Racial Differences in Suppressing and Expressing Negative Emotions Relate to Cardiovascular Health in the Midlife in the United States (MIDUS) Study

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Data availability: Data is available at https://midus.colectica.org/. All code used for analyses and plots are publicly available on OSF at https://osf.io/u78vr/

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Abstract

Recent theoretical work suggests the expression of emotions may differ among Black and White Americans, such that Black Americans engage more frequently in expressive suppression to regulate emotions and avoid conflict. Prior work has linked expressive suppression usage with increases in cardiovascular disease risk, suggesting that racial differences in expressive suppression usage may be one mechanism by which racism "gets under the skin" and creates heath disparities. To examine racial differences in expressive suppression and blood pressure (a measure of cardiovascular disease risk), we used data from two cohorts of Black and White Americans from the Midlife in the United States (MIDUS) longitudinal study (MIDUS 2, *n* = 271, 34.7% Black, collected from 2004-2009; MIDUS Refresher 1, *n* = 114, 31.6% Black, collected from 2012-2016; total *N* = 385, 33.9% Black). Black Americans reported engaging in expressive suppression more frequently than White Americans and showed less corrugator facial electromyography (fEMG) activity during negative images but no difference in self-reported valence or arousal. Self-reports of daily discrimination partially moderated the link between self-reported expressive suppression and corrugator fEMG activity for Black Americans only. Finally, less corrugator activity during negative images was associated with higher systolic blood pressure only for Black Americans. Overall, results are consistent with theoretical accounts that Black Americans engage more frequently in expressive suppression, which in turn is related to higher cardiovascular risk. Additional research is needed to further test this claim, particularly in real-world contexts and self-reports of in-the-moment usage of expressive suppression.

Key Words

Expressive Suppression; Race; Discrimination; Blood Pressure; Corrugator facial electromyography

Introduction

Expressive suppression is a response-focused strategy entailing the inhibition of emotion-expressive behavior (Gross, 1998). While expressive suppression reduces the outward expression of emotion, it is suggested to occur relatively late in the time course of an emotional event, does little to alter emotional experience (Gross, 1998; Gross & Levenson, 1993; Kalokerinos et al., 2015; Webb et al., 2012), and results in an array of negative outcomes relative to other emotion regulation strategies (Gross, 2002; John & Gross, 2004). Expressive suppression has been linked to worse cognitive outcomes, including concurrently reducing memory and executive functioning, as well as negative impacts on social relationships (Franchow & Suchy, 2015; Richards et al., 2003; Richards & Gross, 2000), including reduced rapport with others, less social support, reduced likeability, and reduced relationship closeness (Butler et al., 2003; Chervonsky & Hunt, 2017; Gross & John, 2003; Srivastava et al., 2009; Waters et al., 2020). Physiologically, expressive suppression is associated with increased sympathetic nervous system activation, which has negative implications for cardiovascular health (DeSteno et al., 2013; Gross, 1998; Gross & Levenson, 1997). Indeed, expressive suppression, whether experimentally manipulated or measured as a trait, has been associated with higher blood pressure and higher cardiovascular disease risk scores (Appleton et al., 2014; Butler et al., 2003; Griffin & Howard, 2022; Tyra et al., 2022). Therefore, expressive suppression is not typically considered a “successful” emotion regulation strategy.

Recent work suggests that social and cultural factors, including race and ethnicity, impact the usage of expressive suppression and other forms of emotion regulation (Weiss et al., 2022). In particular, compared to White Americans, Black Americans appear to engage in expressive suppression more often (Wilson & Gentzler, 2021). Additionally, large racial disparities in cardiovascular health exist between Black and White Americans, such that Black Americans have higher rates of a range of cardiovascular diseases, including hypertension (Go et al., 2014). To examine the extent to which racial differences in the use of expressive suppression may be a pathway through which racism "gets under the skin" (Brownlow, 2022), the current study examines racial differences in expressive suppression measured via self-reports and a psychophysiological measure of emotional expression using the facial electromyography (fEMG) measure of corrugator activity, as well as the association between expressive suppression and blood pressure, from two cohorts in the Midlife in the United States (MIDUS) study.

Contexts When Expressive Suppression May Be Adaptive

Overall, research suggests that expressive suppression is a maladaptive emotion regulation strategy that does not reduce the experience of negative affect (Webb et al., 2012). So why do individuals continue to use it? More recent research suggests that the social and cultural context in which emotion regulation strategies are used impacts their effectiveness and the likelihood an individual will engage in a particular strategy. Expressive suppression has been found to be adaptive when used in some intrapersonal contexts (versus interpersonal contexts) and may be a preferred strategy when in the presence of non-close others (Benson et al., 2019; English et al., 2017; Paul et al., 2023). This highlights the social nature of expressive suppression, such that it may assist with impression formation and management.

Cultural contexts reflect pervasive, powerful situations that individuals navigate based on culturally shared values and norms. Initial work examining the impact of culture on emotion regulation focused primarily on differences between individualistic and collectivistic cultures. Compared to White Americans or Europeans, individuals from Asian and other collectivistic cultures report more suppression of emotion and may experience fewer negative effects (Ramzan & Amjad, 2017; Soto et al., 2011; Weiss et al., 2022). In more collectivistic cultures, expressive suppression may serve the function of maintaining group harmony and tends to be associated with fewer negative outcomes as compared to more individualistic cultures (Ramzan & Amjad, 2017; Soto et al., 2011).

Culture may also constrain how certain individuals can safely interact with others, particularly in cultures with large social power differentials between groups. Initial work focusing on racial differences in anger inhibition in the United States highlighted the conundrum Black Americans face, either choosing to express anger and risk physical violence from individuals in power or suppress anger and experience a physiological cascade resulting in increased cardiovascular disease risk (Brosschot & Thayer, 1998; Dorr et al., 2007; Thayer et al., 2020). Subsequent work has broadened these initial findings to include a wider range of emotions. Brownlow's (2022) model of Culturally Compelled Coping posits that, in the United States in particular, the cultural pervasiveness of racism and White supremacy has led to specific culturally endorsed strategies within Black American culture to cope with discrimination and racism. This proposed model of Culturally Compelled Coping includes multiple emotion regulation strategies that involve expressive suppression, including the masking of feelings, appearing self-controlled, and the adoption of an aloof or distanced attitude (Brownlow, 2022). The model is consistent with other theorizing suggesting that Black Americans may suppress the expression of a range of emotions, particularly negative emotions, to both cope with and avoid racial stressors (Thayer et al., 2020; Wilson & Gentzler, 2021).

Expressive Suppression in Contexts of Social Power/Status Differentials

A wide body of experimental work has found that individuals in lower power roles or with lower status express emotions less intensely, consistent with the use of expressive suppression by lower power/status individuals (see Hall et al., 2005 for a meta-analysis). In daily life, individuals report using expressive suppression in situations where they feel they have less social power (Catterson et al., 2017), and individuals who feel they have low social power report using suppression more frequently (Petkanopoulou et al., 2012; Zerwas et al., 2023). Conversely, individuals high in social power express emotions more and report engaging in expressive suppression less (Leach & Weick, 2020; Petkanopoulou et al., 2012).

Within the United States, social power differentials exist across a number of social factors, including socioeconomic status, race, and ethnicity. Of particular concern to the current research, White Americans typically experience higher social status and more social power than minoritized racial and ethnic groups, including Black Americans (Brownlow, 2022). Within this broader cultural context, expressive suppression may provide immediate protective effects to minoritized individuals, such as preventing, dealing with, or escaping negative situations enacted against members of minoritized groups (Allen et al., 2019; Dorr et al., 2007; Hollinsaid et al., 2023; Thayer et al., 2020; Wilson & Gentzler, 2021; Wingfield, 2007). While expressive suppression and related avoidance coping mechanisms may be immediately adaptive for minoritized individuals in the United States to avoid social dangers and reduce negative experiences and stress related to discrimination and racism, there may be downstream physiological consequences of chronic use of expressive suppression that have a negative impact on cardiovascular health (Appleton et al., 2014; Brosschot & Thayer, 1998; Jacob et al., 2023; Thayer et al., 2020).

Potential Link Between Expressive Suppression and Racial Disparities in Cardiovascular Health in the United States

Experiences of racism and discrimination in the United States are pervasive social stressors and are associated with negative mental and physical health outcomes, including increased psychological distress and increased rates of hypertension and cardiovascular disease (Borrell et al., 2006; Clark et al., 1999; Krieger & Sidney, 1996; Pascoe & Richman, 2009; Quartana & Burns, 2010; Williams et al., 1997). While the experience of chronic social stressors is likely one mechanism by which racism "gets under the skin," given the relationships between chronic use of expressive suppression and cardiovascular disease, the reliance on expressive suppression may be an additional mechanism that leads to racial disparities in cardiovascular health (Appleton et al., 2014; Brownlow, 2022; Das, 2013; Thayer et al., 2020), including in American Indian populations (Tyra et al., 2022). The current study examined self-reported expressive suppression and physiological measures of emotional expression and experience in Black and White Americans to assess the associations between expressive suppression and blood pressure, an indicator of cardiovascular health, by race.

Psychophysiological Measures of Emotion

Muscle activity can be measured continuously from facial muscles using facial electromyography (fEMG). Two commonly used fEMG measures of emotion experience and expression used in the current study are described below.

Corrugator fEMG. The corrugator supercilli muscle is the facial muscle responsible for furrowing the brow. Corrugator muscle activity measured with fEMG sensors placed above the brow has been reliably shown to have a linear increase in activity with negative affect, such that higher corrugator activity is associated with higher negative valence and affective response ratings, while a relaxation in corrugator activity is associated with higher positive valence and affective ratings of stimuli used to evoke the corrugator responses (Cacioppo et al., 1986; Larsen et al., 2003). In addition to being sensitive to affective experience, the corrugator is also under volitional control and is sensitive to manipulations of expressive suppression, whereby less corrugator activity is associated with more expressive suppression, particularly to negative emotions (Mohammed et al., 2021). Therefore, corrugator fEMG activity during negative images can provide a measure of both affective experience and expressive suppression. However, this prior research using corrugator fEMG activity as a measure of expressive suppression has done so in experimental designs where participants were instructed to suppress emotional expressions. It is therefore ambiguous in an uninstructed paradigm how much corrugator fEMG activity reflects expressive suppression vs. the experience of (negative) emotions, and how the balance between suppression and experience may differ between individuals. We therefore rely on additional measures, including self-reports, to better contextualize any group differences in corrugator fEMG activity.

