 0.0798$, $Z = 0.08$, $p = .94$, but again a strong quadratic effect, with longer RT for more ambiguous stimuli, $b = -6.433$, $Z = -19.08$, $p < .0001$. However, there was neither a significant main effect of interracial exposure, $b = 13.726$, $Z = 1.20$, $p = .23$, nor a significant interaction of quadratic morph level and interracial exposure, $b = 0.303$, $Z = 1.11$, $p = .27$. Thus, there was some support for the hypothesis that low-exposure participants exhibited a longer delay in categorizing racially ambiguous faces than high-exposure participants, and that this delay was unique to race and not color categorization.

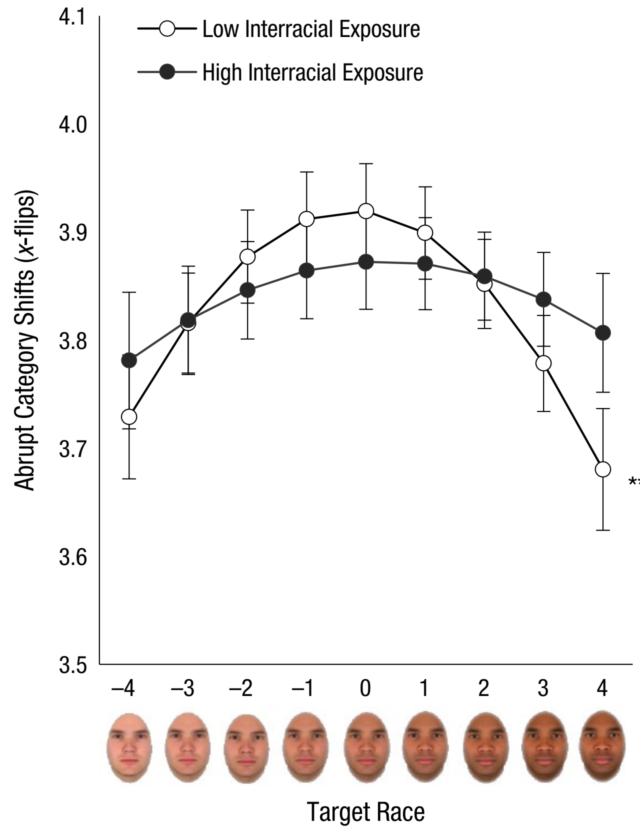

Fig. 3. Mean number of abrupt category shifts (*x*-flips) in the race-categorization task of Study 1. Results are shown for each morph level, separately for participants with low and high interracial exposure (1 *SD* below and above the mean, respectively). Asterisks indicate a significant quadratic morph-level effect (i.e., racial-ambiguity effect; $^{**}p < .001$). Error bars show standard errors of the mean.

Velocity dynamics. Evidence for abrupt category shifts should manifest in the velocity dynamics of mouse trajectories as well. The velocity profile can be considered an index of White and Black categories' activation over time, which indicates the relative confidence of selecting one response alternative over the other. Specifically, according to the dynamic interactive model (see Fig. S1), one category (e.g., White) should activate more quickly for less ambiguous faces, which would lead to strong lateral inhibition of the alternate category (e.g., Black), and this would result in an early, high-velocity trajectory toward the selected category (White). For more ambiguous faces, simultaneous activation of White and Black categories will create more competition and lead them to mutually inhibit one another, which overall reduces velocity early on. Once one category starts to win out, however, lateral inhibition is then gradually lifted, which allows velocity toward that alternative to increase later in processing. From this, we can predict that more ambiguous stimuli will elicit less velocity early on, which is then gradually regained later in the categorization process. Indeed, such velocity dynamics have been observed with ambiguous or incongruent stimuli in a number of mouse-tracking tasks (e.g., Yu, Wang, Wang, & Bastin, 2012).

