Differences in Emotion Expression, Suppression, and Cardiovascular Consequences Between Black and White Americans in the Midlife in the United States (MIDUS) Study

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Objective: Recent theoretical work suggests that 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 racialized differences in expressive suppression usage may be one mechanism by which racism "gets under the skin" and creates health disparities.
Method: To examine racialized differences in expressive suppression and blood pressure (a measure of cardiovascular disease risk), we used self-report and facial electromyography (fEMG) 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 to 2009; MIDUS Refresher 1, $n = 114$, 31.6% Black, collected from 2012 to 2016; total $N = 385$, 33.9% Black).
Results: Black Americans reported engaging in expressive suppression more frequently than White Americans ($t(260.95) = 2.18$, $p = .002$) and showed less corrugator fEMG activity during negative images ($t(969) = 2.38$, $p_{FDR} = .026$). Less corrugator activity during negative images was associated with higher systolic blood pressure only for Black Americans ($b = -4.63$, $t(375) = 2.67$, $p = .008$).
Conclusion: 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, blood pressure, corrugator fEMG

Abbreviations: BMI = body mass index, **FDR correction** = false discovery rate correction, **fEMG** = facial electromyography, **HRV** = heart rate variability, **IAPS** = International Affective Picture Schedule, **MIDUS** = Midlife in the United States study, **M2** = second timepoint assessing the Main MIDUS sample, **MR1** = first timepoint assessing the MIDUS Refresher sample

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INTRODUCTION

Large racial disparities in cardiovascular health exist in the United States, such that Black Americans have higher rates of cardiovascular disease and hypertension than White Americans (1). Experiences of racism and discrimination in the United States are pervasive social stressors associated with negative mental and physical health outcomes, particularly for Black Americans (2–7). Understanding *how* racism "gets under the skin" (8) is critical to developing potential interventions to support the health and well-being of individuals who cannot avoid the effects of systemic racism.

Culturally relevant strategies for regulating emotions may influence the impact of social stressors on health and well-being (8–11). Recent work suggests that social and cultural factors, including race, affect the usage of emotion regulation strategies (12). In particular, Black Americans appear to engage in expressive suppression more often than White Americans, potentially to cope with the distress experienced from discrimination and avoid exacerbating racially charged conflicts (13,14). The current study examines the extent to which racialized differences in the use of expressive suppression may be a pathway through which racism "gets under the skin" (8) via self-reports, a psychophysiological measure of emotional expression, and blood pressure.

Expressive Suppression and Health

Expressive suppression, or the inhibition of emotion-expressive behavior (15), generally does little to reduce the experience of negative emotions and is associated with an array of negative outcomes relative to other emotion regulation strategies, including increased psychological distress, reduced rapport with others, less social support, reduced likeability, and reduced relationship closeness (16–21). Physiologically, expressive suppression is associated with increased sympathetic nervous system activation, which can negatively affect cardiovascular health (15,22,23). Expressive suppression, whether experimentally manipulated or measured as a trait, is associated with higher blood pressure and increased cardiovascular disease risk (9,20,24,25).

Contexts When Expressive Suppression May be Adaptive

If expressive suppression is a maladaptive emotion regulation strategy that does not reduce the experience of negative affect (26), why do individuals continue to use it? Recent

research suggests social and cultural contexts in which emotion regulation strategies are used affect their effectiveness and the likelihood an individual will engage in a particular strategy. For example, expressive suppression has been found to be adaptive when used in some social intrapersonal contexts and may be a preferred strategy when in the presence of nonclose others (27–29). Early work on culture and emotion regulation focused primarily on differences between individualistic and collectivistic cultures, and found that, compared to individuals from individualistic United States or Europe, individuals from East Asian and other collectivistic cultures report using expressive suppression more and may experience fewer negative effects, possibly due to expressive suppression functioning to maintain group harmony (12,30–32).

Culture may also constrain how certain individuals can safely interact with others, particularly in cultures with large social power differentials. Work on racialized differences in anger inhibition in the United States highlights the conundrum Black Americans face, choosing to either express anger and risk physical violence from individuals in power or suppress anger and experience a physiological cascade resulting in increased cardiovascular disease risk (11,14,33).

