ETHNIC DIFFERENCES IN EXPERIMENTAL PAIN: THE ROLE OF ADVERSE SOCIAL ENVIRONMENTS AND EMOTION REGULATION

A Dissertation

by

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ABSTRACT

Hispanic Americans report enhanced clinical pain severity relative to non-Hispanic White Americans; however, the pain mechanisms driving this discrepancy are relatively unknown. Therefore, the present study examined ethnic differences in pain responses to a battery of distinctly different quantifiable sensory tasks, as well as the role of psychosocial factors underlying these pain differences, between pain-free Hispanic and Non-Hispanic White adults. After completing several measures related to demographics, mood, adverse life experiences, and social status, participants were administered a battery of heat, cold, and mechanical noxious stimuli. Each sensory task was paired with self-report or electrophysiological pain responses. Chapter 1 begins by characterizing differences between ethnic groups on several measures of adverse life experiences and self-report pain responses to noxious stimuli. Chapter 2 follows up by examining differences in response styles between ethnicity groups and the impact these styles have on pain responses. Results showed that Hispanics displayed greater evidence for both a general and pain response minimization bias, suggesting the potential for heightened pain experiences to painful stimuli amongst Hispanics. To examine how adverse life experiences interact with pain mechanisms that contribute to later pain risk for Hispanics, chapter 3 assesses the relationship between markers of social status and temporal summation of pain (a proxy measure of central nervous system sensitization). Results from this chapter revealed that changes in subjective, but not objective, social status from childhood mediated the greater temporal pain summation observed amongst Hispanics relative to non-Hispanic Whites. Chapter 4 examines whether neural responses to noxious stimulation mirror ethnic and gender differences in subjective pain experiences. To that end, this chapter finds that while Hispanics and women

display evidence for greater - albeit relatively unique - responses to the high intensity stimuli, only women displayed greater contact-heat evoked brain potential relative to their control group. Taken together, these studies provide new insights into pain risk factors amongst Hispanic Americans. These results may motivate efforts to identify additional biological and psychosocial mechanisms underlying the enhanced pain severity observed amongst Hispanic Americans, as well as help guide the development of targeted clinical pain interventions for this population.

DEDICATION

I dedicate this dissertation to my mom. Without your love, understanding, reassurance, patience, encouragement, and support, I would not be where I am today. Thank you.

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1. INTRODUCTION

Hispanic Americans[1] re among the largest minority groups in the United States[2] and experience among the biggest economic,[3] environmental, and social stressors.,[3] environmental, and social stressors.[4] Given elevated adverse experiences, there has been greater recognition of mental health issues among Hispanic Americans.[5–8] Considering the greater clinical pain severity Hispanic Americans experience relative to non-Hispanic Whites,[9–17] there has also been increased study of clinical pain amongst this population.[18,19] However, as expressed by Hollingshead and colleagues' (2016) recent review of the Hispanic American pain experience,[18] the underlying factors contributing to greater reports of clinical pain severity amongst Hispanic Americans are relatively unknown. To begin to explore potential underlying factors contributing to the enhanced pain severity amongst Hispanic Americans, the current study broadly characterized pain sensitivity responses to controlled and quantifiable physical stimuli, as well as clinically relevant background psychosocial characteristics, between Hispanic and non-Hispanic White adults.

Theories linking stress with health suggest that adverse environmental demands or stressors may be a factor contributing to the development and progression of psychiatric and physical syndromes,[20–22] including chronic pain. Evidence in line with these theories find that adverse experiences in the form of low socioeconomic status predict greater rates and severity of chronic pain, as well as worse pain outcomes.[17,23,32,24–31] Adverse life stressors such as physical, sexual, or emotional trauma, are also associated with increased risk for the development of numerous clinical pain disorders.[33–38] Moreover, the relationship between adverse life experiences and clinical pain risk may be exceptionally problematic for demographic groups who disproportionately fall into lower socioeconomic strata and also face additional, unique psychosocial stressors (e.g., acculturation, perceived discrimination), such as Hispanic Americans.[17] Thus, disproportionately experiencing adverse events as part of an ethnic minority membership may be one factor explaining the increased risk of clinical pain severity amongst Hispanic Americans. However, it is unclear by what pain mechanism Hispanic status membership contributes to pain risk development.

One pain risk mechanism that may be adversely influenced in Hispanic Americans is pain sensitivity. Indeed, relative to non-Hispanic Whites with clinical pain,[39–41] other ethnic minorities within the U.S. who disproportionately fall into lower socioeconomic strata, such as African Americans,[17] demonstrate enhanced sensitivity to quantifiable sensory tests (QST) purported to assess central and peripheral nervous system pain processing.[42–44] The enhanced sensitivity to QSTs amongst racial/ethnic minority clinical populations relative to non-Hispanic White Americans generalizes to some non-clinical, pain-free racial/ethnic minority groups in the U.S., including African[45,46] and Hispanic Americans,[47] suggesting a potential pain sensitivity mechanism underlying the risk for clinical pain development and persistence evident in racial/ethnic minorities. However, additional research is particularly needed for Hispanic Americans; a review of the literature finds only six published studies that have examined pain sensitivity in Hispanic Americans using QSTs,[47–51] and the results have been mixed. Specifically, studies have noted a) enhanced,[47,48,50,51] b) reduced,[52] or c) no group differences[48,50] in pain sensitivity to QSTs. Different findings across the five studies may be attributed to the variety of QSTs utilized that differ on a number of core features including duration, intensity, and modality. In addition to these limitations, all five studies only measured sensory-discriminatory (pain intensity) or motivational pain dimensions (pain tolerance) while overlooking emotional and coping behavior (i.e., emotion regulation) responses, two dimensions implicated in the suffering component of pain.[53–56]

Therefore, to begin to characterize pain sensitivity responses to controlled and quantifiable physical stimuli, as well as to explore relevant background psychosocial characteristics that may contribute to and/or buffer these pain responses, the current study examined responses to cross-modality physical sensory stimuli and background risk and protective characteristics between pain-free Hispanic and non-Hispanic White participants. For each physical sensory task, a combination of self-report sensory, emotional, and/or coping responses were assessed.

1.1. Methods

This study was approved by the Institutional Review Board at Texas A&M University and informed consent was obtained from all participants. Participants were recruited between January 2018 and May 2019.

1.1.1. Participants

Participants were invited to the laboratory based on their self-reported ethnicity. To control for nativity/migration status, only participants reporting being born and raised in the U.S. were invited to participate.[57] To determine if enhanced sensitization develops preceding the onset of clinical pain, and to rule out disease status explaining any group differences, healthy, pain-free undergraduate students enrolled in a psychology course between the ages of 18 and 40 were recruited for the study and received course credit for their participation. To control for any additional confounds beyond the study's objectives that could impact laboratory pain sensitivity, exclusionary criteria included: a) present use of any prescription medicines (except for hormonal contraceptives), b) history of fainting spells, c) any skin condition/numbness on the hands or forearms, d) history of neurological disorders, e) current chronic pain or health condition, and f) use of allergy or pain medication within 24 hours prior to the experiment. Table 1 presents full study completion by ethnicity and gender.

1.1.2. General Overview of Procedures/Testing

Figure 1 provides an overview of the laboratory visit procedures. Participants were pre-screened for inclusion/exclusion criteria prior to receiving an invitation to the laboratory, and again on the day of testing. After giving consent to participate in the study, participants first completed several questionnaires to assess background characteristics. Participants then completed several physical sensory tests assessing threshold, tolerance, and pain ratings to several physical modalities (e.g., heat, cold, mechanical). Participants also completed a task assessing emotional responses to negative and neutral images. Each task occurred with at least 2 minutes of rest between each task to decrease carryover effects.

1.1.3. Laboratory Testing Setup

The software Presentation (Neurobehavioral Systems, Inc., Berkeley, California, U.S.) directed the experimental protocol for the parent study, while Qualtrics (Qualtrics International Inc., Provo, Utah, U.S.) administered questionnaires. The experimenter viewed the first computer monitor within an adjacent room to ensure experimental progress. The participant used the second computer monitor to complete questionnaires and to make ratings to stimuli. Participants engaged in laboratory procedures within a temperature controlled, sound-attenuated experiment room.

1.1.4. Background Questionnaires

Several self-report questionnaires were distributed to determine eligibility and to describe groups on relevant background attributes.

1.1.4.1. Demographic Data

To characterize the sample and assess for economic stressors, participants provided demographic information and health status to assess background information about their childhood and present experiences, including age, sex, education level, employment, and income.

1.1.4.2. Early Life Trauma

The Early Traumatic Inventory Self-Report (ETISR) assessed traumatic life events before age 18 years. The ETISR is a 27-item questionnaire designed to assess traumatic early life events in four trauma domains: general, physical, emotional, and sexual.[58] The questionnaire ends with two yes/no items assessing the effect of the most impactful event across two dimensions at the time of the adverse event: emotional disturbance symptoms (e.g., intense fear, horror, or helplessness) or dissociative symptoms (e.g., out-of-body experience).

1.1.4.3. Subjective Social Status

The U.S. version of the MacArthur Scale of Subjective Social Status measured childhood[59,60] and adult Subjective Social Status.[61] To measure childhood subjective social status, participants were asked to indicate their parent's social status during childhood (i.e., 0-12 years old) on a diagram of a nine rung ladder in which higher rungs represent those with the most education, money, and respected careers. Participants also indicated their current subjective social status using the same measure.

1.1.4.4. Perceived Ethnic Discrimination

The General Ethnic Discrimination Scale (GEDS)[62] measured the frequency of 17 perceived discriminatory events during a) the past two years and b) their entire life on a 6-point Likert scale from 1 ("never") to 6 ("almost all the time"). Participants also reported their appraisal of how stressful the experience was, on a 6-point scale from "not at all stressful" to "extremely stressful." Responses were summed to create subscales of recent ethnic discrimination, lifetime ethnic discrimination, and appraisal of ethnic discrimination. The GEDS was developed for use with members of any ethnic group and was based on the Schedule of Racist Events,[63] a validated measure developed for African American participants. Higher scores suggest greater perceived discrimination or greater stress appraisals.

1.1.4.4. Perceived Ostracism

The Ostracism Experiences Scale (OES)[64] measured experiences of ostracism on a 7-point Likert scale from 1 ("hardly ever") to 7 ("almost always") regarding how often each scenario happens (e.g., ''In general, others do not look at me when I'm in their presence'') with higher scores indicating greater perceived ostracism.

1.1.4.5. Stigma Consciousness

The Stigma Consciousness Questionnaire for Race/Ethnicity (SCQ-R) measured expectations of ethnicity-related prejudice and discrimination.[65] Participants rated their level of agreement on a Likert-type scale, from 1 ("strongly disagree") to 7 ("strongly agree").

1.1.4.6. Negative Personality Traits

The Negative Emotionality (NEM) scale of the Multidimensional Personality Questionnaire – Brief Form[66] assessed the negative affectivity personality trait. The NEM scale was computed by averaging the items on the Aggression, Alienation, and Stress Reaction subscales. Participants who score high in this negative affectivity trait have a lower threshold for the experiencing anger, anxiety, and other negative emotions.

1.1.4.7. Mood

The Center for Epidemiologic Studies Depression Scale (CES-D) assessed current depressive symptoms over the past week (higher scores indicate greater depressive symptoms).[67] The Perceived Stress Scale (PSS) was administered to assess perceived stress over the past month (higher scores indicate greater perceived stress).[68]

1.1.4.8. Emotion Regulation and Coping Behaviors

The Emotion Regulation Questionnaire (ERQ) assessed suppression and reappraisal tendencies.[69] The questionnaire is comprised of a reappraisal (e.g., when I want to feel more positive emotions, such as joy or amusement, I change what I am thinking about), and suppression subscale (e.g., I control my emotions by not expressing them). The Brief COPE was used to assess self-reported coping behavior tendencies.[70] The questionnaire is comprised of 14 coping strategies.

1.1.5. Pain Self-Report Responses

The current study administered a combination of different self-report measures to determine ethnic differences in pain intensity and pain unpleasantness responses, as well as emotional valence and arousal reactions, and cognitive-emotional coping responses to the pain tasks.

1.1.5.1. Pain Intensity Ratings

The larger study utilized two separate pain intensity visual analog scales (VAS) for separate pain tasks.

1.1.5.1.1. 11-point Pain Intensity VAS

A 11-point ratio VAS assessed pain intensity for the Heat Acclimation Task and the heat pain series task. The VAS consists of a horizontal bar on a sheet of paper with markers at 0 (“no pain”), 2 (“low pain”), 5 (”moderate pain”), 8 (“high pain”), and 10 “intolerable pain”).[71] Participants reported ratings verbally with this VAS.

1.1.5.1.2. 101-point Pain Intensity VAS

A computerized 101-point continuous visual analogue scale (VAS) was used to assess the sensory dimension of the pain experience for the subthreshold and suprathreshold heat pain task, the heat pain tolerance tasks, the cold pressor pain task, and the mechanical cutaneous pain task. Participants rated pain intensity (i.e., how strong the sensation feels). The computerized 101-point VAS consists of a horizontal bar on a computer screen that ranged from 0 to 100, with 0 representing “*no pain intensity*” and 100 representing “*the most intense pain imaginable*.”

1.1.5.2. Pain Unpleasantness VAS

A computerized 101-point continuous VAS was used to assess the emotional dimension of the pain experience for the subthreshold and suprathreshold heat pain task, the heat pain tolerance tasks, and the cold pressor pain task. Participants rated pain unpleasantness (i.e., how emotionally unpleasant or disturbing the sensation feels). The computerized 101-point VAS consists of a horizontal bar on a computer screen that ranged from 0 to 100, with 0 representing “*no pain unpleasantness*” and 100 representing “*the most unpleasant pain imaginable*.”

1.1.5.3. Valence and Arousal Emotional Responses

Self-report emotional reaction responses to the stimuli were assessed with a computerized version of the Self-Assessment Manikin (SAM).[72] The SAM yields current valence (unpleasant to pleasant) and arousal (calm to aroused) scores that range from 1 to 9. Higher scores indicate the participant experienced greater pleasantness and arousal. Participants responded by clicking on any of the nine pictographs individually for each of the 2 dimensions. The SAM provides a valid and reliable measure to assess emotional responses to the manipulation of affect from noxious stimuli administered in the laboratory.[73,74] Valence and arousal responses were recorded for several of the noxious pain tasks, including the subthreshold and suprathreshold heat pain task, the heat pain tolerance tasks, and the cold pressor pain task. Valence and arousal responses were also recorded for the Picture Task.

1.1.5.4. Pain Coping Behavior Responses

Coping behavior was measured using the Coping Strategies Questionnaire-Revised (CSQ-R),[75,76] which consists of 27 items derived from the original CSQ.[77] The CSQ-R consists of six cognitive strategy subscales: diverting attention away from pain (i.e., distraction), catastrophizing, ignoring pain sensations, reinterpreting pain sensations, coping self-statements, and hoping/praying. Two additional subscales were created by summing the previous aforementioned subscales: a) the active coping composite subscale was created from diverting attention away from pain, ignoring pain sensations, reinterpreting pain sensations, and coping self-statements and b) the passive coping composite subscale was the sum of catastrophizing and hoping/praying. Participants rated how often they used each strategy to cope with the pain during the high intensity block on a scale ranging from 0 (never did that) to 6 (always did that), with greater scores indicating greater use of the strategy. The CSQ-R has been shown to be valid and reliable among both pain-free individuals, as well as those with chronic pain.[76] Coping responses were recorded for the suprathreshold heat pain task and the cold pressor pain task.

1.1.6. Picture Task

For the picture task, participants were presented with two blocks of 25 images per block. One block consisted of negative images (e.g., car crashes, sick or injured people) and the other block consisted of neutral pictures (e.g., household objects, buildings). The presentation order for the negative and neutral blocks were randomized for each participant. Within each block, picture presentation was also randomized and participants were presented with each picture once. All pictures were selected from the IAPS database.[1]

Participants were instructed to simply view the pictures on the screen for its entire duration. Pictures were presented and lasted for five seconds. Immediately following the presentation of a single picture, participants were tasked with rating their emotional responses to the image they just viewed using the SAM. After participants made their emotional response ratings, participants were presented with the next image after waiting for a brief, varied inter-stimulus interval that ranged from 2-2.5 seconds. Between the two blocks of pictures, participants were given the opportunity to take a break and could terminate the break whenever they felt comfortable to continue to the next block. All pictures were in color, presented via Presentation software (Neurobehavioral Systems, Inc., Berkeley, California, U.S.), and filled the entire screen.

1.1.7. Exposure to Noxious and Innocuous Physical Stimuli

To assess pain responses, participants completed several suprathreshold pain tasks that included heat, cold, and mechanical cutaneous stimuli. After each pain task, participants

[1] IAPS neutral pictures used: 1670, 2026, 2745.1, 5520, 6150, 7000, 7002, 7006, 7009, 7010, 7012, 7025, 7035, 7036, 7037, 7040, 7042, 7050, 7080, 7081, 7150, 7491, 7500, 7547, 7705. IAPS negative pictures used: 1274, 1300, 2205, 2375.1, 3030, 3120, 3180, 3400, 3550, 6312, 6313, 6560, 6800, 8230, 9041, 9042, 9412, 9413, 9415, 9421, 9423, 9561, 9610, 9910, 9912.

completed self-report measures including the pain intensity and pain unpleasantness VAS, valence and arousal SAMs, and the CSQ-R.

1.1.7.1. Heat Tasks

Heat stimuli were delivered using a Medoc Pathway device with either a Contact Heat Evoked Potential Stimulator thermode with a 27mm diameter probe that covered an area of 572.5mm^2 for the heat pain series task or a 30x30mm Advanced Thermal Stimulator thermode (Medoc Ltd, Ramat Yishai, Israel). The maximum intensity of any heat stimulus was set to 51°C. Participants were blinded to the temperatures of all the heat tasks.

1.1.7.2. Heat Acclimation Task

Participants were presented with 12 heat pulses at a low peak temperature of 42ºC and a baseline of 30ºC on six sites along the volar surface of their non-dominant forearm. Each pulse had a duration of two seconds at peak temperature with a ramp rate of 70ºC/s and a cooling rating of 40ºC/s. Inter-trial intervals (ITI) between heat pulses ranged from 25-30 seconds. Participants' volar forearm was divided into a grid consisting of six separate sites for thermode application. Participants were presented with heat pulses to each site in a semi-random order that avoided stimulation of adjacent sites. Each site was tested once using a randomized sequence, then a second time following the same sequence for a total of two pulses per site. When cued by the experimenter, participants reported the intensity of each heat pulse 7-10 seconds after the heat pulse returned to baseline. After making a VAS rating, the thermode was moved to the next site with 10-15 seconds before the onset of the next heat pulse.

1.1.7.3. Heat Pain Series Task

The average and range of intensity ratings for each site from the Heat Acclimation Task was calculated and used to determine each participant's four most similar sites of pain sensitivity. The four most similar sensitivity sites were then selected for the heat pain series task. In instances where five or more sites had similar sensitivities, sites were chosen by the experimenter that most preserved a square pattern.

Adapting a methodology used by Atlas and colleagues (2010),[71] participants' experienced three distinct temperatures at 41ºC, 44ºC, and 47ºC to elicit low pain, moderate pain, and high pain, respectively. Using the participant's four equivalent sensitivity sites, each site received a semi-randomized sequence of four heat pulses at 41ºC. Succeeding that same site sequence, the participant then received four pulses at 44ºC, followed by four pulses at 47ºC for a total of 12 heat pulses. For this task, each pulse had a duration of five seconds with a baseline temperature of 30ºC, a ramp rate of 70ºC, a cooling rate of 40ºC, and ITI's of 25-30 seconds. Similar to the first task, participants reported the intensity of each heat pulse 7-10 seconds after the heat pulse returned to baseline when prompted by the experimenter. After reporting a VAS rating, the thermode was moved to the next site with 10-15 seconds before the onset of the next heat pulse.

1.1.7.4. Subthreshold and Suprathreshold Heat Pain Task

As with the heat pain series task, the four most similar sensitivity sites from the Heat Acclimation Task were also utilized for the Subthreshold and suprathreshold heat pain task. Contact heat stimuli were delivered by increasing the temperature from a baseline temperature (32˚C) to a fixed peak temperature at a rate of 70˚C/s and cooling at a rate of 40ºC/s. Contact heat stimuli were delivered in separate blocks of low intensity and high intensity stimuli, each block consisting of 25 contact heat stimuli. The low intensity block had a fixed peak temperature of 34˚C. Conversely, the high intensity block had a variable peak temperature of 45˚C to 48˚C that was calibrated to induced a rating corresponding to 8 out of 10 on a 11-point ratio visual analog scale (VAS) with the following labels: 0 = no pain; 2 = low pain; 5 = moderate pain; 8 =

high pain; 10 = intolerable pain. The low intensity block's peak temperature of 34˚C was previously established as an acceptable non-painful, warm stimulus.[78] The order of subthreshold and suprathreshold temperature blocks were randomized for each participant. All contact heat stimuli had a duration of five seconds with ITIs between heat stimuli ranging from 25-30 seconds. During ITIs, participants made ratings to the experienced thermal stimulus. Between the two blocks of low and high intensity thermal stimuli, participants were given a minimum two-minute break.

1.1.7.5. Heat Pain Tolerance Task

Heat Tolerance were assessed two times each on the participant's dominant volar forearm with an ascending method of limits. Each trial began at a baseline of 32°C and rose at a rate of .5°C/second. Participants were instructed to terminate the heat stimulus by clicking a button when the heat became intolerable (i.e., tolerance). Participants reported their valence and arousal response 7-10 seconds after each heat pain tolerance trial when prompted by the experimenter. The thermode was moved to an adjacent spot on the forearm after each trial to avoid sensitization. Heat pain tolerance temperatures were defined as the average of the two tolerance trials, while valence and arousal to the tolerance task were defined as the average of the ratings to the two tolerance task trials.

1.1.8. Cold Pressor Pain Tolerance Task

Cold pain tolerance was assessed once with the cold pressor pain task. Participants submerged their nondominant hand up to their wrist in a circulating bath of 2ºC.[79,80] Participants submerged their hand in the water until they could no longer tolerate the sensation or until reaching four minutes. Upon reaching pain tolerance or the time limit, participants were told to remove their hand from the water. Participants who reached the time limit were told to withdraw their hand from the water. After reaching tolerance or the time limit, participants rated their responses upon removing their hand from the water. Pain tolerance was the total number of seconds that participants kept their hand in the water. Participants were unaware of the time limit.

1.1.9. Mechanical Cutaneous Task

Two series of mechanical stimuli were delivered to assess temporal summation of mechanical pain in the larger study, but the current analyses focused only on the global pain ratings to the stimuli. Participants were presented with a series of mechanical stimuli at 180g and 300g of pressure. Using calibrated nylon monofilaments designed to deliver a consistent gram force upon the filament's bend, participants were assessed on three locations across the participants dominant side: the dorsal surface of the third digit's (i.e., middle finger) intermediate phalanx, the dorsal surface of the second digit's (i.e., index finger) metacarpal, and the upper trapezius muscle. Participants were first assessed for initial pain after receiving a single contact and verbally rating the intensity of the pain from the single contact on a scale ranging from 0 ("no pain") to 100 (the most intense pain imaginable") scale. Participants then received a series of ten additional contacts at a rate of one contact per second at the same body site. Upon completion of the ten contacts, participants then rated the peak or greatest pain intensity experienced during the ten contacts. This initial and peak pain procedure occurred twice on each anatomical site for both the 180g and 300g monofilaments.

1.1.10. Data Analysis

Prior to analyses, data were screened for accuracy and missing values. When values were missing due to equipment malfunction or participant discontinuation, pairwise deletion was used to exclude participants from those particular analyses.[81] Differences in continuous variables were examined with *F* tests, while χ^2 analyses were used for categorical variables. Partial eta squared (η^2_p) was used as a measure of effect size for *F* tests of mean differences, with values of 0.009, 0.0588, and 0.1379 corresponding to small, medium, and large effect sizes, respectively.[82,83] Significance was set at $\alpha < .05$ (2-tailed). SPSS 23.0 (IBM; Armonk, NY) was used for all analyses.