Despite this general prediction for ambiguous stimuli, a unique velocity profile (with abrupt category shifts) would be expected for low-exposure perceivers as they categorize ambiguous faces. A rapid rise in activation of one category will send lateral inhibition to the competing category, which lowers its activation until the next abrupt shift occurs to rapidly increase that category's activation, which in turn sends inhibition to the other category, and so forth. To overcome the initial inhibition of one category to make way for abrupt increases in that category's activation, this process may be accompanied by a ramping up of velocity to compensate, particularly when one is pressured to respond in the sort of speeded task we used here. When the system is pressured to respond and experiences more abrupt category shifts, a participant's response trajectory may naturally move further onto the speed side of the speed/accuracy trade-off, and thus speeding up may reflect an attempt to quickly overcome this lower accuracy and stability early in the categorization process. Over successive abrupt category shifts, this would result in an overall higher peak velocity, and therefore the rapid and unstable category shifting of low-exposure participants may be accompanied by a unique spike in velocity. Thus, we expected low-exposure participants to exhibit higher peak velocity while categorizing racially ambiguous than racially unambiguous faces; higher velocity would allow them to compensate for abrupt category shifts.

Figure 4 depicts the mean velocity along the horizontal *x*-axis (the axis of decision) across normalized time for the race- and color-categorization tasks, for low and high levels of interracial exposure (using a median split for convenience), and for more ambiguous (morph levels: 0, ±1) and less ambiguous (morph levels: ±2, ±3, ±4) stimuli. To estimate peak velocity, we calculated a 10-window average around the maximum point of velocity for each participant. As expected, peak velocity was lower for ambiguous than for unambiguous trials across both tasks, $t(193) = 8.50$, $p < .0001$. Specifically, velocity profiles showed that ambiguous trials involved lower and slower-to-rise velocities that were regained later in the time course, whereas nonambiguous trials involved earlier and higher peak velocity, consistent with previous work (e.g., Yu et al., 2012). Most important, note the sharper and higher spike in velocity in low-exposure (compared with high-exposure) participants for ambiguous trials around the peak, apparent in the race-categorization but not the control task. Indeed, in the race-categorization task, there was significantly higher velocity for ambiguous trials in low- relative to high-exposure participants, $t(192) = 2.11$, $p = .04$. However, this increased velocity for low-exposure participants was not observed in the color-categorization task, $t(192) = 0.11$, $p = .91$.

Together, these results are consistent with our predictions that more unstable activation changes in low-exposure (relative to high-exposure) participants would occur as they categorized racially ambiguous faces. First, the results are consistent with the characteristic reduced and slower-to-rise velocity profile associated with processing ambiguous stimuli in general (e.g., Yu et al., 2012). More important, the increased velocity unique to low-exposure participants' trajectories in cases of racial ambiguity (but not other types of ambiguity) suggests that these participants had to successively speed up to overcome abrupt shifts in race-category activations, which in turn resulted in increased peak velocity. This velocity effect also accounts for the weak, marginally significant effect with RTs, because characteristic effects of longer RTs here were diminished by a speeding up due to unstable category shifts.

Study 2

In Study 2, we examined the downstream consequences of the unstable dynamics observed during low-exposure participants' categorizations of racially ambiguous faces. Specifically, we tested whether more unstable dynamics during categorizations predict more negative evaluations of mixed-race targets.

Method

Participants. White participants ($N = 149$) were recruited through Amazon Mechanical Turk for monetary compensation (73 female, 76 male; age: $M = 39.3$ years, $SD = 12.5$). As in Study 1, only participants who used a mouse were allowed to participate. Because we were interested in White perceivers' interracial exposure,