More recent work broadens these findings to a wider range of emotions. Brownlow's model of Culturally Compelled Coping posits that the cultural pervasiveness of racism and White supremacy in the United States has led to specific culturally endorsed strategies within Black American culture to cope with discrimination and racism, including multiple emotion regulation strategies that involve expressive suppression (i.e., the masking of feelings, appearing self-controlled, and the adoption of an aloof or distanced attitude; (8)). This 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 (11,13).

Cultural Schemas Regarding Strength and Resilience in Black Americans

A large body of work has examined the impacts of cultural schemas regarding strength and resilience in Black Americans, most notably on the constructs of John Henryism and the Strong Black Woman. Both are prevalent in Black American culture, value displaying strength and resilience in the face of adversity, and are associated with negative health consequences, including increased cardiovascular disease risk (34,35).

John Henryism was named after both the character in American folklore, John Henry (a Black American steeldriver who beat a steam-powered machine in a competition but died from the exertion), and the real John Henry Martin (an illiterate sharecropper who, through hard work and determination, taught himself to read and write and owned his own farm, but suffered severe negative health consequences) (34,36). Reflecting its namesakes, John Henryism is an active coping strategy deployed to overcome insurmountable odds through hard work, strength, and resilience. Although John Henryism may be a source of psychological resilience and is associated with reductions in depressive symptoms (37), it is also associated with negative physical health outcomes, including hypertension (34,36–38). Although the construct does not explicitly include expressive suppression, it does encapsulate the ideal of emotional strength through sheer determination to not let emotions impede goal-directed actions (36).

The related Strong Black Woman schema is a cultural schema endorsed by many Black women to be resilient, strong, and self-sufficient in the face of adversity while simultaneously caring for others, often at the expense of one's own health (35,39). Expressive suppression is an explicit component of the schema, and endorsement is associated with cardiovascular disease risk (35,39). The cultural importance to Black Americans to display strength and exhibit stoicism further highlights the importance of cultural contexts in emotion regulation.

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 (40) for a meta-analysis). In daily life, individuals report using expressive suppression in situations where they feel they have less social power (41), and individuals who feel they have low social power report using expressive suppression more frequently (42,43). Conversely, individuals high in social power express emotions more and report engaging in expressive suppression less (42,44).

Within the United States, social power differentials exist across a number of social factors, including socioeconomic status, race, and ethnicity. 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 (11,13,14,45–47). Although expressive suppression and related avoidance coping mechanisms may be immediately adaptive for minoritized individuals to avoid social dangers, there may be downstream negative physiological consequences of chronic use of expressive suppression on cardiovascular health (9,11,33,48).

Psychophysiological Measure of Emotion: Corrugator fEMG

The vast majority of the prior work relies on self-reports. Emotional experience and expression can also be measured physiologically from continuous recordings of facial muscle activity using facial electromyography (fEMG). The corrugator supercilii muscle is the facial muscle responsible for furrowing the brow, is used in studies examining emotional experience and expression, and is measured with fEMG sensors placed above the brow. Corrugator fEMG activity has been reliably shown to have a linear increase in activity with negative affect, such that higher corrugator activity is associated with increased negative valence, whereas a relaxation in corrugator activity is associated with higher positive valence (49,50). In addition to being sensitive to affective experience, the corrugator is under partial volitional control and is sensitive to manipulations of both expressive suppression or reappraisal, whereby lower corrugator activity was found when participants were instructed to suppress or reappraise negative responses (51). Therefore, corrugator fEMG activity during negative images may provide a measure of *both* affective experience and expressive suppression.

However, 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 (or another emotion regulation strategy) versus the experience of (negative) emotions, and how the balance between suppression and experience may differ between individuals. We therefore rely on additional self-report measures to better contextualize any group differences in corrugator fEMG activity. As described in the Supplemental Digital Content, http://links.lww.com/PSYMED/B46, we also examined the emotion modulated startle eyeblink response, an fEMG measure of emotional experience that is outside of volitional control, and did not find any differences between Black and White participants, further suggesting that the racialized differences in corrugator fEMG activity may be due to differences in emotional expression.

