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Perceived Discrimination, Model Minority Stereotyping, and Anxiety Symptoms in Chinese-Heritage College Students

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Short Title: Race-related stressors and anxiety

Key Words: discrimination, stereotyping, anxiety, biological reactivity

Abstract

Objectives: Perceived racial discrimination has been associated with elevated anxiety symptoms. Less is known about the mental health implications of another race-related stressor, model minority stereotyping, which is a salient experience for Chinese-heritage youth. In addition, despite theoretical considerations and indirect empirical evidence suggesting that greater autonomic nervous system (ANS) reactivity may index sensitivity to race-related stressors, ANS reactivity has not been examined as a moderator of links between race-related stressors and mental health. The present study investigated cross-sectional associations between self-reports of two salient race-related stressors (perceived discrimination and model minority stereotyping) and anxiety symptoms in Chinese-heritage youth, as well as whether ANS reactivity moderates these relationships. **Methods:** Chinese-heritage U.S. college students (N=198, 55.6% female, 18-25 years, M_{age}=20.0 years) self-reported experiences with race-related stressors. ANS reactivity (respiratory sinus arrhythmia (RSA) and pre-ejection period (PEP)) to a video depicting discrimination was collected on a subsample of participants (N=103). **Results:** Although both race-related stressors were positively correlated with anxiety symptoms, only perceived discrimination was uniquely associated with anxiety symptoms. Further, RSA (but not PEP) reactivity moderated the relationship between perceived discrimination and anxiety symptoms, such that associations were stronger for participants with greater RSA withdrawal. **Conclusions:** Our results replicate findings on the discrimination-anxiety link in Chinese-heritage college students, and show that model minority stereotyping is correlated with greater anxiety symptoms. Findings suggest that individuals with heightened RSA reactivity may be especially vulnerable to the adverse effect of discrimination. These findings have implications for mental health services for Chinese-heritage U.S. college students.

Key Words: discrimination, stereotyping, anxiety, biological reactivity

Public Significance Statement: Racial discrimination has deleterious effects on mental health, although the mental health implications of model minority stereotyping – an experience unique to Chinese-heritage individuals – is ambiguous. Our results show that discrimination – but not model minority stereotyping – is uniquely and significantly linked to anxiety symptoms in Chinese-heritage college students. Furthermore, this association was stronger among individuals with greater biological parasympathetic reactivity to witnessing discrimination.

Chinese Americans are one of the fastest growing foreign-born populations in the U.S. (Budiman & Ruiz, 2021). Prior research has identified perceived discrimination and being stereotyped as a "model minority" as two salient race-related stressors that have been linked to increased anxiety in Chinese-heritage youth and adults (Gee et al., 2007; Lee & Ahn, 2011; Son & Shelton, 2011; Wei et al., 2010). However, few studies have simultaneously considered the two stressors in one study and examined their unique relations to anxiety symptoms in Chinese-heritage young adults. Moreover, despite theoretical hypothesis and indirect evidence that stress-sensitive biological reactivity can moderate the influence of environmental stressors on mental health, no research has tested autonomic nervous system (ANS) reactivity as a moderator in the relation between race-related stressors and anxiety symptoms in ethnic minority youth.

Race-Related Stressors and Anxiety Symptoms in Chinese-Heritage Students

***Perceived racial discrimination*.** Racial discrimination is broadly defined as unfair treatment of members of a racial or ethnic group based on negative attitudes about that group (Karlsen & Nazroo, 2002). Perceived racial discrimination (hereafter referred to as *perceived*

discrimination[1]) refers to self-reports of being a target of discrimination (Paradies, 2006). Discrimination is a common experience for Chinese-heritage young adults (Juang & Kiang, 2019), and has become especially acute after the onset of the 2020 COVID-19 pandemic (Cheah et al., 2021). Notably, discrimination against Chinese-heritage young adults is especially widespread on university campuses, as one study found that 98% of Asian (primarily Chinese) American college students reported experiencing at least one act of discrimination in the past year (Alvarez et al., 2006).

The adverse psychological effects of racial discrimination are well-documented (Pascoe & Smart Richman, 2009; Schmitt et al., 2014). According to stress and coping theories, perceived discrimination is an environmental stressor that elicits coping strategies and psychological and physiological stress responses that can elevate individuals' risk for anxiety and other psychological symptoms (Clark et al., 1999; Lazarus & Folkman, 1984). In meta-analyses focusing on studies of Asian Americans, effect sizes between perceived discrimination and anxiety disorders and symptoms are larger than other mental health outcomes (Gee et al., 2007; Lee & Ahn, 2011). Therefore, anxiety symptoms may be especially salient psychological outcomes to evaluate in relation to racial discrimination in Asian American young adults.

Model minority stereotyping. The model minority stereotype depicts Asian-heritage students as uniformly hard working and reserved individuals who are skilled in math, science, and music (Kiang et al., 2016; Trytten et al., 2012; Wong & Halgin, 2006). In a study of 165 Asian American adolescents, nearly all (99.4%) participants reported an experience of being

[1] The use of the term "perceived discrimination" does not imply the view that self-reported experiences of discrimination or their consequences are not valid or real (Banks, 2014). Instead, this term is used to acknowledge that self-reports of perceived discrimination may not capture all instances of discrimination and to differentiate them from other measures of discrimination (e.g. systemic and structural), which are conceptually distinct and contribute uniquely to connections between discrimination and health (Cuevas and Boen, 2021).

stereotyped as a model minority (Thompson & Kiang, 2010). As a consequence of the model minority stereotype, Chinese Americans may feel pressured to meet the high expectations or to disconfirm it so as to avoid peer ostracism and resentment (Kim & Lee, 2014; Son & Shelton, 2011). Over time, this pressure and the failure to either conform to or separate themselves from the stereotype may contribute to symptoms of anxiety (Wong & Halgin, 2006). Consistent with this, a daily diary study of Asian American college students found that the more they *expected* to be stereotyped as a model minority, the more anxiety symptoms they endorsed (Son & Shelton, 2011). However, the link between *experienced* model minority stereotype and anxiety symptoms remains untested.

Investigating the relationship between perceived discrimination, model minority stereotyping and anxiety can provide a nuanced understanding of risk processes underlying mental health problems that are experienced simultaneously by Chinese-heritage students. Model minority stereotyping and discrimination share a conceptual basis, in that they both stem from bias and race-related generalizations (Kiang et al., 2016). Qualitative research showed that the model minority stereotype may serve as a basis for discrimination towards Chinese-heritage students, suggesting that the two stressors might be positively correlated (Niwa et al., 2011; Qin et al., 2008). One of the few studies examining both race-related stressors simultaneously showed that perceptions of model minority stereotyping and discrimination were unrelated to one another, and exerted largely unique effects on academic adjustment in a sample of Asian American adolescents (Kiang et al., 2016). However, the study did not examine psychological symptoms such as anxiety.