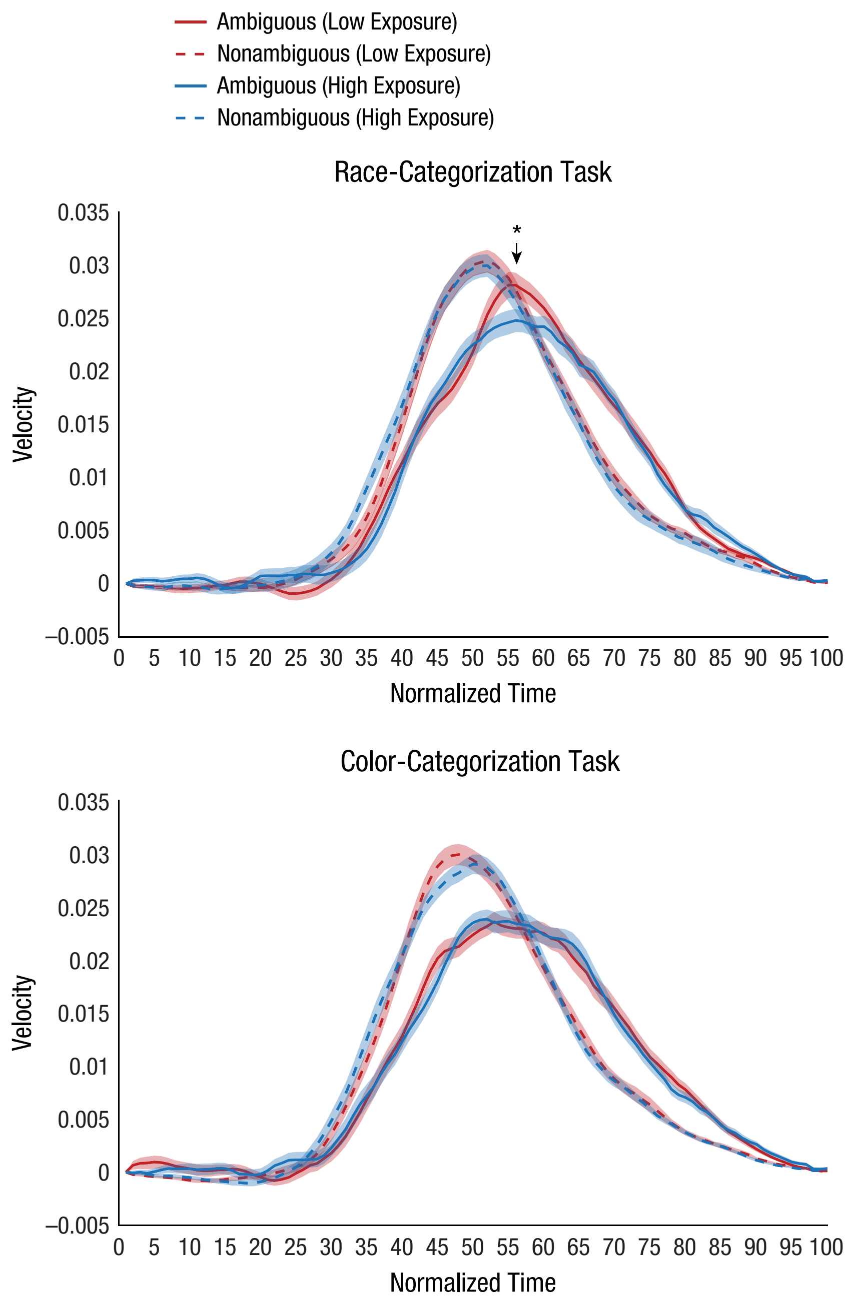

Fig. 4. Mean velocity of mouse movements along the horizontal *x*-axis (axis of decision) as a function of normalized time in the race- and color-categorization tasks of Study 1, separately for all pairings of ambiguity (ambiguous vs. nonambiguous stimuli) and interracial exposure (low vs. high). For the latter, low and high were determined on the basis of a median split. Ambiguous stimuli were morph levels 0 and ±1, and nonambiguous stimuli were ±2, ±3, and ±4. The asterisk indicates a significant difference between exposure groups (*p < .05). Shaded bands represent standard errors of the mean.

non-White individuals completed a separate study unrelated to the present work.

Stimuli. For the mouse-tracking tasks, the face and shape stimuli were identical to those in Study 1. For the evaluative task (see the next section), we used standardized photos of 40 White, 40 Black, and 40 mixed-race faces from Chen, Pauker, Gaither, Hamilton, and Sherman (2016). All photos were cropped to remove the hair and ears and to preserve only the internal face. Mixed-race targets were a morph of one White (50%) and one Black (50%) individual's facial photo. White and Black targets were a morph of two White or two Black individuals' facial photos, respectively. Face stimuli were created using Morpheus Photo Morpher (Version 3.17; http://www.morpheussoftware.net) and were highly realistic.

Procedure. To measure individual differences in evaluative bias against different races, we asked participants to complete a task in which they judged the trustworthiness of faces in a speeded fashion. Trustworthiness ratings account for the bulk of variation in face evaluation and have been shown to be a reliable proxy for general social evaluation, representing axes of positivity-negativity and approach-avoidance (Oosterhof & Todorov, 2008). Moreover, trustworthiness ratings are correlated with activity in the amygdala, a neural region involved in evaluation, automatically in response to faces (Engell, Haxby, & Todorov, 2007), including when a face is not even consciously perceived (Freeman, Stolier, Ingbretsen, & Hehman, 2014). Thus, here we used trustworthiness ratings as an indirect measure of a more basic social evaluation.

