Emotion

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Seeing No Pain: Assessing the Generalizability of Racial Bias in Pain Perception

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Racial disparities in pain care may stem, in part, from perceptual roots. It remains unresolved, however, whether this perceptual gap is driven by general deficits in intergroup emotion recognition, endorsement of specific racial stereotypes, or an interaction between the two. We conducted four experiments (total $N = 635$) assessing relationships between biases in pain perception and treatment and biases in the perception of anger, happiness, fear, and sadness. Participants saw Black and White male targets making increasingly painful and angry (Experiment 1), happy (Experiment 2), fearful (Experiment 3), or sad expressions (Experiment 4). The effect of target race consistently varied based on the emotion displayed. Participants repeatedly saw pain more readily on White (vs. Black) male faces. However, while participants also saw sadness less readily on Black faces, perception of anger, fear, and happiness did not vary by target race. Moreover, the tendency to see pain less readily on Black faces predicted similar differences in recognizing (particularly negative) expressions, though only racial bias in pain perception facilitated similar biases in treatment. Finally, while endorsement of racialized threat stereotypes facilitated recognition of angry expressions and was marginally associated with impeded recognition of happy expressions on Black faces, gaps in pain perception were not reliably related to stereotype endorsement. These data suggest that while racial bias in pain perception is associated with a general bias in recognizing negative emotion on Black male faces, the effects of target race on pain perception are particularly robust and have distinct consequences for gaps in treatment.

Keywords: health disparities, social perception, pain, racial bias, emotion perception

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Pain experienced by Black patients is consistently underdiagnosed and undertreated in clinical settings compared with White patients' pain (Anderson et al., 2009; Green et al., 2003). Black Americans are prescribed opioid and non-opioid-based pain relievers at lower rates than their White counterparts, and when they *are* prescribed pain relievers, they receive significantly lower doses (Lee et al., 2019). Psychological factors like implicit racial bias (Green et al., 2007; Sabin & Greenwald, 2012), stereotypes regarding status (Trawalter et al., 2012), and false beliefs about biological differences between Black and White people (Hoffman et al., 2016) may fuel these disparities.

However, recent work also demonstrates a perceptual route of racial bias in pain care: White perceivers see pain less readily on Black (vs. White) faces, and this perceptual bias facilitates reductions in treatment recommendations for Black (vs. White) targets (Mende-Siedlecki et al., 2019). Rather than merely reflecting ingroup regard, Black faces may be particularly affected by this bias: White perceivers saw pain equally readily on Asian and White faces in this work (Experiment 7, Mende-Siedlecki et al., 2019; but see Contreras-Huerta et al., 2013; Xu et al., 2009).

Reduced sensitivity to pain on Black faces aligns with literature suggesting that, in general, race may disrupt the deployment of basic human face processing mechanisms (Hancock & Rhodes, 2008; Hughes et al., 2019; Michel et al., 2006; Natu et al., 2011). However, in some cases, race may specifically shape the recognition of emotional expressions *in line* with stereotype content (e.g.,

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anger, Hugenberg & Bodenhausen, 2003). In other words, different mechanisms may produce similar discrepancies in emotion perception. That said, little work has directly compared the effects of target race across emotions, particularly pain. The present work examines the generalizability of racial bias in pain perception by comparing it with similar differences in recognizing anger, happiness, fear, and sadness.

By understanding the commonalities and distinctions across race-based gaps in pain and emotion perception, this work will inform attempts to reduce these biases. Disruptions stemming from a shared source could be ameliorated via the same intervention; however, a "one-size-fits-all" approach that assumes common underlying mechanisms may be counterproductive. Moreover, while previous work demonstrates that target race shapes recognition of anger and happiness, considerably less attention has been paid to racial bias in the recognition of fear and sadness. Initial estimates of the magnitude of these perceptual biases will provide a solid foundation for future work on their downstream consequences. Together, we attempt to offer a comprehensive account of where racial biases in emotion perception exist, which are correlated with gaps in pain recognition and treatment, and what common threads might unite these biases.

Pain and Emotional Expressions

Painful expressions are social signals critical for communicating the experience of suffering and soliciting aid (Craig, 2015; Kappesser & Williams, 2002; Williams, 2002). In turn, painful expressions are characterized by specific facial muscle movements (e.g., action units) associated with both clinical and experimental pain—in particular, brow lowering, eyelid tightening, nose wrinkling, opening of the mouth, and raising of the upper lip and cheeks (Hill & Craig, 2002; Kunz et al., 2019; Prkachin & Solomon, 2008). While pain is not typically included among the "basic" emotions (e.g., Ekman, 1992), painful expressions are distinct (Kappesser & de Williams, 2002) and perceivers robustly discriminate between painful and other basic emotional expressions (Simon et al., 2008). Mirroring other emotional displays, facial expressions of pain are rapidly and spontaneously processed (Craig et al., 2010; Vervoort et al., 2013; Yamada & Decety, 2009), generalize across cultures (Chen et al., 2018; Cordaro et al., 2018), and are selectively attended to early in development (Deyo et al., 2004).

At a neural level, painful facial expressions elicit activity in brain regions involved in the first-hand experience of pain (e.g., anterior cingulate cortex and anterior insula; Botvinick et al., 2005). Notably, one study observed overlaps in responses to pain and anger in the superior temporal sulcus (a region engaged by dynamic expressions; Allison et al., 2000), but preferential recruitment of the amygdala for painful expressions (Simon et al., 2006). This finding dovetails with other work demonstrating that for expressions of comparable intensity, pain is perceived as more unpleasant and more arousing (Simon et al., 2008) and that processing of painful expressions may be prioritized over other expressions (Gonzalez-Roldan et al., 2011; Reicherts et al., 2012), potentially reflecting the core relevance of pain experience (Williams, 2002).

In sum, painful expressions are distinct and represent social signals that robustly elicit empathic responses. While the painful expressions bear similar hallmarks to other emotional expressions in terms of their specificity, generalizability, and underlying foundations, differential attention to painful versus other emotional expressions may represent a key distinction.

Perceptual and Psychological Influences on Intergroup Emotion Perception

Racial group membership guides social and emotion perception. Same-race face perception involves the engagement of "expert" face processing mechanisms (e.g., holistic and configural face processing), while other-race faces are processed in a more piecemeal-based manner (e.g., featural processing; Michel et al., 2006; Rhodes et al., 2006). Critically, configural processing also supports emotion recognition (Bombari et al., 2013; Calder et al., 2000; Calder & Jansen, 2005), and disruptions therein may facilitate *gaps* in emotion recognition. For example, White perceivers saw pain earlier on upright White (vs. Black) faces; however, when faces were inverted (disrupting configural face processing; Freire et al., 2000; Maurer et al., 2002), racial bias in pain perception was attenuated (Mende-Siedlecki et al., 2019). Configural face processing may also be disrupted for members of marginalized, dehumanized, or lower social status groups (Cassidy et al., 2017; Fincher & Tetlock, 2016; Shriver & Hugenberg, 2010).

Discrepancies in recognizing pain on Black (vs. White) faces stemming from disruptions in configural face processing might generalize to other emotional expressions. Notably, a seminal meta-analysis by Elfenbein and Ambady (2002) across 97 experiments demonstrated that recognition accuracy is higher for emotions expressed by in-group (vs. out-group) individuals. However, this gap in accuracy was ameliorated somewhat when the groups in question had more direct contact with one another, mirroring findings suggesting that increased intergroup contact has a positive impact on other-race face processing (Anzures et al., 2013; Hancock & Rhodes, 2008; Kelly et al., 2007; Rhodes et al., 2010).

However, other work suggests that biases in detecting emotions may also reflect links between social categories and stereotypes. Racial category membership is rapidly attended to and extracted (Cloutier et al., 2005; Ito & Urland, 2003; Kubota & Ito, 2007; Kubota & Ito, 2016), and can influence perception by activating stereotypes associated with a group (Freeman & Johnson, 2016). In particular, representational similarities between linked race, gender, and emotion categories may guide intergroup emotion perception, facilitating or impeding the detection of certain expressions within certain groups (e.g., Black-angry; Stolier & Freeman, 2016).

For example, Black individuals are more likely to be stereotyped as being threatening or violent (e.g., Devine, 1989; Dixon & Maddox, 2005; Eberhardt et al., 2004). These stereotypes may facilitate recognition of anger on Black faces. Indeed, White participants perceive anger more readily on Black (vs. White) faces as a function of implicit anti-Black bias (Hugenberg & Bodenhausen, 2003) and show a response latency advantage for categorizing Black (vs. White) targets as being angry (Hugenberg, 2005; see also Bijlstra et al., 2010; Shapiro et al., 2009). Moreover, despite the typical cross-race effect for neutral faces, White participants remember angry Black faces more accurately than angry White faces (Ackerman et al., 2006). That said, other work has failed to replicate such effects after controlling for stimulus con-

founds (Gwinn et al., 2015), and observed instead that both Black and White perceivers showed relative difficulty in recognizing angry Black faces.

Conversely, the recognition of happiness may be impeded on Black faces. White perceivers show a response latency advantage for categorizing happy (vs. other) expressions on White (vs. Black) faces (e.g., Hugenberg, 2005). These effects have consequences for how accurately happy expressions are recognized: White participants can better distinguish between genuine (e.g., Duchenne) smiles and false smiles on White (vs. Black) faces, as a function of attention to the eye region (Friesen et al., 2019).

