



## Cardiovascular costs of emotion suppression cross ethnic lines<sup>☆</sup>

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### ARTICLE INFO

#### Article history:

Received 22 March 2008

Received in revised form 5 June 2008

Accepted 16 June 2008

Available online 22 June 2008

#### Keywords:

Suppression

Emotion

Ethnicity

Physiology

### ABSTRACT

Previous research has shown that inhibiting emotion-expressive behavior (emotion suppression) leads to increased sympathetic activation of the cardiovascular system [Gross, J.J. and Levenson, R.W. (1993). Emotional suppression: physiology, self-report, and expressive behavior. *J. Pers. Soc. Psychol.* 64(6), 970–986]. Ethnic differences have been reported in how frequently suppression is used as an emotion regulation strategy [Gross, J.J. and John, O. (2003). Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *J. Pers. Soc. Psychol.* 85(2), 348–362]; however, it remains unknown whether there are ethnic differences in the physiological consequences of suppression. To test this, 168 participants from four ethnic groups (African American, Chinese American, European American, Mexican American) watched a disgust-eliciting film clip; half were instructed to suppress their emotions and half simply watched the film. Consistent with previous research, suppression was associated with decreased facial behavior, increased cardiovascular activation, and no impact on subjective emotional experience. Ethnicity failed to moderate these effects, indicating the generality of the cardiovascular consequences of emotion suppression across ethnic background.

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Previous research has established that relative to uninstructed responding, *emotion suppression* (the conscious inhibition of emotion-expressive behavior during an emotion episode) is associated with an increase in sympathetic activation of the cardiovascular system (Gross and Levenson, 1993; Demaree et al., 2006). This effect has been replicated across age, gender, and type of emotion elicited (Gross and Levenson, 1997; Kunzmann, et al., 2005; Robinson and Demaree, 2007). However, no study to date has explicitly tested the role of ethnicity in emotion suppression. This is a critical omission, because cultures instill beliefs about how emotions should be experienced and expressed (Ekman and Friesen, 1969; Hochschild, 1979), which can translate into cultural group differences in actual emotional responses (Mauss et al., under review). Evidence from questionnaire data also has revealed ethnic differences in the frequency of emotion suppression (Gross and John, 2003; Gross, et al., 2006), however it remains unknown whether ethnic differences in frequency of typical use of suppression translate into group differences in the psychophysiology of suppression. Such differences could result from factors ranging from simple practice effects to more complex emotional effects associated with strong motivations to conform to cultural norms.

To test this question, we studied four major ethnic groups within the United States (African American, Chinese American, European American, Mexican American), using strict inclusion criteria for ethnic group membership and cultural background that were designed to ensure significant exposure to the culture of origin. We used a well-established paradigm (Gross and Levenson, 1993) in which participants watch a disgust-eliciting film clip and are instructed either to simply watch the clip (“no-suppression”) or to hide their behavior (“suppression”). This paradigm is advantageous because it evokes strong behavioral response tendencies (e.g., prototypical signs of disgust, such as wrinkling the nose and turning away), and suppressing these behaviors produces a clear pattern of physiological activation (Gross and Levenson, 1993, 1997; Robinson and Demaree, 2007). Thus, we deemed it a good starting point for testing ethnic differences in suppression.

Based on findings from previous research (Demaree et al., 2006; Gross, 1998; Gross and Levenson, 1993, 1997), we expected that relative to no-suppression participants, participants in the suppression condition would show decreases in expressive behavior, increases in sympathetic activation of the cardiovascular system, and no change in subjective emotional experience. Based on previous findings that Asian Americans, African Americans, and Latino Americans report using suppression more than European Americans (Gross and John, 2003), we hypothesized that African Americans, Chinese Americans, and Mexican Americans would be more successful than European Americans at suppressing emotional facial behavior (i.e., expressions of disgust) and would incur less attendant physiological cost (i.e., smaller increases in sympathetic activation). Suppression has not

<sup>☆</sup> This research was supported by National Institute on Aging Grant R37-AG17766 and by National Institute on Mental Health Grant MH39895 awarded to Robert W. Levenson.