Biological Reactivity to Race-Related Stressors as Moderator of the Links between Race-Related Stressors and Anxiety Symptoms

Stress-sensitive biological systems such as the autonomic nervous system (ANS) may moderate the relation between race-related stressors and anxiety symptoms. The ANS is immediately activated upon stressor exposure through sympathetic and parasympathetic branches, and the strength of the ANS response may parallel the severity or salience of the race-related stressor to an individual (Sawyer et al., 2012). Respiratory sinus arrhythmia (RSA; the rhythmic fluctuation of heart rate across the respiratory cycle) is a metric that reflects parasympathetic functioning, while pre-ejection period (PEP; the time between ventricular depolarization and the opening of the aortic valve) indicates sympathetic functioning. The adaptive stress response is characterized by moderate RSA withdrawal (decrease) and moderate PEP decrease – these responses may be exaggerated (hyperreactivity) or diminished (hyporeactivity) in individuals exposed to chronic stress or adversity (Shakiba et al., 2020). Examining both RSA and PEP is critical in obtaining a full portrait of the ANS's flexible response to stressors, since the two branches of the ANS are not always reciprocal (Berntson & Cacioppo, 2004).

Although several studies have shown links between race-related stressors and resting ANS activity (Hill et al., 2017; Neblett & Roberts, 2013), few studies have directly examined race-related stressors and ANS reactivity. According to biological sensitivity to context (BSC) theory, greater ANS reactivity (change from baseline) may confer greater sensitivity to perceived threats (Boyce & Ellis, 2005). Consistent with the theory, empirical studies showed that individuals who exhibit greater ANS reactivity in response to laboratory challenges showed stronger associations between environmental stressors and psychological adjustment (see Shakiba et al., 2020 for a review). There are several mechanisms through which heightened ANS reactivity may confer environmental sensitivity, although this is still the subject of ongoing

research (Wass, 2018). ANS reactivity may sensitize individuals to perceive threat, such that individuals with a more reactive ANS may experience stressors in a more acute way. A more reactive ANS may also prompt an ineffective behavioral response in the context of threats – activation of the ANS results in bodily changes that physiologically prepare individuals to engage in approach or avoidance behaviors. Another hypothesis is that ANS reactivity is an indicator of psychological capacity in the face of threat. Specifically, some research suggests that ANS reactivity indicates individual emotion-regulatory capacity, as both heightened RSA withdrawal and emotion dysregulation may reflect inadequate top-down prefrontal modulation of affective responding (Beauchaine & Bell, 2020). If greater ANS reactivity indicates higher threat sensitivity, adverse behavioral reactions, or emotion-regulation difficulties (Beauchaine & Bell, 2020; Boyce & Ellis, 2005), then associations between race-related stressors and anxiety symptoms might be stronger for individuals showing greater RSA withdrawal and PEP decrease to race-related stressors.

The Present Study

Using multi-methods data from a cross-sectional study of Chinese-heritage college students in the U.S., the present study had two aims: (1) to investigate the unique associations between race-related stressors (perceived discrimination and model minority stereotyping) and anxiety symptoms, and (2) to explore whether ANS reactivity moderates these associations. We hypothesized that race-related stressors would be positively correlated (Qin et al., 2008), and that greater reports of race-related stressors would be uniquely associated with greater anxiety symptoms (Gee et al., 2007; Lee & Ahn, 2011). Based on extant theoretical models (Beauchaine & Bell, 2020; Boyce & Ellis, 2005), we expected the links between perceived discrimination and anxiety symptoms to be stronger for individuals exhibiting greater ANS reactivity. However,

given the lack of research on race-related stressors and ANS reactivity in samples of Chinese-heritage young adults, our analyses testing the moderation hypotheses were exploratory. We further considered demographic factors that may theoretically relate to both predictors (perceived discrimination and model minority stereotyping) and outcome (anxiety symptoms) as possible covariates. These variables included parental education (Kessler et al., 1999), age (Juang et al., 2018), gender (Hahm et al., 2010), generation status and the number of years lived in the U.S. (Juang et al., 2018).

Our study variables, hypotheses for associations between race-related stressors and anxiety symptoms, data collection procedures, and analytic plan were pre-registered using the Open Science Framework repository prior to any researcher accessing the data (https://osf.io/cw4sa/?view_only=c1ff77af032f4b6cb8ac5ddba06fce63). The hypotheses on the association between perceived discrimination and anxiety symptoms and the association between model minority stereotyping and anxiety symptoms outlined in the pre-registration are reported in this manuscript, with hypotheses on other topics from the study reported in forthcoming manuscripts. Exceptions and deviations from the plan are indicated in a Transparent Changes document (see Supplementary Materials).

Method

Procedure

Chinese-heritage undergraduate students from a large public university in Northern California were recruited through physical flyers posted on campus, online advertisements, emails to Chinese student organizations, and a research participation program for students enrolled in psychology courses. The research was described as a study to understand daily experiences of Chinese undergraduate students. Participants could elect to receive course credit

or a gift card for participation ($5 for questionnaire only, $15 for the questionnaire and lab portion). Interested individuals viewed an electronic consent form and then completed an online screening questionnaire. The study inclusion criteria were: enrollment as an undergraduate student at the target university, ability to understand spoken and written English, being at least 18 years of age, and self-identification as first-, second- or third-generation ethnic Chinese. Individuals who met these inclusion criteria completed a 30-minute online questionnaire assessing demographic variables, perceived discrimination, model minority stereotyping, and anxiety. Participants were also given a link to sign up for a laboratory visit for the ANS reactivity protocol, and had to complete the questionnaire at least 72 hours (but not more than 1 week) before the laboratory visit. The study was approved by UC Berkeley OPHS, 2019-02-11809.

Participants

The current study includes a subsample who completed both the questionnaire and measures of ANS reactivity until COVID-19 restrictions on in-person research were implemented (*N*=103; ANS subsample), and a full sample of participants who completed questionnaire measures (*N*=198). Descriptive statistics of demographic and study variables for the full sample and ANS sample are displayed in Table 1. Some participants in the final sample were international students who came from China to the U.S. for college (*N*=41), although all participants self-identified as "Chinese American." Participants in the ANS subsample (*N*=103) were demographically similar to participants who did not complete ANS measures (*N*=95) on gender, age, and parental education (all *p*s > .05). However, the ANS subsample was comprised of a significantly greater proportion of first-generation students (those born in China; 39.2%) compared to the participants who did not complete ANS measures (20.0%; $\chi^2(1) = 7.77$, *p*=.005), and was also comprised of significantly fewer second-generation students (U.S.-born

with parents born in China; 33.3% compared to 54.7% in non-ANS subsample; $\chi^2(1) = 8.31$, p=.004). Reflecting these differences in generation status, the ANS subsample reported living in the United States for fewer years (M=13.1 years; SD=8.33) than those who did not complete ANS measures (M=15.9 years; SD=6.78; p=0.010). Given these differences in immigration history, separate correlational analyses are run for the full sample and ANS subsample. Participant characteristics are also reported in a separate paper using the same sample (Authors, 2020), which focused on the links of COVID-19 onset and media exposure to perceived discrimination and anxiety symptoms using only self-reported measures.