While threat stereotypes shape perception of anger and happiness on Black faces, stereotypes related to the status (Trawalter et al., 2012), strength (Wilson et al., 2017; Johnson & Wilson, 2019), or pain tolerance (Wandner et al., 2012) of Black individuals might be predicted to fuel disparities in pain care. However, in our previous work, reduced perceptual sensitivity to pain on Black faces facilitated gaps in treatment *over and above* explicit stereotypes, while endorsement of false biological beliefs was not reliably associated with racial bias in pain perception (Drain et al., 2020; Mende-Siedlecki et al., 2019). In other words, present evidence suggests that racial bias in the visual perception of painful expressions and explicit pain-relevant stereotypes may make distinct contributions to disparities in pain care. That said, no work to date has systematically examined the role of threat stereotypes in shaping racial bias in pain perception and the relationship between this perceptual bias and stereotypes regarding status, strength, and pain tolerance deserves additional focus. Critically, these individual-level factors are deeply rooted in a context of structural and historical racism (Trawalter et al., 2020), in which medicine and health care have often scaffolded and perpetuated White supremacist systems (Feagin & Bennefield, 2014). Perceptual insensitivity to the emotions of Black individuals described herein should be understood as operating *within* these structures and this history—a product of pervasive and systematized racism in America, manifesting at the level of individual perception.

The effects of target race on pain perception might be mirrored in other emotions that, relative to anger and happiness, lack specific stereotype content—like fear and sadness. Indeed, previous meta-analysis (Elfenbein & Ambady, 2002) suggests that the ingroup advantage for recognizing fear and sadness is even greater than the advantage for anger or happiness. However, work on the recognition of these emotions in the Black/White context is scant and mixed (Bijlstra et al., 2010; Hugenberg, 2005; Krumhuber & Manstead, 2011). A systematic comparison of racial bias in pain perception to similar effects within anger, happiness, fear, and sadness would deepen our understanding of the perceptual underpinnings of pain disparities.

The Present Research

Pain is less readily perceived on Black (vs. White) faces, with consequences for bias in treatment recommendations. While previous work links these gaps to general disruptions in configural face processing, the effects of target race on the recognition of at least some other emotions (e.g., anger and happiness) vary as a function of racial stereotypes. Therefore, a comprehensive evaluation of race-based influences on pain perception versus other emotions is necessary. Here, we present four experiments that descriptively characterize the generalizability of racial bias in pain perception across several criteria: (a) Which emotions are—like pain—perceived less readily on Black (vs. White) faces? (b) Are gaps in recognizing other emotions on Black faces correlated with racial bias in pain perception? (c) Finally, are racial biases in the perception of pain and other emotions supported by common threads (e.g., stereotype endorsement) and predictive of common behavioral outcomes (e.g., biases in treatment)?

Specifically, we examined how gaps in thresholds for perceiving pain on Black and White faces compare with biases in perceiving anger (Experiment 1), happiness (Experiment 2), fear (Experiment 3), and sadness (Experiment 4). Based on previous research, we initially predicted that anger would be perceived earlier, but that fear, sadness, and happiness (like pain) would be perceived later on Black (vs. White faces). That said, we were somewhat agnostic as to the relationships between perceptual biases, or the extent to which gaps in emotion perception (e.g., aside from pain) would predict racial bias in treatment. Together, these experiments shed light on whether racial biases in emotion perception reflect a general deficit in perceiving emotions on Black (vs. White) faces, a tendency for stereotype content to impede (or facilitate) recognition of certain emotions, or a combination of these influences. In addition, we conducted a series of meta-analyses across these experiments (presented before the General Discussion) and a conceptual similarity analyses, which can be found in the online supplementary materials.

General Methods

Given the similarity of the designs across Experiments 1–4, this section details common procedures across this work, plus any experiment-specific deviations that can be briefly noted.

Procedure

All participants in all four experiments provided informed consent, in accordance with approval from the Institutional Review Board at the University of Delaware. Participants in all experiments completed tasks adapted from prior work (Mende-Siedlecki et al., 2019):

- an *emotion rating phase* in which they rated faces of Black and White targets in increasing (a) pain and (b) one other emotion (anger in Experiment 1, happiness in Experiment 2, fear in Experiment 3, and sadness in Experiment 4)
- a *treatment recommendations task* in which they prescribed pain-relieving cream to Black and White targets in ambiguous pain
- a *social evaluations phase* in which participants rated Black and White targets on various social dimensions
- demographics and individual differences measures

In the *emotion rating phase*, each participant saw equal numbers of Black and White faces making expressions of pain and the other emotion specific to the given experiment. We created series of morphs (11 per target, ranging from 100% neutral to 100% pain or other emotion expression) by pairing racially neutral head identities with previously normed expressions (FaceGen Modeller Core (v3.5) in Experiment 1, FaceGen Modeller Pro (v3.18) in Experiments 2–4). In Experiment 1, each head was manipulated in terms of skin tone (but not structure) to appear Black or White. In

Experiments 2–4, targets varied across race in terms of both skin tone and structure, as these dimensions cannot be decoupled in FaceGen Modeller Pro. Each target was seen twice by each participant—once making painful expressions and once making expressions of the other emotion.

Emotion expressions were created following procedures detailed in the Delaware Pain Database (Mende-Siedlecki et al., 2020). In Experiment 1, participants saw six Black and six White targets making six different expressions of pain and anger. In Experiments 2–4, participants saw eight Black and eight White targets. Fewer fear and sadness expressions were usable, so in Experiments 3 and 4, we showed each expression on two different targets within a given emotion block. Moreover, in Experiments 2–4, we vignetted all stimuli (as in Freeman et al., 2014) to remove their "bald" appearance.

Finally, we used only male stimuli across Experiments 1–4. Our work demonstrates that racial bias in pain perception is larger within male (vs. female) targets (Drain et al., 2020),[1] mirroring effects observed for angry (Krumhuber & Manstead, 2011) and happy expressions (Craig et al., 2017; Craig et al., 2012; Lipp et al., 2015) in other work. As a result, we used only male stimuli in the present experiments in order to study the perceptual bias at the heart of this work under the circumstances where it is most readily observed.

In each experiment, we partially counterbalanced the pairings of race, head, and expression across four versions of the task.[2] Stimuli were blocked with regards to expression and block order was randomized. Within blocks, targets were randomized with regards to race and head identity. We used a cover story stating that we were examining the effects of real versus computer-generated images on visual processing, and that the participant had been selected to see computer-generated images. Pain expressions were described as digitally rendered images of actual subjects who were video-recorded receiving burning stimulations on their forearms.

In Experiment 1, before the anger block, participants received similar instructions, with one small change. Here, targets were described as previous in-lab participants who were video-recorded while they "were playing an economic game and were cheated out of money by their partners." Nonpain expressions in Experiments 2–4 were described as digital renderings of previous participants recorded while watching "funny," "frightening," or "sad" movies, respectively.

Within each block, participants saw images of targets making increasingly intense expressions. Each image was accompanied by a binary-choice yes/no question asking if the face presented was experiencing the emotion that was being tested for (e.g., "Is this face angry?" or "Is this face in pain?" in Experiment 1). If participants answered yes, the task advanced to the next target. If they answered no, the next image in the continuum was presented until the participant perceived the target emotion or until they saw all 11 morphs in the continuum.

Next, participants completed a *treatment recommendations task*, preceded by instructions directly taken from prior work (Mende-Siedlecki et al., 2019). In Experiment 1, two Black targets and two White targets were randomly selected and presented one at a time, each making a 50% intensity pain expression. In Experiments 2–4, *all* targets presented in the *emotion rating phase* reappeared during the *treatment recommendations task*. For each target, participants were asked, *"Based on the expression of pain you see from the individual above, how many grams of the non-addictive pain-relieving cream should they be given?"* and given a slider on a 0- to 20-g scale on which to respond. We described the cream as such to avoid any explicit reference to opioid-based analgesics that could trigger racial stereotypes regarding drug abuse.

Next, participants completed a *social evaluations phase*. In Experiment 1, participants saw the subset of targets (two Black, two White) from in the *treatment recommendations task* now making neutral expressions. Participants rated these targets on dimensions potentially related to racial bias in pain perception (status, Trawalter et al., 2012; strength, Hoffman et al., 2016 and Wilson et al., 2017; threat, Hugenberg & Bodenhausen, 2003), plus three control dimensions, on a 7-point Likert-type scale (e.g., "How strong does this face look?"; 1 = *not at all*, 7 = *extremely*). For brevity's sake in Experiments 2–4, participants made judgments about the status, threat, and physical strength of 12 groups (including "Black Americans" and "White Americans", randomly ordered) on 0 to 100 scales (e.g., "On a scale of 0 to 100, how threatening are people from the following groups?"; 0 = *not at all threatening*, 100 = *very threatening*).

Finally, participants completed demographic (age, gender, race, and political ideology) and individual differences measures. Participants also rated their feelings of warmth (0 to 100 scale) toward 10 groups, including Black and White Americans (randomly ordered). Warmth toward Black Americans was subtracted from warmth toward White Americans to yield a measure of explicit racial bias. We included an exploratory measure of false beliefs regarding biological differences between Black and White people in Experiment 1 (Hoffman et al., 2016), and additional measures in Experiments 2–4: (a) animalistic and mechanistic dehumanization (Haslam & Bain, 2007); (b) blatant dehumanization (Kteily et al., 2015); and (c) self-reported intergroup contact (Cloutier et al., 2014). Exploratory analyses are reported in the online supplementary materials, and notable trends are described in the General Discussion.