Study Aims and Hypotheses

The current study examined racialized differences in expressive suppression and associations with resting blood pressure using self-report and psychophysiological data from two cohorts of the Midlife in the United States (MIDUS) study. 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, and that more expressive suppression will be associated with higher resting blood pressure, particularly for Black participants. To ascertain that group differences in fEMG corrugator activity likely reflect expressive suppression rather than emotional experience, we regressed self-reported expressive suppression and fEMG corrugator activity and examined group differences in a subset of participants who provided self-reported valence and arousal ratings of the negative images.

METHODS

Participants

The data used in this study came from the national MIDUS longitudinal study MIDUS 2 (M2) timepoint assessing the Main MIDUS sample (n = 271, 34.7% Black, collected from 2004 to 2009) and the MIDUS Refresher 1 (MR1) timepoint assessing the MIDUS Refresher sample (n = 114 participants, 31.6% Black collected from 2012 to 2016) from all participants identifying as White or Black/African American (i.e., participants who answered "White" or "Black and/or African American" to the question "What are your main racial origins—that is, what race or races are your parents, grandparents, and other ancestors?") who completed the MIDUS Neuroscience Project at the University of Wisconsin-Madison with sufficient quality corrugator fEMG data. As described in Table 1, the final sample included N = 385 participants (33.8% Black, 55.3% female). The Main MIDUS cohort was initially recruited in 1995 through random-digit-dialing plus siblings and a national sample of twins (52), and an oversample of primarily Black participants in Milwaukee were recruited through door-to-door canvasing in 2005 to 2006 (53). The MIDUS Refresher cohort was recruited in 2011 to 2014 via telephone through a multiframe dynamic sampling design to age-match the initial Main MIDUS cohort (54), and an oversample of primarily Black participants in Milwaukee were recruited through door-to-door canvasing in 2012 to 2013 (55). As described in Table 1, a subset of MR1 participants also reported valence and arousal ratings of the images after the psychophysiology task (n = 108, 30.6% Black, 53.7% female) using the self-assessment manikin (56). The following analyses use all available data. See Table 1 for additional demographic details.

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; "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." (17)), collected as part of the Biomarker Project the day before the psychophysiology task, where participants rated their agreement from 1 (strongly disagree) to 7 (strongly agree). Items were averaged for scoring, Cronbach's α = .73, α_{White} = .74, and α_{Black} = .71.

TABLE 1. Sample Demographics

	Sample With Sufficient Quality Corrugator fEMG (n = 385)	Sample With Self-Reported Valence and Arousal (n = 108)
Cohort (M2/MR1)	271/114	0/108
Sex (male/female)	172/213	50/58
Race (Black/White)	130/255	33/75
Ethnicity (Hispanic/Non-Hispanic	6/379	2/106
Education (high school or less/some college/4-y degree or higher)	114/119/152	24/39/45
Age, years		
Mean (SD)	53.3 (11.5)	48.8 (11.4)
Range	26–84	26–76

fEMG = facial electromyography; M2 = second timepoint assessing the Main MIDUS sample; MR1 = first timepoint assessing the MIDUS Refresher sample; SD = standard deviation.

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 International Affective Picture Schedule (IAPS) images (57). See Supplemental Digital Content for a list of images, http://links.lww.com/PSYMED/B46. Trials began with a 1-second fixation, followed by 0.5 second of the image with a colored border and 3.5 second of the image without the border, with an intertrial interval randomly varied between 14 and 18 seconds. Participants were instructed to respond via button press to indicate the border color (purple or yellow) as quickly as possible. A subset of 18 images included an auditory startle probe (50-millisecond duration at 105 dB) 2900 milliseconds after picture onset, 4400 milliseconds after picture onset (i.e., 400 milliseconds after picture offset), or 5900 milliseconds after picture onset (i.e., 1900 milliseconds after picture offset)[1], resulting in 9 startle probes occurring during the images, split evenly across valence. Only corrugator activity during the image presentation is assessed here; see the Supplemental Digital Content for analyses using the startle probe during picture presentation (2900 milliseconds after picture onset). IAPS images have been found to robustly elicit self-reported and physiological emotional responses in studies conducted around the world (58). 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 collected using BIOPAC hardware and Acknowledge software. See Ref. (59) 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 silver/silver chloride 4-mm Touchproof shielded electrodes was placed above one brow line on the corrugator supercilii muscle. Raw fEMG signals were recorded using BIOPAC hardware and Acknowledge software (amplified 5000 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. Fast Fourier Transformation was performed on all artifact-free 1-second 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-second pre-picture epoch, *Z*-scored within participant, and averaged over three distinct 4-second blocks by image valence. The current analysis focuses on the corrugator activity during the 4 seconds of image presentation. See Refs. (59–61) for additional information.