Self-Report Measures

Demographic Variables and Potential Covariates

Demographic variables and potential covariates (parental education, age, gender, generation status, and number of years in the U.S) were self-reported by participants. The number of years of educational attainment of both parents were averaged to yield a single parental education score between 0 and 21. Data collection for the present study occurred in two waves mirroring the academic semesters: the end of August 2019 until the beginning of December 2019, and the end of January 2020 until the beginning of April 2020.

Perceived Discrimination

Perceived discrimination was measured using a modified version of Everyday Discrimination Scale (D. R. Williams et al., 1997; Benner & Kim, 2009; Hou et al., 2017). This scale consists of nine items assessing the frequency with which individuals report they are being treated unfairly as a result of race or ethnicity (e.g., “You are called names or insulted”) and one added item for use with a Chinese American sample (“People assume my English is poor”). Participants rated each statement using a 4-point Likert scale (*1=never, 2=rarely, 3=sometimes,*

4=often), and mean scores were calculated from the items. The instrument has demonstrated satisfactory reliabilities in previous Chinese American samples (Benner & Kim, 2009; Hou et al., 2017), and the Cronbach's alpha for the current sample is .87.

Model Minority Stereotyping

Model minority stereotyping was assessed using a 9-item questionnaire that has been used in studies containing Chinese American samples (Kiang et al., 2016; Thompson et al., 2016). Participants are asked, "How often do you feel that your ethnicity leads people to automatically assume that you are…" with a list of items including: intelligent, quiet/reserved, ambitious, courteous/polite, family oriented, industrious/hardworking, talented in classical music, likely to pursue a prestigious career, and good at math/science. Participants rate each statement on a 5-point scale according to the frequency with which they perceive being stereotyped in that domain (*1=never, 2=sometimes, 3=about half the time, 4=most of the time, 5=all of the time),* and item responses were averaged. For the current sample, Cronbach's alpha indicated good reliability ($\alpha = 0.87$).

Anxiety Symptoms

The Beck Anxiety Inventory (BAI) was administered to measure anxiety symptoms (Beck et al., 1988). Participants rated the frequency of 21 anxiety symptoms over the past month using a 4-point Likert scale (*0=not at all, 1=mildly, 2=moderately,* and *3=severely*). Symptoms include somatic and panic-related symptoms of anxiety (e.g., feeling hot, face flushed, terrified or afraid). Items are summed to yield a total score ranging from 0 to 63, with scores of 0 to 21 representing low anxiety, scores of 22 to 35 representing moderate anxiety, and scores of 36 and above representing elevated levels of anxiety. The BAI has shown strong psychometric

properties across racial and ethnic groups, including samples with Asian participants (Cheng et al., 2002; De Ayala et al., 2005). Cronbach's alpha in the current sample is 0.95.

Autonomic Nervous System Reactivity Measures

Neutral and discrimination films

For the present study, a neutral film was used to establish a standardized, baseline reference of ANS activity across participants. The neutral film was a 1-minute clip from an emotional film database specifically designed for Asian viewers (Y. Deng et al., 2017), and depicts a scene of four Chinese young adults driving through a country mountainside with no discernible dialogue. The authors abstracted a 1-minute clip from the movie *Crazy Rich Asians* for the "discrimination film", which shows a Chinese woman and her family encountering discrimination at a hotel staffed by White concierges. Both films were first tested with a demographically matched pilot sample (see Supplementary Materials).

General ANS procedure

Between three and seven days after completing the online self-report questionnaire, laboratory visits for participants from the ANS subsample (N=103) were conducted in a private lab room. An interviewer (who was the same gender and ethnicity as the participant) obtained written informed consent and then applied electrodes to participants to obtain electrocardiogram (ECG) and impedance cardiography (ICG; see below). After electrodes were applied, research assistants situated participants approximately 18 inches away from a desktop computer screen that was adjusted to the participant's height. Participants were instructed that they would watch two videos and should attend to the screen for the next 10 minutes. The participant viewed the white fixation cross for 5 minutes, followed by the neutral video (1 minute), a short interfilm

interval (30 seconds), the discrimination video (1 minute), and a recovery period with a white fixation cross (3 minutes; see Supplementary Materials).

Collection and Computation of Electrocardiogram (ECG) and Impedance cardiography (ICG)

ECG and ICG were recorded using Biopac Nomadix wireless transmitters (Biopac Systems Inc.; details in Supplementary Materials). RSA was obtained from the ECG data with MindWare HRV analysis software (version 3.2.5) in 60-second epochs. RSA reactivity scores were calculated as RSA during the discrimination video minus RSA during the baseline neutral video[2] (Berntson et al., 1997) – scores were reversed so that higher, more positive scores indicate greater RSA decrease (parasympathetic withdrawal) from the neutral to the discrimination video. PEP was obtained using ECG and ICG data with MindWare IMP analysis software (version 3.2.5). PEP reactivity was calculated by subtracting PEP during the discrimination video from PEP during the neutral video. Thus, higher and more positive PEP reactivity scores reflect shorter cardiac latencies, indicating higher sympathetic activity during the discrimination video as compared to the neutral video.

Analytic Plan

First, descriptive statistics were computed, and t-tests and chi-square tests were conducted to compare the ANS subsample to participants without ANS testing. Second, correlations were computed between hypothesized covariates and study variables to select covariates for the regression analyses. Third, two separate multiple linear regressions were used to examine the associations between race-related stressors (perceived discrimination and model minority stereotyping) and anxiety, controlling for covariates. For both the full sample and ANS

[2] All analyses were also conducted using a residual score approach to ANS reactivity, as well as with absolute values of ANS activity to the discrimination video as the measure of ANS reactivity. Results did not change in significance or directionality using these alternate methods.

subsample, all regressions, heteroscedasticity, linearity, and normality were checked using plots. Finally, four separate multiple linear regressions were used to examine the interaction between race-related stressors and ANS reactivity (RSA and PEP reactivity) in predicting anxiety. To minimize the risk of a Type 1 error and given the exploratory nature of the analysis involving ANS measures, a Benjamini-Hochberg false discovery rate (FDR) procedure was used to correct p-values for these four tests (Benjamini & Hochberg, 1995). A-priori power analyses conducted in G*Power (Faul et al., 2009) and reported in our pre-registration indicated that a sample size of 100 would be needed to detect medium effect sizes for the regressions predicting anxiety symptoms from perceived discrimination and model minority stereotyping; thus, the sample size of the present study (N=198 for these analyses) provides sufficient power. All analyses were also conducted excluding international students (N=41) from the sample given their unique background, in order to test whether this significantly changed results.

Results

Descriptive Statistics and Correlation Analyses

Descriptive statistics of study variables are presented in Table 1. In the full sample, 93% of participants reported at least one experience with discrimination, and the mean value of perceived discrimination (M=1.77) in the overall sample is similar to mean values found in other studies (1.72 – 1.78) using the same measure with Chinese American samples (Benner & Kim, 2009; S. Deng et al., 2010; Hou et al., 2015, 2017). All but one participant reported experiencing model minority stereotyping, and the mean reported model minority stereotyping (M=3.43) indicates that on average, participants in the present sample experience model minority stereotyping between “about half of the time” and “most of the time”. The average reported

anxiety (*M*=12.07) is in the mild range (8-15) as classified by the Beck Anxiety Inventory (total range 0-63), reflecting the non-clinical nature of the present sample.