Analyses

Our analytic approach was directly adapted from prior work on racial bias in pain perception (Drain et al., 2020; Mende-Siedlecki et al., 2019). We first calculated average thresholds for pain perception and other emotion perception (separately for Black and White targets) from responses during the *emotion rating phase*. For each target, the morph on which a participant answered "yes" during this task represented this threshold. These values were

[1] In this previous work, Black female targets received less pain reliever compared with all other target types. These data align with well-documented gender disparities in pain care (Chen et al., 2008; Hirsh et al., 2014; Hoffmann & Tarzian, 2001), as well as the disproportionate extent to which these disparities affect Black women (Glance et al., 2007; Green & Hart-Johnson, 2010; Johnson et al., 2019; Mathur et al., 2020; Ndao-Brumblay & Green, 2005).

[2] This counterbalancing procedure ensured that (a) each expression appeared on both a Black and a White target and (b) in each version, each head appeared with both Black and White skin tone, making different expressions of pain and the other emotion. Finally, any head/pain expression pairing appearing in one version appeared in another version of the task as a different race. (Full details are available in the online supplementary materials.)

averaged across targets within race and expression, and transformed to a 0 to 1 scale.

We then conducted a 2 (target race: Black vs. White) × 2 (expression: pain vs. other) repeated measures ANOVA on participants' perceptual thresholds to assess (a) the main effects of target race and target emotion, as well as (b) the interaction between target race and emotion. We conducted similar analyses to assess the effect of target race on treatment recommendations and social evaluations. (All analyses of social evaluations appear in Supplementary Methods).

Next, we examined the association between racial bias in pain perception and other emotion perception, and the degree to which either of these perceptual biases was related to gaps in treatment recommendations. Racial bias in pain perception was operationalized as a tendency to see pain less readily on Black (vs. White) faces (e.g., Black pain thresholds minus White pain thresholds). Across experiments, racial biases in the perception of other emotions were operationalized in the same direction as pain—a tendency to see these emotions *less* readily on Black (vs. White) faces (e.g., Black happiness thresholds minus White happiness thresholds).

Finally, we assessed whether racial bias in pain perception facilitates biases in treatment over and above other potential factors using the MEMORE macro for within-subjects mediation analysis (Montoya & Hayes, 2017). In each experiment, we estimated the indirect effect of race on treatment recommendations through bias in pain perception[3] (as well as the total and direct effects of race on treatment), compared in parallel against bias in other emotion perception, explicit racial bias, and explicit stereotypes (e.g., judgments of status, strength, and threat, plus dehumanization measures in Experiments 2–4) using percentile bootstrapping (10,000 samples).

Our procedure for determining sample size, all data exclusions, all manipulations, and all measures included in this research are fully reported in this article. Materials and de-identified data have been made available online (https://osf.io/emjdg/).

Experiment 1: Racial Bias in Pain and Anger Perception

We began by comparing racial bias in pain perception to similar gaps in recognizing anger. While pain is less readily seen on Black (vs. White) faces, potentially due to disruptions in configural face processing (Mende-Siedlecki et al., 2019), the perception of anger may be *facilitated* on Black faces (Hugenberg & Bodenhausen, 2003) as a result of stereotype associations between the Black racial category and anger (Stolier & Freeman, 2016).[4]

If racial bias in pain perception is driven by general differences in perceiving emotions on Black faces, this gap might be expected to generalize to other emotions like anger. Alternatively, if the effect of target race varies by emotion, and if the two biases are *not* correlated across participants or differentially associated with stereotype content, this might suggest that different mechanisms support racial bias in pain and anger perception. However, it remains possible that both factors exert simultaneous influence. Overall, emotions might be seen less readily on Black (vs. White) faces due to low-level perceptual disruptions, but endorsement of specific stereotypes (e.g., threat) may enhance detection of certain emotions (e.g., anger).

Method

Participants

We recruited 140 U.S.-based Mechanical Turk (MTurk) participants (71 males, 68 females, one nonreported; $M_{age} = 36.26$, $SD_{age} = 11.82$; 110 White, 10 Hispanic, 12 Asian, five Native American, one Pacific Islander, and two participants identifying with another racial group). Thirteen Black individuals were excluded from analyses.[5] We recruited via MTurk given its diversity in age, race, gender, and geographic distribution across the U.S. (Huff & Tingley, 2015; Paolacci & Chandler, 2014) versus the typical psychology subject pool (Henrich et al., 2010; see Figure 1).

Across experiments, we aimed for at least 80% power to detect the relationship between biases in pain perception and treatment, based on the average effect size observed in our prior work ($r = .250$, Mende-Siedlecki et al., 2019). However, these data were collected during a spike in fraudulent MTurk participation, involving non-U.S. participants using virtual private servers (Dennis et al., 2018; Dreyfuss et al., 2018). Thirty-five additional participants were excluded based on repeated IP addresses or geotags. In Experiments 2–4, enhanced screening prevented fraudulent participation (Winter et al., 2019). We also excluded participants from previous studies using similar paradigms, and participants from each experiment herein were excluded from all subsequent experiments.

Stimuli

We selected six pain expressions that were rated as looking more like pain on average than any emotion ($M = 4.66$ out of 7) including anger ($M = 2.31$; $p < .001$), and six anger expressions that were rated as looking more like anger ($M = 4.67$) on average than any other emotion, including pain ($M = 2.58$; $p < .001$). For further details, see the online supplementary materials.

[3] In Experiment 1, as in Mende-Siedlecki et al. (2019), we reasoned that the most relevant measure of perceptual bias for this analysis would be specific to participants' thresholds for seeing pain on targets later presented during the *treatment* task—e.g., "*treated*" bias in perception. In the other three experiments, all targets appeared in both the *emotion rating phase* and *treatment task*, so there was no need to differentiate between "overall" and "treated" bias.

[4] In a separate sample, we examined participants' conceptual representations of various race, gender, and emption categories (including anger, pain, fear, sadness, and happiness (see the online supplementary materials). Representations of anger were positively correlated with representations of the Black racial category, $r(94) = .281$, $p = .006$, negatively correlated with representations of the White racial category, $r(94) = -.241$, $p = .018$, and the difference between these effects was statistically significant ($z = 4.05$, $p < .001$), replicating the findings of Stolier and Freeman (2016). Notably, representations of pain were not reliably associated with either racial category.

[5] While our previous work used entirely White samples, we analyzed the data of all non-Black participants in the present experiments. This approach afforded us an increase in statistical power with a more representative sample. Moreover, our previous results (e.g., Experiment 7, Mende-Siedlecki et al., 2019) suggest that racial bias in pain perception is not merely a case of in-group bias. Across Experiments 1-4, the primary patterns of results do not change substantively if non-White participants are excluded from analyses.

Figure 1
Example Stimuli From Experiment 1

Note. Participants saw morphs between neutral expressions and both (A) painful expressions and (B) angry expressions. Both Black and White targets depicted above are making the same painful expression in (A) and the same angry expression in (B). See the online article for the color version of this figure.

Results

Racial Bias in Emotion Perception

We observed a statistically significant main effect of target race on overall perceptual thresholds, $F(1, 139) = 18.41$, $p < .001$, $\eta_p^2 = .12$, while the main effect of emotion was not statistically significant, $F(1, 139) = 1.46$, $p = .229$, $\eta_p^2 = .01$. Specifically, participants' thresholds for perceiving emotion in general were significantly higher for Black targets ($M = .332$, $SD = .177$) than for White targets ($M = .313$, $SD = .166$).

However, these effects were qualified by an interaction of target race and emotion, $F(1, 139) = 13.86$, $p < .001$, $\eta_p^2 = .09$. Specifically, the effect of target race on pain perception was statistically significant, $F(1, 139) = 32.09$, $p < .001$, $\eta_p^2 = .19$; $M_{Black} = .345$, $SD_{\text{Black}} = .188$, $M_{White} = .312$, $SD_{\text{White}} = .184$, but the effect of target race on anger perception was not, $F(1, 139) = 0.67$, $p = .414$, $\eta_p^2 < .01$; $M_{Black} = .319$, $SD_{\text{Black}} = .183$, $M_{White} = .314$, $SD_{\text{White}} = .171$ (see Figure 2A). In other words, participants saw pain less readily on Black (vs. White) faces, but contrary to our predictions, their thresholds for seeing anger did not vary as a function of race.

Racial Bias in Treatment Recommendations

We observed a significant effect of target race on treatment recommendations. Specifically, participants recommended prescribing significantly more pain-relieving cream, $F(1, 139) = 6.07$, $p = .015$, $\eta_p^2 = .04$ for White targets than Black targets ($M_{Black} = 9.84$, $SD_{\text{Black}} = 5.22$, $M_{White} = 10.61$, $SD_{\text{White}} = 5.59$).