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affected negative emotional experience in previous studies (Demaree et al., 2006; Gross, 1998; Gross and Levenson, 1993, 1997), and we expected this to be true regardless of ethnicity.

## 1. Method

### 1.1. Participants

Participants were 64 male and 96 female college students (mean age = 20.8 years [SD = 2.5]) from four ethnic groups (24 women, 16 men per group<sup>1</sup>): African American, Chinese American, European American, and Mexican American. The study was approved by the University of California, Berkeley, Committee for the Protection of Human Subjects and informed consent was obtained from participants in accordance with APA standards. Participants received \$60.00 as compensation. To ensure exposure to the culture of origin at least 50% of participants' close friends during childhood/adolescence and at least 10% of their neighbors during childhood/adolescence were from their ethnic group of origin. To ensure exposure to American culture, all participants were born, raised, and currently attending college in the United States. Group specific inclusion criteria were as follows: (a) for African Americans, parents and grandparents were African American, were born and raised in the United States, and participants were raised in a predominantly Christian background; (b) for Chinese Americans, parents and grandparents were Chinese, were born and raised in China, Taiwan, or Hong Kong, and Chinese (e.g., Mandarin) was spoken in the home at least 50% of the time; (c) for European Americans, parents and grandparents were European American, were born and raised in the United States, and participants were raised in a predominantly Protestant or Catholic background; and (d) for Mexican Americans, parents and grandparents were Mexican, were born and raised in Mexico, Spanish was spoken in the home at least 50% of the time, and participants were raised in a predominantly Catholic background. (Criteria for religious background were included because the ethnic groups of interest frequently differ in religious background (Fitchett et al., 2007), and these backgrounds are an integral part of each group's cultural make-up (e.g., Chiu et al., 1998; Cohen and Hill, 2007; Garcia-Preto, 2002; Reminick, 1988). Finally, all participants had to endorse at least a "3" on a 0–5 scale asking how much they identified with their ethnic group of origin (with 0 = not at all and 5 = extremely).

### 1.2. Stimulus films

Participants viewed two clips found in previous research to elicit disgust and to be well-suited for instructed emotion regulation tasks (Gross and Levenson, 1993, 1995; Kunzmann et al., 2005). One clip showed the treatment of a burn victim (55 s) and the other clip showed a close-up view of the amputation of an arm (62 s). As in previous research, in our sample disgust was the primary emotion displayed and reported.

### 1.3. Procedure

To maximize participant comfort and reduce the likelihood of cross-ethnicity experimenter effects, each participant was greeted by a laboratory assistant of the same ethnicity and gender as the participant (Graham, 1992; Marin and Marin, 1991). The participant was seated in a chair approximately 5 ft from a video monitor. A general consent form, brief health checklist, and initial self-report emotion inventory were administered, and physiological sensors

(described below) were attached. Subsequent instructions were presented on the video monitor.

All participants viewed the burn clip and then the amputation clip (these were preceded by a neutral clip to allow participants to acclimate to the laboratory setting and were followed by four additional clips not relevant to emotional suppression that have been reported elsewhere; Roberts and Levenson, 2006). Two-minute resting baseline periods preceded and followed each clip. After each post-film rest period, participants completed a self-report emotion inventory (described below). Participants were video-recorded and physiological measures were collected continuously throughout the procedure.