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

Picture Ratings

For a subset of n = 108 MR1 participants only, following the affective picture viewing task, participants viewed and rated the images from the task on 1- to 9-point valence (unpleasant to pleasant) and arousal (calm to excited) scales using Self-Assessment Manikins (56). Responses were averaged separately for valence and arousal ratings for positive, negative, and neutral images.

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 and 1 = Black. Additional variables were included as covariates in analyses, including demographic covariates such as sex (dichotomized as 0 = male, 1 = female), mean-centered age at the 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), and cardiovascular covariates such as mean-centered body mass index (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 medication status) were included only in blood pressure analyses.

Transparency and Openness

All data are publicly available at https://midus.wisc.edu/data/index.php. A list of variable names and all codes for analyses is 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. This study was not preregistered. Data were analyzed using R, version 4.3.2 (62), 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, Cook's *D* using cooks.distance() from the stats package, and plots using the ggplot2 package (62–65).

RESULTS

Self-Reported Expressive Suppression

We examined self-reported expressive suppression by race with a Welch two-sample t test and found a significant effect ($t(260.95) = 2.18$, $p = .002$) such that Black participants reported engaging in expressive suppression ($M = 4.33$, SD = 1.35) more than White participants ($M = 3.86$, SD = 1.36), which remained significant when controlling for sex, age, and education ($F(1,380) = 10.83$, $p = .001$).

Corrugator During Image Presentation

Next, we examined corrugator fEMG activity during image presentation using a 2 (between subjects: race) by 3 (within subjects: image valence) repeated-measures ANOVA. There was a significant between-subject main effect of race ($F(1,383) = 6.73$, $p = .010$), a significant within-subject main effect of valence ($F(2,766) = 146.86$, $p < .001$), but no race by image valence interaction ($F(2,766) = 1.06$, $p = .347$). Follow-up post-hoc comparison contrasts for race using the estimated means with false discovery rate (FDR) correction found a significant effect of race and corrugator activity during negative ($t(969) = 2.38$, $p_{FDR} = .026$) and neutral ($t(969) = 2.41$, $p_{FDR} = .026$) but not positive ($t(969) = 0.91$, $p_{FDR} = .364$) images, such that Black participants showed less corrugator activity during negative and neutral images. 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 than neutral images ($t(766) = 9.10$, $p_{FDR} < .001$), and higher for neutral than positive images ($t(766) = 6.66$, $p_{FDR} < .001$). See Figure 1A. Results remained consistent when age, sex, and education were included as covariates.

Self-Reported Expressive Suppression and Corrugator Activity During Negative Images

To examine if corrugator fEMG 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 ($B = -0.08$, $\beta = -0.11$, $t(381) = 2.01$, $p = .045$). As shown in Figure 1B, for all participants, corrugator activity is reduced as participants report using expressive suppression more frequently (simple slopes: $b_{Black} = -0.079$, $b_{White} = -0.076$). When controlling for age, sex, and education, the main effect of expressive suppression is no longer significant but in the same direction ($B = -0.05$, $\beta = -0.07$, $t(378) = 1.23$, $p = .221$).

Self-Reported Valence and Arousal

The clearest indication of emotional experience is self-report. As described in Table 1, a subset of $n = 108$ (33 Black, 75 White) MR1 participants completed valence and arousal Self-Assessment Manikin ratings of the affective picture viewing task images after task completion, which we analyzed in separate 2 (between subjects: race) by 3 (within subjects: image valence) repeated-measures ANOVAs.