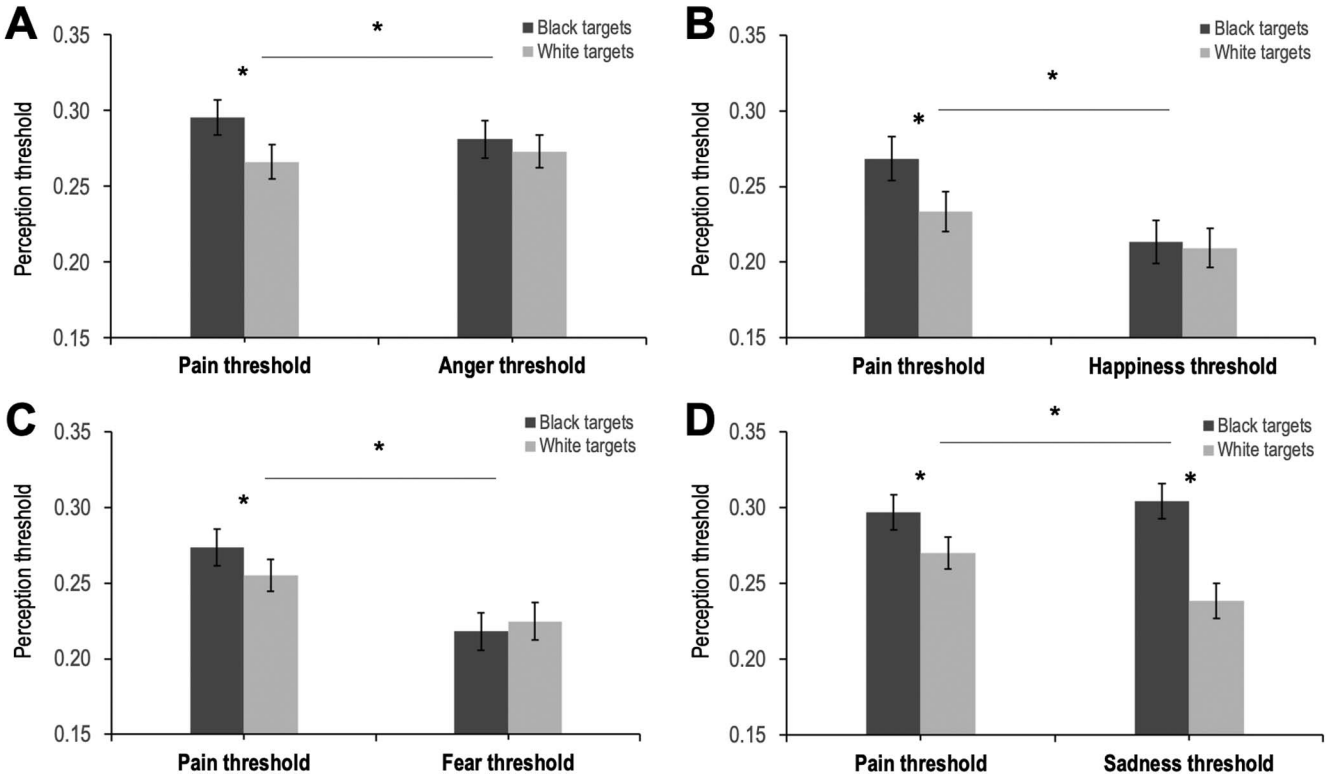
Correlational Analyses

Overall racial bias in pain perception was marginally associated with racial bias in anger perception (overall: $r(138) = .146$, $p = .084$). In other words, a tendency to see pain less readily on Black (vs. White) targets was weakly correlated with a tendency to see anger less readily on Black (vs. White) targets, as well. Moreover, racial bias in pain perception was positively associated with racial bias in treatment outcomes, $r(138) = .228$, $p = .007$: a tendency to see pain less readily on "treated" Black (vs. White) targets was associated with prescribing Black (vs. White) targets less pain-relieving cream. However, racial bias in anger perception was *not* associated with bias in treatment, $r(138) = .050$, $p = .558$.

Finally, we examined which, if any, additional bias measures were related to racial bias in pain and anger perception. Notably,

Figure 2

Racial Bias in Pain Perception Is Distinct From Race-Based Differences in the Perception of Other Emotions



Note. Race consistently interacted with emotion across four experiments (A–D). Participants had more stringent thresholds for seeing pain on Black (vs. White) faces, but target race did not influence perceptions of anger, happiness, or fear (A–C). That said, racial bias in perceiving sad expressions was even greater than the bias observed for pain (D). Error bars represent adjusted 95% within-subject confidence intervals (Morey, 2008).
* $p < .05$.

racial bias in anger perception was associated with racial stereotypes about threat. Participants who judged Black targets as being more threatening than White targets saw anger more readily on Black faces, $r(138) = -.204$,[6] $p = .016$. However, no other bias measures (e.g., explicit racial bias, racial bias in stereotypes regarding status and strength) showed a statistically significant positive correlation with racial bias in pain perception (all $ps > .411$). (A table of zero-order correlations is available online; https://osf.io/emjdg/).

Mediation Analysis

Finally, we tested whether biases in perception *facilitate* the effect of race on treatment recommendations using within-subjects mediation analyses. We obtained a point estimate of −0.176 for the indirect effect of race on treatment recommendations through bias in pain perception, and the 95% confidence interval (CI) bounding this effect did not include zero (95% CI [−0.404, −.020]; $z = -1.83$, $SE = 0.10$). In other words, racial bias in pain perception was associated with a .176-g reduction in analgesic prescribed to Black (vs. White) targets.

This effect held when bias in anger perception was entered as a competing within-subjects mediator (along with explicit racial bias and bias in status, strength, and threat judgments; indirect effect = −0.188, 95% CI [−0.454, −0.018]; $z = -1.87$, $SE = 0.11$). Notably, bias in anger perception did not help to explain the relationship between race and treatment (indirect effect = 0.002, 95% CI [−0.082, 0.078], $z = 0.08$, $SE = 0.04$), nor did any of the additional measures entered as competing within-subjects mediators.

Discussion

Experiment 1 demonstrated several distinctions between racial bias in pain and anger perception. First, while perceivers saw pain less readily on Black (vs. White) faces, target race did not significantly affect anger perception. Second, while racial bias in pain perception facilitated gaps in treatment, the same could not be said for racial bias in anger perception. Third, participants who rated Black targets as comparatively threatening saw anger *earlier* on Black faces, but threat stereotypes were not associated with differential sensitivity to pain on Black faces. However, these results do not rule out an under-

[6] Note that a negative correlation here reflects the fact that both pain and anger bias have been calculated in the same direction: Black thresholds minus White thresholds.

lying, generalized association between the underperception of pain and other emotions on Black faces: We also observed a marginally significant association between tendencies to see both pain *and* anger less readily on Black faces.

Experiment 2: Racial Bias in Pain and Happiness Perception

Next, we tested whether racial bias in pain perception is related to race-based differences in recognizing happy expressions. Like anger, there are race-specific stereotypes associated with happiness (e.g., Stolier & Freeman, 2016[7]) and in turn, perceivers may detect happy expressions faster on White (vs. Black) faces (Hugenberg, 2005), especially within male targets (Craig et al., 2012; Craig et al., 2017; Lipp et al., 2015).

In other words, both potential sources of bias referenced above—generalized bias in emotion perception and facilitation via stereotype associations—would yield similar patterns of results: Perceivers should see both pain and happiness less readily on Black (vs. White) faces. However, in Experiment 1, we also observed that perception of pain and anger were differentially predicted by endorsement of stereotype content. As such, we also predicted that a tendency to rate Black individuals as comparatively more threatening would be associated with blunted sensitivity to happy (but not painful) expressions on Black (vs. White) faces.

Method

Participants

We recruited 158 U.S.-based MTurk participants (84 males, 72 females, one nonbinary, one nonreported; $M_{age} = 35.27$, $SD_{\text{age}} = 10.69$; 127 White, 15 Hispanic, 12 Asian, two Native American, two participants identifying with another racial group). Thirty-seven Black individuals were excluded from analyses. Individuals using a VPN or VPS were prescreened out (Winter et al., 2019).

Stimuli

We selected eight pain expressions rated as looking more like pain than any other emotion ($M = 5.19$ out of 7) including happiness ($M = 2.18$; $p < .001$), and eight happy expressions rated as looking more like happiness ($M = 5.27$) than any other emotion, including pain ($M = 2.16$; $p < .001$; e.g., see Figure 3A). (For further details, see the online supplementary materials).

Results

Racial Bias in Emotion Perception

We observed a significant main effect of target race on emotion perception thresholds in the *emotion rating phase*, $F(1, 157) = 27.17$, $p < .001$, $\eta_p^2 = .15$, as well as a significant main effect of emotion, $F(1, 157) = 14.04$, $p < .001$, $\eta_p^2 = .08$. Specifically, participants' thresholds for perceiving emotion in general were significantly higher for emotion expressed by Black targets ($M = .266$, $SD = .013$) than by White targets ($M = .246$, $SD = .012$). Participants' thresholds for perceiving emotion were also significantly higher for pain perception ($M = .281$, $SD = .014$) than for happiness perception ($M = .232$, $SD = .013$).