Skewness values for all variables were within -2 and 2, and kurtosis values were within -7 and 7, indicating no substantial departures from normality (West et al., 1995). For RSA and PEP variables, outliers were defined as values that fell outside of 3 standard deviations of the sample mean (Alkon et al., 2011). One RSA value during the neutral video was identified as an outlier in the low range – RSA change was therefore not calculated for this individual. In addition, PEP could not be derived for two participants due to excessive noise in the ICG data. Thus, of the ANS subsample (*N*=103), we had usable RSA reactivity data for *N*=102 participants, and usable PEP reactivity data for *N*=101 participants. RSA and PEP values during both the neutral and discrimination video are within ranges that are physiologically plausible according to past research guidelines (Byrne et al., 1996; Mendes, 2009).

Following the suggestion of Steiner, Cook, Shadish, and Clark (2010), we included a variable as a covariate in subsequent regression analyses testing the study hypothesis if it was at least marginally correlated with both the predictor and the outcome. No hypothesized covariate correlated with both the predictors (perceived discrimination and model minority stereotyping) and the outcome (anxiety symptoms) for the study. Correlation analyses were also performed separately for the ANS subsample (Supplementary Table 1), and key correlations did not differ in significance or directionality from the full sample. Correlation analyses are in line with hypothesized relations between race-related stressors and anxiety symptoms, such that greater reports of model minority stereotyping and perceived discrimination are significantly correlated with increased reports of anxiety symptoms (*r*s=.14 and .35, *p*s=.049 and <.001, respectively for the full sample; *r*s=.27 and .39, *p*s=.006 and <.001, respectively for the ANS subsample). The

two race-related stressors were significantly correlated in the full sample (r=.27, p<.001) and ANS subsample (r=.33, p<.001). Race-related stressors were not significantly correlated with either PEP or RSA reactivity.

Regression Models Predicting Anxiety Symptoms from Race-Related Stressors

For all regression models, diagnostic tests indicated no problems with multicollinearity (all tolerance values > .10 and variance inflation factor <10; Tabachnick & Fidell, 2013). Residual scatterplots were visually inspected to confirm a linear relationship among independent and dependent variables. As shown in Table 3, perceived discrimination was a significant predictor of anxiety (β=0.35, p<.001) as was pre-registered, controlling for model minority stereotyping. However, contrary to the pre-registered hypothesis, with perceived discrimination in the regression, model minority stereotyping was not a significant predictor of anxiety (β=0.04, p=.56).

Regression Models Predicting Anxiety Symptoms from the Interaction of Race-Related Stressors and RSA Reactivity

For regression models with interaction terms, all continuous predictor variables (perceived discrimination, model minority stereotyping, RSA reactivity) were centered around sample means to minimize multicollinearity (Aiken & West, 1991). As shown in Table 4, the interaction term between perceived discrimination and RSA reactivity was significant in the model predicting anxiety using the FDR-corrected p-value (β=0.32, p=.0092), controlling for perceived discrimination, RSA reactivity, and RSA neutral. The interaction was probed using simple slopes analysis at low (more negative; -1 SD below the mean) and high (more positive; +1 SD above the mean) values of RSA reactivity. As displayed in Figure 1, simple slopes analysis indicated that greater perceived discrimination predicted greater anxiety when

individuals exhibited greater RSA reactivity (withdrawal) in response to the discrimination video (unstandardized β=15.15, p<.001), but not when they exhibited less RSA reactivity (unstandardized β=3.26, p=.30).

There was no significant interaction between model minority stereotyping and RSA reactivity in the model predicting anxiety (Table 4; β=0.04, p=.53). There was a significant main effect of model minority stereotyping in predicting anxiety symptoms (β=0.26, p=.008), indicating a significant and positive relationship between model minority stereotyping and anxiety symptoms for individuals with meal levels of RSA reactivity.

Regression Models Predicting Anxiety from the Interaction of Race-Related Stressors and PEP Reactivity

As shown in Table 5, PEP reactivity did not significantly interact with perceived discrimination in a model predicting anxiety symptoms. PEP reactivity also did not significantly interact with model minority stereotyping in a separate model predicting anxiety symptoms.

We repeated analyses excluding Chinese international students (N=41) from the sample who had come to the U.S. for college, based on research that time in the U.S. may relate to both perceived discrimination and anxiety symptoms (Juang et al., 2018; Lau et al., 2013; Yip et al., 2008). When excluding these students, results did not change in terms of significance or directionality of findings. Thus, to preserve power, we include these participants in our final analyses.

Discussion

The present study investigated cross-sectional associations between race-related stressors (perceived discrimination and model minority stereotyping) and anxiety symptoms in a sample of Chinese-heritage college students. The study also explored the role of ANS (RSA and PEP)

reactivity as moderator of these associations. Consistent with our hypothesis, we found that perceived discrimination and model minority stereotyping were significantly correlated. As hypothesized, study results showed that perceived discrimination was significantly associated with greater anxiety symptoms. Model minority stereotyping was positively and significantly correlated with anxiety symptoms, but contrary to our hypothesis, it did not significantly predict anxiety symptoms when controlling for perceived discrimination. Our hypothesis regarding the moderating role of ANS reactivity was partially confirmed. Parasympathetic reactivity in response to a film clip depicting discrimination moderated associations between racial discrimination and anxiety, such that stronger associations emerged for individuals with greater RSA withdrawal. RSA reactivity did not moderate associations between model minority stereotyping and anxiety, and PEP reactivity did not moderate associations between either race-related stressor and anxiety. Overall, these findings replicate studies documenting associations between perceived discrimination and anxiety in Chinese-heritage college students (Chia-Chen Chen et al., 2014; Hwang & Goto, 2008; Wei et al., 2010). The study extended previous work by demonstrating the unique relation of perceived discrimination to anxiety symptoms and the role of parasympathetic reactivity as a moderator in the discrimination-anxiety symptoms association.

Race-related Stressors and Anxiety Symptoms

The strong association between perceived discrimination and anxiety symptoms observed in the present study replicates findings from prior studies. The magnitude of this association (r=.35 in full sample, r=.39 in ANS subsample) in the current study is consistent with correlations reported in previous meta-analyses with Asian samples (r=.28, k=4 studies; Lee & Ahn, 2011), and across other racial minority samples (r=.25, k=62 studies; Schmitt et al., 2014). When considered along with longitudinal studies showing that perceived discrimination predicts

mental health outcomes in Chinese-heritage youth (Juang et al., 2018; Juang & Kiang, 2019), these results suggest that perceived discrimination can be a salient risk factor for Chinese-heritage college students' mental health.