Valence Ratings

There was a significant between-subject main effect of race ($F(1,106) = 5.14$, $p = .025$), a significant within-subject main effect of image valence ($F(2,212) = 715.82$, $p < .001$), and a marginal race by image valence interaction ($F(2,212) = 2.91$, $p = .057$). Follow-up post-hoc comparison contrasts of the estimated means of image valence with FDR

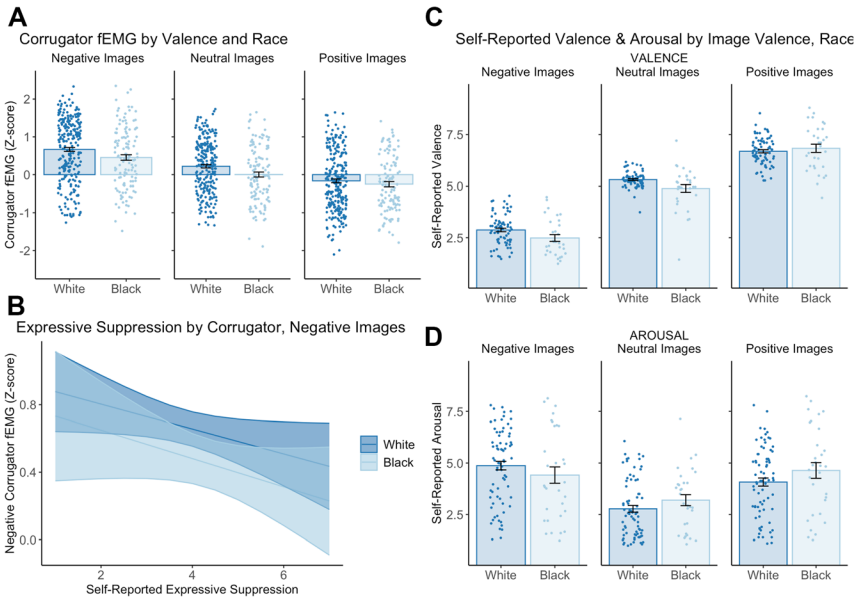

FIGURE 1. Corrugator fEMG by valence and race, effect of race for negative images $p_{FDR} = .026$, neutral images $p_{FDR} = .026$, positive images $p_{FDR} = .364$ (A); expressive suppression by corrugator, negative images, main effect of expressive suppression $p = .045$ (B); self-reported valence by image valence and race, effect of race for negative images $p_{FDR} = .070$, neutral images $p_{FDR} = .038$, positive images $p_{FDR} = .471$ (C); and self-reported arousal by image valence and race, effect of race for negative images $p_{FDR} = .132$, neutral images $p_{FDR} = .370$, positive images $p_{FDR} = .278$ (D). In panel A, boxes represent group mean levels from zero, and standard errors are represented by the error bars. In panel B, bands represent 95% confidence intervals. In panel C and D, boxes represent group mean levels, and standard errors are represented by the error bars. fEMG = facial electromyography.

correction found significant differences between all image valences, such that valence ratings were lower for negative than neutral images ($t(212) = 21.01$, $p_{FDR} < .001$) and lower for neutral than positive images ($t(212) = 14.30$, $p_{FDR} < .001$). 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. See Figure 1C. The results remained when age, sex, and education were included as covariates.

Arousal Ratings

There was a significant within-subject main effect of image valence ($F(2,212) = 69.35$, $p < .001$) and a significant race by image valence interaction ($F(2,212) = 4.66$, $p = .010$). 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 than negative images ($t(212) = 9.52$, $p_{FDR} < .001$) and lower for neutral than positive images ($t(212) = 7.68$, $p_{FDR} < .001$), but 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 ($t(198) = 1.51$, $p_{FDR} = .132$), neutral ($t(198) = 0.90$, $p_{FDR} = .370$), or positive ($t(198) = 1.09$, $p_{FDR} = .278$) 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 ($t(212) = 0.54$, $p_{FDR} = .592$). See Figure 1D. Results remained consistent when controlling for age, sex, and education.

Overall, this suggests that Black participants experienced similar levels of negative affect during negative images as White participants despite showing *less* corrugator activity to negative images, but data were only available for a smaller subset of participants.