Critically, we also observed an interaction between target race and emotion ratings, $F(1, 157) = 27.05$, $p < .001$, $\eta_p^2 = .15$. Unpacking this interaction, we observed a statistically significant effect of target race on thresholds for perceiving pain, $F(1, 157) = 10.79$, $p = .001$, $\eta_p^2 = .06$; $M_{Black} = .301$, $SD_{\text{Black}} = .015$; $M_{White} = .261$, $SD_{\text{White}} = .014$, but not on thresholds for perceiving happiness, $F(1, 157) = .007$, $p = .933$, $\eta_p^2 < .01$; $M_{Black} = .232$, $SD_{\text{Black}} = .014$; $M_{White} = .231$, $SD_{\text{White}} = .013$; Figure 2B. In other words, participants continued to see pain less readily on Black (vs. White) faces, but once again, contrary to our predictions, their thresholds for seeing happiness did not vary between Black and White targets.

Racial Bias in Treatment Recommendations

Again, we observed a statistically significant main effect of race on treatment recommendations, $F(1, 157) = 14.86$, $p < .001$, $\eta_p^2 = .09$. As in Experiment 1 and throughout our prior work (Drain et al., 2020; Mende-Siedlecki et al., 2019) participants recommended less pain-relieving cream to Black targets, versus White targets ($M_{Black} = 9.413$, $SD_{\text{Black}} = .336$, $M_{White} = 10.055$, $SD_{\text{White}} = .344$).

Correlational Analyses

Overall, racial bias in pain perception was not associated with racial bias in happiness perception, $r(156) = .020$, $p = .804$. In other words, a tendency to see pain less readily on Black (vs. White) faces was not predictive of bias in participants' perceptions of happy expressions. Moreover, the association between racial bias in pain perception and bias in treatment was only marginally significant, $r(156) = .140$, $p = .080$, but consistent with the direction of association observed in Experiment 1 and in prior work. Racial bias in happiness perception was not associated with bias in treatment, $r(156) = .053$, $p = .506$.

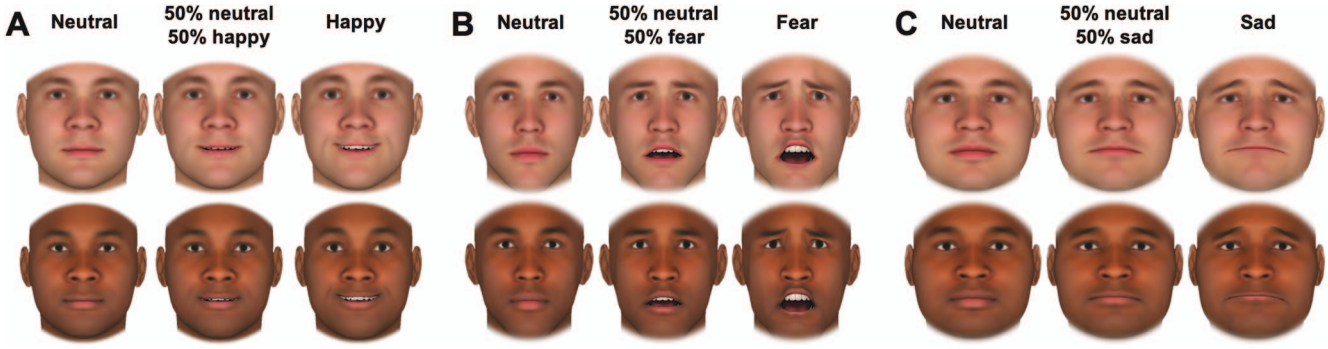
Finally, we examined which, if any, additional bias measures were related to racial bias in pain and happiness perception. In line with Experiment 1, there was a marginally significant correlation between racial bias in happiness perception and racial stereotypes regarding threat: Participants who judged Black Americans as being more threatening than White Americans saw happiness less readily on Black faces, $r(156) = .154$, $p = .053$. However, biased judgments of threat were not significantly correlated with racial bias in pain perception, $r(156) = .120$, $p = .133$, though the difference between these associations was not significant. (A table of zero-order correlations between measures is available online; https://osf.io/emjdg/.)

Mediation Analysis

We obtained an estimate of -0.159 for the indirect effect of race on treatment through bias in pain perception (95% CI [-0.472, 0.094]; $z = -1.60$, $SE = 0.15$), though the 95% confidence

[7] In terms of our own conceptual similarity analysis (see the online supplementary materials), representations of happiness were strongly positively correlated with representations of the White racial category, $r(94) = .558$, $p < .001$, only marginally positively correlated with representations of the Black racial category, $r(94) = .173$, $p = .092$, and the difference between these two correlations was statistically significant ($z = 3.29$, $p = .001$).

Figure 3
Example Stimuli From Experiments 2–4



Note. Participants saw Black and White targets (generated in FaceGen) in varying degrees of pain, as well as happiness (A; Experiment 2), fear (B; Experiment 3), and sadness (C; Experiment 4). Stimuli were vignetted to remove their "bald" appearance. See the online article for the color version of this figure.

interval included zero.[8] Notably, bias in happiness perception did not help to explain the relationship between race and treatment (indirect effect <0.001, 95% CI [−0.031, 0.038]; $z = -0.01$, $SE = 0.02$), nor did any additional measures entered as competing mediators.

Discussion

Mirroring the results of Experiment 1, Experiment 2 suggested several notable dissociations between racial bias in pain and happiness perception. First, target race exerted an effect on overall thresholds for perceiving pain, but not happiness, on Black versus White faces. Second, a tendency to see happiness less readily on Black (vs. White) faces was not associated with race-based differences in pain perception or gaps in pain treatment recommendations. Third, explicit racial stereotypes regarding threat were marginally associated with a tendency to see happiness less readily on Black (vs. White) faces.

In sum, these results complicate the story somewhat. On one hand, they reflect the robustness of racial bias in pain perception, and separately, demonstrate the influence of stereotype endorsement on emotion recognition. On the other hand, they cast some doubt on the broad generalizability of racial bias in emotion perception, given the lack of association between gaps in pain and happiness perception. It is likely that the complementary contributions of general perceptual disruptions and stereotypes may vary by emotion and context. In Experiments 3–4, we tested the effects of target race on the recognition of fearful and sad expressions.

Experiment 3: Racial Bias in Pain and Fear Perception

Moving forward, we tested the relationship between racial bias in pain perception and race-based differences in perceiving fear. Fearful faces signal an external threat (Adolphs et al., 1999; Morris et al., 1996), and as a result, motivate approach-related (rather than avoidance-related) behavior (Marsh et al., 2005). Unlike anger or happiness, relatively little work has examined whether race facilitates or impedes recognition of fear, and the work that exists is relatively mixed. While some data suggests that fear improves face memory for Black targets (Krumhuber & Manstead, 2011), potentially due to enhanced attention to fearful expressions on Black faces, overall, meta-analysis demonstrates that an in-group advantage for fear is even larger than gaps observed for angry or happy expressions (Elfenbein & Ambady, 2002). Further, representations of fear demonstrate comparable conceptual similarity to the Black and White racial categories.[9] Thus, Experiment 3 provided a test of whether racial bias in pain perception is related to gaps in recognizing a negative emotion *without* stereotype associations to either racial category. Ultimately, we predicted that participants would see both painful and fearful expressions less readily on Black (vs. White) faces.

Method

Participants

We recruited 164 U.S.-based MTurk participants (78 males, 84 females, two nonbinary; $M_{age} = 37.51$, $SD_{age} = 11.62$; 138 White, 13 Hispanic, six Asian, five Native American, two participants identifying with another racial group). Forty-three Black individuals were excluded from analyses. Individuals using VPN or VPS were prescreened out (Winter et al., 2019).

Stimuli

We selected four pain expressions rated as looking more like pain than any other emotion ($M = 4.74$ out of 7) including fear ($M = 2.55$; $p < .001$), and four fear expressions rated as looking more like fear ($M = 4.70$) than any other emotion, including pain ($M = 2.53$; $p < .001$; e.g., see Figure 3B). (For further details, see the online supplementary materials.)

[8] When pit against competing within-subject mediators, this effect weakened (indirect effect = −0.114, 95% CI [−0.402, 0.134]; $z = -1.02$, $SE = 0.14$).

[9] In our conceptual similarity analysis (the online supplementary materials), representations of fear were not significantly correlated with representations of the Black racial category, $r(94) = -.146$, $p = .156$, or the White racial category, $r(94) = -.125$, $p = .225$, and the difference between these correlations was not significant ($z = 0.16$, $p = .874$).

Results

Racial Bias in Emotion Perception

We observed a significant main effect of emotion, $F(1, 163) = 20.87$, $p < .001$, $\eta_p^2 = .11$, but not target race, $F(1, 163) = 1.31$, $p = .255$, $\eta_p^2 < .01$, on participants' perceptual thresholds in the *emotion rating phase*. Specifically, participants' thresholds for perceiving emotion in general were significantly higher for painful expressions ($M = .274$, $SD = .015$) than for fearful expressions ($M = .230$, $SD = .012$).

Critically, we once again observed an interaction between target race and emotion, $F(1, 163) = 14.40$, $p < .001$, $\eta_p^2 = .08$. Specifically, we observed a statistically significant effect of target race on pain perception, $F(1, 163) = 15.18$, $p < .001$, $\eta_p^2 = .085$; $M_{Black} = .283$, $SD_{\text{Black}} = .015$, $M_{White} = .264$, $SD_{\text{White}} = .014$, but no effect of target race on fear perception, $F(1, 163) = 0.90$, $p = .345$, $\eta_p^2 = .01$; $M_{Black} = .226$, $SD_{\text{Black}} = .012$, $M_{White} = .234$, $SD_{\text{White}} = .013$ (see Figure 2C). In other words, participants saw pain more conservatively on Black (vs. White) faces, but that contrary to our prediction, thresholds for seeing fear did not vary by target race.