Participants first completed the race- and color-categorization mouse-tracking tasks in counterbalanced order, as in Study 1. After completing the categorization tasks, participants proceeded to a filler task involving unrelated questions. They then completed the speeded evaluative ratings, in which they rapidly judged how trustworthy they deemed 120 White, Black, and mixed-race faces. On each trial, a fixation cross was presented for 500 ms, followed by the face and a Likert scale from 1, *very untrustworthy*, to 5, *very trustworthy*. As in previous research (e.g., Rudoy & Paller, 2009), to encourage less deliberate responses, we instructed participants to form their judgment within 2,000 ms.

As in Study 1, participants provided demographic information, including their current zip code for determining their geographical location, which was used to index the percentage of the local Black population using U.S. Census Bureau data (Humes et al., 2011; see Procedure in Study 1 for details). They also completed a questionnaire used to directly assess differential exposure to White and Black individuals. They were asked to rate from 1, *None (0%)*, to 7, *Almost all (100%)*, how many of their (a) acquaintances, (b) friends, and (c) close friends identify as "White/European American" (α = .89) and in another set of questions as "Black/African American" (α = .87). The three ratings for each race were averaged together separately. Expectedly, these White- and Black-exposure scores were negatively correlated, $r(147) = -.36$, $p < .0001$. A difference score (Black – White) was then used to index participant's interracial exposure. Thus, more positive scores indicate greater exposure to Black individuals, and more negative scores indicate greater exposure to White individuals. We also obtained information regarding participants' political orientation for use as a covariate, as in Study 1.[1]

Results and discussion

One participant did not provide a valid zip code, which left 148 participants for our analyses. Participants exhibited a sizable range of local interracial exposure (0.3–64.2% local Black population; M = 11.4%, SD = 12.3). The measure of local interracial exposure based on U.S. Census Bureau data was significantly related to participants' self-reported interracial exposure, $r(146) = .21$, $p = .01$, which supported our use of the measure. Excessively long trials (> 2,000 ms) were discarded from analysis (4.4% of all trials).

Evaluative bias. To assess evaluative bias, we regressed trustworthiness ratings onto target race (dummy coded with White as the comparison condition), interracial exposure, and their interactions using GEE regression. As predicted, there were strong biases overall, with significant effects of mixed-race bias and Black bias, such that mixed-race targets ($M = 3.06$, $SE = 0.04$), $b = -0.136$, $Z = -6.69$, $p < .0001$, and Black targets ($M = 2.83$, $SE = 0.05$), $b = -0.378$, $Z = -18.23$, $p < .0001$, were judged to be less trustworthy than White targets ($M = 3.19$, $SE = 0.05$). A planned contrast further showed that the Black bias was relatively stronger than the mixed-race bias, with Black targets judged to be less trustworthy than mixed-race targets, $b = -0.121$, $Z = -12.04$, $p < .0001$ (mixed-race = −1, Black = 1).

There was also a main effect of interracial exposure, $b = 0.050$, $Z = 2.99$, $p = .003$, which was qualified by a marginally significant interaction of interracial exposure and mixed-race bias, $b = 0.038$, $Z = 1.67$, $p = .09$. Given our a priori hypothesis and to better specify the nature of this interaction, we examined the pattern of bias across low- and high-exposure participants. Specifically, low-exposure (1 SD below the mean) participants judged both mixed-race targets, $b = -0.087$, $Z = -6.01$, $p < .0001$, and Black targets, $b = -0.208$, $Z = -13.96$, $p < .0001$, as less trustworthy than White targets. High-exposure (1 *SD* above the mean) participants also judged both mixed-race targets, $b = -0.049$, $Z = -3.01$, $p = .003$, and Black targets, $b = -0.170$, $Z = -10.05$, $p < .0001$, as less trustworthy than White targets, but the mixed-race bias dropped substantially in size. Given the wide range in exposure levels, noted earlier, an analysis at further levels indicated that participants with the lowest exposure (2 *SD* below the mean) showed both strong mixed-race bias, $b = -0.106$, $Z = -4.41$, $p < .0001$, and Black bias, $b = -0.228$, $Z = -9.06$, $p < .0001$. Participants with the highest exposure (2 *SD* above the mean), however, no longer showed a significant mixed-race bias, $b = -0.029$, $Z = -1.13$, $p = .26$, while the Black bias persisted (although was reduced in size), $b = -0.151$, $Z = -5.47$, $p < .0001$. The interaction of Black bias with interracial exposure was not significant, $b = 0.039$, $Z = 1.59$, $p = .11$.