Emotion Modulated Startle Eyeblink Response. The startle eyeblink response is a highly conserved reflex to unexpected stimuli, such as loud noises, that is defensive in nature and not under conscious control (Blumenthal et al., 2005; Cuthbert et al., 1998). It is measured using fEMG sensors placed under the eye to assess the magnitude of the eyeblink response to a startle probe generated by the orbicularis oculi. Importantly, the startle eyeblink response is modulated by emotional experience, such that individuals show larger startle eyeblink magnitudes to probes presented during negative images or emotional states and smaller magnitudes to probes presented during positive images or emotional states (Bradley et al., 2006; Lang et al., 1990). Therefore, the emotion modulated startle eyeblink response represents a psychophysiological measure of affect that is not under conscious control and therefore not susceptible to expressive suppression insofar as expressive suppression does little to alter the underlying emotional experience. However, compared to corrrugator fEMG, emotion-modulated startle eyeblink measures tends to be more noisy, more influenced by sensory and attentional processes, and may be less reliable. than corrugator fEMG activity (Kaye et al., 2016; Larson et al., 2000; Manber et al., 2000).

Study Aims and Hypotheses

The current study examined racial differences in expressive suppression as assessed with self-reported levels of habitual suppression and emotional expression with fEMG activity in the corrugator muscle during an emotional picture viewing task using data from two cohorts of the Midlife in the United States (MIDUS) study. We also assessed racial differences in emotional reactivity to affective images, measured with self-reported valence and arousal as well as the emotion-modulated startle eyeblink response. Lastly, we assessed linkages between expressive suppression, as indexed by self-report as well as fEMG measures of emotional expression, and resting blood pressure. Based on the reviewed research, we hypothesized that Black Americans will exhibit greater expressive suppression, both as a greater self-reported usage of expressive suppression and less emotional expression as indexed fEMG corrugator activity during negative images. To ascertain that group differences in fEMG corrugator activity reflect expressive suppression rather than emotional experience, we will correlate self-reported expressive suppression and fEMG corrugator activity. In addition, we will assess effects of race in self-reported valence and arousal ratings of the negative images, and in startle eye blink response. - Finally, we hypothesized that expressive suppression will be associated with higher resting blood pressure, particularly for Black participants.

Methods

Participants

The data used in this study came from the national Midlife in the United States (MIDUS) longitudinal study, specifically the MIDUS 2 (M2) timepoint assessing the Main MIDUS sample (*n* = 271, 34.7% Black, collected from 2004-2009) and the MIDUS Refresher 1 (MR1) timepoint assessing the MIDUS Refresher 1 sample (*n* = 114 participants, 31.6% Black collected from 2012-2016) from all participants identifying as White or Black/African American who completed the psychophysiology session with sufficient quality corrugator data within the MIDUS Neuroscience Project at the University of Wisconsin-Madison. The Main MIDUS cohort was initially recruited in 1995 through random-digit-dialing plus siblings and a national sample of twins (Brim et al., 1996), and an oversample of primarily Black participants in Milwaukee were recruited through door-to-door canvasing in 2005-2006 (Elver & Oliver, 2007). The MIDUS Refresher cohort was recruited in 2011-2014 via telephone through a multiframe dynamic sampling design to age-match the initial Main MIDUS cohort (Lein, 2015), and an oversample of primarily Black participants in Milwaukee were recruited through door-to-door canvasing in 2012-2013 (Ryff et al., 2014). Participation in the MIDUS Neuroscience Project for both M2 and MR1 were restricted to participants who completed the MIDUS Biomarker Project at the University of Wisconsin-Madison (MIDUS, 2023). A subset of these participants also had sufficiently high-quality emotion modulated startle eyeblink data (*n* = 293), while a different subset of only MR1 participants also reported valence and arousal ratings of the images after the psychophysiology task (*n* = 108) using the self-assessment manikin (Bradley & Lang, 1994). See Table 1 for demographic details of the overall sample and subsamples.

Table 1. Sample demographics			
	Total Sample (n = 385)	Sample with sufficient quality eyeblink data (n = 293)	Sample with self-reported valence and arousal (n = 108)
Cohort (M2/MR1)	271/114	192/101	0/108
Sex (Male/Female)	172/213	123/170	50/58
Race (Black/White)	130/255	88/205	33/75
Education (high school or less/some college/4 year degree or higher)	114/119/152	83/91/119	24/39/45
Age Mean (SD) Range	53.3 (11.5) 26-84	52.2 (11.3) 26-84	48.8 (11.4) 26-76

Measures

Emotion Regulation Questionnaire. To measure self-reported expressive suppression, we used a shortened two-item version of expressive suppression subscale of the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003, collected as part of the Biomarker Project the day before the psychophysiology task, where participants rated their agreement on items from 1 (strongly disagree) to 7 (strongly agree). Items were averaged for scoring, Cronbach's α = 0.73. Items included "*I keep my emotions to myself*" and "*When I am feeling negative emotions (such as sadness or anger), I make sure not to express them*."

Affective Picture Viewing Task. During the Neuroscience Project, participants completed an affective picture viewing task during which psychophysiological measures were collected, including eyeblink startle reflex and corrugator activity via fEMG. After electrode placement (described below), participants were seated alone in an electrically shielded booth in front of a computer screen. Participants viewed 30 positive, 30 negative, and 30 neutral IAPS images

(Lang et al., 2005)[1]. Trials began with a 1 s fixation, followed by 0.5 s of the image with a colored border and 3.5 s of the image without the border, with an intertrial interval randomly varied between 14-18 s. Participants were instructed to respond via button press to indicate the border color (purple or yellow) as quickly as possible. A subset of 81 images included an auditory startle probe (50 ms duration at 105 dB) either 2900 ms after picture onset, 4400 ms after picture onset (i.e., 400 ms after picture offset), or 5900 ms after picture onset (i.e., 1900 ms after picture offset)[2], resulting in 9 startle probes occurring during the images, split evenly across valence. Only corrugator activity during image presentation and startle eyeblink to probes occurring during the images are assessed here. The first 56 M2 participants were run in a different lab room using SAI Bioelectric amplifiers (SA Instrumentation Co., Encinitas, CA) with the remaining participants' data was collected using BIOPAC hardware and Acknowledge software. See (van Reekum et al., 2011) for additional details of the differences in data collection in M2. Described below are the methods common to M2 and MR1 data collection using BIOPAC hardware and Acknowledge software.

Corrugator fEMG. To measure corrugator activity continuously during the affective picture viewing task, a pair of Ag/AgCl 4mm Touchproof shielded electrodes were placed above one brow line on the corrugator supercilii muscle. Raw EMG signals were recorded using

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[1] All participants saw the following images for each valence category: Neutral – 1670, 2190, 2271, 2320, 2383, 2495, 2514, 2580, 2620, 2830, 2870, 2880, 5390, 5731, 7002, 7080, 7140, 7185, 7186, 7205, 7490, 7491, 7595, 7710, 7950, 8010, 8117, 9210, 9401; Positive – 1440, 1720, 1722, 2058, 2208, 2270, 2310, 2340, 2389, 2550, 4599, 5460, 5623, 5891, 5910, 7220, 7230, 7260, 7270, 7330, 7350, 7480, 7501, 8031, 8180, 8210, 8340, 8380, 8500, 8503; Negative – 1230, 1274, 1280, 1301, 2120, 2590, 3051, 3160, 3220, 3230, 3261, 3350, 6020, 6530, 6531, 7380, 9120, 9180, 9181, 9190, 9270, 9340, 9415, 9470, 9560, 9611, 9620, 9912, 9920. Due to minor changes between M2 and MR1, M2 participants saw 9402 (neutral) and 9621 (negative), while MR1 participants saw 2309 (neutral) and 5973 (negative).

[2] For the MR1 sample only, there was a variable timing delay due to hardware issues in startle probe presentation with a mean of 62ms between when the probe was supposed to occur and when it actually occurred. Preprocessing and analyses were adjusted accordingly.

BIOPAC hardware and Acknowledge software (amplified 5,000 times prior to digitization at 1000 Hz with 16-bit precision). Offline, the data were notch filtered at 60 Hz prior to visual inspection and artifact removal. FFT was performed on all artifact-free 1 s chunks of data (Hanning windows with 50% overlap) to derive spectral power density estimates (μV^2/Hz, 30-200 Hz frequency band), which were log-transformed to normalize the data. Data in 12 one-second epochs were baseline-corrected by subtracting a 1 s pre-picture epoch, Z-scored within participant, and averaged over 3 distinct four-second blocks by image valence. The current analysis focuses on the corrugator activity during the 4 s of image presentation. See (Pedersen et al., 2020, 2022; van Reekum et al., 2011) for additional information.

Emotion Modulated Startle Eyeblink. To measure blink magnitude in response to auditory startle probes during the affective picture viewing task, a pair of Ag/AgCl 4mm Touchproof shielded electrodes were placed below one eye on the inferior orbicularis oculi muscle. Raw EMG signals were recorded using BIOPAC hardware and Acknowledge software (amplified 5,000 times prior to digitization at 1000 Hz with 16-bit precision). Offline, the data were highpass filtered at 30 Hz and underwent rectification and integration with a time constant of 20 ms. Eyeblink magnitudes (μV) were calculated by subtracting the maximum amount of integrated EMG at reflex onset from peak amplitude between 20 and 120 ms following probe onset. Trials with no eyeblink reflex were assigned a magnitude of zero and included in analysis. Values were log-transformed to normalize and z-scored within participant before averaging by image valence. The current analysis focuses on the startle eyeblink magnitude to probes during the image presentation. Participants were excluded if there were less than 10 valid eye blinks or if they were missing a magnitude value for any valence. See (van Reekum et al., 2011) for additional information.

Picture Ratings. For MIDUS Refresher 1 participants only, following the affective picture viewing task, participants viewed and rated the images from the task on a 1-9 point valence (unpleasant to pleasant) and arousal (calm to excited) scales using Self-Assessment Manikins (Bradley & Lang, 1994). Responses were averaged separately for valence and arousal ratings for positive, negative, and neutral images.