1.1.10.1. Primary Analyses

A series of analyses were used to address the current study's second objective of exploring pain response differences between ethnicity groups to noxious QST stimuli. Analyses for stimulus intensity (e.g., heat pain tolerance) outcomes were conducted using a one-way analysis of variance (ANOVA) with ethnicity (non-Hispanic White, Hispanic) and gender (male, female) as the independent variables. When a pain task was individually calibrated to the participant (i.e., suprathreshold heat pain task) or the pain task was a tolerance test (i.e., heat pain tolerance task, cold pain tolerance task), then pain intensity, pain unpleasantness, valence, arousal, and coping responses were analyzed with analyses of covariance (ANCOVA) to control for differences in stimulus intensity. Bonferroni-adjusted alpha level was set based on the number of self-report outcomes within a pain task (EX: suprathreshold heat pain task $\alpha = 0.05$ / 12 outcomes = 0.004). However, regardless of Bonferroni-adjustment alpha levels, outcomes that were significant at the .05 level were reported.

1.2 Results

1.2.1. Final Sample

As noted in Table 1, a total of 134 individuals consented to participate. Of those, 85.8% completed the full study (n = 115) and 14.2% (n = 19) did not complete the full study for reasons including choosing to discontinue, the study running over-time, or equipment malfunction. Therefore, the number of participants for each task varies. However, there were no differences in full study completion rates when assessed across the four ethnicity X gender groups, χ^2 (3) = 1.44, p = .696, or when comparing across ethnicity groups alone, χ^2 (1) =.37, p = .541.

1.2.2. Background Characteristics

As denoted in Table 2, ethnic and gender groups differed on a number of background characteristics. Regarding ethnicity, differences primarily occurred across a number of economic, environmental, and social stressors. Specifically, Hispanics not only reported experiencing greater numbers of traumatic events, primarily in the domains of emotional or sexual trauma, but also greater disturbance and dissociative symptoms in relation to a traumatic event. In relation to socioeconomic indices, Hispanics had lower household incomes during childhood and adulthood, had lower paternal and maternal education levels, demonstrated lower subjective social status levels during childhood and adulthood relative to non-Hispanic Whites. Additionally, Hispanics reported greater frequency of recent and lifetime ethnic discriminatory events, as well as perceiving said events as more stressful.

Concerning gender differences, women too reported experiencing greater number of sexual traumas and greater disturbance symptoms in relation to a traumatic event, but lower instances of physical trauma relative to men. Like Hispanics, women also reported lower childhood subjective social status. However, unlike Hispanics, women reported experiencing greater negative moods and negative personality traits including greater depressive symptoms and perceived stress relative to men, greater stress reactivity traits relative to men, but lower levels of aggressive traits relative to men. Moreover, Women reported differences in coping strategy use relative to men, including greater use of social support strategies, including emotional and instrumental support (i.e., asking for help/advice), as well as greater use of behavioral disengagement. However, women also expressed utilizing less active coping, humor, and acceptance to cope with stressful situations relative to men. Finally, women in the study were slightly younger than men.

1.2.3. Ethnicity and Gender Differences in Self-Report Responses to Negative and Neutral Pictures

As described in Table 3, the results indicated that there were no differences in emotional responses to negative or neutral images between ethnicity groups. Regarding gender, women reported lower valence emotional responses to the negative images ($p = .001$). No other differences were observed between genders.

1.2.4. Ethnicity and Gender Differences in Stimulus Intensity / Duration

Before examining ethnicity differences in responses to noxious stimuli, stimulus intensity/duration was analyzed. As depicted in Table 4, there were no significant differences across ethnic groups for the heat pain tolerance task's temperature intensity, the tested suprathreshold heat pain task's temperature intensity, and the cold pressor pain task's tolerance duration. Conversely, women demonstrated significantly lower heat pain tolerance temperatures relative to men.

1.2.5. Ethnicity and Gender Differences in Self-Report Responses to Noxious Stimuli

As portrayed in Table 5, the results indicated that compared with non-Hispanic White participants, Hispanics reported significantly a) greater pain intensity to the mechanical von Frey series at 300g (p = .012), b) greater valence responses to the heat pain tolerance task (p = .031), c) greater arousal to the suprathreshold heat pain task (p = .03) and the heat pain tolerance task (p = .004), d) greater catastrophizing pain coping to the suprathreshold heat pain task (p = .008), e) greater reinterpretation of pain sensation coping to the suprathreshold heat pain task (p = .01) and the cold pressor task (p = .018), f) greater hope/prayer pain coping to the suprathreshold heat pain task (p = .039) and the cold pressor task (p = .002), e) and greater passive coping to the suprathreshold heat pain task (p = .004) and the cold pressor task (p = .007). Of these significant values, only a) arousal response to the heat pain tolerance test, b) pain intensity to the 300g von Frey series, and c) hope/prayer coping response to the cold pressor task survived Bonferroni-adjustment for the number of outcomes within a task.

Regarding gender differences, results indicated that when compared with male participants, women reported greater a) pain intensity to the 47°C heat pain series task (p = .020) and b) diverting attention pain coping to the suprathreshold heat pain task (p = .017). However, only pain intensity to the 47°C heat pain series task survived Bonferroni-adjustment for the number of outcomes within a task.

An ethnicity X gender interaction was observed for pain coping self-statements (p = .039). Bonferroni adjusted pairwise comparisons revealed this interaction was driven by the greater ratings among Hispanic men ($M_{HispanicMen}$ = 20.00, $SD_{HispanicMen}$ = 4.08) relative to non-Hispanic White men ($M_{non\text{-}HispanicWhiteMen}$ = 17.28, $SD_{non\text{-}HispanicWhiteMen}$ = 5.71), $F_{1,114}$ = 5.28, p =

.023, $\eta^2_p = .044$. However, this finding did not survive the Bonferroni-adjustment for the number of outcomes within the task.

1.3. Discussion

Hispanic Americans face a number of economic,[3] environmental, and social stressors,[4] stressors which are often linked with greater rates and severity of clinical pain syndromes.[17,23,32–36,38,24–31] However, the potential factors contributing to these greater reports are relatively unknown. In light of work demonstrating the utility of quantitative sensory tests' for predicting clinical pain symptoms,[39,40,84] the current study examined responses to cross-modality physical sensory stimuli and background risk and protective characteristics between pain-free Hispanic and non-Hispanic White participants. The goal of the current study was to begin to characterize pain sensitivity responses to controlled and quantifiable physical stimuli, as well as to explore relevant background psychosocial characteristics that may contribute to and/or buffer these pain responses in Hispanic Americans.

Briefly summarized, results demonstrated that Hispanics reported greater adverse life experiences across a number of domains (e.g., trauma, social, economic, perceived status) relative to non-Hispanic Whites, but displayed no mood or personality differences. Hispanics also demonstrated heightened responses on a number of self-report pain outcomes. The following discussion reviews the results from the current study, then concludes by addressing studies conducted in the subsequent chapters.

1.3.1. Ethnic Differences for Self-Report Responses to Noxious Stimuli

While Hispanics reported greater pain intensity on all pain tests than non-Hispanic Whites (although nonsignificant at the $p < .05$ level), significant sensory pain response differences were observed between Hispanics and non-Hispanic Whites on the mechanical von

Frey series at 300g. The 300g series was administered as part of a task examining temporal pain summation, a non-invasive correlate of pain processing sensitization within the dorsal spinal cord horn.[42] While temporal summation is not reported here (see Chapter 3), increased hyperalgesia to the punctate stimuli may reflect sensitization at the level of several peripheral and central nervous system structures (e.g., peripheral nerves, spinal cord, thalamus, cortices). However, given the lack of significant differences across self-report pain intensity ratings to the other noxious tasks (see Table 5), as well as the dynamics of the 300g von Frey series task (one contact per second), the elevated pain intensity ratings to the 300g series task may better reflect amplification of spinal activity. Considering temporal pain summation is greater in individuals with chronic pain,[85,86] the greater intensity ratings to the von Frey task may provide a potential mechanism underlying the risk for clinical pain development and persistence for Hispanic Americans.

With regards to emotional responses to noxious stimuli, Hispanics generally presented with lower valence and greater arousal. For example, Hispanics reported lower valence to the heat pain tolerance task and greater arousal responses to both the heat pain tolerance task and the suprathreshold heat pain series task; however, only the arousal response to the heat pain tolerance task survived after adjusting for familywise type I error. Considering negative affect's relation to pain,[87–89] greater emotional responsivity to noxious events may represent a potential risk factor for increased pain severity amongst Hispanics with clinical pain.

A stable pattern of coping response differences were also observed between ethnic groups. For example, Hispanics reported greater catastrophizing, reinterpreting pain sensations, hoping / praying, and overall passive coping to the heat stimuli to the suprathreshold heat pain task; however, these differences did not survive after adjusting for familywise type I error. For the cold pressor task, Hispanics reported greater reinterpretation of pain sensations, hoping / praying, and passive coping; however, only hoping / praying differences survived after adjusting for familywise type I error. Elevated passive coping amongst Hispanics does align with literature observing greater passive coping behavior use in the face of pain,[18,19] including general pain catastrophizing for clinical pain,[16,90] as well as general religious coping in both clinical[16,90–93] and healthy, pain-free populations.[91] Passive cognitive coping behaviors are consistently associated with worse clinical pain outcomes[94–96] and may represent a potential pain risk factor for Hispanics.

1.3.2. Impact of Ethnicity on Background Characteristics

Regarding adverse life experiences or stressors, Hispanic Americans in the current study reported greater total trauma frequency experiences that appear to be driven by emotionally and sexually traumatic events (see Table 2). Inspection of trauma symptoms also suggests Hispanics were more likely to report experiencing disturbance and dissociation in response to their experienced traumatic events. Moreover, Hispanics not only reported greater experiences of perceived ethnic discrimination, but also greater stress appraisals from those events. This is contrasted by lack of differences on perceived ostracism, trait social alienation, and ethnicity related stigma consciousness relative to non-Hispanic White Americans. This could suggest that Hispanics in the current study may be experiencing a great deal of ethnically based, prejudicially stressful events that are not better explained by either general perceived exclusion experiences or expectations to be mistreated or stereotyped by others due to one’s ethnicity. Examination of socioeconomic stressors also revealed that Hispanics reported lower household income during childhood and adulthood. These stressors were compounded for Hispanics with observed lower childhood and adulthood subjective social status, as well as less paternal and maternal education relative to parental education levels for the non-Hispanic White adults.

Given the theories linking environmental stressors with the development and progression of not only physical, but psychiatric syndromes,[20–22] examination of depressive and stress symptoms, as well as trait stress reactivity, surprisingly revealed no differences between Hispanics and non-Hispanic Whites. Lazarus and Folkman's Transactional Model of Stress[97] might suggest the lack of stress or depressive psychological symptoms may be due to the presence of resources that may buffer the negative effects of environmental stressors. However, examination of adaptive, as well as maladaptive, coping and emotional regulation strategies to environmental stressors reveals no differences between Hispanics and non-Hispanic Whites.

Taken together, examination of background characteristics that may interact with pain suggest that Hispanics in the current study report experiencing a number of adverse life experiences, but don't appear to display differences for general negative mood or coping behaviors.

1.3.3. Conclusions, Implications, and Follow-up Analyses

The differences in pain experiences between ethnicity groups, particularly for emotional and coping responses, is consistent with the greater rates of clinical pain severity observed amongst Hispanic Americans.[9–17] As such, the current findings may have implications for understanding the neurophysiological and psychosocial mechanisms driving ethnic clinical pain severity differences, as well as the factors contributing to greatest future pain risk. Indeed, one strength of the current study is the utilization of numerous QSTs to assess perceptual responses to characterize somatosensory function. Moreover, the QST tasks administered in the current study differ from one another on several features (e.g., stimulus type, sensation elicited, testing device, duration, tissue depth assessed, repetition) and consequently engage different nerve endings, afferent nerve fibers (e.g., Aβ, Aδ, C), and central nervous system pathways (e.g., lemniscal, spinothalamic) involved in somatosensory transmission and processing.[43,44,98] When paired with psychosocial assessment, a related benefit of utilizing QSTs in healthy, pain-free individuals is the ability to address a variety of questions pertinent to the Hispanic pain experience,[18] including the influence of adverse life experiences, psychological features, and neural underpinnings related to the experience of pain. Therefore, the following chapters embark on these aims and delve into follow-up analyses focusing on three topics, all with the intention of addressing the pain experience for Hispanic Americans: (Chapter 2) the influence of response styles on self-reported pain; (Chapter 3) the role of objective and subjective social status markers on pain summation; and (Chapter 4) neural responses to noxious heat stimuli and its relationship with self-report responses.

2. GREATER LABORATORY HEAT PAIN SENSITIVITY AMONGST HISPANIC AMERICANS: THE ROLE OF SOCIALLY DESIRABLE RESPONDING

2.1. Introduction

Hispanic Americans[1] report differences in laboratory[47] and clinical pain severity relative to non-Hispanic Whites.[9–17] However, the measurement factors contributing to these pain differences remain largely understudied. To begin to address these issues, the current study examined the impact of ethnicity on laboratory pain sensitivity, as well as the role that response bias may play in self-report pain for Hispanics.

The Multidimensional Model of Pain Assessment[99] suggests that pain involves a number of different features beyond sensory, including affective-motivational and cognitive-evaluative dimensions.[87,99] Contemporary pain models such as the Biopsychosocial[100] and Biocultural[101,102] Models of Pain extend this line of thinking, suggesting that the experience and expression of pain can be influenced by top-down proximal (e.g., cognitions, affect) and distal factors (e.g., social environment, cultural influence). As such, ethnicity, a social category encompassing a group of people's shared environments, histories, behaviors, and beliefs,[103] should also modulate pain. Indeed, ethnic groups such as Hispanic Americans experience greater clinical pain severity relative to non-Hispanic White Americans.[11–17] However, the greater severity in clinical pain observed for Hispanics does not consistently generalize to laboratory pain sensitivity.[49] This would suggest the presence of additional factors related to ethnicity that may contribute to pain responses amongst Hispanics.

One pain reporting factor entwined with ethnicity that may contribute to pain responses amongst Hispanics is that of response bias. Pain response bias refers to a general phenomenon in which factors other than an individual's pain influence pain response values.[104,105] Response bias is pertinent to pain assessment because Hispanics are more likely to score higher than non-Hispanic Whites on self-report markers of socially desirable responding (i.e., over-reporting "good", under-reporting "bad"),[106–110] which may have numerous implications for clinical pain management. This socially desirable pattern of responding generalizes to clinical pain reporting as well, where qualitative studies assessing the impact of culture on Hispanic pain find common themes, including beliefs that pain is predetermined, pain should be tolerated with stoicism, , pain is a necessary part of life, and there is value in not letting pain problems interfere with relationships.[9,111–113] Commonly held cultural beliefs among Hispanics such as simpatía (i.e., seeking harmony in interpersonal relations) are proposed to contribute to the minimization observed for Hispanics for both general mental health[106,110] and clinical pain assessment.[112] However, while previous studies have quantitatively examined the impact that positive response bias has on Hispanic mental health,[106] the influence of this response style on pain for Hispanics is largely unknown.

Therefore, secondary analyses were conducted on data derived from a larger study on ethnic pain sensitivity differences to examine the relationship between response bias and laboratory pain sensitivity to heat stimuli between two pain-free ethnic groups: Hispanic and non-Hispanic White Americans. Additionally, the study evaluated whether the pattern in pain sensitivity between ethnic groups was similarly observed between genders, as women show greater laboratory pain sensitivity[47,114–118] and clinical pain severity relative to men.[114,119] Given previous evidence for greater clinical pain severity[11–17] and socially desirable responding in Hispanic Americans,[106–110] the current study had three hypotheses:

1) Hispanics would demonstrate significantly greater sensitivity to suprathreshold nociceptive heat stimuli relative to non-Hispanic White individuals,

2) Hispanics would present with a general social desirability bias, as well as a positive pain response bias, and
3) Positive response biases in Hispanics would impact observed self-report pain sensitivity ratings.

2.2. Methods

This study was approved by the Institutional Review Board at Texas A&M University and informed consent was obtained from all participants. Participants were recruited between January 2018 and May 2019.

2.2.1. Participants

Participants were invited to the laboratory based on their self-reported ethnicity. To control for nativity/migration status, only participants reporting being born and raised in the U.S. were invited to participate.[57] To determine if enhanced sensitization develops preceding the onset of clinical pain, and to rule out disease status explaining any group differences, healthy, pain-free undergraduate students enrolled in a psychology course between the ages of 18 and 40 were recruited for the study and received course credit for their participation. To control for any additional confounds beyond the study's objectives that could impact laboratory pain sensitivity, exclusionary criteria included: a) present use of any prescription medicines (except for hormonal contraceptives), b) history of fainting spells, c) any skin condition/numbness on the hands or forearms, d) history of neurological disorders, e) current chronic pain or health condition, and f) use of allergy or pain medication within 24 hours prior to the experiment. Table 1 presents full study completion by ethnicity and gender.

2.2.2. Sample Size Calculation

A power analysis using G*Power version 3.1 (Franz Faul, Universitat Kiel, Germany; http://www.gpower.hhu.de/) was used to estimate the needed sample sizes. Based on meta-analysis examining racial and ethnic differences in experimental pain sensitivity, a medium effect was expected in comparing ethnicity groups on pain ratings and tolerance.[120] In estimating with a medium effect ($f = 0.25$), 80% power, $\alpha = .05$, for a repeated measures analysis with two groups and three number of measurements (i.e., 41ºC, 44ºC, 47ºC) for a within-between interaction, the required sample size is a total 28 participants while only a between factors effect would require a total sample size of 86 participants. A final sample of 115 participants were available for analysis in the current study (see Table 1 for participant characteristics by group).

2.2.3. General Overview of Procedures/Testing

Figure 1 presents the timeline of procedures in the current study (note: additional assessments in the figure will be reported in future manuscripts). Laboratory testing took place during a session lasting approximately five hours. All participants were provided an overview of the study before informed consent was obtained. Prior to being invited to the laboratory and again on the day of testing, participants were pre-screened for inclusion/exclusion criteria. If eligible, participants first consented to participation then filled out several questionnaires to assess background characteristics. Participants then completed a number of physical sensory tests assessing threshold, tolerance, and pain ratings to several physical modalities (e.g., heat, cold, mechanical). Each task occurred with a minimum of a 2-minute break between tasks. The mandatory breaks administered between tasks were used to minimize carryover effects.

2.2.4. Laboratory Testing Setup

The software Presentation (Neurobehavioral Systems, Inc., Berkeley, California, U.S.) directed the experimental protocol for the parent study, while Qualtrics (Qualtrics International Inc., Provo, Utah, U.S.) administered questionnaires. The experimenter viewed the first computer monitor within an adjacent room to ensure experimental progress. The participant used the second computer monitor to complete questionnaires and to make ratings to stimuli. Participants engaged in laboratory procedures within a temperature controlled, sound-attenuated experiment room.

2.2.5. Demographic and Background Questionnaires

To characterize the sample, participants provided demographic and health status information to assess background information about their experiences, including age, sex, education level, employment, and income. Participants also completed additional questionnaires to assess group differences in psychological characteristics known to affect pain.[19,38] The Center for Epidemiologic Studies Depression Scale (CES-D) was used to assess current depressive symptoms over the past week.[67] The Beck Anxiety Inventory (BAI) was used to assess anxiety symptoms over the past month.[68] Subjective Social Status was measured using the U.S. version of the MacArthur Scale of Subjective Social Status,[61] with lower scores indicating lower perceived social status relative to others in the country. State anxiety was assessed with the State-Trait Anxiety Inventory (STAI),[121] while state positive and negative affect were measured with the Positive and Negative Affect Schedule (PANAS).[122]

2.2.6. Social Desirability Response Bias Assessment

The Positive Impression Management (PIM) scale of the the Personality Assessment Inventory (PAI) was used as a measure of social desirability. PIM is an eight-item measure intended to reflect socially desirable responding. The PAI[123] is a 344-item instrument with a four-point response format and multiple scales and indicators of constructs related to response style, psychopathology, and personality. The PAI is reliable amongst diverse populations and valid for a variety of assessment purposes.[124]

2.2.7. Pain Intensity Ratings

A 11-point ratio visual analog scale (VAS) was used to rate pain intensity. The VAS consists of a horizontal bar on a sheet of paper with markers at zero ("no pain"), two ("low pain"), five ("moderate pain"), eight ("high pain"), and ten "intolerable pain").[71] Participants reported ratings verbally.

2.2.8. Pain Valence and Arousal Responses

Self-report emotional reaction responses to the heat pain tolerance task were assessed with a computerized version of the Self-Assessment Manikin (SAM).[72] The SAM yields current valence (unpleasant to pleasant) and arousal (calm to aroused) scores that range from 1 to 9. Higher scores indicate the participant experienced greater pleasantness and arousal. Participants responded by clicking on any of the nine pictographs individually for each of the 2 dimensions. The SAM provides a valid and reliable measure to assess emotional responses to the manipulation of affect from noxious stimuli administered in the laboratory.[73,74]

2.2.9. Pain Rating Training

Prior to any pain assessment, participants were trained to make pain ratings until confident with their own ability. As part of training, participants practiced making VAS and SAM ratings to practice heat stimuli.

2.2.10. Heat Tasks

Heat stimuli were administered using a Medoc Pathway device with either a Contact Heat Evoked Potential Stimulator thermode with a 27mm diameter that covered an area of $572.5mm^2$ for the Heat Pain Series Task or a 30x30mm Advanced Thermal Stimulator thermode for the heat pain threshold/tolerance task (Medoc Ltd, Ramat Yishai, Israel). The maximum intensity of any heat stimulus was set to 51°C.

2.2.10.1. Heat Acclimation Task

Participants were presented with 12 heat pulses at a low peak temperature of 42ºC and a baseline of 30ºC on six sites along the volar surface of their non-dominant forearm. Each pulse had a duration of two seconds at peak temperature with a ramp rate of 70ºC/s and a cooling rating of 40ºC/s. Inter-trial intervals (ITI) between heat pulses ranged from 25-30 seconds. Participants' volar forearm was divided into a grid consisting of six separate sites for thermode application. Participants were presented with heat pulses to each site in a semi-random order that avoided stimulation of adjacent sites. Each site was tested once using a randomized sequence, then a second time following the same sequence for a total of two pulses per site. When cued by the experimenter, participants reported the intensity of each heat pulse 7-10 seconds after the heat pulse returned to baseline. After making a VAS rating, the thermode was moved to the next site with 10-15 seconds before the onset of the next heat pulse. Participants were blinded to the temperature of the heat pulses.

2.2.10.2. Heat Pain Series Task

The average and range of intensity ratings for each site from the Heat Acclimation Task was calculated and used to determine each participant's four most similar sites of pain sensitivity. The four most similar sensitivity sites were then selected for the Heat Pain Series

Task. In instances where five or more sites had similar sensitivities, sites were chosen by the experimenter that most preserved a square pattern. Figure 2 illustrates the Heat Pain Series Task procedure used in the current study.

Adapting a methodology used by Atlas and colleagues (2010),[71] participants' experienced three distinct temperatures at 41ºC, 44ºC, and 47ºC to elicit low pain, moderate pain, and high pain, respectively. Using the participant's four equivalent sensitivity sites, each site received a semi-randomized sequence of four heat pulses at 41ºC. Succeeding that same site sequence, the participant then received four pulses at 44ºC, followed by four pulses at 47ºC for a total of 12 heat pulses. For this task, each pulse had a duration of five seconds with baseline temperature of 30ºC, a ramp rate of 70ºC, a cooling rate of 40ºC, and ITI's of 25-30 seconds. Similar to the first task, participants reported the intensity of each heat pulse 7-10 seconds after the heat pulse returned to baseline when prompted by the experimenter. After reporting a VAS rating, the thermode was moved to the next site with 10-15 seconds before the onset of the next heat pulse. Participants were blinded to the temperature of the heat pulses.