Because the evaluative task included female targets as well (unlike the primary mouse-tracking task), we additionally examined the possible role of gender in these biases. Indeed, including gender in the model revealed a significant main effect, with women trusted more than men overall, $b = 0.235$, $Z = 28.95$, $p < .0001$. This is consistent with prior work finding that women tend to be evaluated more favorably than men (see Eagly, Mladinic, & Otto, 1991). However, gender did not moderate the relationship between mixed-race bias and interracial exposure, $b = -0.018$, $Z = -1.17$, $p = .24$.

Race-categorization responses. As in Study 1, categorization responses were regressed onto morph level, interracial exposure, and their interaction using GEE logistic regression. There was no effect of interracial exposure on the likelihood of Black categorization, $b = 0.091$, $Z = 1.21$, $p = .23$, nor an interaction of morph level and interracial exposure, $b = -0.040$, $Z = -0.59$, $p = .56$. When examining only the most ambiguous faces (morph levels: 0, ±1), we again found no effect of exposure, $b = -0.017$, $Z = -0.30$, $p = .76$. Participants' PSE was significantly shifted in the direction of Black categorization ($M = 0.35$, $SE = 0.06$), one-sample $t(147) = 11.25$, $p < .0001$, consistent with the findings of Study 1 and previous work on hypodescent. However, there was no correlation between participants' PSE and interracial exposure, $r(146) = -.019$, $p = .83$. These results replicate those of Study 1.

Mouse-tracking data. We ultimately sought to test a mediation model examining the relationship between interracial exposure and mixed-race trust (Fig. 5). Critically, we predicted that abrupt category shifts (*x*-flips), as opposed to overall category competition (maximum deviation, or less directly, RT), would mediate this relationship. To index such mouse-tracking effects in this framework, we calculated for each participant an *x*-flips, maximum deviation, and RT difference score between the most ambiguous stimuli (morph levels: 0, ±1) and least ambiguous stimuli (morph levels: ±2, ±3, ±4).

First, to replicate Study 1's mouse-tracking findings, we conducted one-sample *t* tests comparing the difference scores between ambiguous and nonambiguous trials (ambiguous − nonambiguous) against 0. These tests confirmed significant ambiguity effects across all measures in the race-categorization task—maximum deviation: $t(147) = 9.988$, $p < .0001$; *x*-flips: $t(147) = 2.809$, $p = .006$; RT: $t(147) = 17.530$, $p < .0001$—and in the control task—maximum deviation: $t(147) = 8.759$, $p < .0001$; *x*-flips: $t(147) = 2.438$, $p = .02$; RT: $t(147) = 8.900$, $p < .0001$, all of which were observed in Study 1. Regressing these effects onto interracial exposure revealed that a lower level of exposure was predictive of a stronger *x*-flips ambiguity effect in the race task, $b = -0.059$, $SE = 0.029$, $p = .04$, but not in the control task, $b = 0.024$, $SE = 0.034$, $p = .48$. Further, there was no significant relationship between exposure and ambiguity effects of overall competition in either the race task (maximum deviation: $b = -0.014$, $SE = 0.011$, $p = .20$; RT: $b = -7.45$, $SE = 5.81$, $p = .20$) or the control task (maximum deviation: $b = 0.006$, $SE = 0.013$, $p = .64$; RT: $b = -12.73$, $SE = 13.52$, $p = .35$). Thus, these results replicated those of Study 1 and confirmed that the path between interracial exposure and the *x*-flips ambiguity effect in the mediation model was significant.