Daily Discrimination Questionnaire. To measure individual differences in discrimination experience, we used the 9-item Daily Discrimination Scale collected during the Survey Project, where participants answered on a 1 (*often*) to 4 (*never*) scale "*How often on a day-to-day basis do you experience each of the following types of discrimination*" (Williams et al., 1997). Items were reverse coded (so that larger numbers indicated more discrimination experience) and summed for cases with valid values for at least five of the items, Cronbach's α = 0.94.

Blood Pressure Measurements and Self-Reported Diagnosis. Three seated blood pressure measures were taken during the Biomarker Project. The two most similar measures were averaged for systolic and diastolic blood pressure. Additionally, during the Survey Project, participants responded yes/no to the question "In the past twelve months, have you experienced or been treated for any of the following - HIGH BLOOD PRESSURE OR HYPERTENSION?", dichotomized such that "yes" = 1, "no" = 0.

Demographics and Covariates. Self-reported race was dichotomized as 0 = White, 1 = Black. Additional variables were included as covariates in analyses, including: Demographic covariates – sex (dichotomized as 0 = male, 1 = female), mean-centered age at time of Neuroscience Project, and education (effects coded as -1 = less than a high school diploma, 0 = some college, 1 = 4-year college degree or higher); Cardiovascular covariates – mean-centered BMI, and if participants were on medication to reduce blood pressure (dichotomized as 0 = not taking medication with antihypertensive effects, 1= taking medication with antihypertensive effects). BMI and antihypertensive medication status were assessed during the Biomarker Project via measured height and weight (for BMI) and by participants bringing in all prescription medication to the session, which were recorded and subsequently classified based on pharmacological class to be an antihypertensive agent. Demographic covariates (i.e., sex, education, and mean-centered age) are included as covariates in all analyses, whereas cardiovascular covariates (i.e., mean-centered BMI and mediation status) were included only in blood pressure analyses. Finally, for analyses combining Daily Discrimination and other variables, the lag between the Survey Project and Biomarker/Neuroscience Project was included as a covariate (*M* = 25.3 months, *SD* = 14.5 months, *range* = 0 – 61 months).

Transparency and Openness

All data are publicly available at https://midus.wisc.edu/data/index.php. A list of variable names and all code for analyses are available at https://osf.io/u78vr/. Data collection was conducted in compliance with the University of Wisconsin-Madison Health Sciences IRB, and consent included information about deidentified data sharing. We report how we determined our sample size, all data exclusions, and all relevant measures. A full list of measures collected in MIDUS is available at https://midus.wisc.edu/data/index.php. This study was not pre-registered. Data were analyzed using R, version 4.2.1 (R Core Team, 2022), with ANOVA and ANCOVA analyses conducted with aov() from the stats package and follow-up post-hoc comparisons with emmeans() from the emmeans package, regression analyses conducted with glm() from the stats package and follow-up simple-slopes with simple_slopes() and standardized beta coefficients with beta() from the reghelper package, mixed effects model using the lmerTest package, mediation analyses with lavaan package, Cook's D using cooks.distance() from the stats package, and plots using the ggplot2 package (Hughes & Beiner, 2022; Kuznetsova et al., 2017; Lenth, 2023; R Core Team, 2022; Rosseel, 2012; Wickham, 2016). See full R scripts available at https://osf.io/u78vr/ for more information.

Results

Self-Reported Expressive Suppression

First, we examined self-reported expressive suppression by race with a Welch two sample t-test and found that there was a significant effect ($t(260.95) = 2.18$, $p = .002$) such that Black participants reported engaging in emotional suppression ($M = 4.33$, $SD = 1.35$) more than White participants ($M = 3.86$, $SD = 1.36$). This difference remained significant in an ANCOVA controlling for sex, age, and education ($F(1, 380) = 10.83$, $p = 0.001$).

Corrugator During Image Presentation

Next, we examined corrugator EMG activity during image presentation as a physiological metric of emotional suppression using a 2 (between-subjects: race) by 3 (within-subjects: image valence) repeated measures ANOVA. There was a significant between-subjects main effect of race ($F(1, 383) = 6.73$, $p = 0.010$), and significant within-subjects main effect of valence ($F(2, 766) = 146.86$, $p < 0.001$), but no race by image valence interaction ($F(2, 766) = 1.06$, $p = 0.347$). Follow-up post-hoc comparison contrasts for race of the estimated means with FDR correction found a significant effect of race to corrugator activity during negative ($t(969) = 2.38$, $p_{FDR} = .026$) and neutral ($t(969) = 2.41$, $p_{FDR} = .026$) images but not positive images ($t(969) = 0.91$, $p_{FDR} = .364$, such that Black participants showed less corrugator activity during both negative and neutral images than White participants. Follow-up post-hoc comparison contrasts for image valence of the estimated means with FDR correction found significant differences between all image valences, such that corrugator activity was higher for negative images than neutral images ($t(766) = 9.10$, $p_{FDR} < .001$), and higher for neutral images than positive images ($t(766) = 6.66$, $p_{FDR} < .001$). See Figure 1. The between-subjects main effect of race remained significant when age, sex, and education were included as covariates ($F(1, 380) = 7.19$, $p = 0.008$).

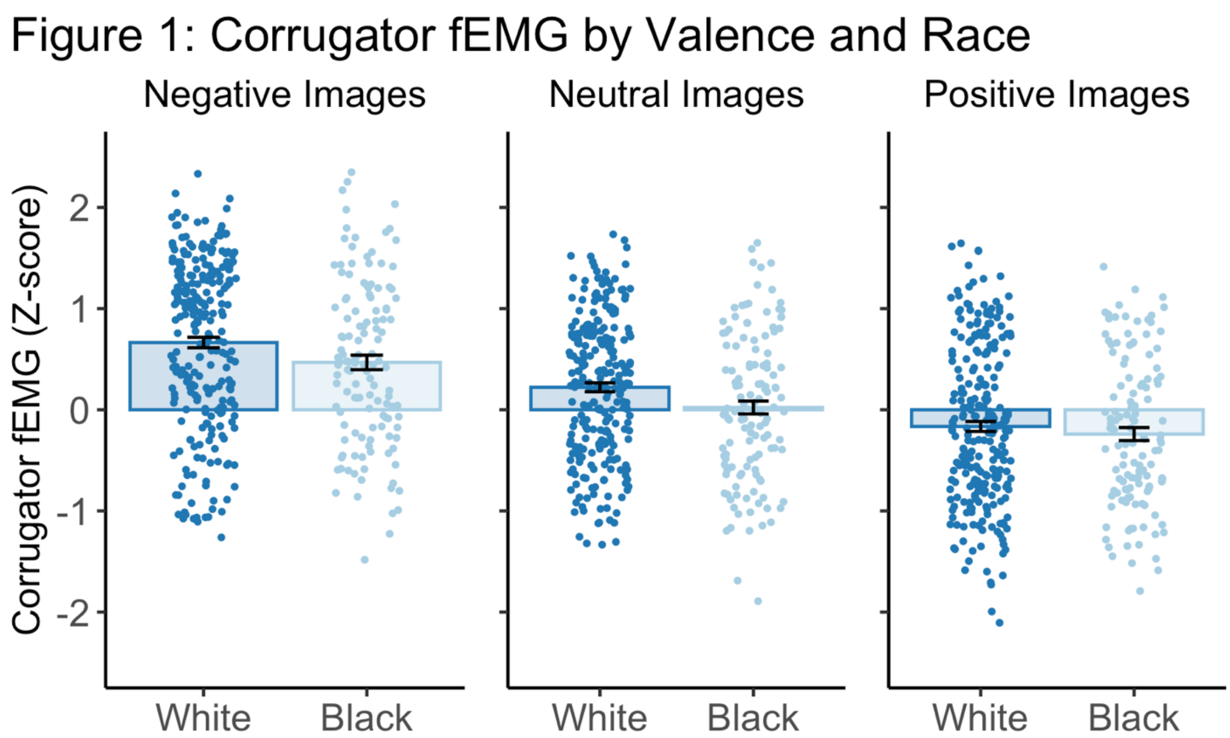

Figure 1. Corrugator fEMG activity by image valence and race.

Self-Reported Expressive Suppression and Corrugator Activity During Negative Images

To examine if corrugator EMG activity during negative images is related to self-reported expressive suppression and if this relationship varies by race, we regressed race, self-reported expressive suppression, and their interaction on corrugator activity during negative images and found only a significant effect of expressive suppression ($B = -0.08$, $\beta = -0.11$, $t(381) = 2.01$, $p = .045$), with no significant interaction, $p = 0.959$. As shown in Figure 2, for both Black and White participants corrugator activity is reduced as participants report using emotional suppression more frequently, simple slopes b_{Black} = -0.079, b_{White} = -0.076 . When controlling for age, gender, and education, the interaction between race and expressive suppression remains non-significant, p = .848, whereas the main effect of suppression is no longer significant but in the same direction (B = -0.05, β = -0.07, t(378) = 1.23, p = .221).