### 1.4. Suppression manipulation

Half of the participants ( $n=81$ ) were randomly assigned to the suppression condition. For these participants, just before the second film clip (the amputation film), they received the following instructions on the video monitor: *We will now be showing you a short film clip. It is important to us that you watch the film clip carefully, but if you find the film too distressing, just say "stop." This time, if you have any feelings as you watch the film clip, please try your best not to let those feelings show. In other words, as you watch the film clip try to behave in such a way that a person watching you would not know you were feeling anything.* Participants who had been randomly assigned to the "no-suppression condition" ( $n=79$ ) received only the first two sentences of these instructions.<sup>2</sup>

### 1.5. Measures

#### 1.5.1. Expressive behavior

A remotely controlled high resolution video camera partially concealed by darkened glass was used to obtain a frontal view of each participant's face and upper torso. An ethnically-diverse team of trained research assistants who did not have any knowledge of the purpose of the study or the specific film clips used and who were blind to experimental condition coded participants' behavior from video recordings using a modified version of Gross and Levenson's (1993) Emotional Expressive Behavior coding system. Videos were scored using custom-designed software (Levenson, 2005). Facial expressions of disgust were coded using a 4-point intensity scale: 0 = none, 1 = slight, 2 = moderate, and 3 = strong (other emotional and non-emotional facial behaviors were coded as well). Twenty percent of the sample was double-coded and reliability was computed using intraclass correlations (average measure intraclass correlation = 0.83). Change scores were computed by subtracting mean behavior coded during the last 15 s of the pre-film baseline from mean behavior coded during a period encompassing the film period and the first 20 s following the film.

#### 1.5.2. Physiological recordings

Twelve physiological measures were collected to broadly sample sympathetic, parasympathetic, and somatic branches of the peripheral nervous system: (1) Cardiac interbeat interval (time in milliseconds between successive R waves of the electrocardiogram), (2) finger pulse amplitude (recorded with a finger photo-plethysmograph and measured in units that reflect the amount of blood in the vasculature at the tip of the finger), (3–4) pulse transit time to the finger and ear (time interval in milliseconds between the R-wave on the electrocardiogram and the arrival of the pulse pressure wave at the finger tip or ear lobe, recorded by respective photo-plethysmographs), (5) finger temperature (measured in degrees Fahrenheit with a Thermistor), (6–7) systolic and

<sup>1</sup> Twenty-four European American men were enrolled in the original sample; to equalize the number of males across groups, we randomly selected 16 for inclusion in this report.

<sup>2</sup> After the amputation clip, participants rated the extent to which they attempted to control their facial expressions, physiological reactions, and emotional experience (0 = not at all and 8 = very much). Participants in the suppression condition reported greater control than participants in the no-suppression condition (all  $F_s > 10.47$ ,  $p_s < .001$ ), and there were no ethnic group differences in these ratings (all  $F_s < 1.23$ ,  $p_s > .30$ ).

diastolic blood pressure (measured in millimeters of mercury with a Finger Arterial Pressure [FINAPRES] monitor), (8–9) respiratory inter-cycle interval and respiration depth (measured with a pneumatic bellows stretched around the thoracic region of the participant's abdomen; intercycle interval was calculated as the time in milliseconds between successive inspirations, and respiration depth was calculated by subtracting the point of maximum expiration from the point of maximum inspiration), (10) respiratory sinus arrhythmia (RSA; computed as the difference in milliseconds between the longest interbeat interval that occurred during the expiratory phase of the respiratory cycle and the shortest interbeat interval that occurred during the inspiratory phase; Grossman et al., 1990), (11) skin conductance level (measured by placing two electrodes filled with an electrolyte of sodium chloride in Unibase on the first and second fingers and by using a constant-voltage device to pass a small voltage between them; calculated in micromhos), and (12) general somatic activity (measured in arbitrarily-designated units using a transducer attached to a platform under the participant's chair that generated an electrical signal proportional to the amount of movement in any direction). In addition to the transducers required to obtain these measures, a grounding clip filled with Redux paste was placed on the participant's left ear. More detailed descriptions of our methodology may be found elsewhere (see Hagemann et al., 2006; Roberts and Levenson, 2006). Physiological measures were collected using a 12-channel Grass Model 7 polygraph and a microcomputer system equipped with analog to digital conversion hardware. Software written by one of the authors (Levenson, 2001) provided second-by-second averages of each measure.