In Study 1, not only did interracial exposure uniquely predict the *x*-flips racial-ambiguity effect, but there was also an effect on velocity. Specifically, low-exposure participants exhibited increased velocity for racially ambiguous trials. This likely reflected a process of speeding up to overcome abrupt category shifts when confronting racial ambiguity, as discussed in Study 1. Indeed, using

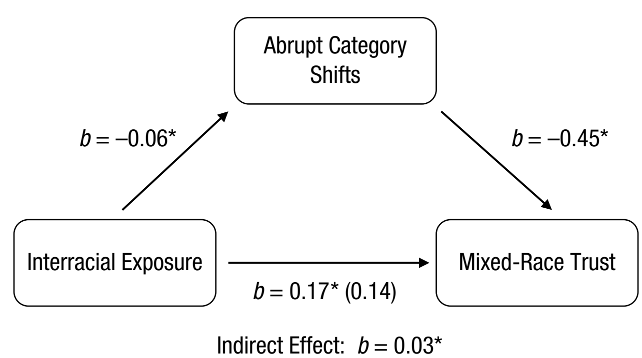

Fig. 5. Mediation model from Study 2 showing the effect of interracial exposure on mixed-race trust, as mediated by the abrupt category shifts (*x*-flips) racial-ambiguity effect (i.e., a greater number of shifts for ambiguous than nonambiguous faces). Asterisks indicate significant paths (*$p \leq .05$). Along the bottom path, the value inside parentheses is the direct effect, and the value outside parentheses is the total effect.

the same method of estimating velocity as in Study 1, here too there was higher peak velocity during ambiguous trials for low-exposure relative to high-exposure participants in the race task, $t(146) = 2.034$, $p = .04$, but not in the control task, $t(146) = −0.524$, $p = .60$. There was also again overall reduced peak velocity for ambiguous trials, $t(147) = 8.138$, $p < .0001$, consistent with prior work (e.g., Yu et al., 2012). These results replicate the velocity analyses of Study 1, showing that lower interracial exposure is associated with greater abrupt White-Black category shifts as well as peak velocity when resolving racial ambiguity.

In support of the novel hypothesis of Study 2, results showed that a larger *x*-flips ambiguity effect in the race task was significantly predictive of lower mixed-race trust, $b = −0.518$, $SE = 0.230$, $p = .03$, while this relationship was not observed for the *x*-flips ambiguity effect in the control task, $b = −0.095$, $SE = 0.201$, $p = .64$. Mixed-race trust was also not significantly predicted by ambiguity effects of overall competition (maximum deviation, or less directly RT) in either the race task (maximum deviation: $b = −0.439$, $SE = 0.620$, $p = .48$; RT: $b = −0.0008$, $SE = 0.001$, $p = .50$) or the control task (maximum deviation: $b = −0.401$, $SE = 0.508$, $p = .43$; RT: $b = −0.0005$, $SE = 0.0005$, $p = .29$). Thus, experiencing more abrupt category shifts while processing racially ambiguous faces was uniquely predictive of less trust for mixed-race individuals. Additionally, including interracial exposure in the model showed that the *x*-flips racial-ambiguity effect still predicted mixed-race trust, $b = −0.459$, $SE = 0.231$, $p = .05$, which thereby confirmed that the path between the *x*-flips racial-ambiguity effect and mixed-race trust in the mediation model was significant.

Finally, as expected given the previous results, interracial exposure was significantly predictive of mixed-race trust, with less exposure associated with less mixed-race trust, $b = 0.168$, $SE = 0.082$, $p = .04$. To estimate the indirect effect that exposure exerted on mixed-race trust via abrupt category shifts, we used a bootstrapping procedure (Preacher & Hayes, 2008). Indeed, abrupt category shifts (the *x*-flips ambiguity effect) significantly mediated the relationship between exposure and mixed-race trust, as the direct effect was no longer significant, $b = 0.141$, $SE = 0.082$, $p = .09$, and the indirect effect's confidence interval excluded zero: $b = 0.027$, $SE = 0.014$, 95% confidence interval = [0.007, 0.066].