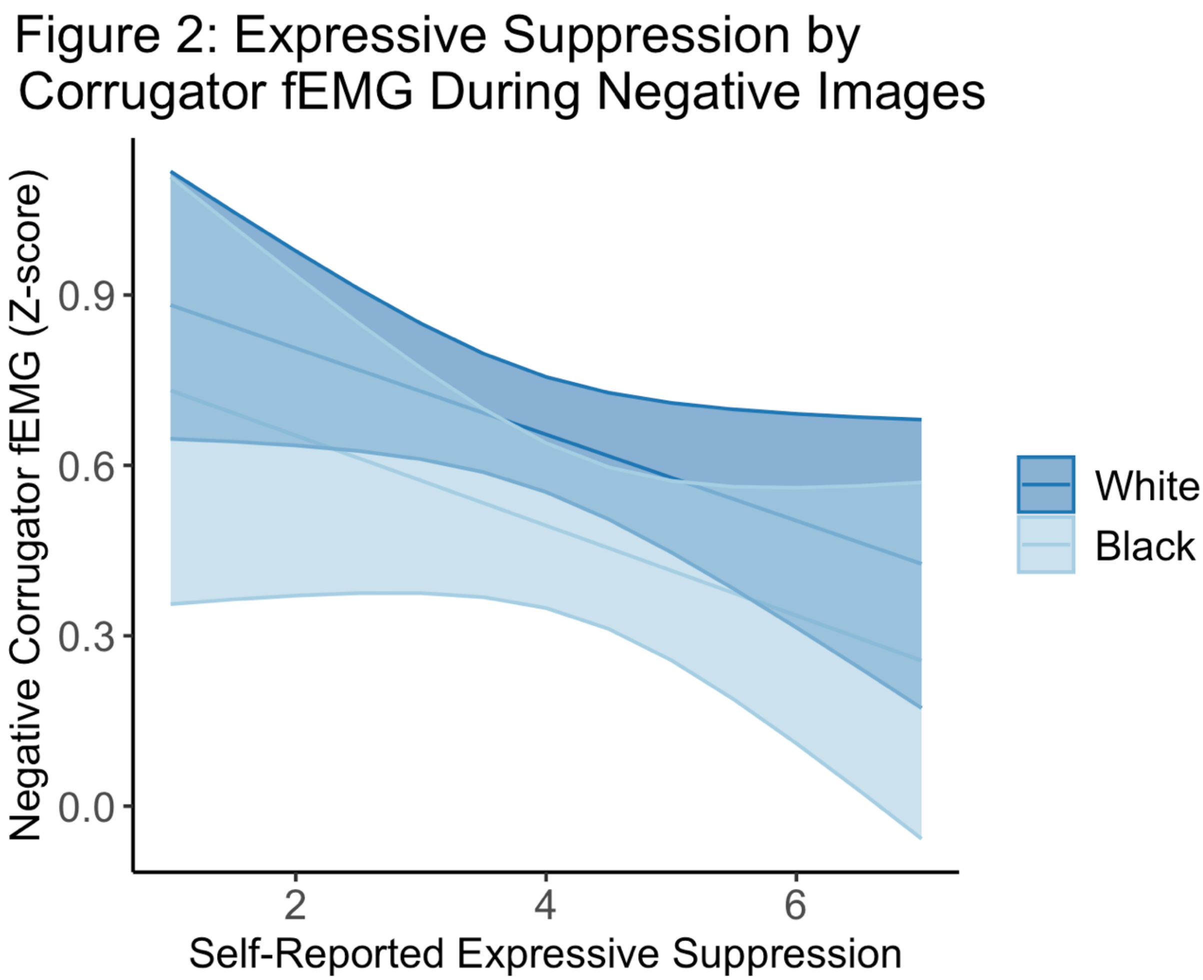

Figure 2. Self-reported expressive suppression and corrugator fEMG activity during negative images by race, no covariates included. Main effect is no longer significant but in the same direction when controlling for age, sex, and education.

Emotion Modulated Startle Eyeblink During Image Presentation

While corrugator activity is sensitive to expressive suppression, a difference in corrugator activity may reflect group differences in how emotional images are perceived. The emotion modulated startle eyeblink response provides an additional physiological measure of affective experience such that smaller emotion modulated startle eyeblink responses are observed during positive affect and larger responses are observed during negative affect. Importantly, the emotion modulated startle eyeblink response operates outside of conscious control and should therefore not be influenced by expressive suppression (Cuthbert et al., 1998).

We examined the emotion modulated startle eyeblink magnitude during image presentation using a 2 (between-subjects: race) by 3 (within-subjects: image valence) repeated measures ANOVA. There was only a significant within-subjects effect of valence ($F(2, 582) = 11.05$, $p < 0.001$), with no between-subjects main effect of race ($F(1, 291) = 0.16$, $p = 0.688$) nor a valence by race interaction ($F(2, 582) = 1.86$, $p = 0.157$). Follow-up post-hoc comparison contrasts for image valence of the estimated means with FDR correction found startle eyeblink magnitude was higher for negative images than neutral images ($t(582) = 4.41$, $p_{FDR} < .001$), and higher for negative images than positive images ($t(582) = 3.87$, $p_{FDR} = .002$), but not significantly different between neutral and positive images ($t(582) = 0.54$, $p_{FDR} = .590$). See Figure 3. The between-subjects main effect of race remained non-significant when age, sex, and education were included as covariates ($F(1, 288) = 0.16$, $p = 0.686$).

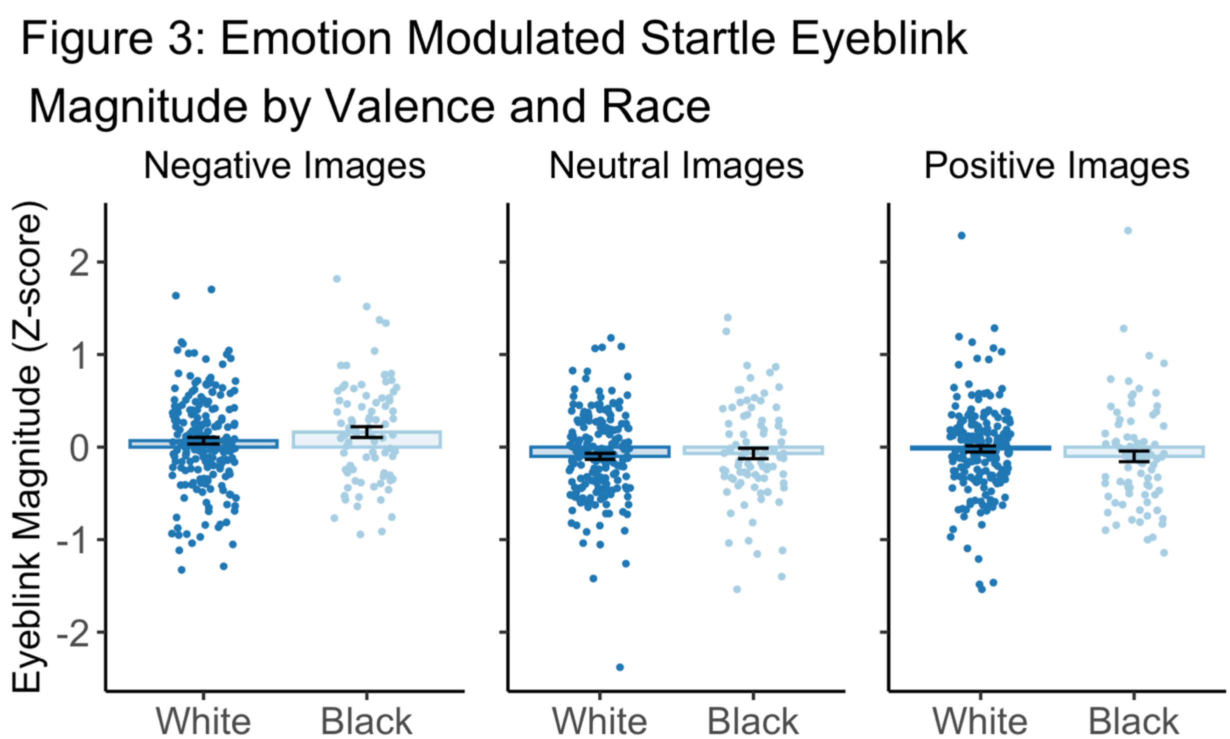

Figure 3. Emotion modulated startle eyeblink magnitude by image valence and race.

While the null race finding is consistent with the interpretation that there were no differences in emotion-modulated startle by race, it is difficult to confidently interpret null findings. To further contextualize this finding, we next examine the association between self-reported expressive suppression and startle eyeblink responses during negative images.

Self-Reported Expressive Suppression and Startle Eyeblink Responses During Negative Images

To examine if startle eyeblink responses during negative images is related to self-reported expressive suppression and if this relationship varies by race, we regressed race, self-reported expressive suppression, and their interaction on startle eyeblink magnitude during negative images and found no significant relationship between self-reported suppression and negative image startle eyeblink magnitude (p = .131), and no significant interaction with race (p

= .066), both of which remained non-significant (p's > .080), when controlling for age, sex, and education.

However, given that there are only 3 startle eyeblink probes during each image valence (for a total of 9 probes) compared to 30 images of each valence for corrugator fEMG (for a total of 90 trials), it is likely the emotion modulated startle eyeblink magnitude is a noisier measure than the corrugator fEMG activity. We therefore turn to self-reports of emotional experience to further contextualize these findings.

Self-Reported Valence and Arousal

The clearest indication of emotional experience is relying upon participant self-reports. All MIDUS Refresher 1 participants completed valence and arousal Self-Assessment Manikin ratings of all images presented during the emotion picture viewing task after completing the task. We therefore analyzed both valence and arousal ratings in separate 2 (between-subjects: race) by 3 (within-subjects: image valence) repeated measures ANOVAs.

For valence ratings, there was a significant between-subjects main effect of race ($F(1, 106) = 5.14$, $p = 0.025$), a significant within-subjects main effect of valence ($F(2, 212) = 715.82$, $p < 0.001$), and a marginal race by valence interaction ($F(2, 212) = 2.91$, $p = 0.057$). Follow-up post-hoc comparison contrasts of the estimated means of image valence with FDR correction found significant differences between all image valences, such that valence ratings were lower for negative images than neutral images ($t(212) = 21.01$, $p_{FDR} < .001$), and lower for neutral images than positive images ($t(212) = 14.30$, $p_{FDR} < .001$). Additional follow-up post-hoc comparison contrasts of the estimated means with FDR correction found a significant effect of race on neutral valence ratings ($t(317) = 2.51$, $p_{FDR} = .038$), but not negative ($t(317) = 2.00$, $p_{FDR} = .070$) or positive ($t(317) = 0.72$, $p_{FDR} = .471$) images, such that Black participants rated neutral images as more negative in valence than White participants. See Figure 4. The between-subjects main effect of race remained significant when age, sex, and education were included as covariates ($F(1, 103) = 5.02$, $p = 0.027$). Overall, this suggests that Black participants experienced similar levels of negative affect during negative images as White participants and may have experienced more negative affect during neutral images despite showing less corrugator activity than White participants to both negative and neutral images.