To provide continuity with prior work on emotion suppression (see Gross and Levenson, 1997; Hagemann et al., 2006), we created two composite scores: (1) a measure of sympathetic activation of the cardiovascular system using finger pulse amplitude, pulse transit time to the finger, pulse transit time to the ear, and finger temperature,<sup>3</sup> and (2) a measure of respiratory activation using respiratory period and respiration depth. Standardized change scores were used (measures were standardized across all conditions and time periods to permit comparisons among experimental groups), and signs for all measures except respiration depth were inverted so that larger Z scores indicated greater activation. For the remaining six measures (systolic and diastolic blood pressure, cardiac interbeat interval, RSA, skin conductance level, and general somatic activity), separate change scores were computed by subtracting mean response during the two-minute pre-film baseline from mean response during the film period.

### 1.5.3. Self-reported emotion experience

Participants rated their experience of disgust using a 9-point Likert scale (anchored by 0 = *not at all* and 8 = *very much*). Disgust was presented in a field of 15 other emotion terms (e.g., amusement, sadness).

### 1.6. Data analysis

For each set of dependent measures (i.e., disgust behavior, each physiological measure or composite, and disgust experience), we conducted a 2 (condition—no-suppression, suppression) × 4 (participant ethnicity—African American, Chinese American, European American, Mexican American) ANCOVA or MANCOVA, with condition and ethnicity as between-subject factors.<sup>4</sup> Significant main effects and

interactions were followed up using univariate ANOVAs to characterize group differences. For all significant effects, the partial  $\eta^2$  representing the proportion of explained variance in the dependent variable is reported.

To provide control for possible individual differences in emotional responsiveness to disgust films, in all analyses the response to the burn film (the “just watch” film) was used as a covariate. There were no effects of suppression in response to the burn film for any of the dependent measures, indicating randomization to conditions was effective. There also were no ethnic group differences in response to the burn film with one exception: African Americans ( $M=4.0$ ,  $SD=2.9$ ) reported less disgust than Chinese Americans ( $M=5.7$ ,  $SD=2.2$ ) and European Americans ( $M=5.4$ ,  $SD=2.7$ ),  $F(3,155)=2.96$ ,  $p=.034$ . Using difference scores in which self-reported disgust to the burn film was subtracted from self-reported disgust to the amputation film, findings were the same as those presented below.

## 2. Results

### 2.1. Ethnic differences in baseline responses

Prior to testing the effects of our suppression manipulation, we examined whether there were ethnic differences in physiology during the two-minute pre-film baselines and two-minute post-film rest periods before and after each of the two disgust clips.<sup>5</sup> There were ethnic differences during both pre-film baselines for skin conductance level ( $F_s > 12.24$ ,  $ps = .000$ ), systolic blood pressure ( $F_s > 3.05$ ,  $ps < .030$ ), diastolic blood pressure ( $F_s > 4.22$ ,  $ps < .007$ ), and sympathetic activation (based on the sympathetic composite;  $F[3,155]=2.63$ ,  $p=.052$ , and  $F[3,156]=2.82$ ,  $p=.041$ , for the two pre-film baselines, respectively). Follow-up pairwise comparisons using Bonferroni corrections revealed that African Americans showed lower levels of skin conductance than the other three ethnic groups (African Americans:  $M=2.1$ ,  $SD=1.3$ ; Chinese Americans:  $M=4.1$ ,  $SD=2.8$ ; European Americans:  $M=5.1$ ,  $SD=2.6$ ; Mexican Americans:  $M=4.3$ ,  $SD=2.4$ ), greater systolic blood pressure than European Americans (African Americans:  $M=132.0$ ,  $SD=19.0$ ; Chinese Americans:  $M=123.0$ ,  $SD=18.1$ ; European Americans:  $M=119.0$ ,  $SD=18.7$ ; Mexican Americans:  $M=128.6$ ,  $SD=20.2$ ), greater diastolic blood pressure than European Americans (African Americans:  $M=80.5$ ,  $SD=11.6$ ; Chinese Americans:  $M=75.8$ ,  $SD=14.9$ ; European Americans:  $M=69.0$ ,  $SD=11.0$ ; Mexican Americans:  $M=75.7$ ,  $SD=14.1$ ), and greater sympathetic activation than European Americans (African Americans:  $M=0.2$ ,  $SD=0.6$ ; Chinese Americans:  $M=-0.0$ ,  $SD=0.5$ ; European Americans:  $M=-0.2$ ,  $SD=0.7$ ; Mexican Americans:  $M=0.1$ ,  $SD=0.5$ ; for simplicity of interpretation, these means reflect averages of the two pre-film baselines, however the F tests were calculated separately for each pre-film baseline).