2.2.10.3. Heat Pain Threshold / Heat Pain Tolerance Task

Heat pain threshold and tolerance were assessed two times each on the participant's dominant volar forearm with an ascending method of limits. Each trial began at a baseline of 32°C and rose at a rate of .5°C/second. Participants were instructed to terminate the heat stimulus by clicking a button as soon as they first perceived the stimulus as painful (i.e., threshold) or when the heat became intolerable (i.e., tolerance). Participants reported their valence and arousal in response 7-10 seconds after each heat pain tolerance trial when prompted by the experimenter. The thermode was moved to an adjacent spot on the forearm after each trial to avoid sensitization. Heat pain threshold and tolerance temperatures were defined as the average of the two respective threshold and trials, while valence and arousal to the tolerance task were defined as the average of the ratings to the two tolerance task trials.

2.2.11. Data Analysis

Prior to analyses, data were screened for accuracy and missing values. When values were missing due to equipment malfunction, pairwise deletion was used to exclude participants from those particular analyses.[81] Differences in continuous variables were examined with *F* tests, while categorical data were examined using χ^2 tests. Significance was set at $\alpha < .05$ (two-tailed). Partial eta squared (η^2_p) was used as a measure of effect size for *F* tests of mean differences, with values of 0.009, 0.0588, and 0.1379 corresponding to small, medium, and large effect sizes, respectively.[82,83] SPSS 23.0 (IBM; Armonk, NY) was used for all analyses.

2.2.11.1. Background Characteristics

Though not significant ($p = .058$), preliminary χ^2 analyses determined that group imbalances existed for gender, with the Hispanic group possessing more women. Consequently, to study group differences in background psychosocial factors, a new independent variable was formed that incorporated for ethnicity and gender within the one variable (i.e., an amalgam variable that coded for non-Hispanic White men, non-Hispanic White women, Hispanic men, and Hispanic women). *F* tests and χ^2 analyses used the new independent variable to explore group differences for participant characteristics. Significance level for group differences in background characteristics were set at $\alpha < .05$ (2 tailed).

2.2.11.2. Covariates

While the current study examined healthy participants, the presence of confounding factors that relate to positive impression management and pain sensitivity are still likely. It was expected that any effects in the current study would not be explained by factors outside of the study's purpose that have been shown to contribute to the experience of pain. Given this goal and the pre-existing group differences for depressive and anxiety symptoms (see Table 6), CES-D and BAI scores were included in all primary analyses related to pain sensitivity and social desirability bias as covariates.

2.2.11.3. Primary Analyses

A series of analyses were used to address the current study's first objective of examining whether Hispanic individuals demonstrate significantly greater sensitivity to suprathreshold nociceptive stimuli relative to non-Hispanic White individuals:

1) a three-way ethnicity (between: 2 levels) X gender (between: 2 levels) X averaged heat pulse pain ratings (within: 3 levels) repeated measures analysis of co-variance (RM-ANCOVA) for the Heat Pain Series Task;
2) 2) a two-way ethnicity (between: 2 levels) X gender (between: 2 levels) ANCOVA was used for the heat pain sensitivity range score[50,125,126] (i.e., heat pain tolerance temperature minus threshold temperature difference scores);
3) 3) two separate two-way ethnicity (between: 2 levels) X gender (between: 2 levels) ANCOVAs were used for SAM valence and arousal ratings to the heat pain tolerance task;

To address the study's second objective of exploring whether a positive response bias in Hispanics may impact the observed self-report pain sensitivity ratings, follow-up analyses were conducted:

1) a two-way ethnicity (between: 2 levels) X gender (between: 2 levels) ANCOVA was used to assess the presence of a social desirability bias using PIM *T* scores;

2) a three-way ethnicity (between: 2 levels) X gender (between: 2 levels) X averaged heat pulse pain ratings (within: 2 levels) RM-ANCOVA for the Heat Pain Series Task, controlling for averaged pain ratings to the low intensity (i.e., 41ºC) heat pulses;

3) a two-way ethnicity (between) X gender (between) X heat pain averaged threshold/tolerance temperatures (within: 2 levels) RM-ANCOVA.

2.3. Results

2.3.1. Background Characteristics

Though not significant, the χ^2 analysis indicated that groups were off balance by gender, $\chi^2 = 3.58$, $p = .058$. Sixty-two percent of the Hispanic group were women, whereas only 44% of the non-Hispanic White group were women. Therefore, all unadjusted background psychosocial characteristic analyses utilized a 4-level independent variable that coded for ethnicity and gender. Inferential statistics, as well as the means and standard deviations (SDs), or percent, for these analyses are reported in Table 6. As shown, groups were comparable on most variables except for depressive ($p = .018$) and anxiety symptoms ($p = .009$).

2.3.2. Ethnic and Gender Differences for Heat Pain Ratings, Tolerance, and Affective Responses

The left panel of Figure 3 depicts pain intensity ratings to the Heat Pain Series task by ethnicity (A) and gender (C). Analyses for pain intensity revealed a significant main effect of temperature, $F_{2,218} = 103.14$, $p < .001$, $\eta^2_p = .486$, as well as a significant temperature X ethnicity interaction, $F_{2,218} = 10.06$, $p < .001$, $\eta^2_p = .084$, but no temperature X gender interaction, $F_{2,218} = .84$, $p = .435$, $\eta^2_p = .008$. Post hoc mean comparisons for the temperature X ethnicity interaction revealed that Hispanic individuals reported greater pain intensity ratings at 47ºC, $F_{1,109} = 4.85$, $p = .03$, $\eta^2_p = .043$.

The left panel of Figure 4 depicts heat pain sensitivity range to the tolerance task by ethnicity (A) and gender (C). Analyses for heat pain sensitivity range revealed a significant main effect of ethnicity, $F_{1,109} = 4.54$, $p = .035$, $\eta^2_p = .040$, and gender, $F_{1,109} = 6.35$, $p = .013$, $\eta^2_p = .055$, with Hispanics and women demonstrating lower heat pain tolerance ranges relative to their respective counterparts.

Figure 5 depicts affective responses to the heat pain tolerance task by ethnicity (A) and gender (C). Analyses for SAM valence revealed a significant main effect of ethnicity, $F_{1,109} = 4.85$, $p = .030$, $\eta^2_p = .043$, but not gender, $F_{1,109} = .24$, $p = .624$, $\eta^2_p = .002$, with Hispanics reporting lower valence in response to the heat pain tolerance task relative to non-Hispanic Whites. Analyses for SAM arousal revealed a significant main effect of ethnicity, $F_{1,109} = 8.15$, $p = .005$, $\eta^2_p = .070$, and gender, $F_{1,109} = 4.52$, $p = .036$, $\eta^2_p = .040$, with Hispanics demonstrating greater affective arousal relative to their respective non-Hispanic Whites, while women demonstrated lower arousal responses relative to men.

2.3.3. The Presence of a Social Desirability Bias by Ethnicity and Gender

Analyses for social desirability using the PIM scale revealed a significant main effect of ethnicity, $F_{1,109} = 4.16$, $p = .044$, $\eta^2_p = .037$, but no effect of gender, $F_{1,109} =.00$, $p = .993$, $\eta^2_p = .000$. Hispanics presented with significantly greater PIM T scores ($M = 70.47$, $SD = 9.95$) relative to non-Hispanic Whites ($M = 66.71$, $SD = 9.72$).

2.3.4. The Presence of a Pain Response Bias by Ethnicity and Gender

To examine the impact of response bias on pain ratings, analyses for the Heat Pain Series Task were conducted using a two-way factorial repeated measures ANCOVA with ethnicity and gender as the independent variables and averaged pain intensity ratings to the 41ºC stimuli as an added covariate (Fig. 4, B and D). Averaged pain intensity ratings to the 41ºC stimuli were a significant covariate in the model, $F_{1,108}$ =222.36, p < .001, η^2_p = .673, suggesting that pain intensity ratings to low intensity thermal stimuli were significantly related to pain intensity ratings to the moderate and high intensity stimuli. Analyses continued to reveal a significant main effect of temperature, $F_{1,108}$ =53.11, p < .001, η^2_p = .330. While there was no temperature X ethnicity interaction, $F_{1,108}$ =.48, p = .489, η^2_p = .004, there was a significant main effect of ethnicity, $F_{1,108}$ =16.61, p < .001, η^2_p = .133, such that Hispanics reported greater pain relative to non-Hispanics Whites at the 44ºC and 47ºC stimuli. When gender was added as a covariate in the model (p = .571), the main effect of ethnicity remained (p < .001, η^2_p = .133).

Analyses to examine the presence of a pain response bias for heat pain threshold and tolerance tasks (Fig. 5, B and D) revealed a significant main effect of task, $F_{1,109}$ = 122.36, p < .001, η^2_p = .529, as well as a significant temperature X ethnicity interaction, $F_{1,109}$ = 4.54, p = .035, η^2_p = .040, and temperature X gender interaction, $F_{1,109}$ = 6.35, p = .013, η^2_p = .055. Post hoc mean comparisons for the temperature X ethnicity interaction revealed that Hispanics reported greater thresholds – though not at the .05 level of significance –, $F_{1,109}$ = 3.07, p = .083, η^2_p = .027, but displayed no difference for tolerance temperature, $F_{1,109}$ =.15, p = .703, η^2_p = .001. Addition of gender as a covariate in the model (p = .113) did not significantly change the differences for threshold (p = .073, η^2_p = .029). Post hoc mean comparisons for the temperature X gender interaction revealed that women demonstrated lower tolerance temperatures, $F_{1,109}$ = 14.13, p < .001, η^2_p = .115, but exhibited no difference for heat pain threshold, $F_{1,109}$ =.01, p = .935, η^2_p = .00.

2.4. Discussion

To better address issues underlying pain assessment factors that may be contributing to clinical pain management disparities observed among Hispanic Americans, the current study had three hypotheses:

1) Hispanics would demonstrate significantly greater sensitivity to suprathreshold nociceptive heat stimuli relative to non-Hispanic White individuals,
2) Hispanics would present with a general social desirability bias, as well as a positive pain response bias, and
3) positive response biases in Hispanics would impact observed self-report pain sensitivity ratings.

Briefly, Hispanics displayed lower heat pain sensitivity range scores and reported greater pain intensity to high intensity heat pain stimuli. Second, Hispanics displayed evidence for a self-report and pain positive response bias. Finally, adjusting for a positive pain response bias contributed to greater pain ratings to moderate and high intensity heat pain stimuli.

2.4.1. Ethnic Differences in Suprathreshold Heat Pain Sensitivity

Heat pain sensitivity differences occurred between Hispanics and non-Hispanic Whites to suprathreshold laboratory heat pain stimuli. Hispanics rated higher on pain intensity to 47ºC thermal stimuli for the Heat Pain Series task which may reflect a heightened sensory experience to noxious stimuli.

Additionally, Hispanics reported greater affective unpleasantness and arousal in response to the heat pain tolerance task, as well as lower heat pain sensory range scores, which may reflect a heightened affective-motivational pain experience to noxious stimuli. However, inspection of tolerance temperatures in Figure 4 suggests that Hispanics did not display lower heat pain tolerance temperatures relative to non-Hispanic Whites, suggesting that affective, rather than motivational, factors in relation to pain may be impacted by ethnicity.

The ethnic differences in heat pain sensitivity to suprathreshold heat stimuli in the current study are consistent with a recent study examining laboratory pain sensitivity in a large cohort of participants identifying as healthy or having temporomandibular disorder.[47] Hispanics in that study reported greater pain intensity ratings to suprathreshold heat pulses relative to non-Hispanic Whites.[47] The smaller heat pain sensitivity range scores for Hispanics relative to non-Hispanic Whites in the current study is also consistent with a previous study comparing these two ethnic groups for laboratory heat pain sensitivity in healthy participants.[50] While these two studies observed significantly lower heat pain tolerances for Hispanics, a finding that is not replicated in the current sample, the current study did observe greater affective responses to the tolerance task. These two studies, as well as the current results, suggest that the experienced unpleasant or disturbing emotional responses, as well as strength of the emotional responses, to noxious stimuli may represent a potential risk factor for the increased pain severity experienced amongst Hispanics with clinical pain.

2.4.2. The Role of Positive Pain Response Bias

Positive response bias differences were also observed between Hispanics and non-Hispanic Whites on the Positive Impression Management scale of the Personality Assessment Inventory. This finding is consistent with previous research observing higher self-report indicators of socially desirable responding among Hispanics relative to non-Hispanic Whites.[106,107,110] Notably, one study assessing social desirability across a number of indicators in healthy Hispanics examined within the same university setting as the current study concluded that differences were not related to psychopathology, intentional faking, or lack of insight, but rather a reflection of normative cultural differences between Hispanics and non-Hispanic Whites in social presentation.[106]

In addition to the observed socially desirable response bias, positive pain response bias differences were also observed between Hispanics and non-Hispanic Whites on laboratory heat stimuli. Specifically, an identical pattern of significant temperature X ethnicity interactions were observed for both heat pain sensitivity tasks: Hispanics reported lower pain sensitivity to the less intense heat stimuli, and the pattern flipped as suprathreshold heat stimuli were presented. The reported pain minimization findings in the current study align with a number of studies assessing the impact of culture on Hispanic clinical pain.[9,111–113] One particular qualitative study of the Hispanic pain experience by Sherwood and colleagues (2003) observed themes regarding beliefs and expectations about pain that differed from pain responses.[112] Specifically, respondents in this study expressed beliefs and expectations toward pain including the belief that pain could be tolerated if it was temporary and that pain was an experience one had to deal with, ignore, or get used to.[112] Responses to pain, in contrast, included negative emotional expressions and behaviors including crying and sadness. These beliefs or expectations expressed by the Hispanics in the study by Sherwood and colleagues (2003) such as "dealing with" or "ignoring" the pain may reflect pain coping strategies that could be adaptive to low intensity noxious stimuli, but maladaptive to moderate or high intensity noxious stimuli. These maladaptive coping strategies manifested as greater perceived pain intensity and heightened negative emotional expressions, as demonstrated by the contrasting pain responses (e.g., crying, sadness) respondents demonstrated that study, or the greater affective responses observed in the current study. However, to test this maladaptive coping hypothesis, future studies are needed to assess whether ethnic differences in pain coping and expectations could contribute to heighted reported pain experiences to high intensity noxious events in Hispanics.

2.4.3. Clinical Implications for Hispanic American Clinical Pain Management

Previous research finds common pain beliefs for Hispanics include that pain is predetermined, pain is a necessary part of life, pain should be tolerated with stoicism, and there is value in not letting pain problems interfere with relationships.[9,111–113] Patients may possess any number of unintentional reasons for minimizing their true experience including not wanting to be judged[127] or beliefs that are culturally derived (e.g., stoicism, machismo, simpatía). Regardless of the social or cultural influence driving these beliefs, a minimization to disclose pain severity to examiners may undermine patient care. This may be particularly problematic if untreated acute pain could be prevented from later transitioning to chronic pain or disability.

Given past literature and current findings, the patient-provider relationship may be a noteworthy target of study and intervention. Additional resources directed towards better addressing the nature of pain assessment or treatment for patients could reduce potential social desirability bias and improve patient-provider relations. Improving patient-provider relations may also address the disproportionately lower rates of medical consultation for pain observed amongst Hispanics.[11,17,92,128]

2.4.4. Gender Differences in Suprathreshold Heat Pain Sensitivity

The current study observed mixed effects of gender for heat pain sensitivity scores across the measures. For example, women demonstrated lower heat pain sensitivity range scores relative to men, a pattern similar to the one observed for Hispanics relative to non-Hispanic Whites. However, whereas Hispanics demonstrated no differences in heat pain tolerance, but reported greater valence and arousal in response to the task relative to non-Hispanic White individuals, women tolerated heat pain less than men and reported lower affective arousal, but no difference in valence. The lower arousal and lack of a valence difference in response to the heat pain tolerance task may be due to gender differences in tolerance duration and not to lower affective reactivity to noxious stimuli. Specifically, since men tolerated significantly greater temperatures to the tolerance, men experienced a more intense - and potentially more unpleasant and arousing - noxious stimulus. Therefore, the gender differences in heat pain tolerance observed in the current study may reflect a potential risk factor for the greater perceived pain experienced for women.

The lower tolerance durations observed for women in the current study is consistent with a large body of literature observing gender differences for laboratory pain sensitivity[47,114–118] as well as clinical pain severity.[114,119]

Limitations

Limitations should be considered when interpreting or generalizing the current study's findings. First, the study was comprised of healthy, pain-free individuals. The use of healthy participants helps to ensure that observed group differences in pain sensitivity are not attributable to confounding factors such as medication use or disease status. While this limits generalizability, a recent study observed similar ethnic differences in heat pain sensitivity to suprathreshold heat in a large cohort of participants identifying as healthy or having temporomandibular disorder.[47] Future research could expand on these collective works by examining if ethnic differences in laboratory pain sensitivity generalizes to a fully clinical sample.

Second, all participants were U.S. college students, so these results may not generalize to a community sample or older individuals. Furthermore, given the observed impact of stereotype threat on ethnic minority university students,[129,130] Hispanic students in a largely non-Hispanic White university environment may be especially inclined to portray themselves in a favorable self-image. Therefore, future research should examine the presence of a social desirability pain response bias Hispanics in both clinical and community samples.

Finally, while all participants in the current analyses completed the same procedures and breaks were provided throughout, participants completed several sensory tasks. Consequently, the possibility of carryover effects may have affected the results of the current study. Therefore, replication is warranted.

2.4.5. Conclusions

Hispanics experienced greater sensitivity to laboratory heat pain relative to non-Hispanics Whites. Hispanics also displayed greater social desirability response biases. When controlling for pain report biases, ethnic sensory pain differences substantially increased. These results suggest that Hispanics may particularly benefit from addressing positive response biases in clinical settings to better assess pain and ultimately improve patient pain outcomes.

3. SOCIAL STATUS IS LINKED TO GREATER MECHANICAL TEMPORAL SUMMATION IN HISPANIC AMERICANS

3.1. Introduction

Hispanic Americans[1] experience disproportionate health inequalities for numerous health conditions,[131–133] including pain.[9–17] Lower socioeconomic status is proposed to contribute to the greater chronic pain rates observed in Hispanics.[17] However, the mechanisms underlying how social status contributes to later pain risk for Hispanics is relatively unknown. Therefore, the current study examined the relationship between social status markers and endogenous pain facilitatory processes for Hispanic and non-Hispanic White adults.

A growing body of literature finds that social determinants of health, including subjective social status, can adversely impact physical health.[61,134–136] Subjective social status refers to one's perceived standing in a social status hierarchy and therefore reflects appraisals of one's social position relative to others based on factors including income, education, and occupation.[61,134,137] Subjective social status is not only associated with poorer physical health when adjusting for objective status[134,135,138] but also uniquely predicts physical symptomatology,[139] potentially due to the range of factors subjective social status encapsulates (e.g., income, psychological well-being, relative social status) while remaining parsimonious.[139,140] Notably, the relationship between subjective social status and health generalizes across demographic groups, including Hispanic Americans.[141–143] For pain, objective[17,23–30] and subjective social status[144] is related to greater rates and severity of chronic pain, as well as worse pain outcomes.[17,23–27] This relationship between social standing and chronic pain risk may be particularly problematic for demographic groups who disproportionately fall into lower socioeconomic strata, such as Hispanic Americans.[17] However, it is unclear by what mechanism socioeconomic status contributes to pain risk development. One pain risk mechanism that may be adversely impacted by lower socioeconomic status is central sensitization.

Several disrupted endogenous pain mechanisms are implicated in greater risk for chronic pain, including – but not limited to - heightened nociceptive input, reduced descending pain inhibition, and/or enhanced central sensitization. Central sensitization is a phenomenon characterized by an amplification of neural signaling within the central nervous system that elicits pain hypersensitivity.[86,145–151] This hyperexcitability of nociceptive neurons can be brought on by repeated nociceptive afferent stimulation at a consistent rate of $\leq$ 3 secs.[152,153] A non-invasive proxy measure of central sensitization in humans is temporal summation of pain, a progressive increase in pain intensity ratings to repetitive noxious stimuli.[42] Temporal summation of pain is heightened in individuals with chronic pain,[85,86] providing a potential mechanism underlying the risk for clinical pain development and persistence. Adverse life experience that are often associated with low social status, such as physical, sexual, or emotional trauma, are not only linked to heightened temporal pain summation,[154,155] but also increased risk for the development of numerous clinical pain disorders.[33–38] Moreover, demographic groups who disproportionately fall into lower socioeconomic strata such as African Americans with clinical pain[17] demonstrate enhanced temporal summation relative to non-Hispanic White counterparts.[39–41] Enhanced summation also generalizes to non-clinical, healthy African-Americans,[45,46] suggesting that the risk for greater pain severity may even manifest prior to the development of clinical pain. Accordingly, heightened temporal summation in healthy Hispanic Americans may suggest that amplified central pain processing may be a key factor contributing to the greater chronic pain severity seen in clinical Hispanic population.[11–17]

Therefore, the present study examined the relationship between social status and temporal pain summation in pain-free Hispanic and non-Hispanic White Americans. Given evidence for greater clinical pain severity in Hispanics[11–17] and greater temporal summation in demographic groups who disproportionately fall into lower socioeconomic strata (i.e., African-Americans),[39–41,45,46] the following hypotheses were tested:

1. Hispanics will present with lower social status markers compared with non-Hispanic Whites,
2. Hispanics will demonstrate significantly greater temporal pain summation relative to non-Hispanic Whites,
3. Social status markers, particularly subjective social status, will be significantly related to mechanical temporal summation of pain, especially among Hispanics, and
4. Social status markers will mediate the relationship between ethnicity and mechanical temporal summation.

3.2. Methods

This study was approved by the Institutional Review Board at Texas A&M University and informed consent was obtained from all participants. Participants were recruited between January 2018 and May 2019.

3.2.1. Participants

Data for this study was derived from a larger study examining ethnic differences in laboratory pain sensitivity. Participants were invited to the laboratory based on their self-reported ethnicity. To control for nativity/migration status, only participants reporting being born and raised in the U.S. were invited to participate.[57] To determine if enhanced sensitization occurs prior to the onset of clinical pain and to rule out that disease status explains any group differences, healthy, pain-free undergraduate students enrolled in a psychology course between the ages of 18 and 40 were recruited for the study and received course credit for their participation. To control for any additional confounds beyond the study's objectives that that could impact laboratory pain sensitivity, exclusionary criteria included: a) current use of any prescription drugs (with the exception of hormonal contraceptives), b) history of fainting spells, c) any skin condition/numbness on the hands or forearms, d) history of neurological disorders, e) current chronic pain or health condition, and f) use of allergy or pain medication within 24 hours prior to the experiment. A total of 116 participants are in the current study.

3.2.2. Sample Size Calculation

A power analysis using G*Power version 3.1 (Franz Faul, Universitat Kiel, Germany; http://www.gpower.hhu.de/) was used to estimate the needed sample sizes. Based on meta-analysis examining racial and ethnic differences in experimental pain sensitivity, a medium effect was expected in comparing ethnicity groups.[120] In estimating with a medium effect (f = 0.25), 80% power, $\alpha = .05$, with two groups and two number of measurements (i.e., 180g, 300g) for a within-between interaction, the required sample size is a total of 34 participants while only a between factors effect would require a total sample size of 98 participants. Thus, the collected sample size provided satisfactory power to detect an effect.

3.2.3. Overview of Procedures

Laboratory procedures occurred during a single session lasting approximately 5 hours. Participants were pre-screened for inclusion/exclusion criteria prior to being invited to the laboratory, and again on the day of testing. If eligible, participants then filled out several questionnaires to assess background characteristics. Participants then completed a number of physical sensory tests assessing threshold, tolerance, and pain ratings to several physical modalities (e.g., heat, cold, mechanical). Each task occurred with at least a 2-minute rest between each task to reduce carryover effects. Prior to the Mechanical Temporal Summation Task, participants completed two heat sensory tests on the contralateral, non-dominant side of their body.

3.2.4. Laboratory Testing Setup

Presentation software (Neurobehavioral Systems, Inc., Berkeley, California, U.S.) was used to direct the experimental protocol for the larger study, while Qualtrics (Qualtrics International Inc., Provo, Utah, U.S.) was used to administer questionnaires). All laboratory procedures were implemented with participants in a temperature controlled, sound-attenuated experiment room. When not in the experimenter room, experimenters monitored procedures from an adjacent control room via a video camera connected to an additional monitor.