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. Although others have reported that Black participants in the MIDUS Biomarker Project have higher blood pressure than their White counterparts (66), in our subsample of participants with corrugator data, we found no significant group difference for systolic ($t(208.61) = 1.50$, $p = .136$; $M_{Black} = 130.6$, $SD_{Black} = 19.6$; $M_{White} = 127.7$, $SD_{White} = 15.1$) or 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. However, Black participants were more likely to report a hypertension diagnosis (39.2%) than White participants (26.4%; $\chi^2 = 6.67$, $p = .010$), were more likely to be prescribed an antihypertensive medication (43.8%) than White participants (33.3%; $\chi^2 = 4.09$, $p = .043$), and had significantly higher BMIs than White participants ($t(229.0) = 3.70$, $p < .001$; $M_{Black} = 32.1$, $SD_{Black} = 7.0$; $M_{White} = 29.4$, $SD_{White} = 6.1$).

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 controlling for covariates associated with blood pressure (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[2]). Three participants had systolic blood pressure measures over 180 mm Hg. We examined Cook's distance for 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.

We found no significant effects for self-reported expressive suppression, race, or their interaction, although expressive suppression was nonsignificantly associated with higher systolic and diastolic blood pressure (see Supplemental Digital Content, Table S2, http://links.lww.com/PSYMED/B46). There was a significant race by corrugator fEMG 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 ($B = −1.81$, $\beta = −0.71$, $t(375) = 1.31$, $p = .191$; see Supplemental Digital Content, Table S3, http://links.lww.com/PSYMED/B46). Consistent with our hypothesis, 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. Although the interaction is nonsignificant for diastolic blood pressure, exploratory simple-slope analyses suggest that the pattern of results is similar, such that Black participants have higher diastolic blood pressure with less corrugator activity ($b = −2.54$, $t(375) = 2.24$, $p = .026$), whereas White participants show no significant relationship ($b = −0.73$, $t(375) = 0.82$, $p = .373$). See Figure 2.

DISCUSSION

The current study replicates prior findings that Black Americans self-report engaging in expressive suppression more frequently than White Americans (13), 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. Overall, this is consistent with Black Americans suppressing their emotional expressions during negative emotions more than White

[2]We tested for race by covariate interaction predicting 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 slope 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.

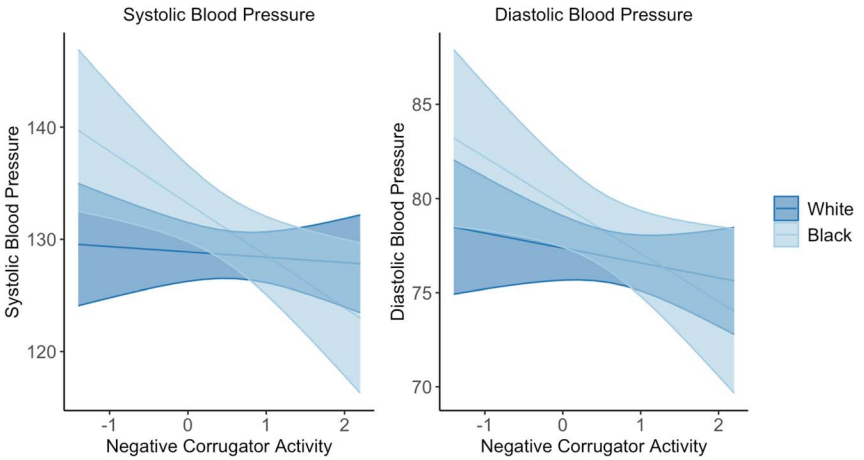

FIGURE 2. Systolic and diastolic blood pressure in White and Black participants by corrugator activity during negative image presentation, systolic blood pressure interaction $p = .047$, diastolic blood pressure interaction $p = .191$. Bands represent 95% confidence intervals. Controls for age, sex, education, BMI, antihypertensive medication usage, and race × BMI interaction. BMI = body mass index.