Model minority stereotyping, a less investigated race-related stressor, was also correlated with greater reports of anxiety symptoms, and showed a significant main effect for individuals with mean RSA reactivity, but was not significant predictor of anxiety symptoms in a regression model controlling for perceived discrimination. Notably, in the current sample, model minority stereotyping appears to be a relatively frequent experience for many Chinese-heritage college students. Because the two race-related stressors were positively correlated, the lack of unique association between model minority stereotyping and anxiety might be due to shared variances. Indeed, some qualitative research suggests that the model minority stereotype may serve as a basis for discrimination towards Chinese-heritage individuals (Niwa et al., 2011; Qin et al., 2008). Perhaps the stressors are more tightly intertwined in a college environment with more frequent peer interactions, given that peers are often the source of both discrimination and model minority stereotyping (Qin et al., 2008). Model minority stereotyping may be more related to academic outcomes compared to mental health, as is suggested by studies linking model minority stereotyping to academic performance (Kiang et al., 2016; Thompson & Kiang, 2010). Model minority stereotyping might be beneficial in an academic context, as youth's appraisal of positive academic-related stereotypes could boost their college performance. In line with this idea, a study of Chinese-heritage adolescents showed that perceptions of model minority stereotyping were related to greater valuation of school and higher perceived academic performance (Kiang et al., 2016). Model minority stereotyping may be more damaging to mental health outcomes outside of academic contexts, and mediated by more proximal factors such as how much

individuals internalize the stereotype or negative peer relationships (Padgett et al., 2020; Thompson et al., 2020). Given the prevalence and salience of both perceived discrimination and model minority stereotyping in the daily lives of Chinese-heritage students, future research on the bidirectional relations between these experiences and mental health outcomes would be informative to the field.

The Moderating Role of ANS Reactivity

Our results showed that individuals who exhibited greater RSA withdrawal in response to the discrimination video – a pattern associated with energy mobilization to handle a threat – showed strong and significant associations between perceived discrimination and anxiety. In contrast, associations between perceived discrimination and anxiety symptoms were not significant for individuals who showed less RSA reactivity during the discrimination video.

In general, this finding fits with BSC theory that biological stress reactivity (RSA) can indicate individuals who are more vulnerable (e.g. more likely to perceive threat or have anxiety symptoms) in the context of an environmental stressor (perceived discrimination). Greater RSA withdrawal in the present study may reflect relatively poorer emotion regulation capabilities in the face of discrimination (Beauchaine & Bell, 2020; Van Beveren et al., 2019), which could be associated with individuals coping in ways that lead to internalizing symptoms (e.g. rumination). Indeed, previous studies have found stronger associations between discrimination and adjustment outcomes for individuals who used more maladaptive emotion regulation strategies (Juang et al., 2016; Juang & Kiang, 2019). However, other studies utilizing more intense and active stress inductions have associated greater RSA withdrawal with more regulated emotions (Cui et al., 2015; LeMoult et al., 2016). These mixed findings suggest that the categorization of emotion

regulatory strategies and RSA withdrawal as “adaptive” or “maladaptive” may depend on the intensity of the stressor.

BSC theory proposes that physiological profiles that render individuals more vulnerable to environmental stressors also render them more susceptible to the positive effects of interventions (Shakiba et al., 2020). Our empirical findings suggest that there may be a subset of individuals (those with greater RSA reactivity) who would benefit most from interventions aimed to counteract race-related stressors, although this application of BSC theory still needs to be tested. These programs, while beneficial to all individuals experiencing discrimination, should therefore be designed with flexibility in intervention length and intensity for individuals with greater sensitivity to discrimination. This sensitivity (as indexed by greater ANS reactivity) could be addressed by teaching emotion regulatory strategies shown to be effective in the face of discrimination (e.g. self-distanced reappraisal; Duker et al., 2021). As a metric that does not contain the measurement biases inherent in self-reporting, ANS reactivity can be a valuable tool in identifying individuals who may be most sensitive to discrimination’s pernicious effects. Of course, efforts to address sensitivity and reactivity to discrimination in the moment in individuals need to occur in tandem with larger movements to reduce systemic and structural discrimination.

Consistent with prior research, our findings suggest that the role of ANS reactivity as predicted by BSC theory is specific to the branch of the ANS examined and the nature of the environmental stressor (Shakiba et al., 2020). RSA reactivity to the discrimination video did not moderate associations between model minority stereotyping and anxiety. If model minority stereotyping is only indirectly related to anxiety symptoms through mediating factors (internalization of the stereotype, peer relationships), then ANS reactivity may not play a significant role in this association. This finding is also interpreted in light of the fact that the

stressor used to elicit ANS reactivity (watching a scene of racial discrimination towards Chinese individuals) may be more closely related to how individuals respond physiologically when experiencing discrimination than when they are experiencing model minority stereotyping. With limited ecological relevance, ANS reactivity may have failed to moderate associations between model minority stereotyping and anxiety.

Although PEP decreased on average in response to the discrimination video, PEP reactivity did not moderate associations between either race-related stressor and anxiety symptoms. This suggests some specificity for the roles of the parasympathetic (indexed by RSA) and sympathetic nervous systems (indexed by PEP) in the present study. Potentially RSA withdrawal was sufficient to manage the relatively mild discrimination stressor in our study without significant activation of the more energetically costly sympathetic nervous system (Porges, 2007). Perhaps parasympathetic rather than sympathetic reactivity is more involved when individuals respond to perceived discrimination, as parasympathetic reactivity is more theoretically linked to social sensitivity. Sympathetic reactivity on the other hand has been shown to be more related to active coping responses (challenge versus threat) and subsequent behavioral outcomes during in-person cross-racial social interactions (Mendes et al., 2002). In other words, PEP reactivity while passively watching a discrimination video may not have been as involved in influencing the link between perceived discrimination and anxiety symptoms, although this interpretation requires further investigation and replication.

Limitations

There are several limitations of the present study. First, given that the study was cross-sectional, causation between variables cannot be directly tested. Second, race-related stressors and anxiety symptoms were both measured with self-report. This common method variance may

lead to stronger associations between the two variables that could reflect a general negativity bias. Third, the sample for the study came from a university with a sizable population of Chinese students (approximately 17% of enrolled students). Because the prevalence and experience of race-related stressors, campus climate, and mental health resources vary across univeristy campuses, the findings may not generalize to Chinese-heritage students attending other college contexts. Fourth, our discrimination video does not fully capture the experience of participants perceiving discrimination directed at them. Participants' ANS reactivity was measured as they *witnessed* discrimination, not when they actually *experienced* it. Although these two experiences are related, they likely differ in regards to their precise effects on the ANS. Future studies could consider deploying other experimental methods, such as the use of confederates to elicit reactions to perceived discrimination (e.g. Hoggard et al., 2015).

Conclusions

Our results show that greater experiences with discrimination are linked to greater anxiety symptoms, and that this association is stronger for individuals with greater RSA withdrawal to witnessing discrimination. These findings suggest that clinicians should assess Chinese-heritage youths' experiences with discrimination in intake interviews, and incorporate it into case conceptualizations of mental health concerns. In highlighting the salience of a cardiovascular reactivity component in responding to discrimination cross-sectionally, our results are relevant to theories that repeated exposure to discrimination may lead to dysregulation of cardiovascular systems over time, which account for the link between discrimination and health (Paradies et al., 2015). Longitudinal examinations of perceived discrimination, anxiety symptoms, and ANS reactivity are needed to fully test this "biological embedding" model. Other research has shown that strong social support and engagement coping can buffer the deleterious

effects of discrimination in Chinese-heritage youth (Wang et al., 2018; Wei et al., 2010). Mental health professionals working with Chinese and other minority college students might consider incorporating these components as treatment targets given the salience of discrimination for anxiety symptoms and other mental health outcomes.