Abrupt category shifts. To more comprehensively explore what pattern in abrupt category shifts during mouse tracking was associated with this trust bias against mixed-race targets, we regressed mouse-trajectory *x*-flips onto linear and quadratic components of morph level, the participant's average mixed-race trust, and their interactions using GEE Poisson regression (for count data). In race categorization, the significant quadratic effect of morph level (i.e., racial ambiguity), $b = −0.0015$, $Z = −2.40$, $p = .02$, was qualified by an interaction of quadratic morph level and mixed-race trust, $b = 0.0014$, $Z = 2.59$, $p = .01$ (Fig. 6). Participants who turned out to be less trusting of mixed-race targets (1 *SD* below the mean) had shown a strong effect of increasing *x*-flips as race became more ambiguous, simple $b = −0.0029$, $Z = −3.27$, $p = .001$. Participants who turned out to be relatively more trusting of mixed-race targets (1 *SD* above the mean), on the other hand, had shown no such effect of racial ambiguity on *x*-flips, simple $b = −0.0001$, $Z = −0.16$, $p = .88$. Critically, in the color-categorization task, the interaction of quadratic morph level and mixed-race trust was not significant, $b = −0.0005$, $Z = −0.69$, $p = .49$, which demonstrates that abrupt category shifts when resolving racial ambiguity—and not other forms of ambiguity—are associated with the trusting of mixed-race targets.

To summarize, Study 2 replicated the abrupt category-shifting effects found in Study 1 during the processing of racial ambiguity, and more important, showed that

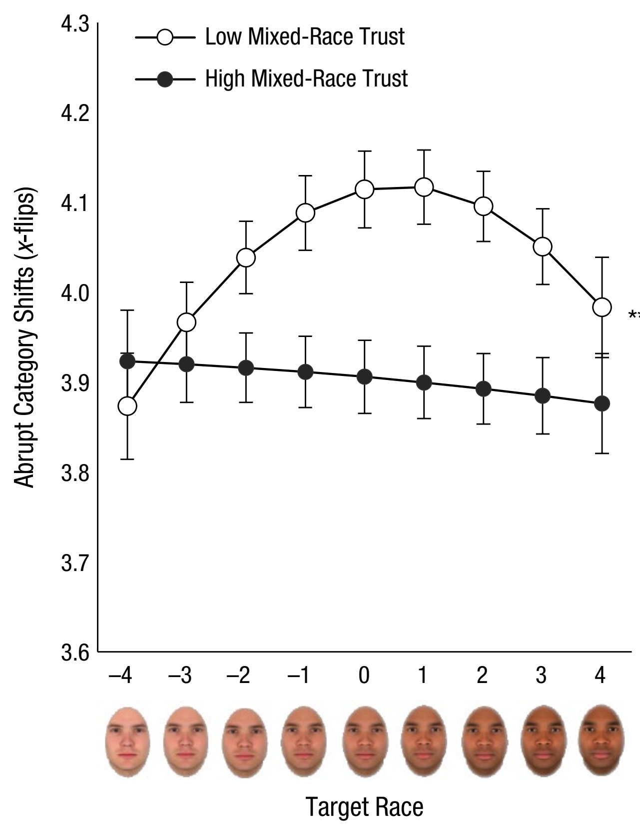

Fig. 6. Mean number of abrupt category shifts (*x*-flips) in the race-categorization task of Study 2. Results are shown for each morph level, separately for participants with low and high levels of mixed-race trust (1 *SD* below and above the mean, respectively). Asterisks indicate a significant quadratic morph-level effect (i.e., racial-ambiguity effect; $^{**}p < .001$). Error bars show standard errors of the mean.

stronger category-shifting effects predict less trust for mixed-race individuals and mediate the effect of less interracial exposure on this reduced trust.

General Discussion

In the present studies, we found that individuals in neighborhoods with lower interracial exposure exhibited a unique effect of abrupt category shifting as racial cues became ambiguous, and this shifting effect was exclusive to race and not to other forms of ambiguity, such as in color categorization. Research has long shown that individuals with lower interracial exposure view a larger divide between "us" versus "them" and have more differentiated social-category representations (Dovidio et al., 2003; Pettigrew et al., 2011). The present research showed through use of computational simulations and converging mouse-tracking findings that for low-exposure perceivers, when such dissimilar categories become inherently blended by racial ambiguity, their perceptual system encounters more unstable categorization dynamics. Such unstable dynamics, in turn, were shown to have negative evaluative consequences, namely they predicted a reluctance to trust mixed-race targets and mediated the effect of one's exposure on that trust bias.