Americans. Critically, less corrugator activity during 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 resulting in lower corrugator fEMG to unpleasant images. Taken together, 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. However, because we did not explicitly ask participants how much expressive suppression they engaged in during the picture viewing task, we cannot rule out the possibility of other factors leading to Black participants' lower corrugator fEMG to unpleasant images, including but not limited to differences in emotional experiences. Some of these potential alternative explanations are further discussed below.

Although consistent with recent social and cultural theories examining emotional expression and regulation in the United States (8,11,13), without direct measurement or manipulation of expressive suppression use during the emotional image viewing task, we cannot definitively claim that the lower levels of corrugator activity in Black participants were due to expressive 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 by explicitly designing a study to test expressive suppression as a mechanism for both racialized differences in corrugator fEMG activity and relationships with blood pressure.

Importance of Social and Cultural Factors to Emotion Expression and Regulation

The current study highlights the importance of considering affective processes within broader social and cultural contexts in considering racial disparities in health. In particular, recent theoretical frameworks highlight the powerful social and cultural contexts within which Black American culture has developed unique patterns of emotional coping in response to racism and discrimination (8,11,13). Cultural schemas endorsed by Black Americans, including but not limited to John Henryism and the Strong Black Woman schema, provide a rich understanding of culturally prescribed coping mechanisms that were developed in response to racism and discrimination, and suggest avenues for future research to consider the interplay between emotion regulation, stress coping, and health in Black Americans (35–37). 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 (11).

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 (11,67). This conundrum is also found in sexual minorities in Italy, suggesting that it may be a physiological adaptation to the experience of discrimination (68). 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 (65,71). Our findings suggest that, insofar as Black Americans are regulating emotions more frequently than White Americans, Black Americans are likely to have higher HRV. However, if Black Americans are using expressive suppression more frequently to regulate their emotions, then the current research would suggest that they would also have higher blood pressure, which would be consistent with the pattern described by the cardiovascular conundrum (i.e., high HRV and high blood pressure). 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.

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 (72) and less sensitivity to social pain (73). 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 (74–76). Emotional dampening has been observed in both normotensive and hypertensive adults (74,77). Therefore, it may be that the relationship between blood pressure and emotional expression as measured by corrugator fEMG is bidirectional, such that higher blood pressure is associated with blunted emotional responses as well as habitual use of expressive suppression resulting in higher blood pressure. However, the self-reported valence and arousal analyses (obtained in only a subset of the sample) suggest that differences in emotional experience are unlikely to be driving the racialized differences in corrugator activity. 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.

Implications for Cardiovascular Health

Consistent with prior studies of expressive suppression and cardiovascular health (9,20,24,25), our study finds significant systolic blood pressure effects. However, the exploratory simple slope analyses found a significant relationship for diastolic blood pressure for Black participants, suggesting that the nonsignificant interaction effect on diastolic blood pressure is an artifact of comparing Black and White participants rather than a lack of a relationship for Black Americans. Both systolic and diastolic blood pressure uniquely contribute to cardiovascular disease risk (78). Therefore, the current findings suggest that expressive suppression may be one mechanism that leads to increased cardiovascular disease in Black Americans.

Constraints on Generality

The current study is limited to the unique context of Black and White American adults living in the United States from 2004 to 2016. However, we anticipate that 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. For example, initial evidence suggests that American Indians show associations between expressive suppression and poorer cardiovascular health (25). 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 instance, 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 (30,31). Future research examining the impacts of emotion regulation strategies on health should consider the specific cultural contexts in which these strategies are employed to provide a nuanced picture of when, how, and for whom various emotion regulation strategies are beneficial or harmful.

Additionally, the current research does not assess further ethnic breakdowns between Black and White Americans (e.g., Black Americans born in the United States versus immigrants from Africa; White Americans born in the United States versus immigrants from European and Slavic countries), whereas research suggests that intergroup ethnic differences play an important a role in emotional experience and expression (79). 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 results, 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 replicate the finding and directly test the mechanism underlying racial differences in corrugator fEMG activity.

Future Directions

The current study represents a "weak" test of racialized 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 racialized differences. Future research should extend this work to examine racialized 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.

Although 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; (8,13)) 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 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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Data Availability: Data are available at https://midus.colectica.org/. All codes used for all analyses and plots are publicly available on OSF at https://osf.io/u78vr/.

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