When examining the two-minute post-film rest periods, ethnic group differences again were found for skin conductance level ( $F_s > 11.31$ ,  $ps < .000$ ), systolic blood pressure ( $F[3,152]=2.62$ ,  $p=.053$ , and  $F[3,154]=5.19$ ,  $p=.002$ , for the two post-film rest periods, respectively), diastolic blood pressure ( $F_s > 4.03$ ,  $ps < .009$ ), and sympathetic activation ( $F_s > 2.70$ ,  $ps < .047$ ), with African Americans showing lower levels of skin conductance than the other three ethnic groups and greater systolic blood pressure, diastolic blood pressure, and sympathetic activation than European Americans.

There were no ethnic differences in the change in physiological responding from the pre-film baseline to the post-film baseline for either of the disgust films, and there were no ethnic differences in the change from the pre-film baseline before the burn film (the first

<sup>3</sup> As noted, we included these particular measures for continuity with prior work. A composite that also included blood pressure yielded the same pattern of findings as reported here. In addition, separate composites of (1) finger pulse amplitude and finger temperature (e.g., to reflect vasoconstriction, or alpha-adrenergic activation), and (2) finger and ear pulse transit time (e.g., to reflect cardiac contractility, or beta-adrenergic activation) also yielded the same pattern of findings.

<sup>4</sup> The reported results maintain significance when including participant sex as a covariate, with the exception of cardiac interbeat interval (which also did not retain significance when controlling for somatic activity, as noted below).

<sup>5</sup> For behavior, there were no displays of disgust during the baseline before the first disgust film (the burn film), and therefore ethnic group comparisons could not be made. There were no ethnic differences in displays of disgust during the baseline before the second disgust film (the amputation film),  $F(3,155)=0.99$ , *ns*. Baseline data were not collected for self-report.

**Table 1**  
Mean (SD) responses to the amputation film by suppression condition and participant ethnicity

	African American		Chinese American		European American		Mexican American		All participants	
	No suppress	Suppress	No suppress	Suppress	No suppress	Suppress	No suppress	Suppress	No suppress	Suppress
Disgust face	0.3 (0.4)	0.0 (0.0)	0.3 (0.4)	0.0 (0.0)	0.4 (0.6)	0.0 (0.1)	0.3 (0.3)	-0.0 (0.0)	0.3 (0.4)	0.0 (0.1)
IBI	18.9 (69.8)	35.9 (76.5)	48.4 (39.3)	44.9 (44.1)	10.1 (49.7)	50.7 (80.5)	49.0 (31.0)	36.3 (60.4)	31.8 (51.4)	41.9 (66.1)
SBP	3.7 (6.1)	7.8 (7.4)	2.9 (10.7)	10.1 (11.2)	5.1 (5.7)	5.2 (7.6)	3.3 (5.9)	4.3 (11.9)	3.8 (7.3)	6.9 (9.8)
DBP	-0.6 (2.4)	2.3 (4.0)	-1.3 (4.9)	3.9 (7.2)	1.8 (2.4)	0.9 (3.4)	0.7 (3.7)	1.2 (4.3)	0.2 (3.6)	2.1 (5.0)
SYMP	0.0 (0.2)	0.1 (0.1)	0.1 (0.1)	0.1 (0.2)	0.0 (0.1)	0.1 (0.2)	-0.0 (0.1)	0.2 (0.1)	0.0 (0.2)	0.1 (0.2)
RESP	-0.0 (0.6)	0.3 (0.5)	0.4 (0.7)	0.2 (0.4)	0.3 (0.5)	0.3 (0.8)	0.3 (0.5)	0.3 (0.5)	0.3 (0.6)	0.3 (0.6)
RSA	9.8 (40.3)	-8.2 (29.2)	-6.0 (33.1)	1.1 (32.0)	-11.5 (41.9)	2.6 (35.6)	14.1 (32.5)	4.6 (28.5)	1.4 (37.9)	0.0 (31.2)
SCL	0.2 (0.9)	0.2 (0.5)	0.4 (1.1)	0.8 (1.2)	0.2 (0.8)	0.8 (1.1)	0.1 (0.5)	0.5 (1.8)	0.2 (0.8)	0.6 (1.2)
ACT	-0.1 (0.2)	-0.2 (0.2)	-0.2 (0.4)	-0.2 (0.2)	-0.0 (0.3)	-0.3 (0.4)	-0.1 (0.3)	-0.2 (0.3)	-0.1 (0.3)	-0.2 (0.3)
Disgust report	5.2 (3.2)	4.2 (3.2)	5.7 (2.7)	5.8 (2.4)	5.4 (3.0)	5.7 (2.5)	5.0 (2.6)	4.6 (2.8)	5.3 (2.8)	5.1 (2.8)