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Table 1. Descriptive statistics of demographics, covariates, and study variables for the full sample and ANS subsample.

	Full Sample (*N*=198)							ANS Subsample (*N*=103)						
	N	**Min**	**Max**	**Mean**	***SD***	**Skewness**	**Kurtosis**	**N**	**Min**	**Max**	**Mean**	***SD***	**Skewness**	**Kurtosis**
Demographics														
Age (years)	198	18	25	20.01	1.32	0.32	0.35	103	18	25	20.10	1.32	0.32	0.77
Time in the U.S. (years)	198	0	24	14.39	7.68	-0.77	-1.13	103	0	22	13.08	8.33	-0.46	-1.59
Parental Education (years)	196	0	21	15.29	3.75	-1.13	1.81	102	0	21	14.87	3.79	-1.17	-1.42
Questionnaire Study Variables														
Model Minority Stereotyping	198	1.00	5.00	3.43	0.76	-0.87	0.81	103	1.33	5.00	3.43	0.69	-0.65	0.50
Perceived Discrimination	198	1.00	4.00	1.77	0.60	0.75	1.33	103	1.00	3.40	1.72	0.46	0.59	0.67
Anxiety Symptoms	197	0	57	12.07	11.17	1.22	1.41	103	0	57	11.89	10.69	1.43	2.78
ANS Study Variables														
RSA – Neutral Video								102	4.24	8.65	6.24	0.96	-0.01	-0.48
RSA – Discrimination Video								103	3.00	9.10	5.94	1.17	0.13	-0.17
RSA Reactivity[a]								102	-2.20	2.67	0.29	0.82	0.35	0.95
PEP – Neutral Video								101	91.00	133.50	108.03	9.16	0.28	-0.41
PEP – Discrimination Video								101	84.00	130.50	107.10	9.20	0.11	-0.38
PEP Reactivity[b]								101	-5.50	12.00	0.93	2.77	1.01	3.33

[a] RSA reactivity is calculated such that higher (more positive) values indicate greater RSA decrease (withdrawal) from the neutral to the discrimination video.

[b] PEP reactivity is calculated such that higher (more positive) values indicate greater sympathetic activation from the neutral to the discrimination video.

Table 2.

Correlations between demographic variables, study variables, and potential covariates for the full sample (N=198). Correlations with RSA and PEP variables are only reported for the ANS subsample (N=103). Binomial correlations are reported for gender and generation.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	--												
2. Gender (0=Male, 1=Female)	-.01	--											
3. Generation	-.03	-.17*	--										
4. Years in U.S.	.07	-.14*	.53***	--									
5. Parental Education (years)	-.07	.04	.01	.11	--								
6. Model Minority Stereotyping	-.07	.15*	.04	.13	-.08	--							
7. Perceived Discrimination	.03	-.05	.14*	.17*	-.11	.28***	--						
8. Anxiety Symptoms	-.04	.04	.08	.07	-.20**	.14*	.35***	--					
9. RSA - Neutral	-.08	-.15	.00	.08	-.01	-.02	-.06	-.13	--				
10. PEP - Neutral	-.12	.07	.08	.08	.14	-.17	-.15	-.05	-.19†	--			
11. RSA – Discrimination	-.05	.00	-.01	-.01	.05	-.01	-.08	-.18	.72***	-.21*	--		
12. PEP – Discrimination	-.14	.13	.09	.09	.14	-.19	-.15	-.01	-.13	.95***	-.19	--	
13. RSA Reactivity	-.05	-.13	.06	.08	-.11	.01	.05	.07	.13	.05	-.59***	.12	--
14. PEP Reactivity	.07	-.21*	-.06	-.06	.02	.06	.00	-.11	-.19†	.14	-.06	-.16	-.14

Note. *p<.05; **p<.01; ***p<.001; RSA = Respiratory Sinus Arrhythmia; PEP = Pre-ejection period; Reactivity scores are calculated by taking ANS activity (RSA or PEP) during the discrimination video minus ANS activity during the baseline neutral video.

Table 3.

Multiple regression predicting anxiety symptoms from model minority stereotyping and perceived discrimination (N=198).

Anxiety Symptoms		
Predictors	***B (SE$_B$)***	β
Perceived Discrimination	7.75 (1.54)	.35***
Model Minority Stereotyping	0.59 (1.02)	.04
Total R^2	.12***	

*Note.****p*<.001

Table 4

Multiple regression predicting anxiety symptoms from perceived discrimination, model minority stereotyping, RSA reactivity, and their interaction (N=103).

Anxiety Symptoms		
Predictors	***B (SE$_B$)***	**β**
Perceived Discrimination	9.21 (2.04)	.40***
RSA Reactivity	1.26 (1.16)	.10
Perceived Discrimination x RSA Reactivity	7.27 (2.79)	.32*
Total R^2	.21***	
	B (SE$_B$)	**β**
Model Minority Stereotyping	4.07 (1.50)	.26**
RSA Reactivity	1.37 (1.30)	.10
MM Stereotyping x RSA Reactivity	0.64 (1.95)	.04
Total R^2	.05	

Note. ****p*<.001; ***p*<.01; **p*<.05;
Significance values presented for all predictors reflect the false discovery rate Benjamini-Hochberg correction

Table 5

Multiple regression predicting anxiety symptoms from race-related stressors, PEP reactivity, and their interaction (N=103).

Anxiety Symptoms		
Predictors	***B (SE$_B$)***	**β**
Perceived Discrimination	8.69 (1.95)	.41***
PEP Reactivity	-0.20 (0.33)	-.06
Perceived Discrimination x PEP Reactivity	-0.36 (0.71)	-.02
Total R^2	.15***	
	B (SE$_B$)	**β**
Model Minority Stereotyping	2.33 (1.42)	.16
PEP Reactivity	-0.31 (0.34)	-.09
MM Stereotyping x PEP Reactivity	-1.16 (0.60)	-.08
Total R^2	.05*	

Note. ****p*<.001; ***p*<.01; **p*<.05;
Significance values presented for all predictors reflect the false discovery rate Benjamini-Hochberg correction
RSA = Respiratory Sinus Arrhythmia; Reactivity scores are calculated by taking RSA activity during the discrimination video minus RSA activity during the baseline neutral video.