Theoretically, the findings call attention to the process rather than products of race categorization. We found that interracial exposure had no influence on ultimate categorical responses or in the overall amount of competition triggered by racial ambiguity; instead, it affected the instability in how categorization unfolded in a way that uniquely predicted evaluative biases. Thus, there are important qualitative differences in the categorization process, such as dynamic category-shifting effects, that operate independently of ultimate categorization responses. Such category-shifting effects are consistent with the recent perspective that a social categorization is the end result of a pattern-completion process wherein the perceptual system settles into one of competing attractors (e.g., White or Black patterns; Freeman & Ambady, 2011). If the two attractors are highly dissimilar (as in the case of low-exposure perceivers), the settling process would be more unstable because of conflicts of bottom-up visual processing "pushing" together race categories that top-down conceptual knowledge is trying to rapidly "pull" apart, consistent with our computational simulations (see Fig. 1). As such, the current findings build on a growing body of research documenting the myriad influences of higher-order social cognition on lower-level perceptual processes (Adams, Ambady, Nakayama, & Shimojo, 2011; Freeman & Ambady, 2011). Specifically, they provide novel evidence that prior experiences with different racial groups can shape the structuring of social categories and how those categories activate and resolve during real-time perceptions—even when ultimate categorical outcomes are unchanged.

Importantly, our findings bolster mounting evidence that the fluency of initial perceptual experiences may affect a variety of downstream social processes, such as evaluation, even independent of group membership itself (Lick & Johnson, 2015). It has long been known that stimuli "easier on the mind" tend to be judged as more favorable (Belke, Leder, Strobach, & Carbon, 2010) and valuable (Alter & Oppenheimer, 2008), and recently such effects of fluency have been additionally extended to social perception (Lick & Johnson, 2015). As discussed earlier, previous studies have found mixed-race individuals to be more negatively evaluated than monoracial individuals (Sanchez & Bonam, 2009), although the mechanisms at work have been less clear. Our findings suggest that such mixed-race evaluative biases are more pronounced in individuals with lower interracial exposure, primarily because their initial perceptual experience of a mixed-race face involves unstable category shifts that help drive those biases.

The current work is not without its limitations. The naturalistic interracial exposure we examined here required a correlational design that limited causal inferences, and future work could benefit from manipulating interracial exposure (e.g., Halberstadt et al., 2011). Moreover, although our participants' neighborhoods exhibited a wide range of interracial exposure, the studies were constrained by overall fairly low levels, albeit typical for the White-majority United States (Rugh & Massey, 2014). Finally, we adopted the census-based measure as a more "objective" proxy of incidental exposure, which has long been used by sociologists (e.g., Rugh & Massey, 2014), but future studies could achieve a more comprehensive understanding of how this measure relates to (and possibly dissociates from) subjective self-reports of interracial exposure.

In summary, our findings demonstrate that interracial exposure in one's local environment shapes the dynamics through which racial categories activate and resolve in the perceptual experience of racial ambiguity, and it is these dynamics in initial perceptions that specifically predict evaluative biases against mixed-race individuals. This research therefore connects the process rather than products of race categorization to evaluative biases against racial groups, and it bolsters the notion that lower-level perceptual aspects of encounters with other people may serve as a foundation for certain forms of prejudice. Fortunately, if interracial exposure can change initial perceptual dynamics in ways that result in evaluative biases, this work may point to an additional perceptually driven pathway by which intergroup experiences are able to get "under the hood" and reduce prejudice.

Action Editor

Jamin Halberstadt served as action editor for this article.

Author Contributions

All authors developed the study concept and contributed to the study design and interpretation of the data. J. B. Freeman collected and analyzed the data. J. B. Freeman drafted the manuscript, and K. Pauker and D. T. Sanchez provided critical revisions. All authors approved the final version of the manuscript for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Supplemental Material

Additional supporting information can be found at http://pss.sagepub.com/content/by/supplemental-data

Note

1. To rule out alternative explanations raised after the study was conducted, we collected additional covariates using a follow-up set of survey questions. These covariates included level of education, openness to experience using the subscale from the 44-item Big Five Inventory (John & Srivastava, 1999), and years of residence. Of all participants, 105 responded to the follow-up for this additional information (71% of the final sample). In analyses controlling for these variables, multiple imputation was used to estimate missing covariates for the nonrespondents. Including participant age, political orientation, level of education, openness to experience, and length of residence as covariates did not change the significance of the results.

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