Note. Disgust face = facial displays of disgust behavior (combined frequency and intensity); values reported are change scores (film period minus baseline period). IBI = cardiac interbeat interval (ms); SBP = systolic blood pressure (mm Hg); DBP = diastolic blood pressure (mm Hg); SYMP = sympathetic composite, based on standardized change scores for finger pulse amplitude, finger pulse transit time, ear pulse transit time, and finger temperature (scores were scaled so increased arousal is in the positive direction); SCL = skin conductance level (micromhos); RESP = respiratory activation (a composite of standardized change scores for respiratory intercycle interval and respiration depth; scores were scaled so increased arousal is in the positive direction); RSA = respiratory sinus arrhythmia (ms); ACT = general somatic activity (arbitrarily-designated units). Disgust report = ratings of disgust experience (0–8 scale). Values for all physiological measures are change scores. All values are responses to the amputation film without correction for the burn film.

disgust film) to the pre-film baseline before the amputation film (the second disgust film).<sup>6</sup>

## 2.2. Effects of suppression

Means and standard deviations for the amputation film are presented by condition and by ethnic group in Table 1.

### 2.2.1. Expressive behavior

For disgust behavior, there was a significant main effect of suppression condition,  $F(1,148)=39.53$ ,  $p=.000$ ,  $\eta_p^2=.21$ ; participants in the suppression condition displayed less disgust than participants in the no-suppression condition. The main effect of participant ethnicity was not significant,  $F(3,148)=1.06$ , ns, and the interaction of Condition  $\times$  Ethnicity was not significant,  $F(3,148)=0.45$ , ns.

### 2.2.2. Physiology

The overall MANCOVA revealed significant main effects for condition,  $F(8,124)=4.90$ ,  $p=.000$ ,  $\eta_p^2=.24$ . Follow-up univariate analyses revealed significant condition effects for five measures: cardiac interbeat interval,  $F(1,149)=5.73$ ,  $p=.018$ ,  $\eta_p^2=.04$ , the sympathetic composite,  $F(1,150)=17.25$ ,  $p=.000$ ,  $\eta_p^2=.10$ , systolic blood pressure,  $F(1,148)=4.62$ ,  $p=.033$ ,  $\eta_p^2=.03$ , diastolic blood pressure,  $F(1,148)=5.93$ ,  $p=.016$ ,  $\eta_p^2=.04$ , and general somatic activity,  $F(1,146)=8.33$ ,  $p=.004$ ,  $\eta_p^2=.05$ . Specifically, participants in the suppression condition showed greater increases in cardiac interbeat interval, greater increases in sympathetic activation, systolic, and diastolic blood pressure, and greater decreases in general somatic activity compared with participants in the no-suppression condition (the effect for cardiac interbeat interval was no longer significant when controlling for somatic activity; Obrist, 1981). The main effect of condition was not significant for skin conductance level, RSA, or the respiratory composite (all  $F_s < 2.07$ ,  $p_s > .15$ ,  $\eta_p^2_s < .02$ ). Based on the overall MANCOVA, the main effect of participant ethnicity was not significant,  $F(24,368)=0.75$ , ns, and the interaction of Condition  $\times$  Ethnicity was not significant,  $F(24,368)=1.02$ , ns.