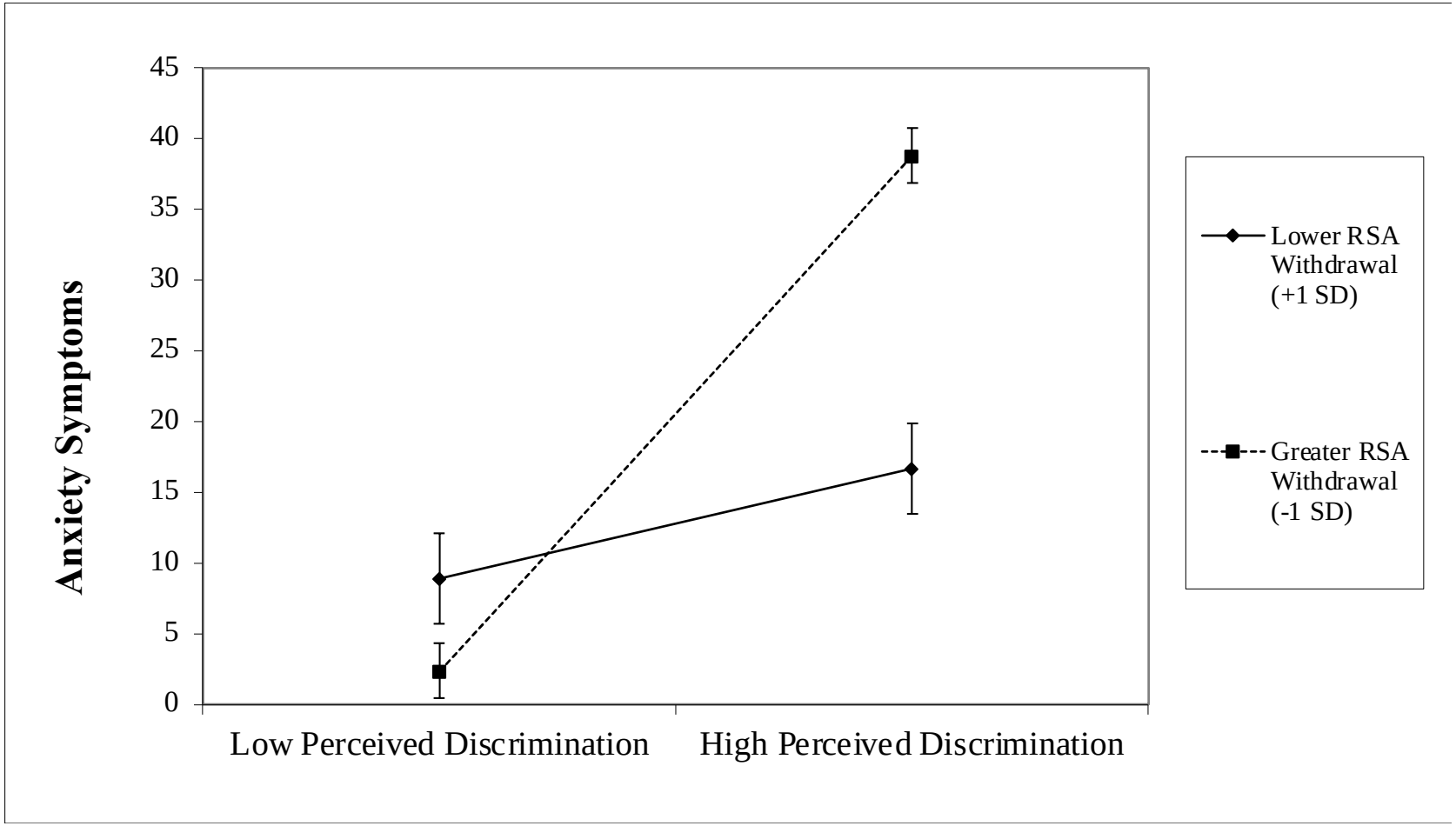


Figure 1. Interaction plot of simple slopes for associations between perceived discrimination and anxiety symptoms at values one standard deviation above mean RSA reactivity (lower RSA reactivity/withdrawal), and one standard deviation below mean RSA reactivity (greater RSA reactivity/withdrawal).

Supplementary Materials

Methods

Description of pilot study of neutral and discrimination films

We recruited a pilot sample (*N*=41) of participants through Amazon's Mechanical Turk (MTurk) to watch and rate the discrimination and neutral film clips (1-minute each) through an online survey platform. The goal of this pilot study was to verify that the discrimination film (and not the neutral film) was indeed interpreted as a scene of discrimination, and that relevant emotions were elicited. Films were presented in a random order for each participant. After watching each film, participants completed a modified version of the Post Film Questionnaire – a survey that is recommended for use in validating films for experimental research (J. Rottenberg et al., 2007). Eligibility requirements for the MTurk study included: being between 18 and 24 years of age, living in the United States, identification as ethnic Chinese, proficiency in English, having an Mturk quality rating of 90% or greater, and passing a validity check in the questionnaire ("Please select 5 for this option"). The pilot sample ranged in age from 20 to 23 years old (*M*=21.8 years, *SD*=1.04), and was 46% female. The total MTurk study took approximately 8 minutes to complete and participants were paid $3. Informed online consent was obtained from all pilot study participants and all pilot study procedures were approved by the university's institutional review board.

The modified Post Film Questionnaire asked participants to rate "how much did the event shown in the film depict discrimination" on a 9-point scale (*1* = I did not think the event showed discrimination, *9*=I think the event very much showed discrimination). The questionnaire also asked participants to indicate the greatest amount of each of 17 listed emotions experienced while watching the film on a 9-point scale (*1*=not at all/none, *5*=somewhat/some, *9*=extremely/a great deal). These negative emotions have been shown in prior research to be related to witnessing intergroup prejudice (Johns et al., 2005; Schmader et al., 2012) and included angry, anxious, ashamed, depressed, disgraced, disappointed, disgusted, embarrassed, guilty, humiliated, hurt, nervous, offended, regret, remorseful, sad, and sorry. Given strong internal consistency, a single composite of negative emotion was created for both the neutral film ($\propto$=.95) and the discrimination film ($\propto$=.94). After viewing the discrimination film, all participants rated depicted discrimination as a 3 or higher (*M*=7.41, *SD*=1.82), and for the neutral film, all participants rated depicted discrimination as a 5 or lower (*M*=2.41, *SD*=1.36). A paired samples t-test showed that ratings of whether the film depicted discrimination were significantly higher for the discrimination film as compared to the neutral film (t(40)=-12.81, p<.0001). According to another paired samples t-test, participant ratings of negative emotion were significantly greater after viewing the discrimination film (*M*=3.89, *SD*=1.15) as compared to ratings after viewing the neutral film (*M*=3.29, *SD*=0.97; t(40)=-8.14, p<.0001). Thus, the neutral and discrimination films were considered appropriate for use in the present study.

Collection and Computation of Electrocardiogram (ECG) and Impedance cardiography (ICG)

ECG was recorded with a sampling frequency of 1000 Hz using three disposable, pre-gelled spot electrodes placed in a Lead II configuration on the right clavicle, the lower right rib, and the lower left rib. ICG was recorded using eight spot electrodes placed in a tetrapolar configuration. A respiration signal was derived from the raw impedance data. The ECG electrodes were attached via leads to a Biopac Nomadix BN-RSPEC transmitter, while the ICG

electrodes were attached via leads to a BN-NICO transmitter (Biopac Systems Inc.). These transmitters were worn on a Velcro belt strapped around the participant's waist, and wirelessly sent ECG and ICG signals to a Biopac MP-160 data acquisition unit positioned across from the participant in the same room. All data were recorded continuously, stored, and analyzed offline.