Racial Bias in Treatment Recommendations

We observed a statistically significant main effect of target race on treatment recommendations, $F(1, 163) = 6.48$, $p = .012$, $\eta_p^2 = .04$. As in Experiments 1 and 2, participants recommended prescribing less pain-relieving cream to Black (vs. White) targets ($M_{Black} = 10.132$, $SD_{\text{Black}} = .364$, $M_{White} = 10.485$, $SD_{\text{White}} = .340$).

Correlational Analyses

Racial bias in pain perception was positively associated with racial bias in fear perception, $r(162) = .437$, $p < .001$. Participants who saw pain less readily on Black (vs. White) targets also saw fear less readily on Black (vs. White) targets. Moreover, racial bias in pain perception was again significantly associated with biased treatment outcomes, $r(162) = .196$, $p = .012$. Once again, participants who saw pain less readily on Black (vs. White) targets also prescribed less pain-relieving cream to Black (vs. White) targets. In addition, racial bias in fear perception was also marginally associated with biased treatment outcomes, $r(162) = .144$, $p = .066$.

No other stereotype measures showed a statistically significant, positive correlation with racial bias in pain perception (all ps $> .221$) or fear perception (all ps $> .165$, for racial bias in threat judgments). (A table of zero-order correlations is available online; https://osf.io/emjdg/.)

Mediation Analysis

We obtained an estimate of $-.087$ for the indirect effect of race on treatment recommendations through bias in pain perception (95% CI [-0.194, -0.004]; $z = -1.84$, $SE = 0.05$). (That said, when additional within-subjects mediators were accounted for—including bias in fear perception, explicit racial bias and stereotypes, and dehumanization measures—the 95% confidence interval bounding this effect did include zero; indirect effect = $-.072$, 95% CI [-0.194, 0.024]; $z = -1.31$, $SE = 0.06$.) Notably, bias in fear perception did not help to explain the relationship between race and treatment (indirect effect = 0.015, 95% CI [-0.025, 0.059]; $z = 0.74$, $SE = 0.02$), nor did any of the additional measures entered as competing mediators.

Discussion

In line with Experiments 1 and 2, target race continued to shape participants' thresholds for seeing pain (but not fear) on Black versus White faces. While this might seem to support the distinctiveness of racial bias in pain perception, one notable divergence emerged: Participants who saw pain less readily on Black faces were also more likely to show differential sensitivity to fear on Black faces. While this effect is in line with the marginal association between racial biases in pain and anger perception observed in Experiment 1, it runs counter to the lack of association between racial biases in pain and happiness perception observed in Experiment 2.

Experiment 4: Racial Bias in Pain and Sadness Perception

Experiments 1–3 demonstrate that racial bias in pain perception is, overall, stronger and more consistent than corresponding biases within other emotional expressions. That said, gaps in recognition were related across emotion: participants who saw pain less readily on Black (vs. White) faces were more likely to see other negative emotional expressions (e.g., fear, anger) less readily on Black faces, as well. Moreover, individual difference factors supporting these gaps in recognition varied by emotion. While racial bias in pain perception was not related to stereotypes regarding threat, status, or strength, judgments of threat were associated with differences in thresholds for seeing anger and happiness on Black versus White faces. As a final step, we examined the association between racial bias in pain and sadness perception.

Sad facial expressions communicate a need for social support (Eisenberg et al., 1989) and motivate concern (Decety & Howard, 2013). Moreover, sensitivity to sad expressions is positively related to individual differences in empathy (Marsh et al., 2007) and prosocial behavior (Chikovani et al., 2015). Previous literature on the effects of target race on sadness perception is mixed (Bijlstra et al., 2010; Craig et al., 2017; Hugenberg, 2005), and like fear, representations of sadness demonstrate comparable conceptual similarity to the Black and White racial categories.[10] As such, Experiment 4 provided a further test of whether racial bias in pain perception is related to gaps in recognizing a negative emotion *without* stereotype associations to either racial category.

Method

Participants

We recruited 173 U.S.-based MTurk participants (87 males, 84 females, one nonbinary, one nonreported; $M_{age} = 35.81$, $SD_{\text{age}} =$

[10] In our conceptual similarity analysis (online supplementary materials), representations of sadness were significantly negatively correlated with representations of the Black racial category, $r(94) = -.257$, $p = .011$, but only weakly negatively correlated with the White racial category, $r(94) = -.165$, $p = .108$. The difference between these effects was not significant ($z = 0.71$, $p = .480$).

10.78; 130 White, 17 Hispanic, 20 Asian, two Native American, and four participants identifying with another racial group). Forty-two Black individuals were excluded from analyses. Individuals using a VPN or VPS were prescreened out (Winter et al., 2019).

Stimuli

We selected four pain expressions rated as looking more like pain than any other emotion ($M = 5.25$ out of 7) including sadness ($M = 2.66$; $p = .002$), and four sad expressions rated as looking more like sadness ($M = 5.39$) than any other emotion, including pain ($M = 2.72$; $p = .002$; e.g., see Figure 3C). (For further details, see the online supplementary materials.)

Results

Racial Bias in Emotion Perception

We observed a significant main effect of target race, $F(1, 172) = 237.86$, $p < .001$, $\eta_p^2 = .58$, but not emotion, $F(1, 172) = 1.65$, $p = .200$, $\eta_p^2 = .01$, on participants' perceptual thresholds in the *emotion rating phase*. Specifically, participants' thresholds for perceiving emotion in general were significantly higher for Black targets ($M = .331$, $SD = .013$) than for White targets ($M = .277$, $SD = .012$).

Critically, we once again observed an interaction between target race and emotion, $F(1, 172) = 62.92$, $p < .001$, $\eta_p^2 = .27$. Specifically, while target race continued to shape thresholds for perceiving pain, $F(1, 172) = 62.64$, $p < .001$, $\eta_p^2 = .27$, $M_{Black} = .326$, $SD_{\text{Black}} = .014$, $M_{White} = .295$, $SD_{\text{White}} = .014$, the effect of race on thresholds for perceiving sadness was even stronger, $F(1, 172) = 231.55$, $p < .001$, $\eta_p^2 = .57$; $M_{Black} = .335$, $SD_{\text{Black}} = .014$, $M_{White} = .259$, $SD_{\text{White}} = .013$ (see Figure 3D). In other words, participants saw both painful and sad expressions less readily on Black (vs. White) targets, but this bias was larger within sadness (vs. pain).

Racial Bias in Treatment Recommendations

We observed a statistically significant main effect of target race on treatment recommendations, $F(1, 172) = 20.46$, $p < .001$, $\eta_p^2 = .11$. As in Experiments 1–3, participants recommended prescribing less pain-relieving cream to Black (vs. White) targets ($M_{Black} = 10.073$, $SD_{\text{Black}} = .382$, $M_{White} = 10.650$, $SD_{\text{White}} = .360$).

Correlational Analyses

Racial bias in pain perception displayed a positive, statistically significant association with racial bias in sadness perception, $r(171) = .201$, $p = .008$: Participants who saw pain less readily on Black (vs. White) targets also saw sadness less readily on Black (vs. White) targets. Racial bias in pain perception was only marginally significantly associated with treatment bias, $r(171) = .136$, $p = .074$, while racial bias in sadness perception was not significantly associated with treatment bias, $r(171) = .066$, $p = .386$.

Racial bias in pain perception was also positively correlated with a tendency to rate Black Americans as being more threatening than White Americans, $r(171) = .245$, $p = .001$—a pattern not observed in Experiments 1–3. That said, no measures showed a significant positive correlation with racial bias in sadness perception (all ps $> .270$). (A full table of zero-order correlations between measures is available online; https://osf.io/emjdg/.)

Mediation Analysis

We obtained an estimate of $-.131$ for the indirect effect of race on treatment recommendations through bias in pain perception (95% CI [−0.297, 0.011]; $z = -1.65$, $SE = 0.08$), though the 95% confidence interval contained zero.[11] When additional mediators were added, we also observed an estimate of $-.232$ for an indirect effect via racial bias in sadness perception (95% CI [−0.567, 0.035]; $z = -1.44$, $SE = 0.15$). However, none of the additional measures entered as competing mediators (e.g., status, strength, and threat judgments; dehumanization measures; intergroup contact) facilitated the effect of race on treatment.

Discussion

In a departure from Experiments 1–3, race influenced thresholds for perceiving sadness on Black versus White faces, and moreover, this racial bias was significantly larger for sad (vs. painful) expressions. In addition, a tendency to see sadness less readily on Black (vs. White) faces was positively associated with racial bias in pain perception. Taken together, these results imply a link between racial bias in the perception of painful and sad facial expressions.