3.2.5. Participant Characteristics Questionnaires

3.2.5.1. Demographic Data

To characterize the sample, participants provided demographic information and health status to assess background information about their childhood and present experiences, including age, sex, education level, employment, and income.

3.2.5.2. Mood

The Center for Epidemiologic Studies Depression Scale (CES-D) was administered to assess current depressive symptoms over the past week (higher scores indicate greater depressive symptoms).[67] The Perceived Stress Scale (PSS) was administered to assess perceived stress over the past month (higher scores indicate greater perceived stress).[68]

3.2.5.3. Early Life Trauma

The Early Traumatic Inventory Self-Report (ETISR) was administered to assess traumatic life events before age 18 years. The ETISR is a 27-item questionnaire to assess traumatic life events in four domains: general, physical, emotional, and sexual trauma.[58]

3.2.5.4. Subjective Social Status

Childhood[59,60] and adult Subjective Social Status was measured using the U.S. version of the MacArthur Scale of Subjective Social Status.[61] To measure childhood subjective social status, participants were asked to indicate their parent's social status during childhood (i.e., 0-12 years old) on an illustration of a nine step ladder in which the top rung represents those with the most education, money, and respected jobs, while the bottom rung of the ladder represents those with the least education, money, and respected jobs. Scores range from 1 (lowest status) to 9 (highest status). Participants also indicated their current subjective social status using the same measure. Change in subjective social status across the lifespan was also calculated by subtracting childhood subjective social status from current subjective social status, with more positive numbers indicating greater increases in subjective social status across the lifespan. Subjective social status is significantly correlated with objective indicators of socioeconomic status such as education history, income, and employment status.[134] Furthermore, subjective social status ladders have been employed in several studies with ethnically diverse participants, including Hispanics.[141,156–158]

3.2.6. Mechanical Temporal Summation

As depicted in Figure 6, a Mechanical Temporal Summation Task (MTS) was used to assess summation of pain ratings to mechanical stimuli. Temporal summation refers to the increase in perceived pain from either C or Aδ fiber stimulation by repetitive, constant-intensity, noxious stimuli delivered at frequencies greater than .33 Hz.[159] To assess temporal summation of mechanical pain, participants were presented with a series of mechanical stimuli at 180g and 300g of pressure. Using calibrated nylon monofilaments designed to deliver a consistent gram force upon the filament's bend, participants were assessed on three locations across the participants dominant side: the dorsal surface of the third digit's (i.e., middle finger) intermediate phalanx, the dorsal surface of the second digit's (i.e., index finger) metacarpal, and the upper trapezius muscle. Participants were first assessed for initial pain after receiving a single contact and verbally rating the intensity of the pain from the single contact on a scale ranging from 0 ("no pain") to 100 (the most intense pain imaginable") scale. Participants then received a series of ten additional contacts at a rate of one contact per second at the same body site. Upon completion of the ten contacts, participants then rated the peak or greatest pain intensity experienced during the ten contacts. This single and 10 contacts procedure occurred twice on each anatomical site for both the 180g and 300g monofilaments. Temporal summation at each site was calculated by averaging the initial and peak pain responses across the two trials at each site then subtracting pain intensity ratings of the single contact from the peak pain intensity. Total temporal summation was calculated by subtracting averaged initial pain intensity ratings from averaged peak pain intensity ratings. [40,46,160] The order of testing across the three anatomical sites were randomized per individual.

Prior to any pain assessment, participants were trained to make pain intensity ratings until confident with their own ability.

3.2.7. Data Analysis

Prior to analyses, data were screened for accuracy and missing values. When values were missing due to equipment malfunction, pairwise deletion was used to exclude participants from those particular analyses.[81] Differences in continuous variables were examined with *t* or *F* tests, while categorical data were examined using chi-square (χ^2) analyses. Significance was set at $\alpha < .05$ (2-tailed). Partial eta squared (η^2_p) was used as a measure of effect size for *F* tests of mean differences, with values of 0.009, 0.0588, and 0.1379 corresponding to small, medium, and large effect sizes, respectively.[82,83] Cohen's d was used as a measure of effect size for *t* tests, with values of 0.2, 0.5, and 0.8 corresponding to small, medium, and large effect sizes, respectively.[83] SPSS 23.0 (IBM; Armonk, NY) was used for all analyses.

3.2.7.1. Primary Analyses

A series of analyses were used to address the current study's first hypothesis that Hispanics demonstrate significantly greater temporal summation of mechanical pain relative to non-Hispanic White individuals: Paired samples *t* tests compared the averaged pain rating following a single contact to the averaged maximal pain rating following ten contacts were used to evaluate whether significant temporal summation occurred at each site for the 180g and 300g filaments, collapsed across ethnicity. A two-way ethnicity (between: non-Hispanic White, Hispanic) X total body temporal summation scores for von Frey weights (within: 180g, 300g) repeated measures Analysis of Co-Variances (RM-ANCOVA) was used to evaluate ethnic differences in temporal summation (i.e., averaged total body peak pain minus averaged initial total body pain difference scores).

To address the study's second hypothesis that Hispanics would present with lower objective socioeconomic status and subjective social status compared with non-Hispanic Whites: separate two-way ethnicity X gender ANCOVAs were used for measures of objective and subjective status.

To address the study's third hypothesis that social status markers would be associated with mechanical temporal summation of pain, particularly among Hispanics: Pearson correlations were used to assess zero order associations among the current study's variables separately for Hispanic and non-Hispanic Whites.

To address the study's fourth hypothesis that social status markers would mediate the relationship between ethnicity and mechanical temporal summation: Model number 4 of the PROCESS macro (version 3.0)[161] was used for mediation analyses. To test significance, bootstrapped confidence intervals (CI) were generated from repeated resampling (5,000 samples) of the observed data. Mediation was considered statistically significant when the 95% CI did not span zero.[161]

3.3. Results

3.3.1. Participant Characteristics

Table 7 displays demographic, socioeconomic, and early life trauma experience characteristics separately for Hispanics and non-Hispanic Whites. Although more women than men participated in this study, the distribution of men and women across the two ethnic groups did not statistically differ, $\chi^2 = 3.74$, $p = .053$. Hispanics also did not differ in age ($p = .132$, $\eta^2_p = .020$), depressive symptoms ($p = .381$, $\eta^2_p = .007$), or perceived stress ($p = .752$, $\eta^2_p = .001$).

Hispanics reported greater experiences of total trauma ($p = .027$, $\eta^2_p = .042$) that appeared to be driven by emotionally ($p = .013$, $\eta^2_p = .053$) and sexually ($p = .017$, $\eta^2_p = .05$) traumatic experiences.

With regards to markers of socioeconomic status during childhood, a number of participants reported not knowing their household income or did not respond to questions regarding income. Of those who did report, Hispanics reported having lower household income,

$\chi^2 = 26.64$, $p = .014$. Furthermore, Hispanics also reported having lower father's education level, $\chi^2 = 27.38$, $p < .001$, mother's education levels, $\chi^2 = 31.31$, $p < .001$, and childhood subjective social status in the U.S., $\chi^2 = 32.72$, $p < .001$, relative to non-Hispanics whites.

Regarding indicators of current socioeconomic status, Hispanics continued to report lower household income, $\chi^2 = 26.64$, $p = .014$. Although Hispanics did not report having lower current subjective social status within the broader U.S., $\chi^2 = 12.95$, $p = .073$, Hispanics did present with greater increases in subjective social status within the U.S. from childhood to present day relative to non-Hispanic Whites, $\chi^2 = 19.36$, $p = .022$.

These participant characteristics results suggest that while 1) there are no mood differences at baseline between ethnic groups, 2) Hispanics generally experience lower levels of socioeconomic status and traumatic experiences.

3.3.2. Ethnic Differences in Temporal Summation of Mechanical Pain

Table 8 displays pain ratings to mechanical stimuli collapsed across ethnicity. Paired samples *t* tests revealed that averaged pain intensity ratings following the tenth contact with the mechanical stimulus was significantly greater than averaged pain intensity ratings following the first contact when assessed at the third digit's intermediate phalanx, the second digit's metacarpal, and the upper trapezius muscle for both the 180g and 300g von Frey stimuli.

Figure 7 depicts temporal pain summation between Hispanic and non-Hispanic White individuals across the 180g and 300g weights. Analyses revealed significant main effects of von Frey weight, $F_{1,114} = 21.29$, $p < .001$, $\eta^2_p = .157$, and ethnicity, $F_{1,114} = 4.49$, $p = .036$, $\eta^2_p = .038$, but no weight X ethnicity interaction, ($p = .404$, $\eta^2_p = .006$). However, exploratory post hoc mean comparisons indicated a statistically significant difference of MTS at the 300g weight, $F_{1,114} = 4.88$, $p = .029$, $\eta^2_p = .041$, but not at the 180g weight, $F_{1,114} = 3.28$, $p = .037$, $\eta^2_p = .028$.

Taken together, these results suggest that 1) mechanical temporal summation occurs at moderate and high intensity stimuli, 2) the temporal summation phenomenon increases as a function of von Frey intensity, and 3) Hispanics experience greater temporal summation relative to non-Hispanic White individuals at higher intensity stimuli.

3.3.3. Correlations Between Background Characteristics and Mechanical Temporal Summation

To reduce redundancy of highly similar constructs and phenomenon, new indices were created including average parental education (i.e., mother and father) and average total mechanical temporal summation (i.e., 180g and 300g).

Table 9 displays two correlation matrices separated by ethnicity including new mechanical temporal summation and background characteristic indices. Neither of the four trauma subscales, nor the trauma composite score, were significantly associated with temporal summation for either ethnicity group. Moreover, none of the markers of objective socioeconomic status (e.g., income, average parental education) from childhood or present day were significantly associated with mechanical temporal summation for Hispanic or non-Hispanic White individuals. Regarding subjective social status markers, current subjective social status also was not correlated with mechanical temporal summation for either ethnic groups. While childhood subjective social status was positively correlated with average total temporal summation within the Hispanic group, it did not reach statistical significance ($p = .06$). However, change in subjective social status across the lifespan was significantly and inversely correlated with average total mechanical temporal summation for Hispanics ($r = -.33$, $p = .008$).

These correlations suggest that increases in subjective social status across the lifespan are associated with reduced mechanical temporal summation for Hispanics. Furthermore, neither objective markers of social status nor frequency of traumatic experiences are related with mechanical temporal summation for either ethnic group.

3.3.4. Subjective Social Status Indices Mediate the Relationship Between Ethnicity and Mechanical Temporal Summation

Guided by significant correlations with average total temporal summation (Table 9), change in subjective social status across the lifespan was used as a potential mediator in subsequent mediation. As depicted in Figure 8, bootstrapping mediation analyses revealed that change in subjective social status across the lifespan (indirect = -2.066, SE = 0.896, 95 % CI [-3.943, -0.424]) significantly mediate observed associations between ethnicity and average total mechanical temporal summation. When the model was tested again with the mediation and criterion variables reversed such that temporal summation predicted change in subjective social status, the mediation results were no longer significant (95% confidence intervals crossed zero).

Although childhood subjective social status was not significantly correlated with total temporal summation ($r = .24$, $p = .06$), childhood subjective social status was tested as a potential mediator. However, childhood subjective social status was not considered a significant mediator (95% confidence intervals crossed zero).

3.4. Discussion

Hispanic Americans[1] experience disproportionate socioeconomic and clinical pain inequalities.[9–17] Since social determinants of health are proposed to contribute to the greater chronic pain rates observed in Hispanics,[17] the current study tested the following hypotheses:

1) Hispanics would present with lower objective socioeconomic status and subjective social status compared with non-Hispanic Whites,

2) Hispanics would demonstrate significantly greater temporal pain summation relative to non-Hispanic Whites;
3) Both subjective and objective social status markers would be significantly related to mechanical temporal summation of pain, especially among Hispanics, and
4) Subjective social status and objective socioeconomic status would mediate the relationship between ethnicity and mechanical temporal summation.

As hypothesized, Hispanics generally displayed lower subjective and objective socioeconomic status markers and greater mechanical temporal summation relative to non-Hispanic Whites. However, only subjective, but not objective, social status indices were related to mechanical temporal summation in Hispanics; no associations were displayed in non-Hispanic Whites. Finally, changes in subjective social status across the lifespan significantly mediated observed associations between ethnicity and general mechanical temporal summation.

3.4.1. Ethnic Differences in Mechanical Temporal Summation of Pain

Hispanics displayed greater temporal summation for the 300g von Frey relative to non-Hispanic Whites. While temporal summation of pain is only a proxy and not analogous to central sensitization, both phenomena are amino acid N-Methyl-D-aspartate dependent[162–167] and increase with repetitive nociceptive stimulation. Thus, the heightened temporal summation in Hispanics may reflect a heightened central sensitization. While temporal summation of pain ratings to noxious stimuli is considered normative for most, temporal summation is greater in individuals with chronic pain,[85,86] providing a potential mechanism underlying the greater risk for clinical pain severity seen in Hispanics.

The greater mechanical temporal summation for Hispanics in the current study is consistent with a recent study examining laboratory pain sensitivity in a large combined cohort of participants identifying as either healthy or having temporomandibular disorder.[47] In that study, Hispanics displayed greater mechanical temporal summation relative to non-Hispanic Whites.[47] The greater summation in the current study also aligns with enhanced summation in other demographic groups who disproportionately fall into lower socioeconomic strata. Indeed, numerous studies of African Americans with clinical pain[39–41] demonstrate enhanced temporal summation relative to non-Hispanic Whites. Enhanced temporal summation of pain evidenced in African-Americans also generalizes to non-clinical, healthy populations,[45,46] suggesting that the risk for greater pain severity may manifest prior to the development of clinical pain. Given evidence supporting the clinical relevance of dynamic measures of laboratory pain sensitivity,[40,168–170] these collective findings suggest that greater pain summation may represent a potential risk factor for demographic groups who disproportionately fall into lower socioeconomic strata, such as Hispanic Americans.

3.4.2. The Role of Subjective Social Status in Ethnic Differences for Mechanical Temporal Summation of Pain

Interestingly, the current study found that not all markers of socioeconomic status are related to ethnic differences in temporal summation. While Hispanics in the current study reported lower objective markers of socioeconomic status, correlations revealed that none of the traditional objective markers were related with mechanical temporal summation. Only change in subjective social status was significantly associated with temporal summation and only for Hispanics. This suggests that subjective social status indices may be of interest when characterizing social status in Hispanics.

It is noteworthy, however, that greater childhood subjective social status in the current study appears to be associated with greater temporal summation (though not significantly, $p =$

.06), whereas decreases in subjective social status across the lifespan were associated with greater temporal summation (p = .008). A possible explanation for this contrasting result may be that childhood subjective social status and subjective social status across the lifespan are two different constructs. Specifically, whereas childhood subjective social status measures just that, change in subjective social status across the lifespan reflects a shift in social status from childhood to present day, better representing a subjective social mobility construct. This change in subjective social status across the lifespan, or subjective social mobility, may represent a shift made by individuals from one level of social status to another within a given social hierarchy.[171] In a study of Hispanics using a similar measure of subjective social mobility, adolescents with stable or downward subjective mobility were more likely to report participating in a number of health risk behaviors (e.g., alcohol consumption, physical fighting),[171] whereas upward mobility was associated with health promoting behaviors. Likewise, intra- and inter-generational downward social mobility among adults using objective social status measures is related to greater cardiovascular risk,[172–174] poorer self-reported health,[175] and chronic pain.[28] Therefore, improvements in social mobility may be a protective factor against poor health (e.g., heightened central sensitization) in healthy Hispanics, while downward mobility may represent a risk factor.

How then is there a positive relationship (p = .06) between childhood subjective social status and mechanical temporal summation in the current study? Of the few studies that have examined the relationship between early life social status and adult clinical pain, such studies have only examined objective status markers and have found mixed results.[28,176–178] One potential explanation for this positive association between temporal summation and childhood subjective social status could be attributable to differences in descending pain modulatory circuits across the social status continuum. While enhanced central sensitization is one mechanism connected to greater risk for chronic pain, the degree of central descending inhibition (i.e., brain-to-spinal cord) is another.[179,180] Since descending inhibition can dampen sensitization in the spinal cord, enhanced descending modulatory circuits may potentially be adaptive in the short-term. Thus, it is possible that while healthy Hispanics in the current study display greater temporal summation (i.e., central sensitization) relative to non-Hispanic Whites, Hispanics with lower childhood subjective social status may present with a simultaneous overactivation of descending inhibition in an attempt to dampen heightened central sensitization, manifesting as lower temporal summation relative to healthy Hispanics with higher childhood subjective social status. However, borrowing from Bruce McEwen's concept of allostasis,[181] an overactivation of endogenous inhibition in an attempt to dampen a heightened central sensitization may become overburdened and depleted in the long-term, resulting as allostatic load in the form of dysfunctional descending modulatory circuits, and ultimately an unchecked, amplified central sensitization. Review of the literature suggests no studies have examined descending inhibition in healthy Hispanics, let alone whether individuals with lower reported social status prior to clinical pain development demonstrate differences in descending inhibition. Therefore, given the relevance of descending inhibition for development of clinical pain,[179,180] future research is warranted to test these hypotheses.

3.4.3. Clinical Implications for Demographic Groups in Lower Socioeconomic Strata

The current study's findings have assessment and treatment implications for reducing risk for development of pain conditions with a central component. Given the greater summation observed in Hispanics, as well as the predictive utility of temporal summation for experiencing future pain,[40,170] efforts can be made towards utilizing psychological interventions for centralized pain[182] to potentially halt the development and/or treat the presence of chronic pain. The relationship between downward subjective social mobility and greater temporal summation also suggests that efforts to better assess childhood and current subjective social status may prove crucial for identifying individuals at greatest risk for chronic pain development.

Moreover, the use of "shift-and-persist" strategies to promote resilience has shown promise at buffering negative health effects of socioeconomic status[183,184] and thus may be useful for reducing centralized pain. Using previously validated procedures for manipulating current subjective social status,[185,186] future work could also begin by assessing whether changes in current subjective social status predict reductions in mechanical temporal summation.

3.4.4. Limitations

A few limitations should be noted when considering the findings of this study. First, this current study was carried out with pain-free participants to learn whether ethnic differences in pain processing occur that may underlie chronic pain risk. While this methodology allows testing group differences while ruling out variance due to disease status, it also limits the ability to know whether the findings generalize to Hispanics experiencing clinical pain. Furthermore, the use of participants from a university setting limits the range of socioeconomic status and therefore limits generalizability to populations who experience even lower socioeconomic status.

Second, while subjective social status across the lifespan was inversely associated with temporal summation, it may not be the only predictor. Since subjective social status encapsulates a range of factors related to socioeconomic position,[139,140] determining construct specificity presents a challenge. Future work could benefit from also measuring distress as a product of subjective social status that may be contributing to greater summation observed in Hispanics.

Finally, although the order of laboratory tasks prior to temporal summation testing was randomized, all participants completed the same procedures prior to the temporal summation task, and breaks were provided throughout, participants completed several sensory tasks. Therefore, it is possible that some carryover occurred, potentially moderating the results of the current study, and as such, replication is warranted.

3.4.5. Conclusions

Hispanics displayed greater mechanical temporal summation of pain that were related to levels of subjective social status. Given that social status markers are related to greater rates and severity of chronic pain,[17,23–30,144] as well as worse pain outcomes,[17,23–27] social status may help explain the greater prevalence of pain in Hispanic Americans.

4. THE IMPACT OF ETHNICITY AND GENDER ON SELF-REPORT AND NEURAL RESPONSES TO CONTACT HEAT STIMULI: AN ERP STUDY

4.1. Introduction

Hispanic Americans[1] report greater clinical pain severity relative to non-Hispanic Whites.[9–17] While pain sensitivity has been proposed as a potential risk mechanism underlying this disparity, sensory tests typically assess self-report responses rather than neural responses. Therefore, the current study examined self-report and neural responses to noxious contact-heat stimuli between Hispanic and non-Hispanic White adults.

Hispanic Americans display greater pain sensitivity compared with non-Hispanic White Americans[47,48,50] on quantitative sensory tests (QSTs) believed to tap into underlying neurophysiological mechanisms contributing to painful experiences.[43,187–189] Relative to non-Hispanic White counterparts with clinical pain,[39–41] demographic groups who disproportionately fall into lower socioeconomic strata, such as African Americans,[17] demonstrate enhanced pain facilitation on QST measures of central sensitization,[42] a phenomenon characterized by an amplification of neural signaling within the central nervous system that elicits pain hypersensitivity.[86,145–151] Enhanced QST proxies of central sensitization are also observed in non-clinical, healthy racial/ethnic minority groups in the U.S., including African Americans[45,46] and Hispanic Americans,[47] providing a potential mechanism underlying the risk for clinical pain development and persistence evident in racial/ethnic minorities.

Although these laboratory QSTs are sometimes used to make inferences about central responsivity to noxious stimuli,[86,145–151] and these inferences are derived from animal studies linking repetitive noxious stimulation with electrophysiological hyperexcitability in central neurons,[162,190] QST proxy measures of central amplification in human laboratory studies rely on self-report responses given the challenges to directly assess human central neuronal hyperexcitability in a manner similar to rodent studies. While self-report QSTs have shown predictive validity for clinical pain symptoms,[39,40,84] identifying neural sensitization responses to noxious stimuli may be useful in evaluating and predicting future clinical pain risk for Hispanic Americans, a demographic group who has already shown evidence for enhanced pain facilitation on QST measures of central sensitization.[47]

One approach to better assess neural response differences is through the use of cortical evoked responses to noxious heat stimuli using contact heat-evoked potentials (CHEPs).[191] CHEPs are event-related potentials (ERP) manifested during ongoing electroencephalogram (EEG) recordings that reflect neural reactivity in response to contact heat stimuli.[192] These evoked potentials to noxious stimuli manifest as a voltage polarity change and appear as peaks or deflections on an averaged waveform.[191] Moreover, CHEPs are marked by several facets, including their polarity (i.e., negative, positive), magnitude (i.e., amplitude), and relative timing to the stimulus onset (i.e., latency). Unlike other neural measures using blood flow-based functional imaging (e.g., functional magnetic resonance imaging/fMRI, positron emission tomography/PET), evoked potentials have greater temporal resolution,[193,194] potentially making CHEPS more suitable to detect and characterize neuronal processes. Furthermore, heat-evoked potential response amplitudes can be influenced by several factors including pain expectations,[195,196] attention,[197,198] sleep,[199] and gender,[200–202] presenting the possibility for CHEPS responses to be impacted by other factors such as ethnicity. Thus, heightened CHEPs in healthy Hispanic Americans could suggest that sensitization in neural responsivity to noxious stimuli may be a key factor contributing to greater future clinical pain risk.

Therefore, the current study examined neural and self-report responses to noxious stimuli between pain-free Hispanic and non-Hispanic White Americans to determine whether perceptual self-report pain differences are similarly reflected in neural responses. The following neural and self-report responses to noxious heat stimuli were assessed:

1) heat-evoked neural responses (N_2 /P_2 potentials),
2) pain intensity,
3) pain unpleasantness,
4) affective responses (i.e., valence, arousal), and
5) cognitive coping behavior responses.

Moreover, the current study also contrasted noxious stimuli neural and self-report response patterns amongst ethnic groups against gender groups, as women have shown greater laboratory pain sensitivity[47,114–118] as well as CHEPs[200,203] relative to men.

4.2. Methods

This study was approved by the Institutional Review Board at Texas A&M University and informed consent was obtained from all participants. Participants were recruited between January 2018 and May 2019.

4.2.1. Participants

Data for this study was derived from a larger study examining ethnic differences in laboratory pain sensitivity. Participants were invited to the laboratory based on their self-reported ethnicity. To control for nativity/migration status, only participants reporting being born and raised in the U.S. were invited to participate.[57] To determine if enhanced sensitization occurs prior to the onset of clinical pain, and to rule out disease status explaining any group differences, , healthy, pain-free undergraduate students enrolled in a psychology course between the ages of

18 and 40 were recruited for the study and received course credit for their participation. To control for any additional confounds beyond the study's objectives that could impact laboratory pain sensitivity, exclusionary criteria included: a) current use of any prescription drugs (with the exception of hormonal contraceptives), b) history of fainting spells, c) any skin condition/numbness on the hands or forearms, d) history of neurological disorders, e) current chronic pain or health condition, and f) use of allergy or pain medication within 24 hours prior to the experiment.