For arousal ratings, there was a significant within-subjects main effect of valence ($F(2, 212) = 69.35$, $p < 0.001$), and a significant race by valence interaction ($F(2, 212) = 4.66$, $p = 0.010$). Follow-up post-hoc comparison contrasts of the estimated means of image valence with FDR correction found significant differences between neutral and emotional images, such that arousal ratings were lower for neutral images than negative images ($t(212) = 9.52$, $p_{FDR} < .001$), and lower for neutral images than positive images ($t(212) = 7.68$, $p_{FDR} < .001$), but there was no significant difference between negative and positive image arousal ratings ($t(212) = 1.84$, $p_{FDR} = .066$). Additional follow-up post-hoc comparison contrasts of the estimated means with FDR correction found no significant effect of race on arousal ratings for negative ($t(198) = 1.51$, $p_{FDR} = .370$), neutral ($t(198) = 0.33$, $p_{FDR} = .370$), or positive ($t(198) = 1.09$, $p_{FDR} = .370$) images. Instead, the significant interaction was driven by White participants rating negative images higher in arousal than positive images (($t(212) = 4.15$, $p_{FDR} < .001$), whereas Black participants did not differ in arousal ratings between negative and positive images (($t(212) = 0.54$, $p_{FDR} = .592$). See Figure 4. Results are similar when controlling for age, sex, and education, such that there is a significant race by valence interaction ($F(2, 212) = 4.66$, $p = 0.010$), with non-significant follow-up post-hoc comparison contrasts of the estimated means by image valence with FDR correction, p_{FDR}'s = .348.

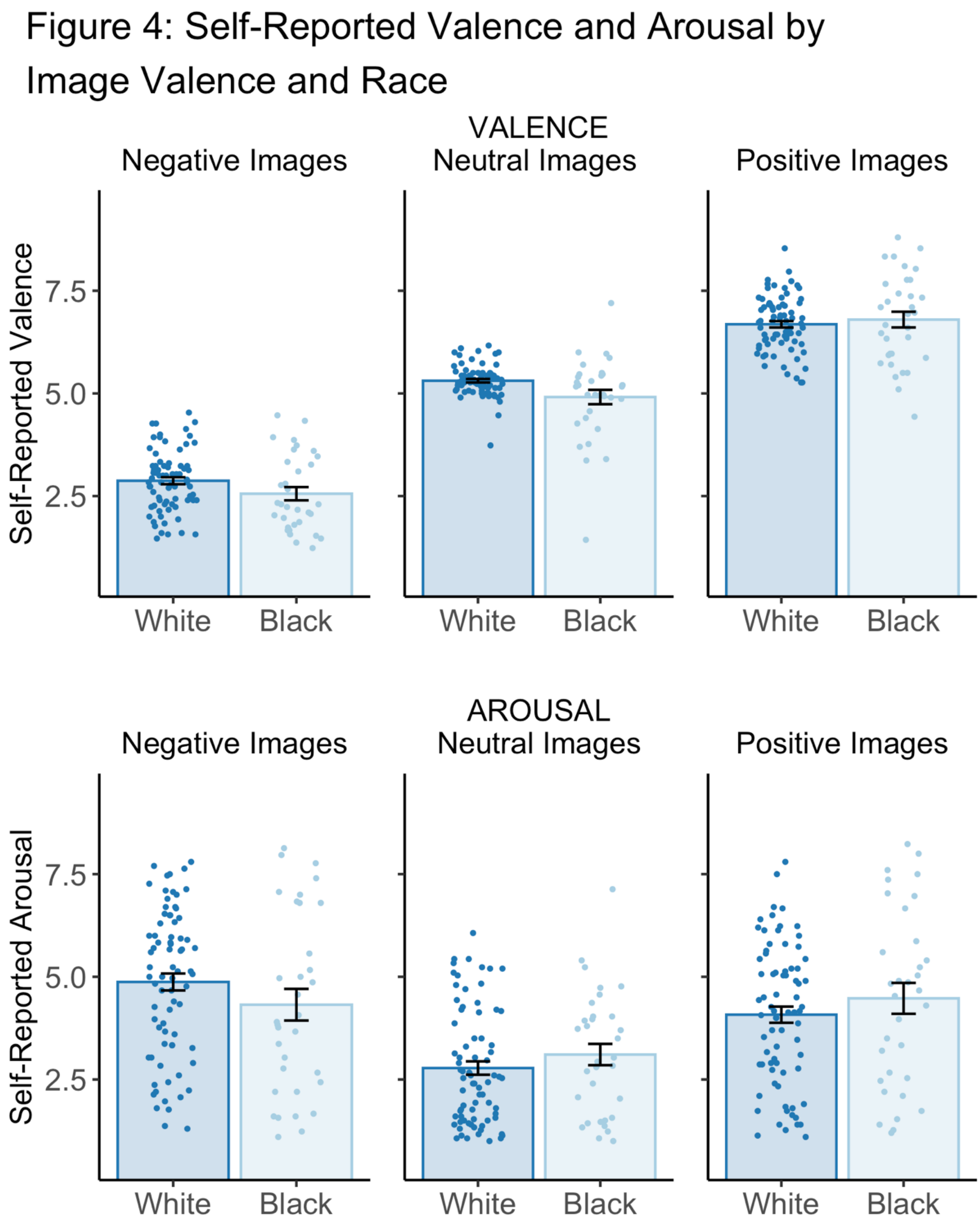

Figure 4. Self-reported valence and arousal ratings by image valence and race.

Overall, this suggests that Black participants experienced similar levels of arousal during each image valence as White participants. We now turn to a series of regressions examining the relationship between self-reported emotional experience and the physiological measures of emotion to further contextualize the differences in corrugator activity during negative images by race.

Self-Reported Valence and Arousal to Negative Images and Corrugator Activity During Negative Images

We examined the relationships between self-reported valence and arousal to negative images and fEMG corrugator activity during negative images in two separate regressions, by regressing each self-report measure and its interaction with race separately onto corrugator activity. These analyses are parallel to the regressions examining the relationship between self-reported expressive suppression and negative corrugator activity, and allow us to examine the relationship between self-reported emotional experience and negative corrugator activity and how it differs from self-reported expressive suppression use. However, because a smaller subset of participants had self-reported valence and arousal, we focus on contrasting the standardized betas.

For self-reported negative image valence, there was no significant interaction between race and self-reported valence, $p = .340$, but there was a marginal main effect of self-reported valence, $B = 0.26$, $\beta = 0.16$, $t(104) = 1.97$, $p = .052$, comparable in size to the relationship between self-reported expressive suppression and corrugator activity during negative images ($\beta = 0.11$). Contrary to expectations, individuals who reported *more* negative valence (i.e., lower numbers on the valence scale) to negative images had *less* corrugator activity during negative images. When controlling for age, sex, and education, the interaction between race and valence ratings remains non-significant (*p* = 0.141), while the main effect of valence remains in the same direction and becomes significant, *B* = 0.25, β = 0.13, t(101) = 1.99, *p* = .049.[3]

For self-reported negative image arousal, there was no significant interaction between race and self-reported arousal, *p* = .587, but there was a marginal main effect of self-reported arousal, *B* = -0.10, β = -0.16, t(104) = 1.82, *p* = .072, comparable in size to the relationship between self-reported expressive suppression and corrugator activity during negative images (β = 0.11). Contrary to expectations, individuals who reported *more* arousal (i.e., higher numbers on the arousal scale) to negative images had *less* corrugator activity during negative images. When controlling for age, sex, and education, the interaction between race and arousal ratings remains non-significant (*p* = 0.722), while the main effect of arousal remains marginal and in the same direction, *B* = -0.09, β = -0.16, t(101) = 1.77, *p* = .079.

Self-Reported Valence and Arousal to Negative Images and Startle Eyeblink Responses During Negative Images

We similarly examined the relationships between self-reported valence and arousal to negative images and startle eyeblink magnitude during negative images in two separate regressions, by regressing each self-report measure and its interaction with race separately onto startle eyeblink magnitude.

For self-reported negative image valence, there was no significant interaction between race and self-reported valence, *p* = .704, but there was a significant main effect of self-reported valence, *B* = -0.11, β = -0.10, t(96) = 2.01, *p* = .047, consistent with expectations such that

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[3] When examining the relationship between self-reported valence (averaged across image valence categories) and corrugator fEMG activity (averaged across image valence categories) in a mixed effects model, we see that the fixed effect for self-reported valence does indeed relate as expected to corrugator fEMG activity, *B* = -0.22, *t*(229.87) = 10.18, *p* < .001, such that lower (more negative) valence ratings are associated with more corrugator fEMG activity.

individuals who reported *more* negative valence (i.e., lower numbers on the valence scale) to negative images had *higher* startle eyeblink magnitudes during negative images. When controlling for age, sex, and education, the interaction between race and valence ratings remains non-significant ($p = 0.686$), while the main effect of self-reported valence remains significant, $B = -0.13$, $\beta = -0.11$, $t(93) = 1.99$, $p = .021$.

For self-reported negative image arousal, there was no significant interaction between race and self-reported arousal, $p = .284$, but there was a marginal main effect of self-reported arousal, $B = 0.04$, $\beta = 0.06$, $t(96) = 1.78$, $p = .079$, consistent with expectations such that individuals who reported *more* arousal (i.e., higher numbers on the arousal scale) to negative images had *higher* startle eyeblink magnitudes during negative images. When controlling for age, sex, and education, the interaction between race and arousal ratings remains non-significant ($p = 0.278$), while the main effect of arousal becomes significant, $B = 0.05$, $\beta = 0.07$, $t(93) = 1.99$, $p = .050$.

Discrimination as Potential Mediator Between Self-Reported Expressive Suppression and Negative Corrugator Activity for Black Americans

The analyses described above are consistent with the hypothesis that Black participants are expressing less negative emotions compared to White participants, as indexed by higher self-reported use of expressive suppression in daily life as well as less fEMG corrugator activity during negative images during an emotional picture viewing task. Additionally, the relationship between self-reported expressive suppression and fEMG corrugator activity during negative images appears to be consistent between Black and White participants. However, theoretical frameworks (i.e., Brownlow, 2022; Wilson & Gentzler, 2021) suggest that the mechanistic linkage between expressive suppression and reduced emotional expression is different for Black participants, such that it is a reaction to coping with discrimination. A Welch's two sample t-test found that Black participants reported experiencing more frequent instances of daily discrimination than White participants ($t(173.88) = 3.26$, $p = .001$; $M_{Black} = 14.3$, $SD_{Black} = 6.9$; $M_{White} = 12.1$, $SD_{White} = 4.1$; see Figure 5), suggesting the potential for daily discrimination experience to mediate the relationship between self-reported expressive suppression and fEMG corrugator activity.