Meta-Analysis Across Experiments 1–4

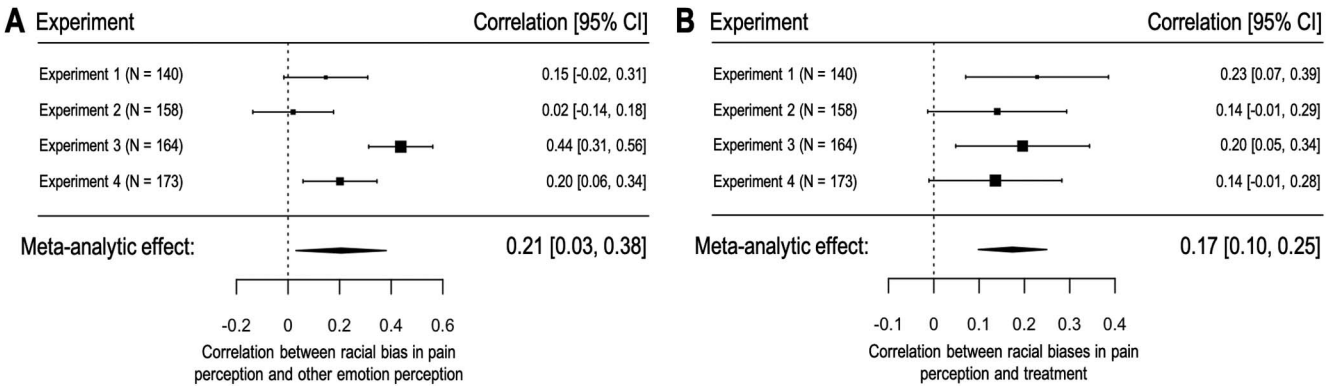
Because Experiments 1–4 share a common set of procedures, we aggregated across these data to obtain a more complete characterization of our main results. Below, we focus on (a) the strength of the relationship between racial bias in pain perception and biases in recognizing other emotions, (b) the strength of the relationship between racial biases in pain perception and treatment, and (c) the extent to which racial bias in perceiving pain was related to racial stereotypes regarding threat, strength, and status. We expand on the effects of target race on pain perception and treatment (as well as the influence of additional individual difference measures) in the online supplementary materials. To assess the robustness of these effects, we conducted separate, sample size-weighted meta-analyses in *R* (Version 3.5.1) using *metafor* (Viechtbauer, 2010). Further, we conducted a mediation synthesis in *R* (Huang et al., 2016) to combine across within-subjects mediation results in Experiments 1–4.

Racial Bias in Pain Perception Is Associated With General Bias in Emotion Perception

First, we assessed whether a tendency to see pain less readily on Black (vs. White) faces was related to a general difficulty in recognizing emotions on Black faces across Experiments 1–4. We operationalized this bias as the threshold for perceiving each emotion (anger, happiness, fear, and sadness) on Black faces, minus the threshold for perceiving the same emotion on White faces. Indeed, racial bias in pain perception was positively associated with a tendency to see emotional expressions less readily on

[11] When pit against other mediators, this effect weakened (indirect effect = −0.064, 95% CI [−0.216, 0.079]; $z = -0.79$, $SE = 0.07$).

Figure 4
Meta-Analyses Across Experiments 1–4



Note. Forest plots of the association between racial bias in pain perception and (A) general bias in perceiving emotion on Black faces and (B) bias in treatment recommendations across Experiments 1–4. Positive values indicate an association between participants' tendency to see pain later on Black targets' faces and (A) a tendency to see other emotions less readily on Black faces (anger, happiness, fear, and sadness in Experiments 1–4, respectively) or (B) a tendency to prescribe less analgesic to those same Black targets. We report correlations between bias measures and the corresponding 95% confidence interval for each study.

black faces in general (meta-analytic estimate of $r = .206$; $z = 2.31$, $p = .021$, 95% CI [.031, .381]; Figure 4A). Notably, this effect was seemingly driven by negative emotions, as it was not observed for happiness in Experiment 2.

Racial Bias in Pain Perception Facilitates Racial Bias in Treatment

Racial bias in pain perception and racial bias in treatment recommendations displayed a consistent positive association (estimated $r = .174$; $z = 4.51$, $p < .0001$, 95% CI [.098, .249]; Figure 4B), though this effect was somewhat smaller than in previous work (Mende-Siedlecki et al., 2019). However, general bias in recognizing other emotions on Black faces was not reliably associated with gaps in treatment (estimated $r = .058$; $z = 1.48$, $p = .139$, 95% CI [−.019, .136]).

Beyond these correlational analyses, we also tested whether differences in perceptual thresholds for recognizing pain as a function of race facilitated gaps in treatment via within-subjects mediation. There was considerable heterogeneity in these results across experiments, particularly when racial bias in pain perception was pit against other potential within-subjects mediators of the relationship between target race and treatment. Mediation synthesis analysis (Huang et al., 2016) yielded an estimate of −.141, 95% CI [−.196, −.092] for the indirect effect of race on treatment recommendations *through* differences in perceptual thresholds for seeing pain on Black versus White targets. In other words, racial bias in pain perception was associated with a .141-g reduction in pain reliever recommended to Black versus White targets.

Furthermore, when accounting for the other potential mediators we measured (e.g., stereotypes regarding status, strength, and threat; dehumanization, etc.), the estimate of this indirect effect was somewhat smaller (meta-analytic estimate = −.116, 95% CI [−.175, −.067]), but the 95% confidence interval bounding the effect did not contain zero. No other measures mediated the relationship between race and treatment, including a general tendency to see other emotional expressions less readily on Black (vs. White) faces.

Influences of Racial Stereotypes on Bias in Pain Perception and Treatment

Racial bias in threat judgments was not reliably related to racial bias in pain perception (estimated of $r = .082$; $z = 1.03$, $p = .304$, 95% CI [−.075, .239]), but was positively associated with treatment bias (estimated $r = .153$; $z = 3.94$, $p < .0001$, 95% CI [.077, .229]). Similarly, while racial bias in status judgments did not reliably predict perceptual bias (estimated $r = .006$; $z = 0.16$, $p = .875$, 95% CI [−.072, .084]), it was also positively associated with treatment bias (estimated $r = .084$; $z = 2.12$, $p = .034$, 95% CI [.006, .161]).[12] Racial bias in strength judgments was not associated with either racial bias in pain perception (estimated $r = .026$; $z = 0.67$, $p = .506$, 95% CI [−.051, .104]) or treatment (estimated $r = -.005$; $z = -0.09$, $p = .930$, 95% CI [−.109, .100]).

General Discussion

Across four experiments, we examined whether reduced sensitivity to pain on Black faces is related to a general racial bias in recognizing emotional expressions. Specifically, we asked several questions: (a) which emotions are perceived less readily on Black (vs. White) faces in a manner similar to pain, (b) are biases in recognizing other emotions on Black faces associated with racial bias in pain perception, and (c) are racial biases in the perception of pain and other emotions similarly predictive of behavioral outcomes (e.g., biased treatment) and supported by common

[12] While estimates of the relationships between racial bias in pain perception and (a) threat bias ($r = .082$) and (b) status bias ($r = .084$) are quite similar, only the latter effect was statistically significant. This may be attributable to greater variability in estimates of the latter effect ($\tau^2 = 0.02$, $I^2 = 76.34\%$, $H^2 = 4.23$, $Q_3 = 12.49$, $p = .006$).

threads (e.g., stereotype endorsement)? Below, we provide answers to these questions, drawing quantitative support from the meta-analyses presented above.

While evidence of racial bias in pain perception was observed across experiments, perceptual thresholds for other emotional expressions were not reliably influenced by target race. Though expressions were created and selected across emotions using identical procedures and equated with pain in terms of intensity in each experiment, participants' thresholds for seeing anger, happiness, and fear did not differ between Black and White faces. However, Experiment 4 presents a key caveat: Participants also saw sadness less readily on Black faces, and this bias was even greater than that observed for pain. Taken together, the overall effects of target race on pain perception are particularly robust compared to most other emotional expressions.

Our meta-analyses provided some initial answers as to the association between racial bias in the perception of painful expressions and other emotions. Despite the comparative strength of racial bias in pain perception, this bias seems to be linked to a general gap in recognizing (particularly negative) expressions on Black faces. We posit that these gaps are supported by disruptions in configural face processing, given our prior work (Mende-Siedlecki et al., 2019). That said, this relationship did not correspond with differential treatment. Across these four studies, only racial bias in pain perception was consistently associated with race-based gaps in treatment recommendations. Moreover, this perceptual bias specific to pain facilitated the effects of target race of treatment even when pit against gaps in perceiving other emotions as potential mediating variables. In sum, while a tendency to see pain less readily on Black faces is associated with general insensitivity to (particularly negative) expressions on Black faces, racial bias in pain perception had distinct consequences for racial bias in treatment.

Finally, we asked what common threads might cut across race-based differences in pain and emotion recognition. Threat judgments were associated with recognition of anger and happiness: Participants who rated Black individuals as being more threatening than White individuals saw anger earlier and happiness later on Black (vs. White) faces—though this association was only marginally significant for happiness in Experiment 2. These results dovetail with work suggesting a tendency to overperceive anger (e.g., Hugenberg, 2005; Hugenberg & Bodenhausen, 2003; Shapiro et al., 2009) and underperceive happiness on Black faces (e.g., Friesen et al., 2019; Hugenberg, 2005). As for painful expressions, meta-analytic results suggest that threat stereotypes were *not* reliably associated with racial bias in pain perception.