4.2.2. General Overview of Procedures/Testing

Figure 9 presents the timeline of procedures used in the current study (note: additional sensory assessments in the figure will be reported in additional manuscripts). Participants were pre-screened for inclusion/exclusion criteria prior to receiving an invitation to the laboratory, and again on the day of testing. After giving consent to participate in the study, participants first completed several questionnaires to assess background characteristics, though these questionnaires were not analyzed in the current study.

Participants were then fitted with an elastic cap (BioSemi headcap) with EEG electrodes filled with electrode gel (Signa gel by Parker). Participants then completed several physical sensory tests assessing threshold, tolerance, and pain ratings to several physical modalities (e.g., heat, cold, mechanical). Each task took place with at least 2 minutes of rest between each task to reduce carryover effects. Prior to the CHEPs task, participants completed a heat pain series task comprised of low, moderate, and high heat stimuli, as well as potentially participating in a picture-evoked potential task (Fig. 9).

Presentation software (Neurobehavioral Systems, Inc., Berkeley, California, U.S.) was used to direct the timing and order of the experimental protocol for the larger study, while

Qualtrics (Qualtrics International Inc., Provo, Utah, U.S.) was used to administer questionnaires. The experimenter viewed the first computer monitor within an adjacent room to ensure experimental progress. The participant used the second computer monitor to complete questionnaires and to make ratings to stimuli.

Prior to any pain assessment, participants were trained to make ratings until confident with their own ability. As part of training, participants practiced making ratings to practice heat stimuli. Participants practiced making ratings to four heat pulses on adjacent sites on the volar surface of their non-dominant arm: two pulses with a peak temperature of 48ºC and two with a peak of 34ºC.

All laboratory procedures were conducted with participants in a temperature controlled, sound-attenuated experiment room. When not in the experiment room, experimenters monitored testing procedures from an adjacent control room via a video camera connected to an additional monitor.

4.2.3. Stimulation Parameters

Contact heat stimuli were administered using a round, 27mm diameter thermode that covered an area of $572.5mm^2$ (PATHWAY, Sensory Analyzer System; Medoc, Israel). Contact heat stimuli were delivered by increasing the temperature from a baseline temperature (32˚C) to a fixed peak temperature at a rate of 70˚C/s and cooling at a rate of 40ºC/s. Contact heat stimuli were delivered in separate blocks of low intensity and high intensity stimuli, each block consisting of 25 contact heat stimuli. The low intensity block had a fixed peak temperature of 34˚C, while the high intensity block had a fixed peak temperature of 48˚C. The low intensity block's peak temperature of 34˚C was previously established as an acceptable non-painful, warm stimulus.[78] The order of the temperature blocks was randomized for each participant. All contact heat stimuli had a duration of five seconds with inter-trial intervals (ITI) between heat stimuli ranging from 25-30 seconds. During inter-trial intervals, participants made ratings of the pain intensity and pain unpleasantness experienced to the heat stimulus as well as emotional response affective ratings using the SAM. Between the two blocks of low and high intensity thermal stimuli, participants were given a minimum two-minute break. As per other CHEPs studies, participants unable or unwilling to tolerate the high intensity contact heat stimuli temperature were considered screening failures and excluded from analyses.[200]

4.2.4. Pain Outcomes

4.2.4.1. Contact-Heat Evoked Potential Recording and Data Reduction Parameters

Per Hajcak and colleagues (2013), continuous EEG was recorded using ActiView software and the ActiveTwo BioSemi system (BioSemi, Amsterdam, Netherlands).[204] Using the 10/20 system, thirty-two electrode sites were used. Additionally, a single electrode was located on both the left and right mastoids. The electrooculogram produced from eyeblinks and ocular activity were logged from four electrodes on the face: vertical ocular activity and blinks were assessed with two electrodes located approximately 1cm directly above and below the right eye while horizontal ocular activity was assessed using two electrodes located roughly 1cm outside the outer edge of each eye. The EEG signal was pre-amplified at the electrode to improve the signal-to-noise ratio. The EEG data were digitized at 24-bit resolution at a sampling rate of 1,024 Hz.

Brain Vision Analyzer software (Brain Products, Gilching, Germany) was utilized to process and reduce signals. Data was segmented for each trial starting from 200ms prior to heat stimulus onset and 1,000ms after heat stimulation onset; baseline correction for each trial was performed using the 200ms prior to stimulus onset. Offline, data were re-referenced to the average of the two mastoids and band-pass filtered with high-pass and low-pass filters of 0.01 and 30 Hz, respectively. After automatic ocular correction, a semi-automatic artifact rejection procedure was used which included visual inspection of the data; data from individual channels containing artifacts were rejected on a trial-to-trial basis. N_2 (the most negative peak in the waveform) and P_2 (the most positive peak in the waveform) components were quantified at the Cz electrode. Per Granovsky and colleagues (2016) published work on adult norms for CHEPs parameters,[200] the N_2 and P_2 components were derived within a 250 to 800ms time window post stimulus onset after averaging all contact heat trials within the high intensity block. The absolute distance between N_2 and P_2 peaks was calculated to derive N_2P_2 amplitudes.[192] Only the high intensity stimuli condition N_2P_2 amplitudes were averaged as only high temperatures were salient enough to yield clear CHEPs.[192,205] Figure 10 displays the grand average CHEPs for high intensity block across the ethnicity X gender groups.

4.2.4.2. Sensory and Affective Pain Dimensions

A computerized 101-point continuous visual analogue scale (VAS) was used to assess sensory and affective dimensions of the pain experience. Participants rated pain intensity (i.e., how strong the sensation feels) and pain unpleasantness (i.e., how emotionally unpleasant or disturbing the sensation feels) after each contact heat stimuli (Fig. 9). The VAS consisted of two horizontal bars on a computer screen that ranged from 0 to 100, with 0 representing "*no pain intensity/unpleasantness*" and 100 representing "*the most intense/unpleasant pain imaginable*."

4.2.4.3. Affective Responses

Self-report emotional reaction responses to the CHEPs task were assessed with a computerized version of the Self-Assessment Manikin (SAM).[72] The SAM yields valence (unpleasant to pleasant) and arousal (calm to aroused) scores that range from 1 to 9. Higher scores indicate the participant experienced greater pleasantness and arousal responses. Participants responded by clicking on any of the nine pictographs individually for each of the two scales. The SAM provides a valid and reliable measure to assess emotional responses to the manipulation of affect from noxious heat stimuli administered in the laboratory.[73,74]

4.2.4.4. Pain Coping Behavior Responses

Coping behavior to the CHEPs task was measured using the Coping Strategies Questionnaire-Revised (CSQ-R),[75,76] which consists of 27 items derived from the original CSQ.[77] The CSQ-R consists of six cognitive strategy subscales: diverting attention away from pain (i.e., distraction), catastrophizing, ignoring pain sensations, reinterpreting pain sensations, coping self-statements, and hoping/praying. Two additional subscales were created by summing the previous aforementioned subscales: a) the active coping composite subscale was created from diverting attention away from pain, ignoring pain sensations, reinterpreting pain sensations, and coping self-statements and b) the passive coping composite subscale was the sum of catastrophizing and hoping/praying. Participants rated how often they used each strategy to cope with the pain during the high intensity block on a scale ranging from 0 (never did that) to 6 (always did that), with greater scores indicating greater use of the strategy. The CSQ-R has been shown to valid and reliable among both healthy, pain-free individuals, as well as those with chronic pain.[76]

4.2.5. Data Analysis

Prior to analyses, data were screened for accuracy and missing values. Differences in continuous variables were examined with F tests, while χ^2 analyses were used for categorical variables. Greenhouse-Geisser corrections were applied as necessary when the sphericity assumption was violated. Bonferroni adjusted pairwise comparisons were conducted when necessary, regardless of interaction α levels. Partial eta squared (η^2_p) was used as a measure of effect size for *F* tests of mean differences, with values of 0.009, 0.0588, and 0.1379 corresponding to small, medium, and large effect sizes, respectively.[82,83] Significance was set at $\alpha < .05$ (2-tailed). SPSS 23.0 (IBM; Armonk, NY) was used for all analyses.

For CHEPs analyses, only the high intensity stimuli condition was used as only high temperatures are salient enough to yield clear CHEPs.[192,205]

4.2.5.1. Primary Analyses

To address the current study's objectives, a series of analyses were used to examine neural and self-report pain processing differences between ethnicity and gender groups:

a) To evaluate differences in CHEPs N_2/P_2 amplitudes to the high intensity block of contact heat stimuli, as well as a N_2 and P_2 latencies, separate two-way ethnicity (between: non-Hispanic White, Hispanic) X gender (between: men, women) Analysis of Variance (ANOVAs) were used.

b) To evaluate self-report sensory and affective pain dimensions as well as valence and arousal affective responses to the heat stimuli, separate ethnicity X gender X block temperature intensity (within: low vs. high) repeated measures ANOVAs were used for VAS and SAM ratings. Additional separate ethnicity (between) X gender (between) X trials (within) repeated measures ANOVAs were conducted to examine how/when gender and ethnic differences during the high intensity block may have emerged for VAS and SAM ratings. For these analyses, trials were reduced from 25 by conducting a split into five segments and averaging trials within each segment to create five averaged pain rating trials.

c) Finally, pain coping behavior responses to the high intensity block were analyzed with a two-way ethnicity X gender multivariate analysis of variance (MANOVA) for ratings to the CSQ-R.

4.3. Results

4.3.1. Participant Characteristics

The sample in the current study consisted of 40 Hispanic and 44 non-Hispanic White individuals. The distribution of men and women across the Hispanic (N_{women} = 20) and non-Hispanic White (N_{women} = 19) did not statistically differ, χ^2 = .392, p = .531. Both Hispanic (M_{age} = 18.93, SD_{age} = 1.02) and non-Hispanic White groups (M_{age} = 19.14, SD_{age} = .93) were comparable in age, $F_{1,80}$ = .692, p = .408, η^2_p = .009. Women (M_{age} = 18.82, SD_{age} = .85) and men were similarly comparable in age (M_{age} = 19.22, SD_{age} = 1.04), $F_{1,80}$ = 3.29, p = .073, η^2_p = .039.

4.3.2. Contact Heat-Evoked Potentials

Figure 10 depicts grand-averaged waveforms at the Cz electrode across all four ethnicity X gender groups for the high intensity block. As demonstrated in Figure 11, analyses for N_2/P_2 amplitudes revealed no differences between ethnicity groups for high intensity contact heat stimuli, $F_{1,80}$ = .45, p = .506, η^2_p = .006. However, a main effect of gender revealed that women demonstrated greater amplitudes to the high intensity contact heat stimuli relative to men, $F_{1,80}$ = 4.37, p = .040, η^2_p = .052. As detailed in Table 10, there were no differences in N_2 or P_2 latencies by ethnicity or gender.

Related to the current study's objective of assessing neural response differences between ethnic and gender groups, these results suggest that 1) women demonstrate enhanced evoked responses to high intensity noxious stimuli relative to men, but Hispanics demonstrate comparable responses relative to non-Hispanic Whites and 2) demographic group status does not impact N_2 or P_2 latencies.

4.3.3. Sensory-Discriminative Pain Dimension

Figure 12 depicts averaged pain intensity ratings collapsed over the 25 trials during the low and high intensity blocks by gender (A) and ethnicity (B). An ethnicity X gender X heat intensity analyses demonstrated a significant main effect of block intensity in which the high intensity block produced stronger perceived pain intensity scores relative to the low intensity block, $F_{1,80} = 849.67$, $p < .001$, $\eta^2_p = .914$. Furthermore, there was a significant heat intensity X gender interaction, $F_{1,80} = 4.90$, $p = .030$, $\eta^2_p = .058$. Bonferroni adjusted pairwise comparisons for the heat intensity X gender interaction revealed that women reported greater pain intensity to the high heat intensity relative to men, $F_{1,80} = 6.30$, $p = .040$, $\eta^2_p = .052$. Analyses unveiled no ethnicity or heat intensity X ethnicity interaction effects, (*p's* > .571) (Fig. 12B).

Moreover, while the heat intensity X gender X ethnicity interaction did not reach significance, $F_{1,80} = .898$, $p = .346$, $\eta^2_p = .011$, Bonferroni adjusted exploratory pairwise comparisons indicated a statistically significant effect of gender for non-Hispanic White individuals during the high intensity block, $F_{1,80} = 4.96$, $p = .029$, $\eta^2_p = .058$, but no effect of gender for Hispanic individuals during the high intensity block ($p = .455$, $\eta^2_p = .007$) (Fig. 12C).

Focusing on the high intensity block, an ethnicity (between) X gender (between) X averaged trial segments (within) repeated measures ANOVA was conducted to examine when gender and ethnic differences during the high intensity block may have emerged for VAS and SAM ratings. Figure 12D depicts a significant main effect of trial segments during the high intensity block, $F_{4,145.98} = 8.00$, $p = .001$, $\eta^2_p = .091$, that was qualified by a significant trial segment X gender interaction, $F_{4,145.98} = 4.32$, $p = .018$, $\eta^2_p = .051$. Women demonstrated a sensitization pattern, with Bonferroni adjusted pairwise comparisons of trial segments demonstrating a significant increase from trial segment 1 to segment 2 ($p = .001$) and onward.

Conversely, men exhibited a steady state pattern with pairwise comparisons demonstrating no change in pain ratings from trial segment 1 to segment 2 (p = 1.00). Differences between genders began to emerge at trial segment 2 (p = .023, η^2_p = .063). Conversely, while there is a slight increase in pain intensity over trial segments, Figure 12E depicts no differences in pain intensity for ethnicity by trial segment (p's > .882) and both ethnic groups appeared to present with a steady state pattern that did not significantly change from trial segment 1 onward (p's > .108).

In relation to the current study's objective of assessing pain intensity differences between ethnic and gender groups, these results suggest that 1) higher intensity heat produces greater perceptions of self-report pain intensity relative to lower intensity heat, 2) the higher intensity heat produces greater pain intensity responses for women relative to men when collapsed across trials, but not for Hispanics relative to non-Hispanic Whites, and 3) women demonstrate a sensitization pattern of reported pain intensity over trial segments to the high intensity block relative to men's consistent responding pattern while Hispanics and non-Hispanic Whites demonstrate comparable pain intensity responses that do not markedly change over repeated stimulations.

4.3.4. Affective-Motivational Pain Dimension

Figure 13 depicts averaged pain unpleasantness ratings to the low and high intensity blocks by gender (A) and ethnicity (B). Ethnicity X gender X heat intensity analyses for pain unpleasantness showed a significant main effect of heat intensity, $F_{1,80}$ = 770.92, p < .001, η^2_p = .906. Moreover, there was a significant main effect of gender, $F_{1,80}$ = 5.90, p = .017, η^2_p = .069, that was qualified by a significant heat intensity X gender interaction, $F_{1,80}$ = 4.05, p = .048, η^2_p = .048. Bonferroni adjusted pairwise comparisons for the heat intensity X gender interaction revealed that women reported greater pain unpleasantness to the high intensity block, $F_{1,80}$ =

5.13, p = .026, η^2_p = .060. While analyses unveiled no ethnicity or heat intensity X ethnicity interaction effects (p's > .083), exploratory Bonferroni adjusted pairwise comparisons demonstrated that while non-Hispanic White women reported greater pain unpleasantness during the high intensity block relative to non-Hispanic White men, $F_{1,80}$ = 8.18, p = .005, η^2_p = .093 (Fig. 13C). However, there was no difference in reported pain unpleasantness between genders amongst the Hispanic group during the same high intensity block (p = .698, η^2_p = .002). Additionally, exploratory Bonferroni pairwise comparisons also demonstrated that Hispanic men reported greater pain unpleasantness during the high intensity block relative to non-Hispanic White men, $F_{1,80}$ = 6.02, p = .016, η^2_p = .070, but there was no difference for women between ethnicity groups during the high intensity block (p = .974, η^2_p = .000) (Fig. 13C).

Upon closer inspection of the high intensity heat block, an ethnicity X gender X averaged trial segments repeated measures ANOVA revealed a significant main effect of trial segments $F_{2.07,165.68}$ = 11.65, p < .001, η^2_p = .127, and a trial segment X gender interaction that did not survive the Greenhouse-Geisser correction, $F_{2.07,165.68}$ = 2.33, p = .098, η^2_p = .028 (Fig.13D). However, women demonstrated a sensitization pattern, with pairwise comparisons of trial segments demonstrating a significant increase from trial segment 1 to segment 3 (p = .045), segment 4 (p = .006), and segment 5 (p = .002). Conversely, Men displayed a relatively steady state pattern, with pairwise comparisons demonstrating no change in pain unpleasantness from trial segment 1 onward (p's >.205). Differences between genders began to emerge at trial segment 2 (p = .032, η^2_p = .056). Regarding ethnicity's influence on pain unpleasantness over trials, there was no trial segment X ethnicity interaction, $F_{2.09,171.40}$ = 1.03, p = .362, η^2_p = .012 (Fig. 13E). Indeed, exploratory pairwise comparisons did not yield differences in pain unpleasantness between ethnicity groups at any trial segment (p's > .062). However, Figure 13E demonstrates that while non-Hispanic White's pain unpleasantness ratings were relatively consistent over trial segments from trial segment 1 (*p*'s > .483), Hispanics demonstrated a clear sensitization pattern with a significant increase from trial segment 1 to segment 3 ($p = .016$), segment 4 ($p = .006$), and segment 5 ($p = .017$).

In relation to the current study's objective of assessing pain unpleasantness differences between ethnic and gender groups, these results suggest that 1) higher intensity heat produces greater perceptions of self-report pain unpleasantness relative to lower intensity heat, 2) the higher intensity heat produces greater pain unpleasantness responses for women relative to men when collapsed across trials, but not for Hispanics relative to non-Hispanic Whites, and 3) women demonstrate a sensitization pattern of reported pain unpleasantness over trial segments to the high intensity block relative to men's consistent responding pattern while Hispanics demonstrate a sensitization pattern of reported pain unpleasantness over trials that differs from non-Hispanic Whites' consistent responding pattern over repeated stimulations.

4.3.5. Affective Valence Responses

Figure 14 depicts averaged SAM valence ratings to the low and high intensity blocks by gender (A) and ethnicity (B). Ethnicity X gender X heat intensity analyses for valence responses showed a significant main effect of heat intensity, $F_{1,80} = 283.68$, $p < .001$, $\eta^2_p = .780$. Additionally, there was a significant heat intensity X gender interaction, $F_{1,80} = 10.78$, $p = .002$, $\eta^2_p = .119$. Bonferroni adjusted pairwise comparisons for the heat intensity X gender interaction during the low intensity block revealed that women reported higher valence relative to men, $F_{1,80} = 4.38$, $p = .040$, $\eta^2_p = .062$, as well as lower valence relative to men during the high intensity block, $F_{1,80} = 7.11$, $p = .009$, $\eta^2_p = .082$. Conversely, analyses yielded no ethnicity ($p = .992$) or heat intensity X ethnicity interaction effects ($p = .070$). However, exploratory Bonferroni adjusted pairwise comparisons demonstrated that non-Hispanic White women reported greater valence during the high intensity block relative to non-Hispanic White men, $F_{1,80} = 5.47$, $p = .022$, $\eta^2_p = .064$, while no differences in reported valence between genders amongst the Hispanic group during the same high intensity block were observed ($p = .151$, $\eta^2_p = .026$) (Fig. 14C).

Expanding on the high intensity heat block, an ethnicity X gender X averaged trial segments repeated measures ANOVA revealed a significant main effect of trial segments $F_{2.82,225.19} = 11.32$, $p < .001$, $\eta^2_p = .124$ and gender, $F_{1,80} = 7.11$, $p = .009$, $\eta^2_p = .082$, but no trial segment X gender interaction, $F_{2.82,225.19} = .44$, $p = .712$, $\eta^2_p = .005$ (Fig.14D). Regardless, exploratory Bonferroni adjusted pairwise comparisons across trial segments demonstrated that negative responses to the high intensity stimuli grew, with differences from the first trial segment emerging at the fourth trial segment for women ($p = .027$) and third trial for men ($p = .037$). Moreover, pairwise comparisons of trial segments between gender revealed that differences between genders emerged as early as trial segment 1 ($p = .006$, $\eta^2_p = .089$) (Fig. 14D). Regarding ethnicity's influence on valence responses over trials, there was no main effect of ethnicity ($p = .116$, $\eta^2_p = .031$) or trial segment X ethnicity interaction, $F_{2.82,225.19} = .10$, $p = .953$, $\eta^2_p = .001$ (Fig. 14E). Moreover, while exploratory Bonferroni adjusted pairwise comparisons demonstrated no differences in valence over any trial segment between ethnicity groups (*p's* > .093), decreases in valence from the first trial segment emerged at the fourth trial segment for both Hispanics ($p = .057$) and non-Hispanic Whites ($p = .011$).

In relation to the current study's objective of assessing affective response differences between ethnic and gender groups, with regards to valence, these results suggest that 1) higher intensity heat produces greater negative affective responses relative to lower intensity heat, 2) the higher intensity heat produces greater negative affective responses for women relative to men when collapsed across trials (particularly between non-Hispanic White women and men), but not for Hispanics relative to non-Hispanic Whites, and 3) while marginal, both men and women, as well as Hispanics and non-Hispanic Whites, display increased negative affective responses over trials to the high intensity block.

4.3.6. Affective Arousal Responses

Figure 15 depicts the pattern of averaged SAM arousal ratings to the low and high intensity blocks by gender (A) and ethnicity (B). Ethnicity X gender X heat intensity analyses for arousal responses showed a significant main effect of heat intensity, $F_{1,80} = 762.59$, $p < .001$, $\eta^2_p = .905$. Furthermore, the presence of a significant main effect of ethnicity, $F_{1,80} = 10.94$, $p = .001$, $\eta^2_p = .120$, was qualified by a significant heat intensity X ethnicity interaction, $F_{1,80} = 10.10$, $p = .002$, $\eta^2_p = .112$ (Fig. 15B). Bonferroni adjusted pairwise comparisons for the heat intensity X ethnicity interaction revealed no difference in arousal between ethnicity groups during the low intensity block ($p = .512$, $\eta^2_p = .005$), but rather a heightened arousal response in Hispanics relative to non-Hispanic Whites during the high intensity block, $F_{1,80} = 11.51$, $p = .001$, $\eta^2_p = .126$. While analyses yielded neither gender, $F_{1,80} = 3.72$, $p = .057$, $\eta^2_p = .044$, nor heat intensity X gender interaction effects, $F_{1,80} = 2.35$, $p = .129$, $\eta^2_p = .029$, there was a significant three-way heat intensity X gender X ethnicity interaction, $F_{1,80} = 4.32$, $p = .041$, $\eta^2_p = .051$. Bonferroni adjusted pairwise comparisons revealed that Hispanic men reported greater arousal response during the high intensity block relative to non-Hispanic White men, $F_{1,80} = 13.09$, $p = .001$, $\eta^2_p = .141$, while non-Hispanic White women reported no difference in arousal response during the high intensity block relative to Hispanic women, $F_{1,80} = 1.59$, $p = .212$, $\eta^2_p = .019$ (Fig. 15C). Moreover, non-Hispanic White women reported greater arousal relative to non-Hispanic White men during the high intensity block, $F_{1,80} = 5.91$, $p = .017$, $\eta^2_p = .069$, but no differences in arousal were found between genders in the Hispanic group during the same high intensity block, $F_{1,80} = .03$, $p = .855$, $\eta^2_p = .000$.