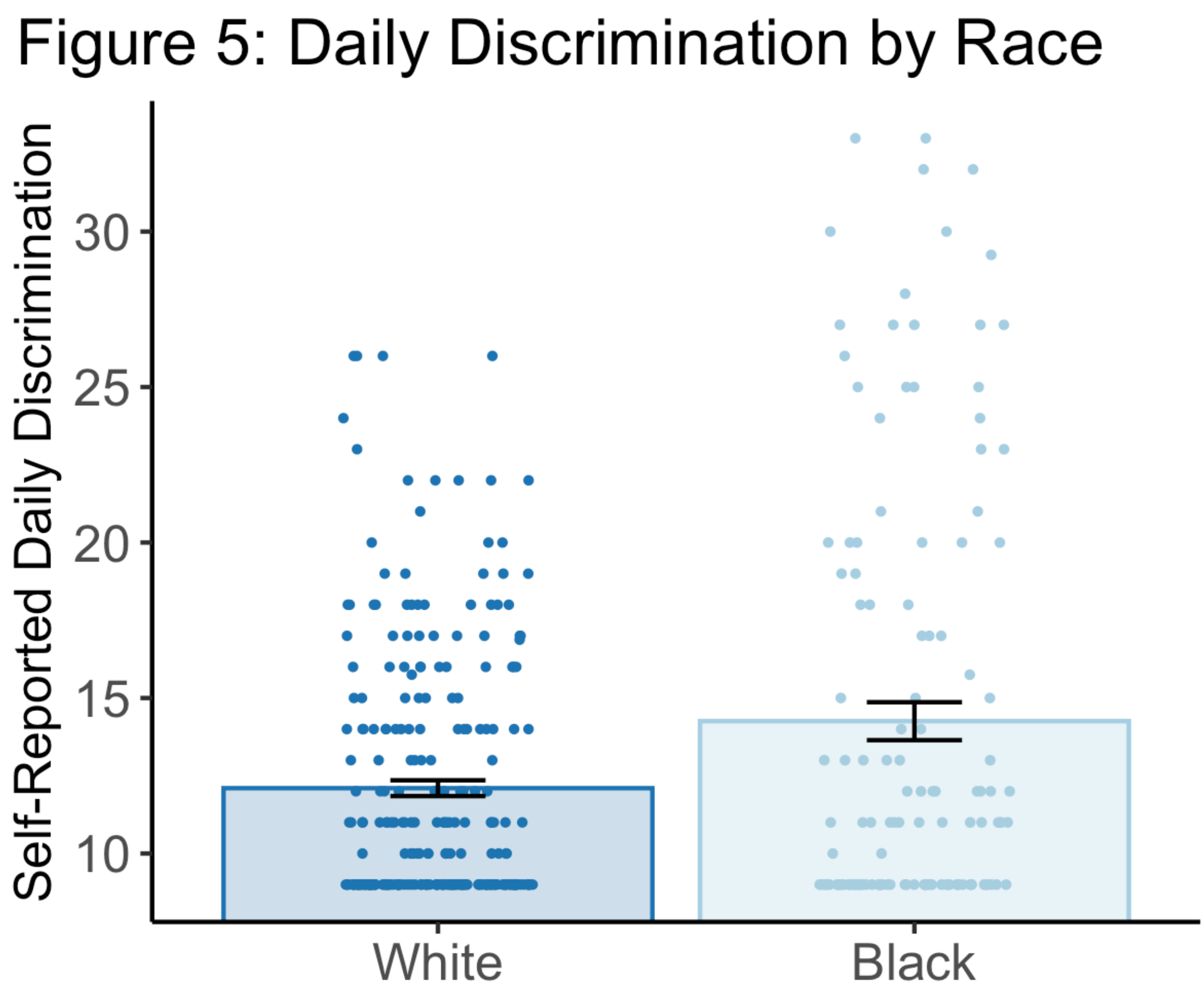

Figure 5. Self-reported daily discrimination by race.

Therefore, we conducted a multigroup moderated mediation (Hayes & Preacher, 2013; Kline, 2011) with self-reported expressive suppression as the independent variable, corrugator activity during negative images as the dependent variable, and self-reported daily discrimination as the mediator, to examine if there are group differences between Black and White participants in the relationship between these variables. Because our prior analyses showed no group differences in the relationship between self-reported expressive suppression and corrugator activity during negative images, we constrained this path to be equal between groups. See Figure 6. Analyses were conducted in laavan (Rosseel, 2012) with 5,000 bootstrap standard error estimates, and lag in months between the daily discrimination questionnaire and other measures as a covariate. The overall effect of race was tested using a Wald Test comparing to a model which constrains the race effects to equality, such that a significant result suggests significant moderation by race (Kline, 2011).

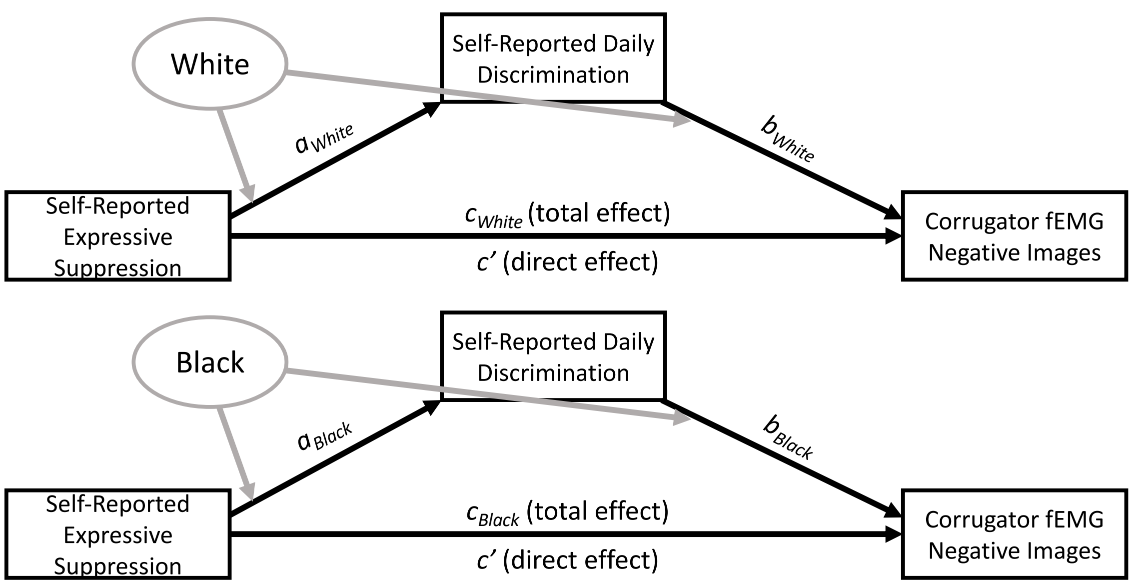

Figure 6. Multigroup moderated mediation path diagram.

As shown in Table 2, there was a significant effect of race, Wald Test $\chi(2)^2 = 8.68$, p = 0.013. For White participants, there is virtually no indirect association between self-reported expressive suppression and corrugator activity during negative images through self-reports of daily discrimination. However, for Black participants, there is evidence of potential mediation through self-reported daily discrimination, such that higher self-reported expressive suppression is associated with higher self-reported experiences of daily discrimination ($a_{Black} = 1.19$, p = 0.010), and higher self-reported experiences of daily discrimination are non-significantly related to less corrugator activity during negative images ($b_{Black} = -0.01$, $p = 0.227$), resulting in 15.6% of the total effect between self-reported expressive suppression and corrugator activity during negative images being explained by self-reported daily discrimination consistent with theoretical accounts. While the overall Wald Test is significant, suggesting that this indirect effect is significantly different between Black and White participants, the indirect effect for Black participants failed to reach significance compared to zero, $a_{Black} \times b_{Black} = -0.01$, $p = 0.240$. However, there were only $n = 129$ Black participants, which may be underpowered for this mediation analysis.

Table 2. Multigroup moderated mediation, controlling for lag.

White Participants (n = 225)					Black Participants (n = 129)				
	Estimate	Standard Error	p-value	95% CI		Estimate	Standard Error	p-value	95% CI
a_{White} (expressive suppression to discrimination)	0.01	0.21	0.969	[-0.40, 0.42]	a_{Black} (expressive suppression to discrimination)	1.19	0.46	0.010	[0.31, 2.10]
b_{White} (discrimination to negative corrugator)	0.01	0.01	0.573	[-0.02, 0.03]	b_{Black} (discrimination to negative corrugator)	-0.01	0.01	0.573	[-0.02, 0.03]
$a_{White} \times b_{White}$ (indirect effect through discrimination)	< 0.001	0.003	0.986	[-0.01, 0.01]	$a_{Black} \times b_{Black}$ (indirect effect through discrimination)	-0.01	0.01	0.240	[-0.04, 0.004]
c' (direct effect, expressive suppression to negative corrugator)	-0.07	0.03	0.026	[-0.13, -0.01]	c' (direct effect, expressive suppression to negative corrugator)	-0.07	0.03	0.026	[-0.13, -0.01]
c_{White} (total effect)	-0.07	0.03	0.027	[-0.13, -0.01]	c_{Black} (total effect)	-0.08	0.03	0.009	[-0.14, -0.02]
Lag effect, discrimination	-0.02	0.02	0.165	[-0.01, 0.01]	Lag effect, discrimination	-0.02	0.02	0.165	[-0.01, 0.01]
Lag effect, negative corrugator	-0.01	0.003	0.085	[-0.01, 0.001]	Lag effect, negative corrugator	-0.01	0.003	0.085	[-0.01, 0.001]

Wald Test of moderation by race: $\chi(2)^2 = 8.68$, $p = 0.013$

The results remained the same when adding age, sex, and education as additional covariates, Wald Test $\chi(2)^2 = 6.99$, $p = 0.030$. Future research should expand upon this initial analysis with a larger sample size, and with a discrimination measure collected in closer proximity to the other variables. Ideally, such future research would also involve experimental manipulations, as the current analyses involve correlational associations, limiting causal inference. Overall, the multigroup moderated mediation is consistent with theoretical accounts which posit that differences in expressive suppression and emotional expression between Black and White Americans are due to a Black American cultural response to discrimination experiences (Brownlow, 2022; Thayer et al., 2020; Wilson & Gentzler, 2021)