RSA was obtained from the ECG data with MindWare HRV analysis software (version 3.2.5) in 60-second epochs. Our measure of RSA was the natural log of heart rate variability within the high-frequency band related to respiration (0.12-0.40 Hz for adults; Berntson et al., 1997). RSA reactivity scores were calculated as RSA during the discrimination video minus RSA during the baseline neutral video (Berntson et al., 1997) – scores were reversed so that higher, more positive scores indicate greater RSA decrease (parasympathetic withdrawal) from the neutral to the discrimination video.

PEP was obtained using ECG and ICG data with MindWare IMP analysis software (version 3.2.5). PEP is defined as the time interval between the electrical stimulation of the heart (Q-wave of the ECG) and the opening of the aortic valve (B-point of the dZ/dt wave). The software computed ensemble averages of data in 60-second epochs, and the B-point was identified using the "% of dZ/dt Time + C" method, which identifies the dZ/dt peak and uses regression modeling to approximate the B-point (Lozano et al., 2007). PEP reactivity was calculated by subtracting PEP during the discrimination video from PEP during the neutral video. Thus, higher and more positive PEP reactivity scores reflect shorter cardiac latencies, indicating higher sympathetic activity during the discrimination video as compared to the neutral video.

Results

RSA and PEP Reactivity to the Laboratory Challenge Task

There was a significant difference in RSA during the neutral video (M=6.24, SD=0.96) as compared to the discrimination video (5.94, SD=1.17), where RSA significantly decreased from the neutral to the discrimination video ($t(101)=3.56$, $p<.001$). PEP also significantly decreased from the neutral (M=108.03, SD=9.16) to the discrimination video (M=107.10, SD=9.20; $t(100)=3.36$, $p=.001$). Overall, these results show that the discrimination video was effective in eliciting the expected stress response (RSA withdrawal and PEP decrease).

Supplementary Figure 1

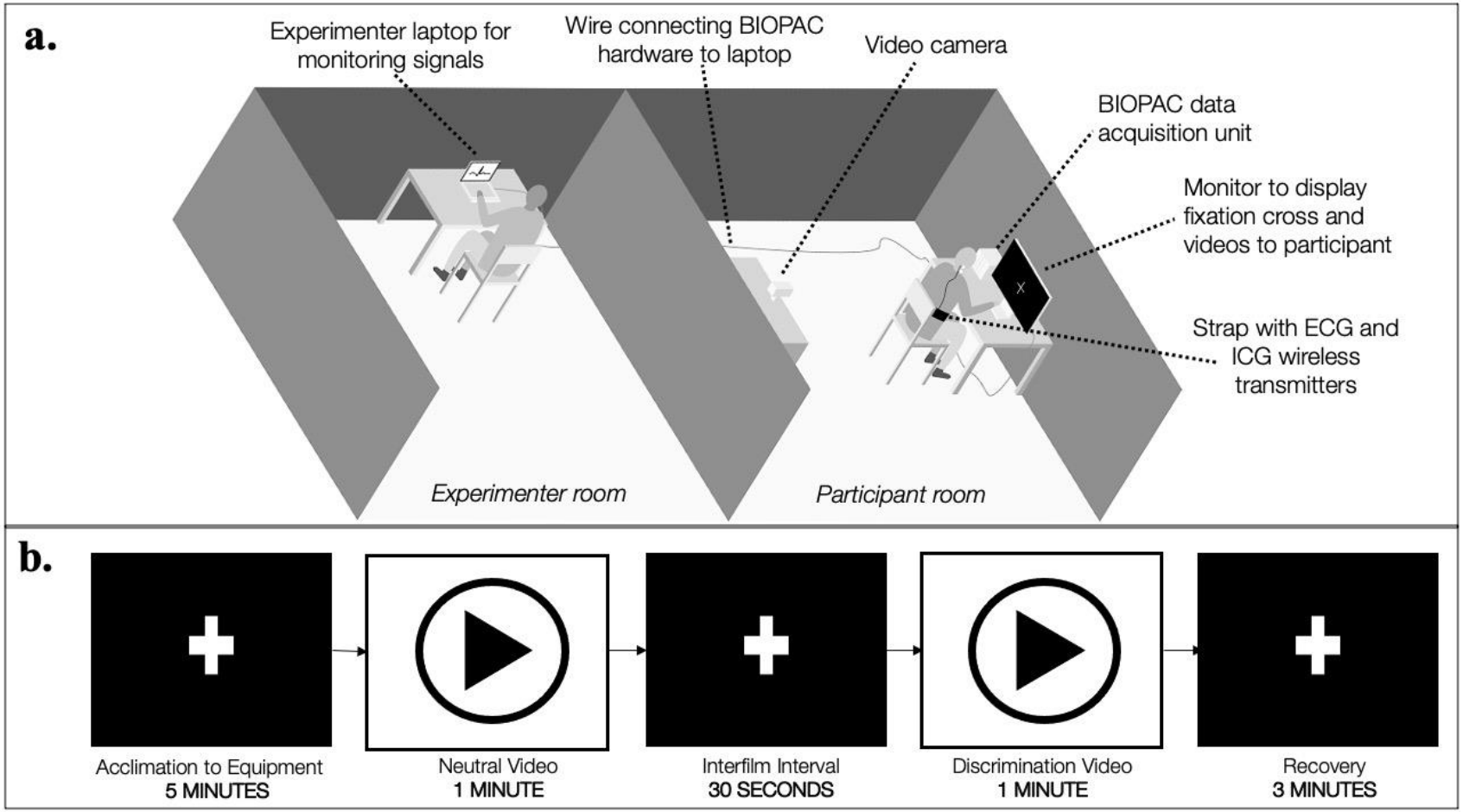


Figure 1. The procedure for ANS data collection, including (a) a diagram of key components of the experimental setup and (b) the order and duration of stimuli used in the experimental paradigm.

Supplementary Table 1.

Correlations between demographic variables, study variables, and potential covariates for the ANS subsample only (N=103). Binomial correlations are reported for gender and generation.

	1	2	3	4	5	6	7	8	9	10	11
1. Age	--										
2. Gender (0=Male, 1=Female)	-.14	--									
3. Generation	-.02	-.26**	--								
4. Years in U.S.	.12	-.21*	.65***	--							
5. Parental Education (years)	-.16	.00	.02	.03	--						
6. Model Minority Stereotyping	.01	.23	.09	.17†	-.14	--					
7. Perceived Discrimination	.11	.01	.11	.17†	.05	.33***	--				
8. Anxiety Symptoms	.03	.11	.03	.01	-.26**	.27**	.39***	--			
9. RSA - Neutral	-.08	-.15	.00	.08	-.01	-.02	-.06	-.13	--		
10. PEP - Neutral	-.12	.07	.08	.08	.14	-.17	-.15	-.05	-.19†	--	
11. RSA Reactivity	-.05	-.13	.06	.08	-.11	.01	.05	.07	.13	.05	--
12. PEP Reactivity	.07	-.21*	-.06	-.06	.02	.06	.00	-.11	-.19†	.14	-.14

Note. *p<.05; **p<.01; ***p<.001