Focusing on the high intensity heat block, an ethnicity X gender X averaged trial segments repeated measures ANOVA revealed a significant main effect of trial segments $F_{2.18,157.59} = 13.15$, $p < .001$, $\eta^2_p = .141$, but no trial segment X gender interaction, $F_{2.18,157.59} = 1.61$, $p = .201$, $\eta^2_p = .020$ (Fig. 15D). However, arousal responses to noxious stimuli did increase over trial segments, with exploratory Bonferroni adjusted pairwise comparisons revealing that significant increases from the first trial segment emerged at the fourth trial segment for women ($p = .040$). Conversely, Men's arousal responses grew to a lesser degree, but no differences emerging from the first trial segment onward (p's > .095). Moreover, differences between genders began to emerge at trial segment 5 ($p = .018$, $\eta^2_p = .067$). Regarding ethnicity's influence on arousal responses over trials, while there was a main effect of ethnicity, $F_{2.18,157.59} = 11.50$, $p = .001$, $\eta^2_p = .126$, there was no trial segment X ethnicity interaction, $F_{2.18,157.59} = .34$, $p = .733$, $\eta^2_p = .004$, (Fig. 15E). Indeed, differences between ethnicity groups were present across each trial segment beginning at trial segment 1 ($p = .001$, $\eta^2_p = .122$). Furthermore, arousal responses to the heat stimuli rose throughout the high intensity block for both ethnicity groups, with exploratory Bonferroni adjusted pairwise comparisons revealing increases in arousal response from trial segment 1 emerging at segment 5 for Hispanics ($p = .034$) and segment 5 for non-Hispanic Whites ($p = .027$).

In relation to the current study's objective of assessing affective response differences between ethnic and gender groups, with regards to arousal, these results suggest that 1) higher intensity heat produces greater affective arousal responses relative to lower intensity heat, 2) the higher intensity heat produces – though not significantly – greater affective arousal responses for women relative to men when collapsed across trials (particularly between non-Hispanic White women and men), while the higher intensity heat produces significantly greater affective arousal responses for Hispanics relative to non-Hispanic Whites (particularly between Hispanic and non-Hispanic White men), and 3) while marginal, both men and women, as well as Hispanics and non-Hispanic Whites, display increased affective arousal responses over trials to the high intensity block.

4.3.7. Pain Coping Behavior Responses

As detailed in Table 11, Hispanics engaged in greater catastrophizing, reinterpretation of pain sensations, hoping/praying, and general use of passive coping. However, women engaged in greater praying/hoping and general passive coping use but displayed no differences in reinterpretation of pain sensations. There were no significant ethnicity X gender interactions for any of the coping strategies (p's > .129).

4.3.8. Exploratory Correlations Between Demographic Factors, Evoked-Potentials, and Self-Report Responses to High Intensity Stimulus Block

Table 12 displays correlations between ethnicity, gender, and averaged responses to the high intensity stimulus block. Of the two demographic factors, only gender, but not ethnicity, was associated with N_2/P_2 amplitudes, with greater evoked potentials observed amongst women. Of the self-report responses to the high intensity stimulus, only SAM valence was correlated with evoked potentials, with greater evoked potential amplitudes being associated with greater negative responses to the high intensity stimulus block.

4.4. Discussion

While pain sensitivity has been proposed as a potential risk mechanism for Hispanic Americans, sensory tests characterizing these differences typically focus on self-report responses while neglecting neural responses. Therefore, to determine whether perceptual self-report differences are similarly reflected in neural responses, the current study examined ethnic and gender differences across these indices to noxious contact-heat stimuli.

4.4.1. Ethnicity's Impact on Neural and Self-Report Intensity Responses to Noxious Stimuli

No differences in neural responses were observed between Hispanics and non-Hispanic Whites to the high intensity stimuli as indexed by CHEPs N_2/P_2 amplitudes, suggesting that cortical responsivity to noxious heat stimuli within a 250-850ms epoch does not appear to be enhanced in Hispanics relative to non-Hispanic Whites (Fig 11). Additionally, pain intensity and CHEPs amplitudes were unrelated to one another (Table 12). While many have observed correlations between evoked-potentials and pain intensity to lasers[193,206–208] and contact heat,[192,193] the absent relationship between the two is also a recurrent finding.[209–212] A possible explanation for this null finding may relate to the nature of CHEPs and what they more likely reflect. Specifically, a growing body of work proposes that heat-evoked potentials better reflect stimulus saliency rather than perceived stimulus intensity.[209,210,213–215] A stimulus' salience can be operationalized by how distinct or striking it is perceived to be.[216] Therefore, Iannetti and Mouraux's saliency hypothesis for heat-evoked potentials[209] might suggest stimuli perceived at a consistent level of pain intensity between groups, as demonstrated between Hispanics and non-Hispanic Whites across trial segments during the high intensity block (Fig. 12E), would then manifest as a lack of difference on CHEPs amplitudes. Conversely, the saliency hypothesis[209] might also suggest that a group that perceived a noxious stimulus as increasing over repeated presentations, as demonstrated by women across trial segments during the high intensity block (Fig. 12D), would then present with greater CHEPs amplitudes relative to a group that perceived a constant level of pain intensity across stimuli presentations (i.e., men). While Hispanics did present with greater SAM arousal relative to non-Hispanic Whites, inspection of Figure 15E finds that Hispanics presented with consistently greater arousal beginning at trial segment 1 and that arousal may not have grown over repeated presentations to a degree that could be considered striking or prominent enough to become salient, perhaps due to ceiling effects preventing arousal growth over trials.

While no differences were found for cortical responsivity to noxious stimuli between ethnic groups, this does not mean that there are no differences between ethnicities on neural responses to noxious stimuli. As discussed earlier, enhanced QST proxies of central sensitization have been observed in pain-free Hispanic Americans,[47] providing a potential mechanism underlying the risk for clinical pain evident in racial/ethnic minorities. However, QST protocols such as temporal pain summation are human self-report analogues of wind-up, a phenomenon characterized by hyperexcitability of central neurons to repetitive noxious stimuli.[162,190] Therefore, ethnic difference in neural responsivity to noxious stimuli could be more prominent at spinal or subcortical supraspinal levels not reflected at the cortex. Alternatively, neural responsivity measures with greater spatial resolution, such as fMRI, find particular cortical areas (i.e., dorsolateral prefrontal, insula, rostral anterior cingulate) positively correlate with pain catastrophizing,[217] a pain self-report response that was significantly greater amongst Hispanics relative to non-Hispanic Whites in the current study. Therefore, the results from the aforementioned proxy central sensitization and fMRI studies provide rationale for continued rigorous work examining neural response differences to noxious stimuli between ethnicities with the goal of determining endogenous central mechanisms contributing to clinical pain disparities.

4.4.2. Ethnicity's Impact on Affective and Pain Coping Response

The current study observed mixed findings for ethnicity's influence across self-report affect related indices to noxious stimuli. For instance, clear ethnic differences were not observed for pain unpleasantness or negative affective reactions (SAM valence) (Figs. 13, 14). Conversely, evidence suggests that Hispanics experienced the noxious stimuli as more arousing (SAM arousal; Fig. 15). Collectively, this would suggest that Hispanics in the current study are experiencing heightened arousal, rather than, unpleasantness experiences to noxious stimuli. Though no study has systematically examined affective responses to noxious stimuli in Hispanics, previous work has observed lower cold pain tolerance in Hispanics relative to non-Hispanic Whites,[50] potentially tapping into arousal dimensions.

Hispanics also reported greater use of several pain coping behaviors, including reinterpretation of pain sensations, as well as passive coping strategies such as catastrophizing and hoping/praying (Table 11). While these passive coping strategies appear to be correlated with all self-report pain measures (Table 12), the four-stage model of pain processing[53,55,56] might suggest greater arousal responses observed in Hispanics generates greater passive coping use, which facilitates a positive feedback loop contributing to intensified arousal responses. Elevated passive coping amongst Hispanics aligns with literature observing greater passive coping behavior use in the face of pain,[18,19] including general pain catastrophizing for clinical pain,[16,90] as well as general religious coping in both clinical[16,90–93] and healthy, pain-free populations.[91] Though, it should be emphasized that the practice of prayer is not an inherently maladaptive pain coping behavior: recent experimental work demonstrates the benefits of active, rather than passive, prayer on experimental pain tolerance.[218]

Considering negative affect's relation to pain,[87–89] as well as passive cognitive coping relationship with worse clinical pain outcomes,[90,94–96] greater arousal responsivity and passive pain coping to noxious events may represent a potential risk factor for increased pain severity amongst Hispanics with clinical pain.

4.4.3. Gender Differences on Neural and Self-Report Responses to Noxious Stimuli

Whereas the current study observed no differences in neural responses or self-report pain intensity between ethnic groups, women demonstrated greater CHEPs N_2/P_2 amplitudes, as well as greater pain intensity sensitization across trials, to the high intensity block relative to men. This perceived pain intensity or saliency[210,213] sensitization pattern in women may explain their heightened N_2/P_2 amplitudes. Alternatively, the four-stage model of pain processing[53,55,56] may suggest that women are first experiencing heightened nociceptive input that contributes to a greater negative sequelae of events, including heightened perceived pain intensity, pain unpleasantness, affective responses, and passive coping behaviors. Therefore, continued work is needed to disentangle the causal factors contributing to greater neural responses to noxious stimuli for women.

Gender differences for CHEPs N_2/P_2 amplitudes and pain intensity observed in the current study are consistent with greater amplitudes[200,203] and reported pain[200,203,219,220] for women to noxious heat stimuli observed elsewhere. Moreover, the observed greater pain intensity is consistent with an extensive literature reporting greater sensory-discriminative pain sensitivity for women across numerous experimental pain modalities.[114,119,221] However, the pattern of pain intensity over trials differs from Hashmi and Davis' work demonstrating greater habituation for women relative to men to repeated thermal stimuli.[222,223] Though the differences in pain intensity patterns between Hashmi and Davis' work and the current study's findings may be attributable to differences in methodologies, including the stimulus intensities, durations, and inter-trial intervals.

In addition to the differences for neural responses and self-report pain intensity, women in the current study also demonstrated greater self-report pain unpleasantness, valence, and general passive coping behavior use, particularly for hoping/praying. Such findings are consistent with the larger body of literature examining gender differences for experimentally induced pain.[79,114,119]

4.4.4. Limitations

This study had several strengths including neural response assessment, collecting self-reports after each trial (as opposed to only at the end of the block), and fixing the stimulus intensity across participants. However, a few limitations should be noted when considering the findings of this study. First, this study included young, pain-free adults to determine whether group differences in pain processing exist that could contribute to future clinical pain risk. This methodology may limit the generalizability of the results to older community or clinical populations, and as such, replication in these populations are crucial. Furthermore, the current sample was recruited from a single university within the South-Central U.S., limiting generalizability to broader female and Hispanic U.S. populations who may differ on any number of psychosocial factors. Therefore, additional studies should determine if these results generalize to women and Hispanics in other geographical U.S. regions. Finally, the duration of the heat stimuli in the current study was longer than typical CHEPs protocols.[192,224] Despite methodological differences, the current protocol produced similar N_2/P_2 waveforms and latencies to shorter duration heat stimuli.[200]

4.4.5. Conclusions

While Hispanic Americans demonstrated comparable neural and self-report pain responses relative to non-Hispanic White Americans, differences in pain experiences emerged for arousal and passive coping behavior responses to the heat stimuli. This pattern is contrasted with amplified neural responses in women, as well as self-report pain and negative affect, relative to men. Moreover, greater neural responses to noxious stimuli was only related to greater negative affect responses. Considering the higher rates and severity of clinical pain amongst Hispanic Americans and women, these neural and self-report responses to noxious stimuli may partially explain the greater clinical pain severity for these populations, as well as help elucidate the relationship between self-report and neural responses to noxious stimuli.

5. CONCLUSIONS

The four previous chapters focus on examining potential factors underlying and contributing to pain experiences for Hispanic Americans. The work reported here extends broader the clinical pain literature demonstrating heightened pain experiences amongst Hispanic Americans. Given the limited literature examining pain sensitivity to quantifiable sensory tests for Hispanic Americans, as well as literature linking stressful events to clinical pain, the study in Chapter 1 focused on characterizing self-report pain responses to a number of uniquely different sensory tests amongst pain-free Hispanic Americans relative to non-Hispanic White Americans. The results showed that Hispanics displayed a number of differences across pain responses, particularly for affective and coping responses to noxious stimuli. Moreover, while Hispanics reported greater adverse life experiences across a number of physical, social, emotional, and economic domains, Hispanics presented with no differences for general stress, depressive symptoms, or stress-related coping strategies relative to non-Hispanic Whites. These findings underscore the heightened pain sensitivity outcomes amongst Hispanics, as well as highlight elevated potential psychosocial factors that may contribute to these differences (i.e., adverse life experiences).

Evidence for elevated socially desirable responding (i.e., over-reporting "good", under-reporting "bad") amongst Hispanics and the impact this response style has on mental health assessments presents the possibility for influence on other self-report measurements, including pain responses to noxious heat stimuli. To that end, Chapter 2 examines the relationship between positive response styles and laboratory pain sensitivity to heat stimuli between pain-free Hispanic and non-Hispanic White adults. Results showed Hispanics reported greater pain and affective responses, as well as lower pain motivation when accounting for pain threshold.

Moreover, Hispanics displayed greater social desirability and evidence for a pain minimization response style. Statistically adjusting for this pain response style contributed to greater pain intensity ratings for Hispanics. Together, these results suggest that Hispanics experience heightened responses to painful stimuli and that a positive response style may minimize reported pain for Hispanics. These findings indicate that minimization may be a prevailing response style amongst Hispanics in the context of pain assessment and that better efforts to assess for such response styles are merited.

Chapter 3 focuses on the presence of pain hypersensitivity on a proxy measure of central pain facilitation called temporal summation of mechanical pain, as well as the relationship this measure has with markers of social status. Extending the findings revealed in Chapter 1, Chapter 3 finds that temporal summation is indeed greater amongst Hispanics, upward social mobility negatively correlates with summation for Hispanics only, and this relationship mediates the ethnic differences observed for temporal pain summation. These findings indicate that heightened pain facilitation may be one factor explaining greater rates of clinical pain severity amongst Hispanics and that the direction of social mobility across the lifespan may modulate this pain sensitivity mechanism.

Chapter 4 measures self-report responses to noxious heat stimuli across demographic groups and examines whether such responses are similarly reflected on neural responses to noxious stimuli. Results revealed that Hispanics displayed no differences in neural responses or self-report pain ratings but demonstrated enhanced self-report arousal and passive pain coping responses (e.g., catastrophizing, hoping/praying) to the noxious stimuli. Conversely, women displayed amplified neural potentials and sensitized self-report pain intensity/unpleasantness responses over trials as well as heightened negative affect, but not arousal. Moreover, of the self-report responses, only negative affect responses to the noxious stimuli were associated with greater neural responses. While both Hispanics and women demonstrated heightened responses relative to their control groups, the heightened responses displayed were separate and unique amongst these two demographic groups. Considering the push towards deriving pain biomarkers for field of pain research, understanding the relationships and dissociations between self-report and neural responses to noxious stimuli is a crucial next step towards realizing that objective.

The preceding chapters capture various factors related with risk for pain amongst Hispanic Americans and implement various methods to evaluate and address the relationship between development, environments, adversity, cognitions, emotions, coping, reporting styles, and reported pain. The impact of these factors on Hispanic pain works across multiple pathways including peripheral and/or central neural systems. The lack of replication for certain findings, particularly the relationship between self-report pain and neural responses to noxious stimuli (see Chapter 4), necessitates the need for continued efforts to enhance understanding of endogenous phenomenon underlying the experience of pain. Additionally, it is also critical to highlight pain response patterns observed amongst Hispanics against other demographic groups, such as women, who have historically demonstrated evidence for heightened clinical pain severity. While Hispanics and women demonstrated a number of similar heightened responses to noxious stimuli, there were also a number of differences between the two that may help elucidate similar, as well as unique, pain risk factors amongst these two groups.

Taken together, the preceding chapters present novel observations on pain risk factors for Hispanic Americans, the relationship between by psychosocial factors and pain across the lifespan, and the neurobiological responses evoked to noxious physical events. The multiple domains of psychosocial assessment, the incorporation of self-report and neural responses to noxious events, the use of quantitative sensory tests, and the integration of all these factors are key to helping push forward the knowledgebase and ultimately better manage pain for Hispanic Americans. Given the elevated clinical pain severity observed for Hispanic Americans, the ultimate goal of these studies is to help further stimulate efforts to better address and treat their pain experiences.

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APPENDIX A

FIGURES

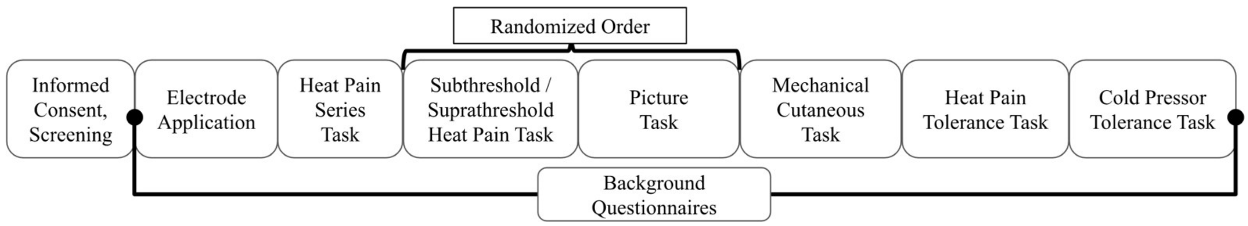

Figure 1 | Broad timeline of the procedures during the laboratory visit.

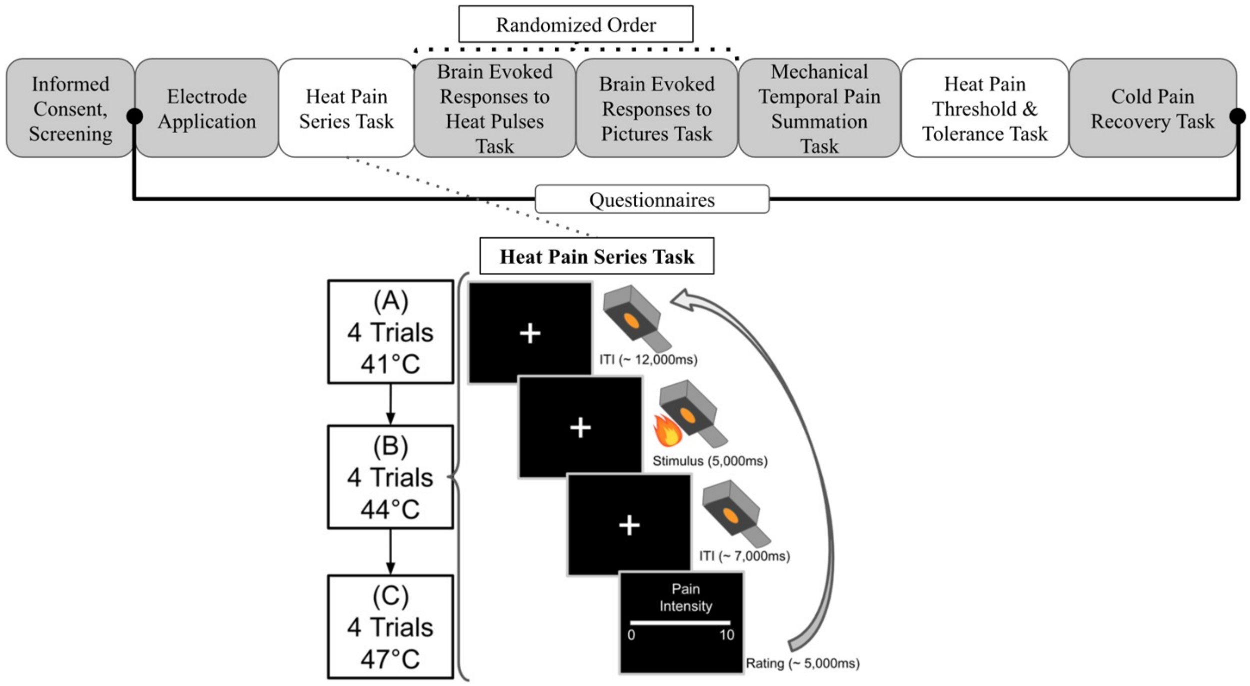

Figure 2 | Timeline of study procedures, including the Heat Pain Series Task and Heat Pain Threshold & Heat Pain Tolerance Task described in the current study.

The Heat Pain Series Task is expanded to show the design of the task. ITI = Inter-trial interval.

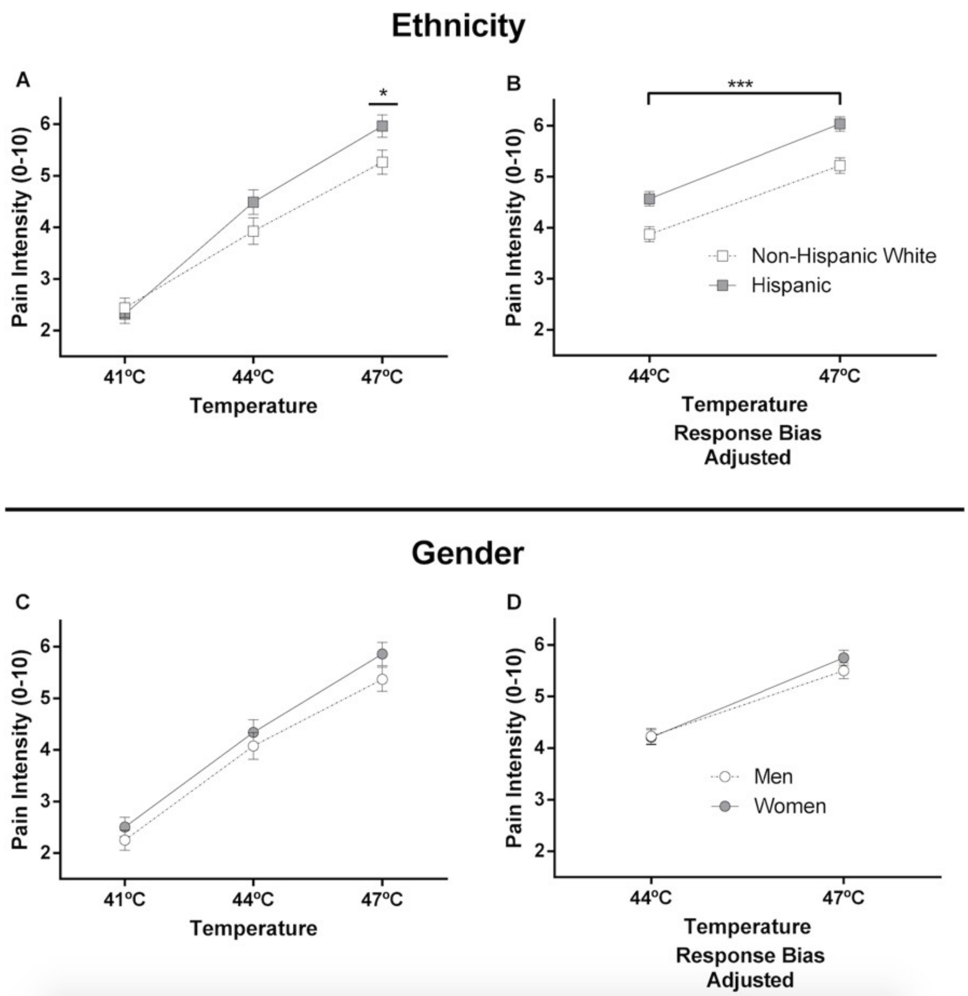

Figure 3 | Comparison of differences for pain intensity by ethnicity (A,B) and gender (C,D) during the Heat Pain Series Task.