Associations Between Self-Reported Expressive Suppression and Corrugator Activity During Negative Images and Blood Pressure by Race

Finally, to understand if the racial differences in expressive suppression and emotional expression have an impact on cardiovascular health, we conducted analyses on seated systolic and diastolic blood pressure. While others have reported that Black participants in the MIDUS Biomarker Project have higher blood pressure than their White counterparts (Curtis et al., 2017), in the subsample of participants who provided corrugator data, we found no significant difference for systolic ($t(208.61) = 1.50$, $p = .136$; $M_{Black} = 130.6$, $SD_{Black} = 19.6$; $M_{White} = 127.7$, $SD_{White} = 15.1$) nor for diastolic ($t(229.8) = 1.48$, $p = .139$; $M_{Black} = 78.3$, $SD_{Black} = 11.9$; $M_{White} = 76.5$, $SD_{White} = 10.3$) blood pressure. We also examined if there were differences by race in self-reported diagnosis of hypertension and found that Black participants were more likely to report a hypertension diagnosis (39.2%) than White participants (26.4%), $\chi^2 = 6.67$, $p = .010$. Because blood pressure is sensitive to BMI and prescription medications, we examined if there were racial differences in BMI and antihypertensive prescriptions. Black participants had significantly higher BMIs than White participants ($t(229.0) = 3.70$, $p < .001$; $M_{Black} = 32.1$, $SD_{Black} = 7.0$; $M_{White} = 29.4$, $SD_{White} = 6.1$), and Black participants were more likely to be prescribed an antihypertensive medication (43.8%) than White participants (33.3%), $\chi^2 = 4.09$, $p = .043$.

We examined the relationship between self-reported expressive suppression, corrugator activity during negative images, race, and systolic and diastolic blood pressure in separate linear regressions[4]. Because blood pressure is sensitive to sex, age, education, BMI, and prescription antihypertensives, we controlled for all covariates in all analyses (i.e., mean-centered age, mean-centered BMI, dichotomized sex, education (coded as -1 = high school or less, 0 = some college, 1 = Bachelor's degree or higher), dichotomized antihypertensive status, and race by mean-centered BMI interaction[5]).

Table 3 describes regressions predicting blood pressure with self-reported expressive suppression. We found no significant effects for expressive suppression, race, or their interaction, although the main effect of expressive suppression is in the direction such that more self-reported use of expressive suppression is associated with higher systolic and diastolic blood pressure.

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[4] Three participants had high systolic blood pressure measures over 180 mmHg. We examined Cook's distance for the regression analyses involving blood pressure, and none of the measures exceeded the cutoff of 0.5 (range 0-0.1). Therefore, we retained the full sample for analyses.

[5] We tested for race by covariate interactions on systolic and diastolic blood pressure and found a significant centered-BMI by race interaction predicting systolic blood pressure ($B = -0.78$, $t(381) = 2.95$, $p = .003$). Follow-up simple slopes analyses found a significant relationship between systolic blood pressure and BMI for White participants ($b = 0.81$, $t(381) = 4.84$, $p < .001$) but not for Black participants ($B = 0.03$, $t(381) = 0.17$, $p = .866$). There was a similar interaction for diastolic blood pressure ($B = -0.52$, $t(381) = 2.99$, $p = .003$), such that there was a significant relationship between diastolic blood pressure and BMI for White participants ($b = 0.11$, $t(381) = 3.50$, $p < .001$) but not for Black participants ($B = -0.13$, $t(381) = 0.99$, $p = .322$). Therefore, we included race by centered-BMI as a covariate in all blood pressure analyses.

Table 3. Blood pressure by race and self-reported expressive suppression

	Systolic Blood Pressure				Diastolic Blood Pressure			
	Estimate (Standard Error)	Standard Estimate (β)	*t*-value	*p*-value	Estimate (Standard Error)	Standard Estimate (β)	*t*-value	*p*-value
Intercept	126.43 (3.44)		36.75	< .001	79.43 (2.25)		35.26	< .001
Self-reported Expressive Suppression	0.92 (0.76)	0.53	1.21	.226	0.14 (0.49)	0.18	0.28	.779
Race	8.91 (5.68)	1.24	1.57	.118	2.00 (3.72)	0.89	0.54	.591
Expressive Suppression × Race	-1.56 (1.28)	-1.02	1.28	.223	-0.03 (0.84)	-0.02	0.03	.973
Age (mean-centered)	0.26 (0.08)	3.17	3.43	.001	-0.09 (0.05)	-1.01	1.67	.095
Sex	-3.79 (1.71)	-1.89	2.22	.027	-5.42 (1.12)	-2.70	4.85	< .001
Education	-0.96 (1.01)	-0.80	0.95	0.342	0.24 (0.66)	0.20	0.36	0.716
BMI (mean-centered)	0.73 (0.17)	3.30	4.36	< .001	0.37 (0.110)	1.57	3.35	< .001
Antihypertensive Medication	1.19 (1.96)	0.57	0.61	.546	-0.84 (1.29)	-0.41	0.65	.513
Race × BMI	-0.66 (0.26)	-2.06	2.53	.012	-0.379 (0.172)	-1.17	2.21	.028

As shown in Table 4, for the regressions involving self-reported expressive suppression to predict blood pressure there is a significant race by corrugator activity during negative images interaction for systolic blood pressure ($B = -4.12$, $\beta = -1.65$, $t(375) = 2.00$, $p = .047$), but not for diastolic blood pressure ($B = -1.81$, $\beta = -0.71$, $t(375) = 1.31$, $p = .191$). Follow-up simple slope comparisons found a significant relationship between systolic blood pressure for Black participants ($b = -4.63$, $t(375) = 2.67$, $p = .008$) but not for White participants ($b = -0.42$, $t(375) = 0.34$, $p = .738$), such that Black participants show higher systolic blood pressure with less corrugator activity. This is consistent with the hypothesis that Black participants who may be suppressing their emotional facial expressions to negative stimuli have higher systolic blood pressure. Although the interaction is non-significant for diastolic blood pressure, exploratory simple-slopes analyses suggest the pattern of results is similar, such that Black participants have higher diastolic blood pressure with less corrugator activity ($b = -2.54$, $t(375) = 2.24$, $p = .026$) while White participants show no significant relationship ($b = -0.73$, $t(375) = 0.82$, $p = .373$). See Figure 7.

Table 4. Blood pressure by race and corrugator activity during negative images.

	Systolic Blood Pressure				Diastolic Blood Pressure			
	Estimate (Standard Error)	Standard Estimate (β)	*t*-value	*p*-value	Estimate (Standard Error)	Standard Estimate (β)	*t*-value	*p*-value
Intercept	130.04 (1.73)		75.00	< .001	80.31 (1.14)		70.75	< .001
Corrugator (Negative Images)	-0.42 (1.25)	-1.52	0.34	.738	-0.73 (0.82)	-1.11	0.89	.373
Race	4.57 (2.17)	0.97	2.11	.035	2.71 (1.41)	0.77	1.91	.056
Negative Image Corrugator X Race	-4.21 (2.11)	-1.65	2.00	.047	-1.81 (1.38)	-0.71	1.31	.191
Age (mean-centered)	0.26 (0.08)	3.01	3.23	.001	-0.10 (0.05)	-1.18	1.94	.054
Sex	-3.56 (1.66)	-1.77	2.15	.033	-5.14 (1.09)	-2.56	4.74	< .001
Education	-0.72 (1.01)	-0.60	0.72	0.473	0.36 (0.66)	0.29	0.54	.589
BMI (mean-centered)	0.74 (0.17)	3.24	4.46	< .001	0.38 (0.109)	1.50	3.46	< .001
Antihypertensive Medication	1.35 (1.96)	0.65	0.69	.492	-0.87 (1.28)	-0.42	0.68	.500
Race X BMI	-0.73 (0.26)	-2.26	2.80	.005	-0.435 (0.171)	-1.35	2.55	.011

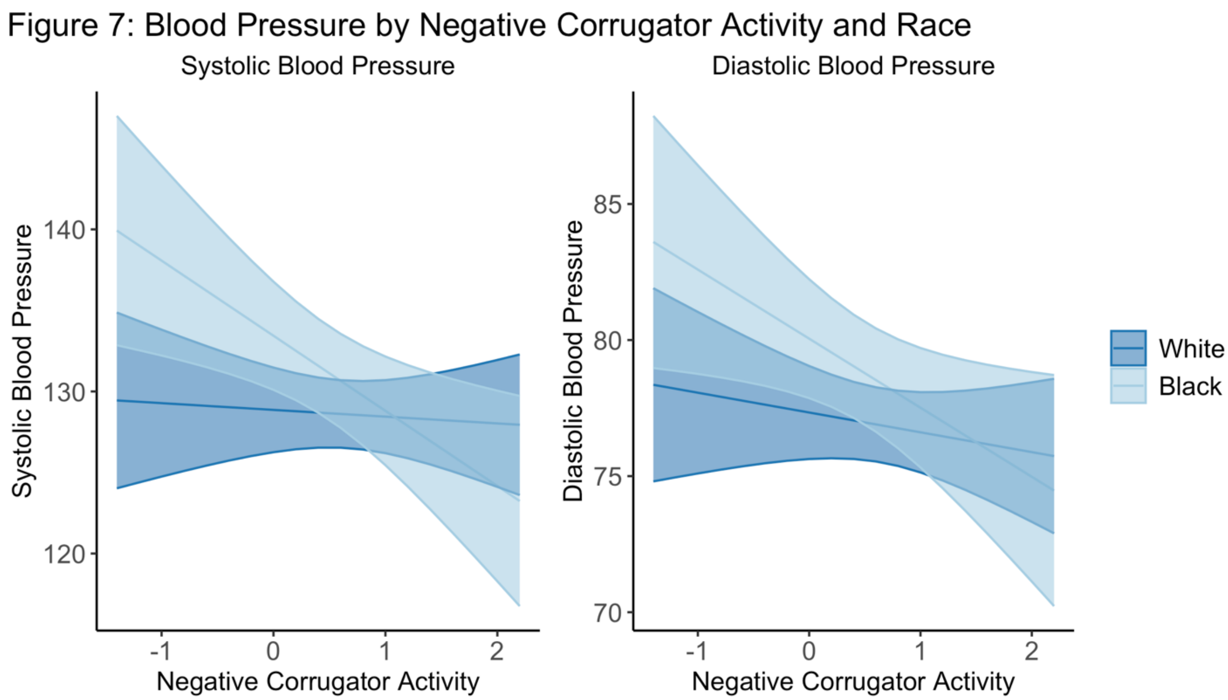

Figure 7. Systolic and diastolic blood pressure by corrugator activity during negative images and race. Controls for age, sex, education, BMI, antihypertensive medication usage, and race × BMI interaction.