Critically, we stress again that differential sensitivity to painful expressions on Black versus White faces represents only one potential route to disparities in *care*. Meta-analyses suggested that biases in judgments of both threat and status were also associated with a tendency to prescribe more pain reliever to White versus Black targets. The latter link between status and treatment bias is in line with previous work suggesting that assumptions regarding status and toughness underpin racial bias in attributions of physical pain (Trawalter et al., 2012) and social pain (Deska, Kunstman, Bernstein, et al., 2020; Deska, Kunstman, Lloyd, et al., 2020). Moreover, it is possible that these perceptual and stereotype-based sources of biases in treatment may be differentially regulable. Ultimately, racial pain disparities are multiply determined by both a range of individual-level factors (e.g., implicit and explicit prejudice, perceptual bias, health- and pain-specific beliefs, communication-related processes, etc.), which themselves have deep roots in structural and historical racism (Trawalter et al., 2020).

The Generalizability of Racial Bias in Pain Perception: An Initial Appraisal

At the outset, we laid out two potentially parallel routes to racial bias in emotion perception. On the one hand, low-level disruptions in face processing might produce general disparities in recognizing affective expressions on Black faces. On the other hand, stereotype associations between race and emotion categories might facilitate (e.g., anger) or impede (e.g., happiness) the recognition of specific emotional expressions. We observed that target race continually impeded pain perception independent of endorsement of racial stereotypes regarding status, strength, and threat. Conversely, target race did not exert an overall effect on recognition of anger, happiness, or fear. However, a common thread emerged: Seeing pain less readily on Black faces was associated with blunted perception of other negative emotions as well.

Thus, the question of generalizability necessitates a nuanced answer—though a common source of bias might suffuse gaps in perceiving negative emotions on Black faces, this bias seems strongest in the context of pain and sadness. Future work should address this heterogeneity across expressions. Because breakdowns in configural face processing directly support racial bias in pain perception (Mende-Siedlecki et al., 2019), a logical next step would be to incorporate factors that disrupt or facilitate configural processing—like dehumanization (Cassidy et al., 2017; Fincher & Tetlock, 2016) and intergroup contact (Hancock & Rhodes, 2008; Rhodes et al., 2006, 2010), respectively—in a more systematic fashion. Indeed, exploratory analyses (see online supplementary materials) suggested that these factors *were* associated with gaps in pain perception: Participants who saw pain less readily on Black (vs. White) faces also had comparatively less contact with Black individuals during childhood and rated Black Americans as being comparatively lower on the "Ascent of Man" scale than White Americans. That said, these findings were mixed across experiments. Further study will require care and specificity, particularly given the breadth of phenomena represented under the umbrella of dehumanization (Fincher & Tetlock, 2016; Haslam, 2006; Kteily et al., 2015; Leyens, 2009).

Some attention should be paid to the strong effect of target race on thresholds for seeing sad expressions. Despite a mixed literature on intergroup sadness recognition (Bijlstra et al., 2010; Craig et al., 2017; Hugenberg, 2005), participants in Experiment 4 saw sadness much less readily on Black (vs. White) faces—a gap that was even larger than the bias we observed for pain. An obvious link between pain and sadness exists: Both expressions convey distress, motivate behavioral approach, and signal needs for care and support (Craig, 2015; Decety & Howard, 2013; Eisenberg et al., 1989; Williams, 2002), and representations of the two emotions are strongly correlated (see Conceptual Similarity Analysis in the online supplementary materials). In turn, expressions of sadness and pain are both susceptible to the cognitive costliness of empathy they command (Cameron et al., 2019), which may vary in magnitude by target race.

More broadly, similar racial disparities in mental health care (Alegría et al., 2008; Atdjian & Vega, 2005; Cook et al., 2017) parallel the longstanding disparities in pain care (Anderson et al., 2009; Green et al., 2003). In particular, Black patients are less likely to be screened for, diagnosed with, and treated for depression than their White counterparts (Hahm et al., 2015; Simpson et al., 2007; Stockdale et al., 2008). Recent findings link these disparities to race-based gaps in attributions of social pain (Deska, Kunstman, Bernstein, et al., 2020; Deska, Kunstman, Lloyd, et al., 2020). While research on the links between facial expressivity and disorders like depression remains mixed (e.g., Rottenberg & Vaughan, 2008), future work could begin to examine the perceptual underpinnings of racial disparities in mental health care.

Limitations

This work is by no means without limitations. First, all four experiments used only computer-generated faces and (extensively pilot-tested) expressions. While we have robustly demonstrated racial bias in pain perception when using "real" (e.g., photographic) stimuli (Mende-Siedlecki et al., 2019), these computer-generated may be processed differently from real faces (Craig et al., 2012; Gaither et al., 2019; MacDorman et al., 2009). Similarly, we relied on static (rather than dynamic) expressions and focused on prompted (rather than spontaneous) emotion recognition—limiting the ecological validity of these stimuli and tasks. Ultimately, while our ability to tightly control these stimuli is a strength in and of itself, it will be necessary to test if these patterns of results are conserved when using real, dynamic expressions and in contexts where emotion recognition is spontaneous.

Moreover, our decision to use only male stimuli represents another limitation. To reiterate, we have demonstrated that racial bias in the visual perception of pain expressions is larger within male targets (Drain et al., 2020). This observation should not overshadow the considerable real-world evidence for overall gender biases in pain care (Chen et al., 2008; Hirsh et al., 2014; Hoffmann & Tarzian, 2001), or the additional burden that Black women face in particular in this domain (Glance et al., 2007; Green & Hart-Johnson, 2010; Johnson et al., 2019; Mathur et al., 2020; Ndao-Brumblay & Green, 2005). That said, it remains to be seen whether the results of these particular experiments will generalize to female targets.

Finally, this sample was predominantly White (79.5%), limiting its generalizability to members of other racial or ethnic minority groups, particularly Black perceivers. Moreover, this sample was also entirely recruited from Mechanical Turk—another potential limitation, given common concerns regarding effort, attentiveness, and deception from MTurkers (Hauser et al., 2018). While we took suggested steps to counteract these issues, future work should assess the prevalence of racial bias in pain perception in community samples and ultimately, in individuals working in health professions.

Conclusion and Future Directions

Taken together, these four experiments provide evidence that racial bias in pain perception is considerably more robust than other race-based gaps in emotion perception. That said, participants who saw pain more readily on White (vs. Black) faces were also more likely to demonstrate a general bias in recognizing negative emotions on Black faces, as well. However, racial bias in pain perception was a better predictor of overall gaps in treatment.

This work demonstrates the necessity of considering perceptual factors support disparities in physical and mental health care. Compared with other expressions, the gaps we observed in perceptual sensitivity to pain (and sadness) were substantial. Moreover, controlling for pain-relevant stereotypes did not eliminate the facilitative effect of this perceptual bias on treatment bias. By confirming the strength and consequences of this bias, these data also illuminate potential avenues for intervention. Approaches enhancing configural face processing by motivating individuation of Black faces (Hugenberg et al., 2007; Hugenberg et al., 2010) or increasing intergroup contact (Hancock & Rhodes, 2008; Rhodes et al., 2010) may address the perceptual roots of gaps in care. Again, we stress that our findings are embedded in a broader context of structural and historical racism. For example, while increased intergroup contact may promote configural processing of Black faces, a baseline *lack* of contact is a consequence of real-world segregation and discrimination (Pager & Shepherd, 2008; Pettigrew, 1998). Moreover, advances in knowledge will be limited by the continued siloing of perspectives regarding intergroup perception. A comprehensive understanding of accuracy and bias in these processes requires an integration of theory and methods from social perception (e.g., configural vs. featural processing, stereotype facilitation), social cognition (e.g., motivation, contact, dehumanization), and the broader sociological literature. Examining these influences in concert may support a more holistic framework linking these factors (e.g., social value).

Future work should also tackle the generalizability of racial bias in pain perception along other dimensions. For example, it is unclear whether these gaps in the visual perception of painful expressions are robust in the face of other diagnostic information, like self-reported pain experience or the nature of injury. Moreover, it will be critical to continue to examine the effects of intergroup contact and dehumanization on racial bias in pain perception—if possible, through direct manipulation of these variables. Each new contour of this perceptual pathway to disparity represents a target for interventions aimed at bringing about racial equity in pain care.

To be clear, we do not suggest that racial bias in pain perception is the sole or primary determinant of pain disparities. Racial disparities in health and health care have been evident for decades (Fiscella et al., 2000; Heckler, 1985) and efforts in closing these gaps have been distressingly slow (AHRQ, 2015; Fiscella & Sanders, 2016; Williams & Wyatt, 2015). Perceptual bias related to pain or mental health care is a downstream consequence of systemic issues spanning care (Bryant et al., 2010; Feagin & Bennefield, 2014; Haider, Scott, et al., 2013; Haider, Weygandt, et al., 2013; Hauck et al., 2011; Morris et al., 2010), provider training (Burke et al., 2017; Phelan et al., 2019; Van Ryn et al., 2015), and the myriad manifestations of systemic racism in the United States (Pager & Shepherd, 2008; Reskin, 2012; Swencionis & Goff, 2017; Sykes & Maroto, 2016). Such gaps in care are exacerbated by daily exposure to ubiquitous racial discrimination (Hagiwara et al., 2015; Hagiwara et al., 2016; Hoggard et al., 2015; Kwate et al., 2003; Williams & Mohammed, 2009). Our findings should be considered against the backdrop of that broader context. In turn, interventions geared toward racial equity in pain care must attend

not only to individual-level biases but also to the systems which produce them.

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