Graphs display intensity ratings before (A,C) and after (B,D) after adjusting for response styles to 41°C stimulus. Hispanics reported significantly greater pain intensity at 47°C relative to non-Hispanic Whites (A). When adjusting for averaged intensity ratings to the 41°C heat pulse, greater averaged pain intensity differences emerged between the two groups at 44°C and 47°C. There were no significant differences for pain intensity between men and women before (C) or after adjusting for averaged intensity ratings to the 41°C heat pulse (D). Adjusted Mean $\pm$ SEM. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

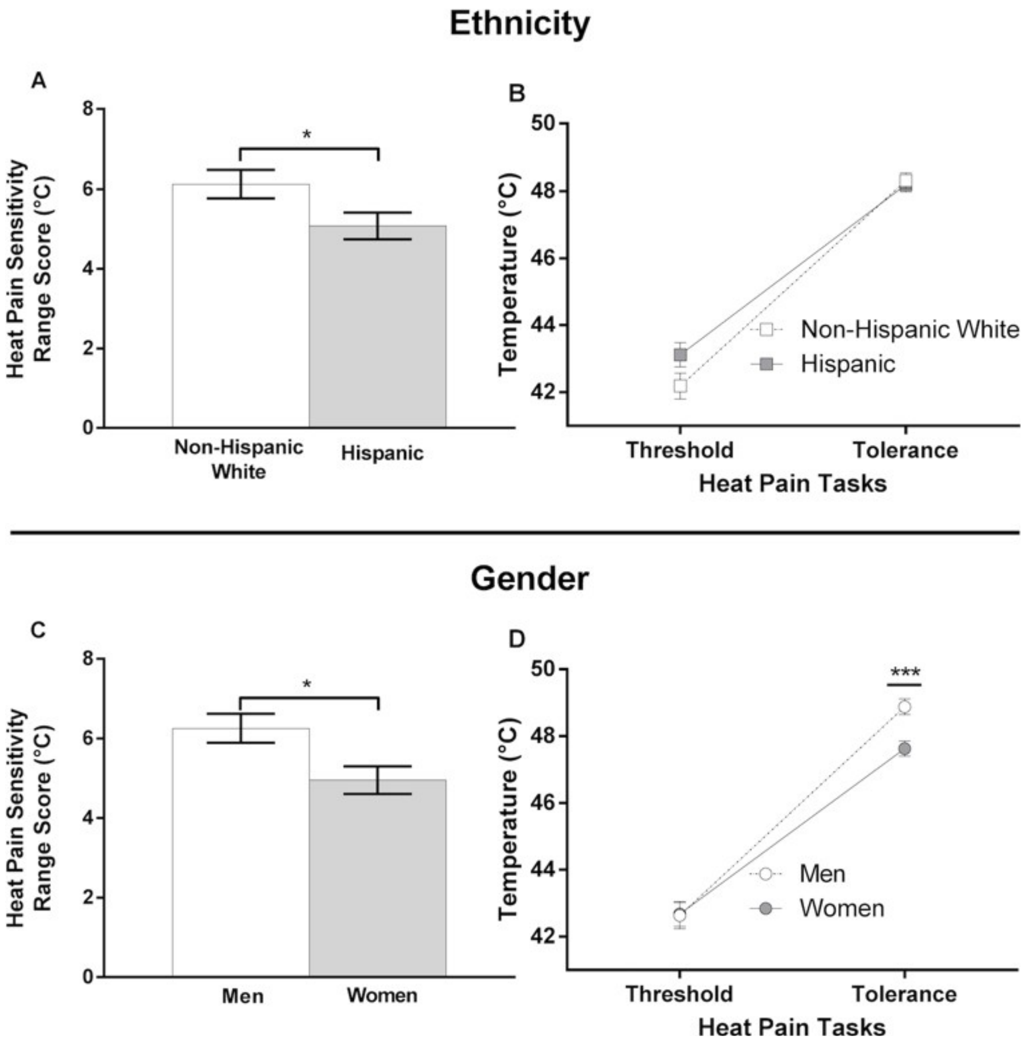

Figure 4 | Comparison of differences for Heat Pain Threshold & Tolerance Task by ethnicity (A,B) and gender (C,D).

Hispanics (A) and women (C) displayed lower heat pain sensitivity range scores relative to non-Hispanic Whites and men, respectively. Observing heat pain threshold and tolerance temperatures, Hispanics appeared to report higher pain thresholds (less sensitive) while demonstrating no difference in heat pain tolerance levels compared to non-Hispanic Whites (B). However, women reported comparable pain thresholds to men, while demonstrating lower heat pain tolerance levels relative to men (D). Adjusted Mean ± SEM. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

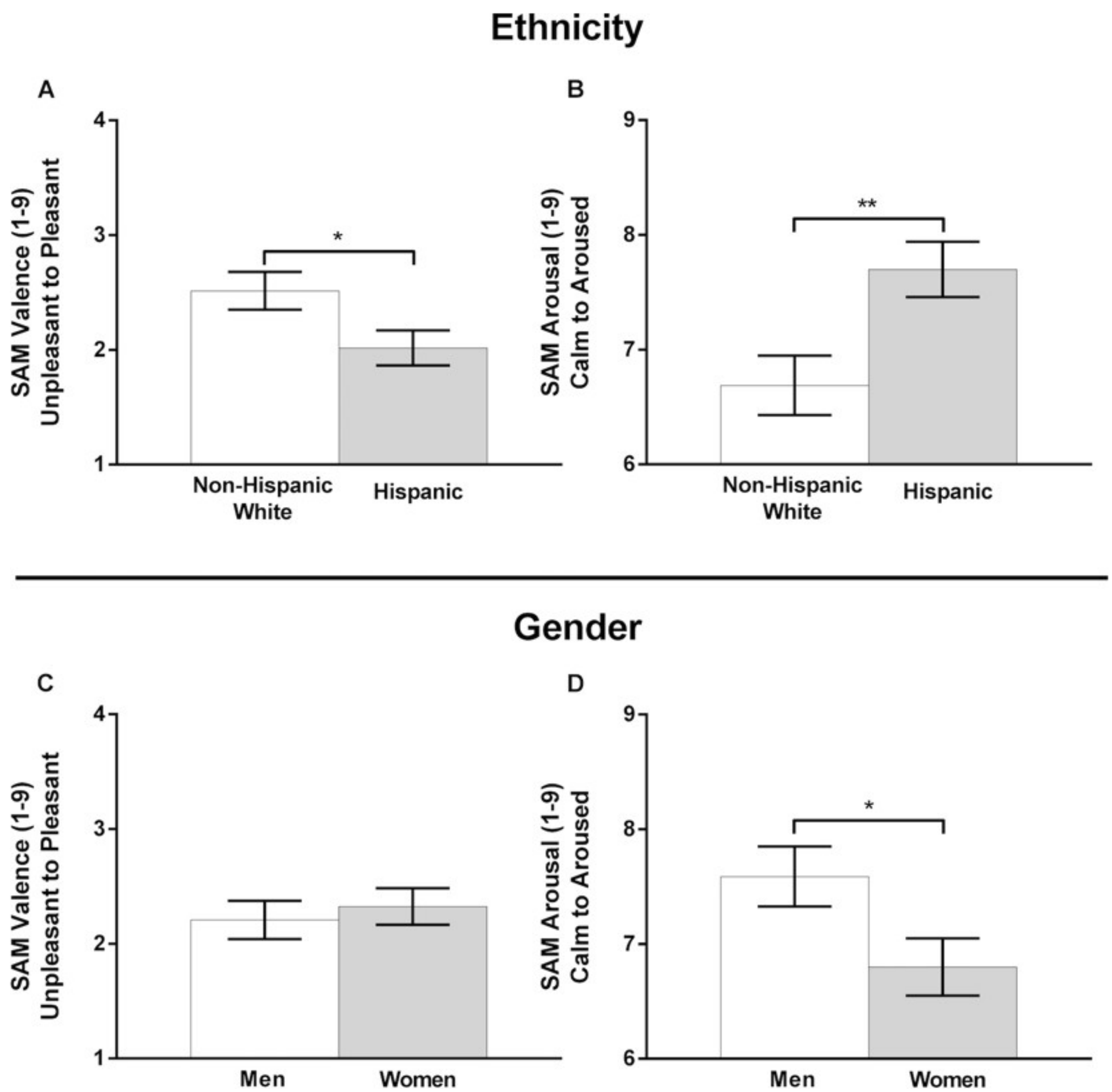

Figure 5 | Comparison of differences for SAM valence and arousal responses to the Heat Pain Tolerance Task by ethnicity (A,B) and gender (C,D).

Hispanics (A) reported greater unpleasantness and arousal in response to the heat pain tolerance task relative to non-Hispanic Whites. However, women displayed no difference in unpleasantness relative to men, but displayed lower arousal. Adjusted Mean ± SEM. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

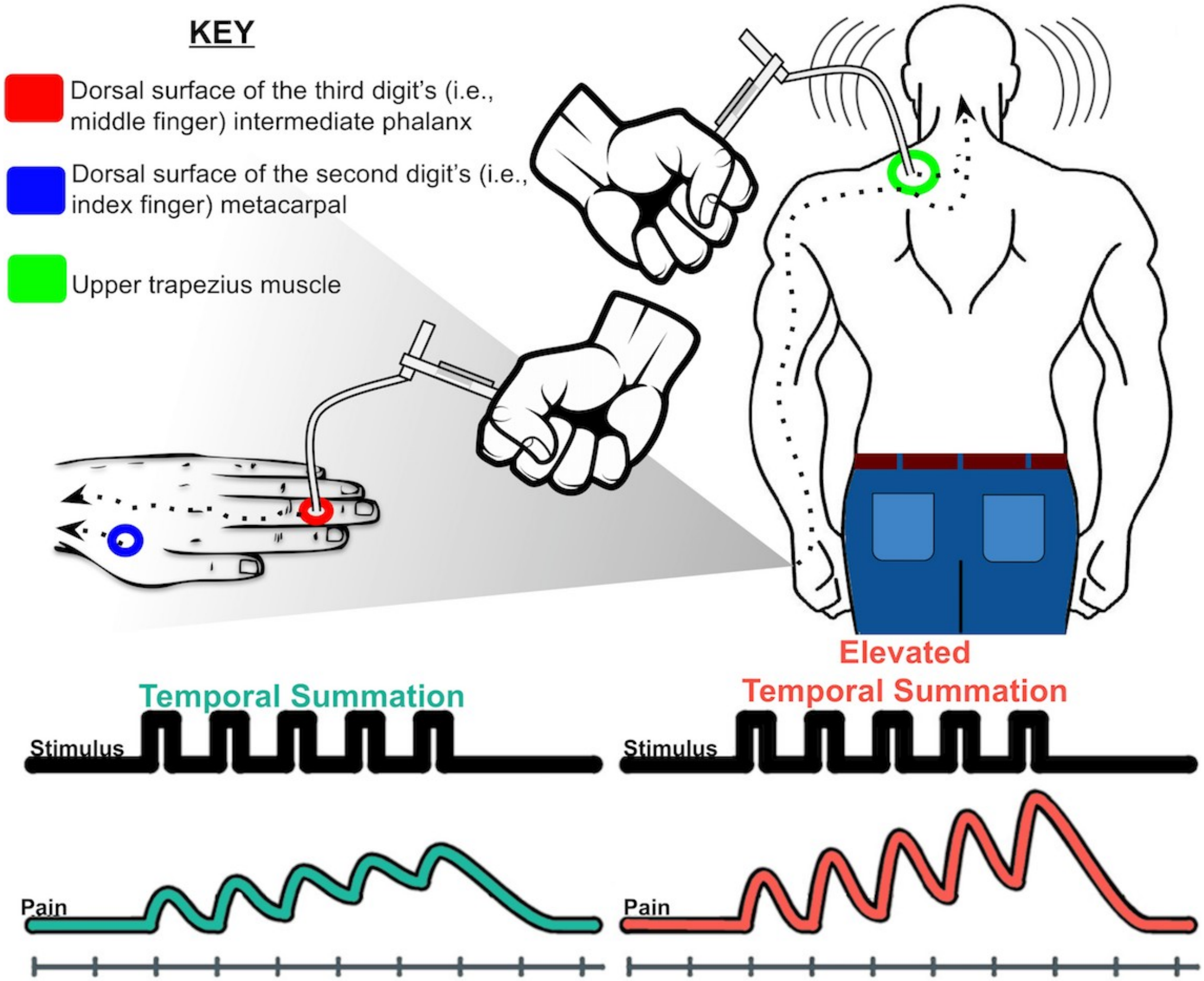

Figure 6 | Mechanical Temporal Summation of Pain procedure described in the current study.

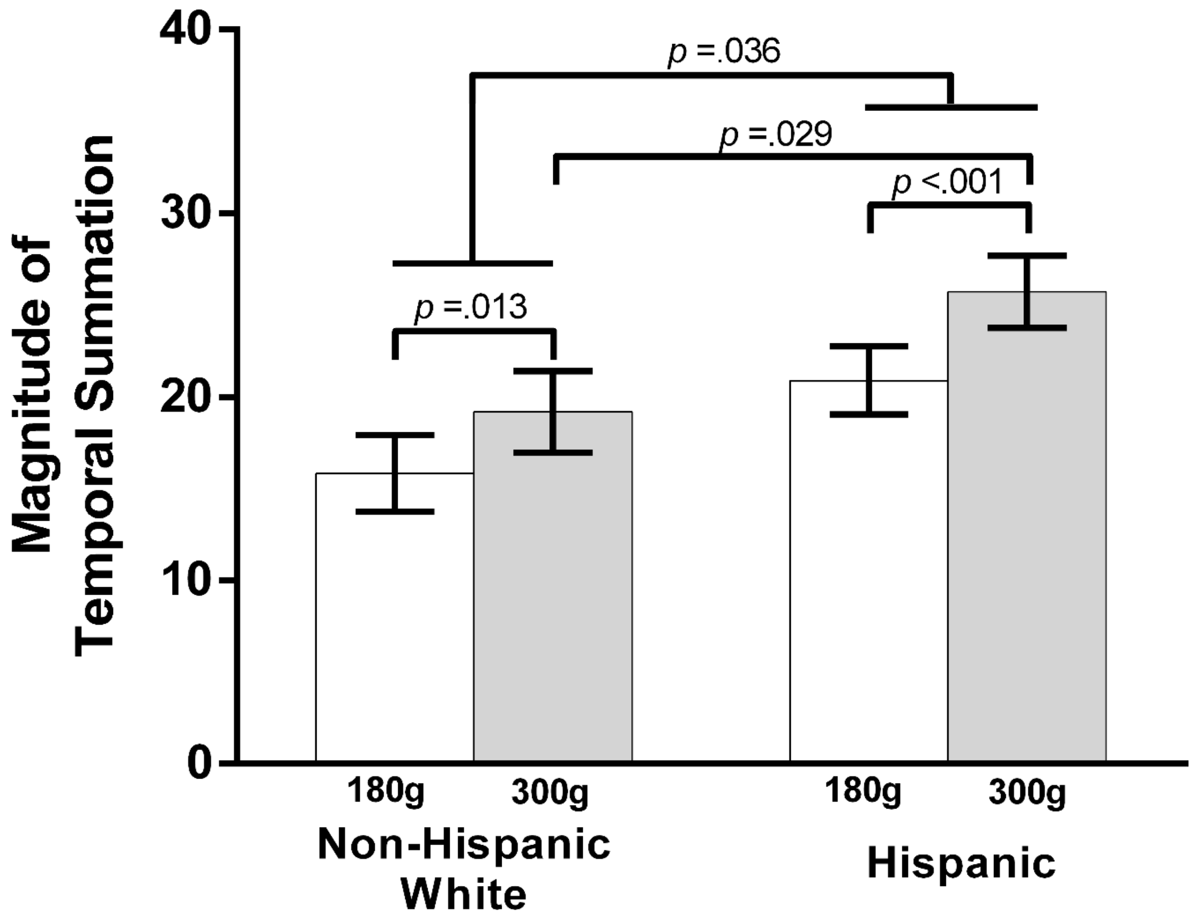

Figure 7 | Comparison of differences for Mechanical Temporal Summation to the 180g and 300g von Frey by ethnicity. Collapsed across body sites, greater summation was demonstrated at 300g relative to 180g. Moreover, Hispanics displayed greater temporal summation at the 300g von Frey relative to non-Hispanic Whites. Adjusted Mean ± SEM.

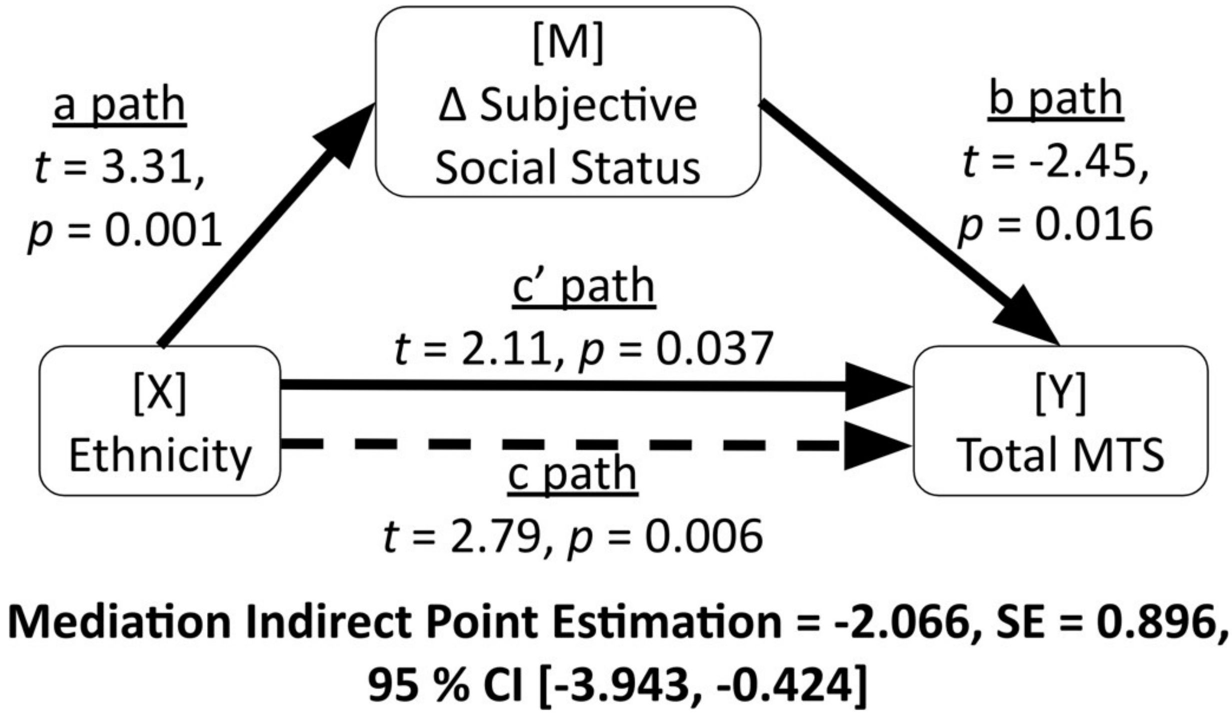

Figure 8 | Mediation model.

Path “a” represents the association between the independent variable and the mediator; path “b” represents the associations between the mediator and the dependent variable, controlling for the independent variable; path “c” represents the total effect of the model (direct effect + indirect effect); and path “ c’ ” represents the direct effect of the independent variable on the dependent variable. Ethnicity coded 0 = Non-Hispanic Whites, 1 = Hispanics; Δ Subjective Social Status = Current Subjective Social Status minus Childhood Subjective Social Status; Total MTS = Averaged 180g and 300g Mechanical Temporal Summation of Pain. * $p < .05$. ** $p < .01$ *** $p < .001$.

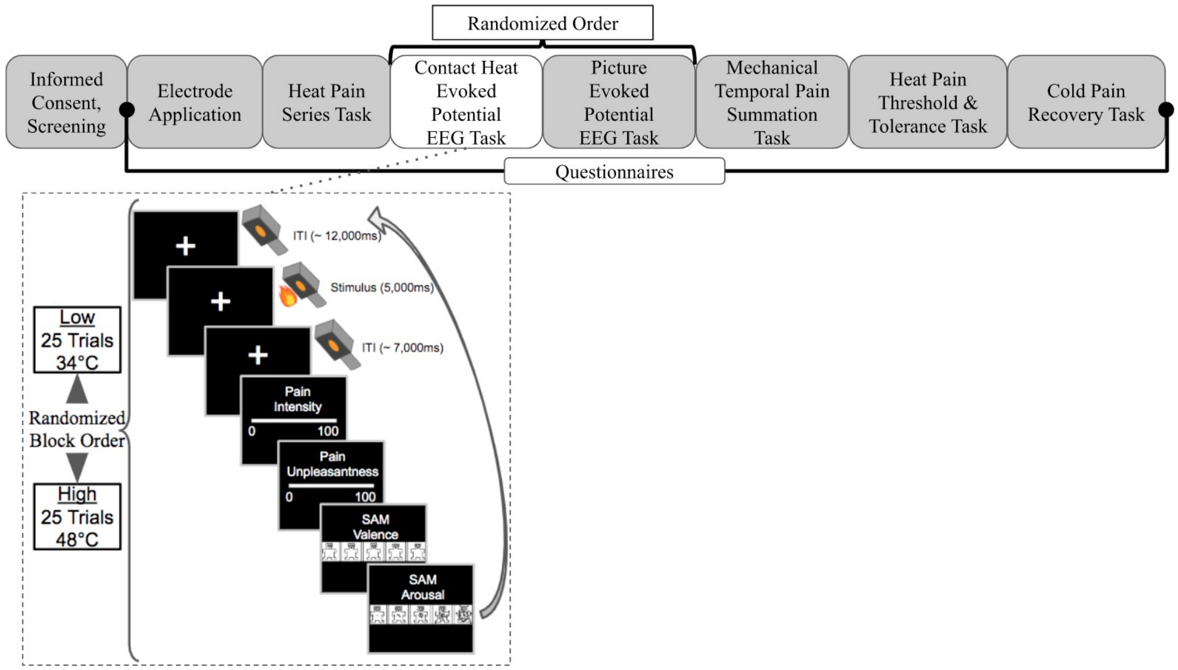

Figure 9 | Timeline of study procedures, including the Contact Heat-Evoked Potential Task described in the current study.

The Contact Heat-Evoked Potential Task is expanded to show the design of the task. Note: ITI = inter-trial interval.

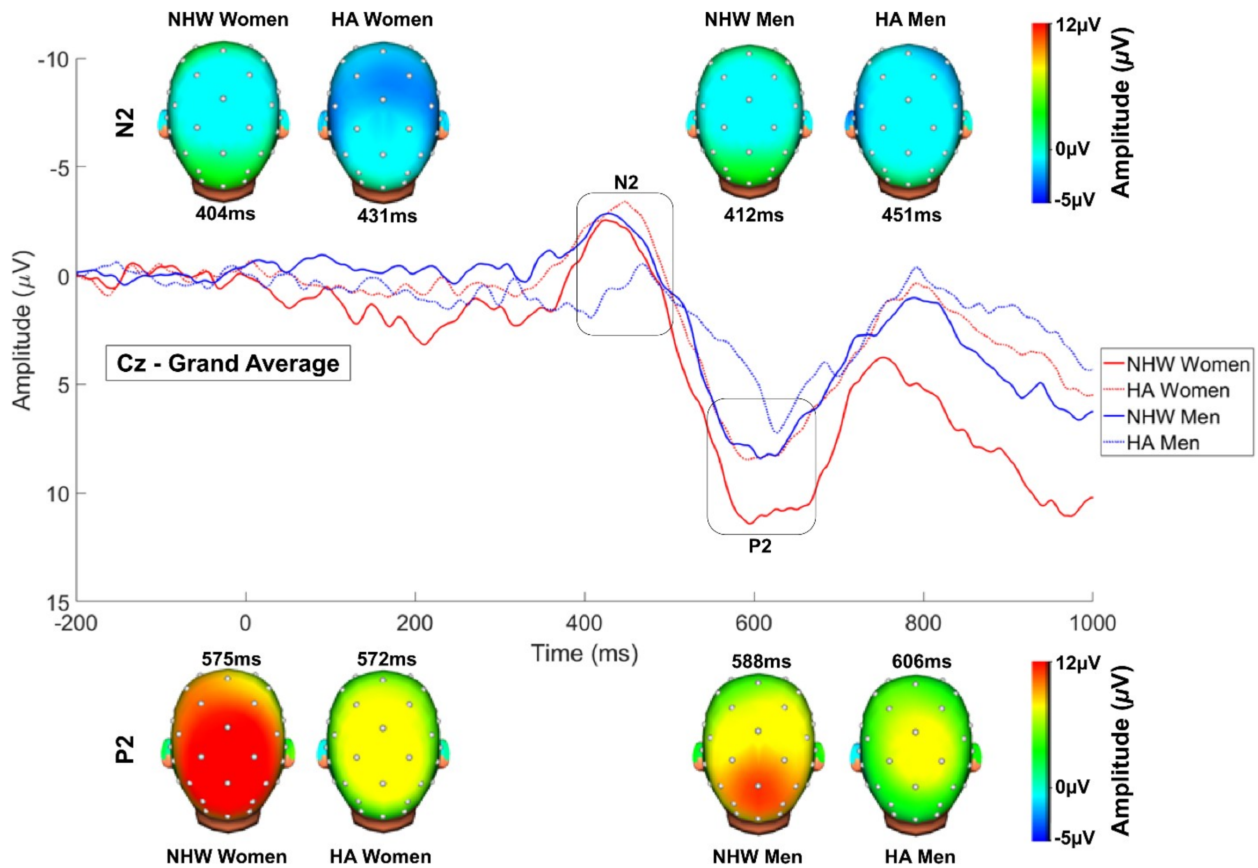

Figure 10 | N_2 and P_2 peaks and head maps of contact heat-evoked potentials (CHEPs).