<sup>6</sup> Participants showed greater systolic and diastolic blood pressure, longer cardiac interbeat intervals (indicating slower heart rate), and greater RSA after the burn film (i.e., during the two-minute post-film baseline) than before the burn film (i.e., during the two-minute pre-film baseline;  $F_s > 7.24$ ,  $p_s < .008$ ); greater systolic blood pressure, longer cardiac interbeat intervals, and greater RSA after the amputation film than before the amputation film ( $F_s > 5.09$ ,  $p_s < .025$ ); and greater diastolic blood pressure, longer cardiac interbeat intervals, and greater somatic activity before the amputation film than before the burn film (indicating a "shift" in pre-film baseline physiology in these measures;  $F_s > 5.70$ ,  $p_s < .018$ ); however, none of these findings were moderated by participant ethnicity.

### 2.2.3. Emotion experience

For self-reported disgust, there were no effects for condition,  $F(1,150)=0.03$ , ns, ethnicity,  $F(3,150)=0.55$ , ns, or their interaction (Condition  $\times$  Ethnicity),  $F(3,150)=0.48$ , ns.

## 3. Discussion

We investigated whether there were ethnic differences in the behavioral, physiological, and subjective consequences of emotion suppression. Consistent with previous research (Gross and Levenson, 1993, 1997), we found that suppression was associated with decreases in facial behavior and body movement and an increase in sympathetic activation of the cardiovascular system. We found that suppression also was associated with increases in systolic and diastolic blood pressure. Suppression was not associated with changes in other aspects of physiological responding, namely respiratory, electrodermal, or parasympathetic activation of the cardiovascular system (as indicated by no effect on RSA). Our physiological findings are consistent with previous research showing that facial modulation of disgust is associated with increased cardiac sympathetic control but not with respiratory activation, electrodermal activation, or cardiac vagal control (Demaree et al., 2006). Although some previous research has found suppression to be associated with electrodermal increases (e.g., Gross and Levenson, 1997), our lack of findings may be attributable in part to the fact that our sample included a relatively sizeable proportion of African Americans and other individuals with dark skin tones, who often show lower levels of electrodermal activation in laboratory provocations of emotion (Brown et al., 2006). Suppression also was not associated with changes in self-reported disgust experience, consistent with previous findings that suppressing emotional facial behavior does not reduce negative emotional experience (Demaree et al., 2006; Gross, 1998; Gross and Levenson, 1993, 1997). Importantly, none of these effects were moderated by participant ethnicity.

Our findings are consistent with models of emotion and empirical data suggesting that when using thematically-simple, powerful, prototypical emotion elicitors (i.e., blood and mutilation injuries for eliciting disgust), ethnicity and cultural background have relatively little effect on the more biologically-based emotional responses such as facial expression and peripheral physiology (Levenson et al., 2007). In the one prior test of ethnic differences in suppression (Hagemann et al., 2006), ethnicity failed to moderate suppression effects to an acoustic startle. Our findings extend these results using disgust films, a stimulus that is more clearly emotional than the acoustic startle, which is thought to exist on the boundary between emotion and reflex (Ekman et al., 1985). We also extended these findings to measures of

blood pressure, which support the pattern of suppression-related increases in cardiovascular activation across members of different ethnic groups. Thus, using multiple physiological measures and samples carefully selected to reflect differences not only in racial identification, but also in ethnic and cultural background, both studies (i.e., Hagemann et al., 2006, and the present study) reveal cross-ethnic consistencies in the physiological correlates of emotion suppression.