Overall, this suggests that suppressing the expression of negative emotions during a lab-based image viewing task, as measured with corrugator fEMG activity, may take a physiologic toll particularly for Black Americans, whereas the general usage of expressive suppression in daily life may not be as detrimental to cardiovascular health. However, while the collection of analyses is suggestive that the racial differences are consistent with differences in emotional expression rather than emotional experience, we cannot definitively rule out the potential for differences in emotional experience driving these results.

Discussion

The current study replicates prior findings that Black Americans self-report engaging in expressive suppression more frequently than White Americans (Wilson & Gentzler, 2021), and finds that Black Americans have less corrugator fEMG activity during negative images than White Americans but have similar self-reported ratings of image valence and arousal as well as similar emotion modulated startle-eyeblink magnitudes. Overall, this is consistent with Black Americans suppressing their emotional expressions during negative emotions more than White Americans. The multigroup mediation analyses further suggest that this racial difference may be driven by discrimination experience, whereby Black Americans demonstrate a different relationship between self-reported expressive suppression and emotional expression partially mediated by discrimination experience, while White Americans do not. This is consistent with Brownlow's (2022) model of Culturally Compelled Coping and related theoretical frameworks (Thayer et al., 2020; Wilson & Gentzler, 2021), such that the relationship between self-reported expressive suppression and psychophysiological measures of (negative) emotional expression are related due to discrimination experience, possibly as a coping mechanism.

Additionally, the current study suggests that less corrugator activity to negative picture presentations is associated with higher systolic blood pressure for Black Americans but not White Americans, which may be due to more expressive suppression or other factors resulting in lower corrugator fEMG to unpleasant images. This finding is consistent with the idea that expressive suppression may be one mechanism (of many) by which racism "gets under the skin" for Black Americans, resulting in downstream negative consequences for cardiovascular health. While consistent with recent social and cultural theories examining emotional expression and regulation in the United States (Brownlow, 2022; Thayer et al., 2020; Wilson & Gentzler, 2021), without direct measurement or manipulation of suppression use during the emotional image viewing task we cannot definitively claim that the lower levels of corrugator activity in Black participants was due to suppression of their facial expressions as opposed to differences in emotional experience. Therefore, future research is needed to definitively tease apart the mechanism underlying the difference in emotional expression as measured by corrugator fEMG by race.

Importance of Social and Cultural Factors to Emotion Expression and Regulation

The current study highlights the importance of considering affective processes, including expression and regulation, within broader social and cultural contexts. In particular, recent theoretical frameworks highlight the powerful social and cultural contexts within which Black American culture has developed unique patterns of emotional coping (Brownlow, 2022; Thayer et al., 2020; Wilson & Gentzler, 2021). By expanding our view of emotion regulation beyond the individual, new insights can be gained into the ways in which various emotion regulation strategies may be adaptive and/or maladaptive in real-world contexts. In this manner, expressive suppression may be adaptive in-the-moment for Black Americans to avoid and cope with racial stressors, but maladaptive in the long run for cardiovascular health (Thayer et al., 2020).

The Cardiovascular Conundrum

Recent work has described the "cardiovascular conundrum" primarily among Black Americans, whereby Black Americans show heightened risk factors for cardiovascular disease (including hypertension) despite having higher resting heart rate variability (HRV), a metric typically associated with *reduced* risk of cardiovascular disease (Hill & Thayer, 2019; Thayer et al., 2020). This conundrum is also found in darker-skinned individuals in Brazil and sexual minorities in Italy, suggesting it may be a physiological adaptation to the experience of discrimination (Kemp et al., 2016; Rosati et al., 2021). Intriguingly, HRV has been associated with emotion regulation, such that individuals who are more successful in emotion regulation and/or engage in emotion regulation more frequently tend to have higher HRV (Christou-Champi et al., 2014; Holzman & Bridgett, 2017; Sakaki et al., 2016). Insofar as Black Americans are regulating emotions more frequently than White Americans to cope with discrimination, they are likely to show higher HRV. However, if Black Americans are using expressive suppression more frequently than White Americans, then the current research would suggest that they would also have higher blood pressure, consistent with the pattern described by the cardiovascular conundrum. Future research should examine the role expressive suppression, measured through self-report and facial measures of emotional expression, may play in explaining the cardiovascular conundrum in Black Americans and possibly other minoritized groups.

Cardiovascular Emotional Dampening as a Potential Alternative Explanation

Increases in blood pressure may be more than a physiological side-effect of experiencing racial stressors – it may also blunt emotional experiences. Higher resting blood pressure has been found to predict lower subjective responses to physical pain (Makovac et al., 2020) and less sensitivity to social pain (Inagaki et al., 2018). Higher resting blood pressure has also been found to be associated with lower arousal and more neutral valence responses to affective images and with less accurate emotional recognition of positive and negative faces and sentences (McCubbin et al., 2011; Shukla et al., 2018; Yoris et al., 2020). Emotional dampening has been observed in both normotensive and hypertensive adults (McCubbin et al., 2011, 2014). Therefore, it may be that the relationship between blood pressure and emotional expression as measured by corrugator fEMG is bidirectional, particularly for Black participants, such that higher blood pressure is associated with blunted emotional responses as well as habitual use of expressive suppression resulting in higher blood pressure. Future research should address this possibility by including measures of blood pressure during an emotional task, as well as measuring changes in blood pressure in response to instructed expressive suppression.

Constraints on Generality

The current study is limited to the unique context of Black and White Americans adults living in the United States from 2004-2016. However, we anticipate these findings may generalize to similar cultural situations where a minoritized group forms a specific cultural script for suppressing emotional expression to cope with the social stress of discrimination, including other minoritized groups in the United States (i.e., racial minorities, sexual and gender minorities) and across the world (i.e., Palestinians in Israel). For example, initial evidence suggests that American Indians show associations between expressive suppression and poorer cardiovascular health (Tyra et al., 2022). However, there may be other cultural scripts for coping that may specify other strategies beyond expressive suppression, or additional cultural factors that may reduce the negative health impacts of expressive suppression. For example, prior work suggests that individuals from collectivistic cultures, including Asian Americans, do not show the same pattern of negative health outcomes associated with expressive suppression in other groups (Ramzan & Amjad, 2017; Soto et al., 2011).

Additionally, the current research does not assess further ethnic breakdowns between Black and White Americans (e.g., Black Americans born in the United States vs immigrants from Africa; White Americans born in the United States vs immigrants from European and Slavic countries), while research suggests intergroup ethnic differences plays an important a role in emotional experience and expression (Consedine & Magai, 2002). Additional work is needed to better understand the specific social and cultural factors that influence emotion regulation strategy usage and downstream consequences on health and well-being.

Finally, as noted previously, we never directly assessed if and how participants were regulating their emotions during the image viewing task. Based on the overall pattern of corrugator fEMG activity, emotion modulated startle eyeblink response magnitudes, and self-reported valence and arousal, we concluded that Black participants were likely engaging in expressive suppression during negative images more than White participants. However, this is a tentative conclusion that warrants future research to both replicate the finding as well as more directly test the mechanism underlying racial differences in corrugator fEMG activity. Additionally, while we replicated the general valence pattern in corrugator fEMG activity across all image valences (such that more corrugator activity is associated with more negative valence ratings; see Footnote 3), when examining the relationship between average corrugator activity during negative images with average self-reported image valence we unexpectedly saw a reversal, such that more corrugator activity was associated with more positive valence. This may be an artifact in restricting analyses to only negative images and/or using only the average self-report and fEMG activity, or it may be that corrugator activity during negative images reflects a blend of expressive suppression and emotional experience, resulting in the unexpected result. Future research should assess the use of expressive suppression during an emotional task while recognizing the difficulties associated with self-reports of spontaneous emotion regulation or emotion regulatory strategies that may be employed automatically and unconsciously, use additional physiological or neural measures of expressive suppression, or experimentally manipulate instructions to engage in expressive suppression.

Future Directions

In some ways the current study represents a “weak” test of the racial differences in expressive suppression usage and outcomes in daily life, as the emotional stimuli used in the current study are removed from social contexts in which expressive suppression usage would be most likely to show racial differences. Future research should extend this work to examine racial differences in the expression of emotions in more socially salient contexts. In particular, research should examine if there are different profiles of emotional expression when individuals are interacting with ingroup versus outgroup members, and if this relationship is asymmetric based on social group power. Research should also examine if expressive suppression is used more frequently when individuals anticipate experiencing discrimination, both in the lab and in daily life.

While the current study suggests that expressive suppression may be one mechanism by which racism and discrimination "gets under the skin," future work should parse multiple mechanisms (e.g., vigilance to potential acts of racism; avoidance of thinking about racially based events; Brownlow, 2023; Wilson & Gentzler, 2021) simultaneously to better understand how experiences of racism and discrimination lead to various racial disparities in health and well-being. Additionally, research should expand to additional minoritized groups to better understand the impacts of differences in culturally endorsed strategies for emotion regulation and coping with discrimination on health and well-being. Better understanding mechanisms is crucial for designing interventions to help individuals cope with unavoidable social stressors like discrimination while simultaneously working for societal change to remove the systemic factors embedded in United States culture and institutions.

Conclusions

The current study finds that Black Americans engage in expressive suppression more than White Americans. Additionally, expressing less emotion in response to negative image presentations as measured by corrugator fEMG activity is related to higher systolic blood pressure for Black Americans only. Overall, this suggests that habitual use of expressive suppression may be one mechanism by which racism “gets under the skin” to result in disparities in cardiovascular health in Black Americans.

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