Nevertheless, our study provided a conservative test of cultural influences on suppression in a number of ways. First, we used the emotion of disgust, which may be more likely to show cross-cultural consistency than an emotion such as anger (Mauss et al., under review). Positive emotional contexts also may be more likely to reveal ethnic differences in suppression. For example, suppressing and exaggerating one's facial response to positive (but not negative) stimuli has been found to decrease and increase self-reported positive emotion, respectively, and ethnic and cultural differences often have emerged in positive but not negative emotional contexts (Gross et al., 2006; Roberts and Levenson, 2006; Tsai and Levenson, 1997). Second, we used a sample of American-born college students in a controlled, "antiseptic," and "Americanized" laboratory environment bereft of cues that might trigger appraisals and behaviors associated with the culture of origin (Mesquita and Albert, 2007). Third, we used instructed suppression, a "response-focused" emotion regulation strategy, versus the types of "antecedent-focused" strategies (e.g., situation selection, attentional deployment, reappraisal) where cultural variation may be even more likely to emerge (Levenson et al., 2007). Having said this, it is important to note that cross-cultural consistencies in the realm of emotional behavior and physiology, which first came to the fore in field studies of emotional facial expressions (Ekman and Friesen, 1971; Izard, 1971) and appeared again in field (Levenson et al., 1992) and laboratory (Soto et al., 2005) studies of emotional behavior and physiology, continue to be the rule rather than the exception.

In sum, the ethnic groups in our sample did not differ in their ability to suppress facial behavior, nor in the physiological correlates of this suppression. An important potential implication of these findings is that individuals who report more frequent emotion suppression are not necessarily spared from its cardiovascular "cost." For example, previous research has found that ethnic minority participants (from African American, Asian American, and Latino backgrounds) report more frequent use of emotion suppression as an emotion regulation strategy than ethnic majority participants (from a European American background; Gross and John, 2003). Other research also suggests greater demands for emotional control among individuals in lower status positions, such as ethnic minority individuals (Keltner et al., 2003). In the present sample, on a questionnaire measure of emotion control Mexican Americans reported more frequent attempts to control their emotions than the other ethnic groups.<sup>7</sup> However, neither Mexican Americans nor the other ethnic minority groups evidenced diminished cardiovascular responses to the suppression task. If greater use of suppression is accompanied by more frequent taxing of the cardiovascular system, our findings may suggest a possible mechanism through which ethnic minority individuals in the United States are placed at heightened risk for poor cardiovascular health outcomes (Mensah and Dunbar, 2006). One possible exception to this may be for Asian Americans, who have been found to report fewer cardiovascular disease risk factors

(Mensah and Dunbar, 2006). Given that emotional suppression (or emotional moderation) is a value in many Asian cultures, this cultural value may mitigate potential negative long-term health consequences of emotion suppression (Butler et al., 2007; Mauss et al., under review). Longitudinal designs that include experience sampling methods or other daily diary approaches, coupled with experimental manipulations, may offer more systematic methods for testing relations among suppression use in daily life, its cardiovascular cost, and long-term health outcomes. Studying emotion in more naturalistic and complex social contexts (e.g., Butler et al., 2007) undoubtedly will offer more opportunity for understanding ethnic and cultural differences in emotion regulation and its physiological consequences.

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<sup>7</sup> Findings are based on a three-item questionnaire asking participants to rate using a 5-point scale (1 = all the time to 5 = not at all), "How much of the time, on average, do you control or regulate your feelings" (a) in public, (b) in private, and (c) with family (reliability for this scale was  $\alpha = 0.70$ ). Mexican Americans reported more frequent use of emotion control than the other groups,  $F(1,158) = 5.69$ ,  $p = .019$ ,  $h_p^2 = .034$ . Means (SD) are as follows (items were reverse-coded so higher numbers reflect more frequent emotion control): African Americans = 8.7 (2.5); Chinese Americans = 9.2 (1.9); European Americans = 9.1 (2.4); Mexican Americans = 10.0 (2.1).

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