Grand-averaged waveforms depict amplitudes at electrode Cz and dashed lines indicate the 250 to 800ms time window after stimulus onset time in which the N_2 and P_2 was scored.[200] Head maps are displayed at the latency of the N_2 and P_2 peaks. Note: NHW = Non-Hispanic White, HA = Hispanic American.

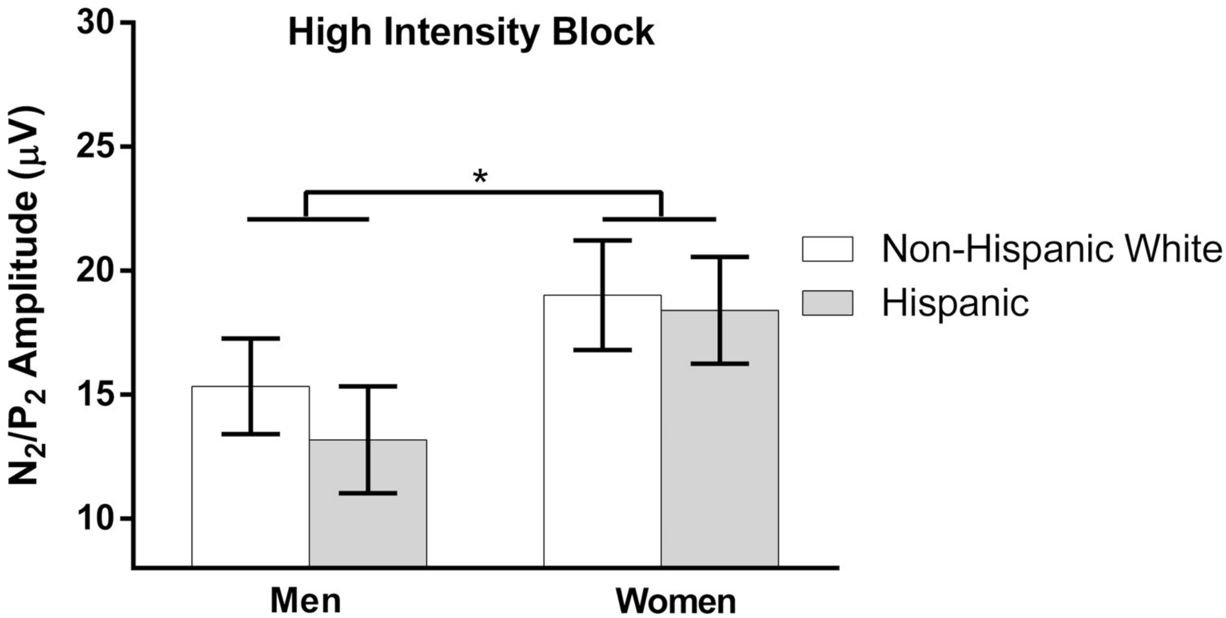

Figure 11 | Comparison of N_2/P_2 amplitudes to the high intensity contact heat stimuli collapsed across the 25 trials by ethnicity and gender.

Relative to men, women demonstrated greater N_2/P_2 amplitudes. Adjusted Mean $\pm$ SEM. * = $p < .05$.

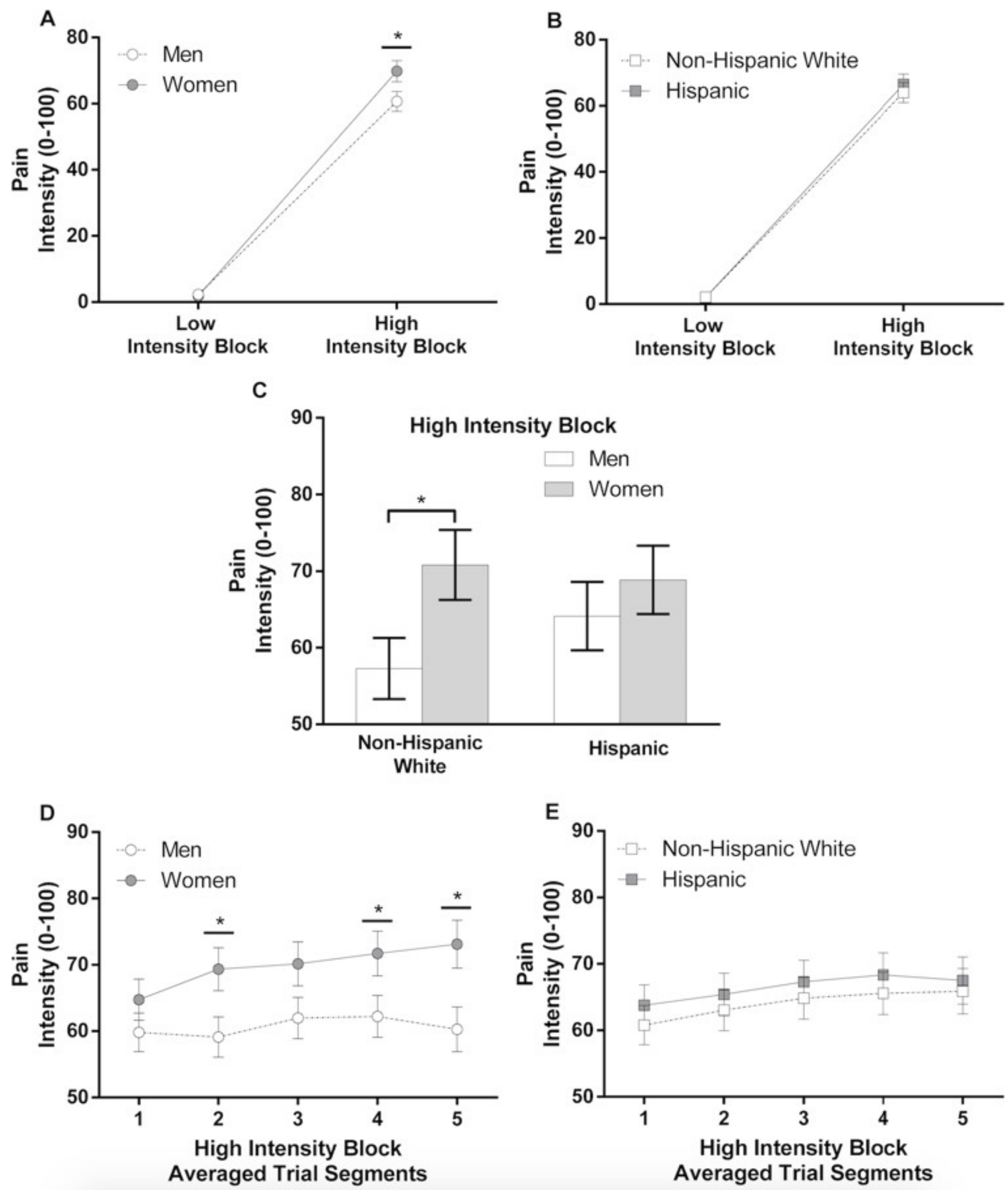

Figure 12 | Comparison of pain intensity by gender (A, D), ethnicity (B, E), and gender X ethnicity (C) to the Contact Heat-Evoked Potential Task.

The high intensity block of heat pulses contributed to greater pain intensity ratings relative to the low intensity block across gender (A) and ethnicity groups (B). Regarding the high intensity block, women reported greater pain intensity relative to men (A), but no difference was found across ethnicity groups (B). Exploratory Bonferroni adjusted pairwise comparisons revealed a significant difference between non-Hispanic White women and men, but no difference across genders within the Hispanic group (C). Dividing the high intensity block into five self-report pain intensity averaged trial segments, a sensitization pattern emerges for women that significantly differs from men (D). While both ethnicity groups increase in pain intensity ratings over trial segments, this sensitization is does not significantly change over trial segments and there are no differences between the groups (E). Adjusted Mean $\pm$ SEM. * = $p < .05$, ** = $p < .01$.

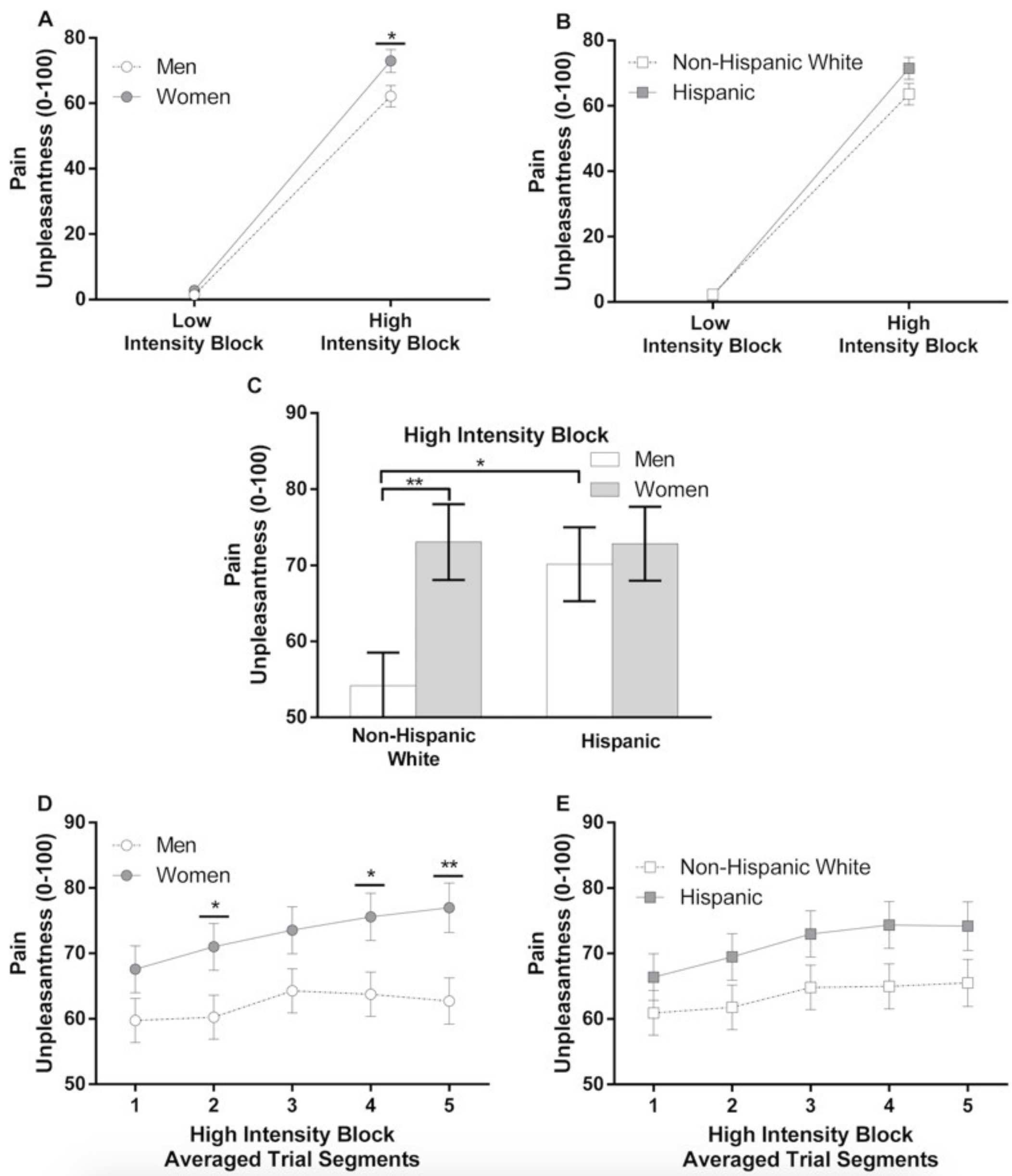

Figure 13 | Comparison of pain unpleasantness by gender (A, D), ethnicity (B, E), and gender X ethnicity (C) to the Contact Heat-Evoked Potential Task.

As with the pain intensity ratings, the high intensity block of heat pulses contributed to greater pain unpleasantness ratings relative to the low intensity block across gender (A) and ethnicity groups (B). Regarding the high intensity block, women reported greater pain unpleasantness relative to men (A), but no difference was found across ethnicity groups (B). Exploratory Bonferroni adjusted pairwise comparisons revealed a significant difference between non-Hispanic White women and men, but no difference across genders within the Hispanic group (C). However, Hispanic men reported greater unpleasantness relative to non-Hispanic White men during the high intensity block as well (C). Dividing the high intensity block into five averaged self-report pain unpleasantness trial segments, a sensitization pattern emerges for women that significantly differs from men (D). While both ethnicity groups increase in pain ratings over trial segments, this sensitization significantly changes over trial segments only for the Hispanic group (E). However, there are no differences between the groups at any trial segment (E). Adjusted Mean $\pm$ SEM. * = $p < .05$, ** = $p < .01$.

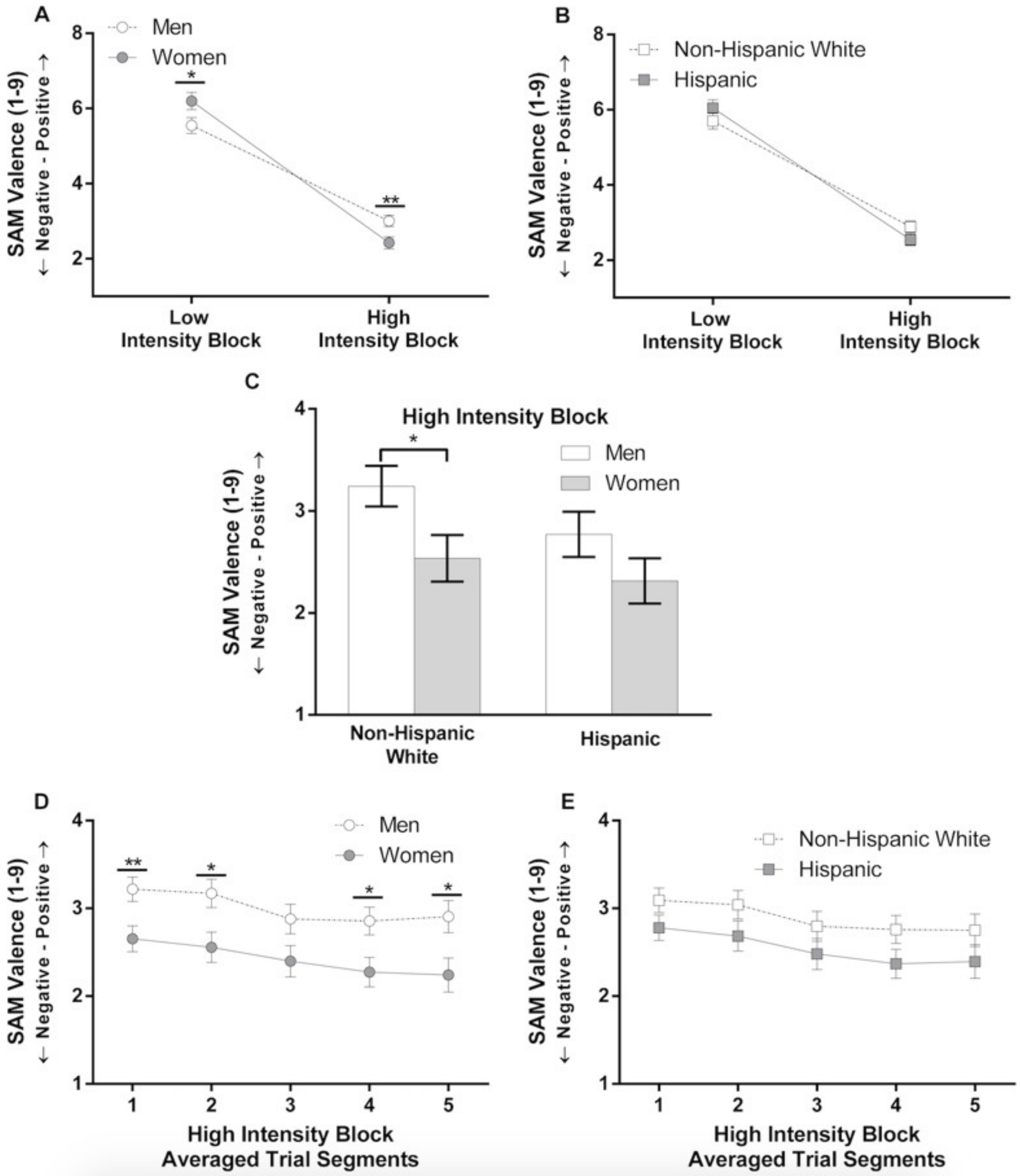

Figure 14 | Comparison of SAM valence ratings by gender (A, D), ethnicity (B, E), and gender X ethnicity (C) to the Contact Heat-Evoked Potential Task.

The high intensity block of heat pulses contributed to greater negative emotional responses relative to the low intensity block across gender (A) and ethnicity groups (B). Women reported more positive emotional responses to the low intensity block relative to men, as well as more negative emotional responses to the high intensity block (A). There were no differences found across ethnicity groups (B) for the low or high intensity block. Exploratory Bonferroni adjusted pairwise comparisons revealed a significant difference between non-Hispanic White women and men, but no difference across genders within the Hispanic group

(C). Dividing the high intensity block into five averaged self-report SAM valence trial segments, women reported greater negative emotional responses relative to men across the entire block beginning at trial segment 1 (D). While both ethnicity groups appear to increase in negative emotional responses over trial segments, the change is not significant for either group (E). Furthermore, there are no differences between the groups at any trial segment (E). Adjusted Mean ± SEM. * = $p < .05$, ** = $p < .01$.

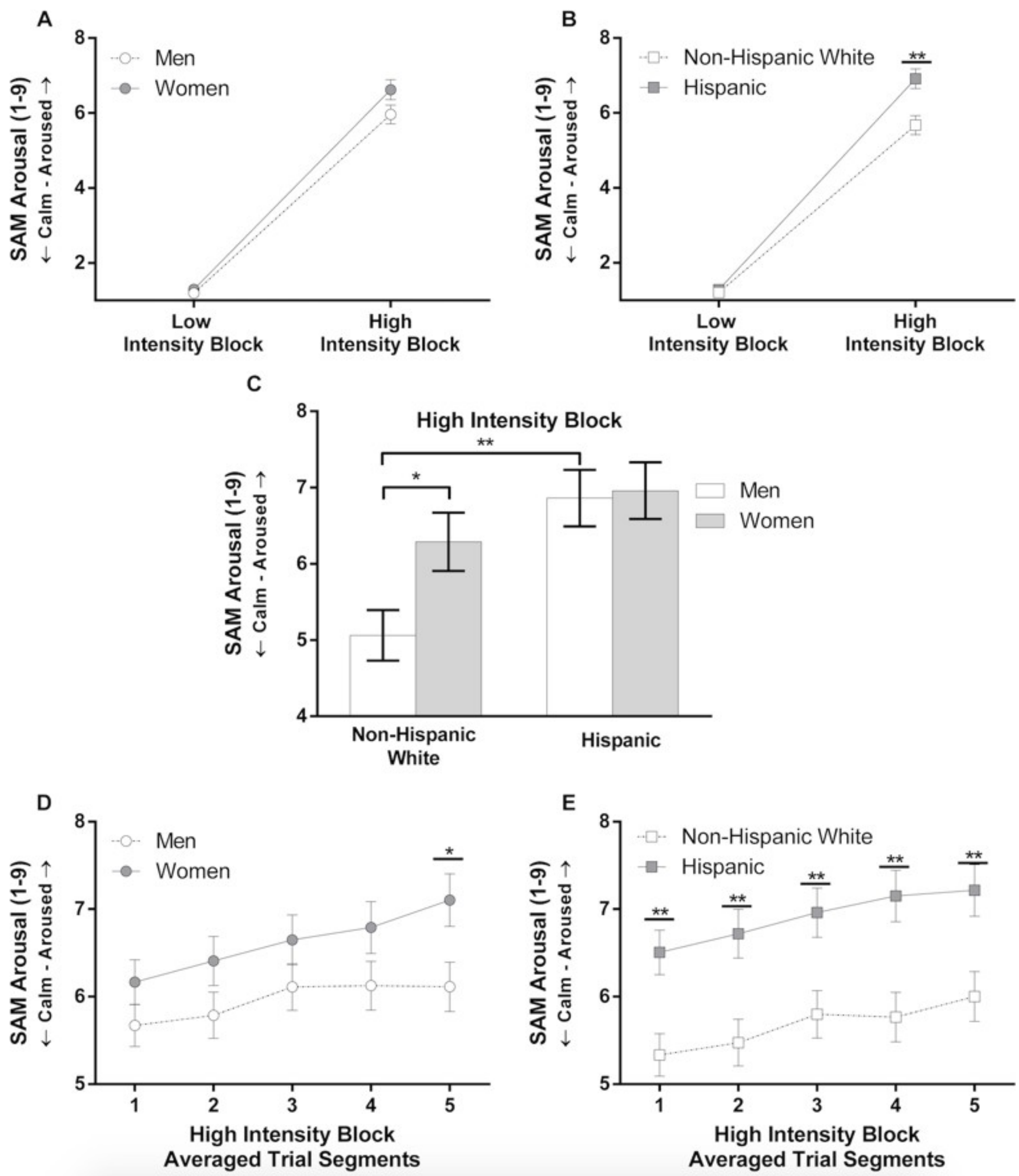

Figure 15 | Comparison of SAM arousal ratings by gender (A, D), ethnicity (B, E), and gender X ethnicity (C) to the Contact Heat-Evoked Potential Task.

The high intensity block of heat pulses contributed to greater arousal responses relative to the low intensity block across gender (A) and ethnicity groups (B). While there was no difference in arousal responses to the low intensity block across gender (A) and ethnicity groups (B), Hispanics reported more aroused responses to the high intensity block relative to non-Hispanic Whites (B) while women demonstrated comparable arousal response to men (A). Regarding the high intensity block, exploratory Bonferroni adjusted pairwise comparisons revealed a significant difference between non-Hispanic White women and men, but no difference across genders within the Hispanic group (C). Additional pairwise comparisons revealed that while there was no difference in women across ethnicity groups during the high intensity block (C). Dividing the high intensity block into five averaged self-report SAM arousal trial segments, sensitization in arousal responses begin for women at trial segment 4, while men demonstrate a shift from trial segment 2 to 3 (D). Furthermore, women reported greater arousal responses relative to men beginning at trial segment 2 (D). While both ethnicity groups appear to increase in negative emotional responses over trial segments, the change occurs at segment 4 for Hispanics and 5 for non-Hispanic Whites (E). Moreover, Hispanics display greater arousal responses throughout, beginning at trial segment 1 (E). Adjusted Mean $\pm$ SEM. * = $p < .05$, ** = $p < .01$.

APPENDIX B

TABLES

Table 1. Chapter 1 Completion Rate by Ethnicity and Gender

	Non-Hispanic White				Hispanic			
	Men		Women		Men		Women	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Total N	31		27		27		49	
Discontinued / Incomplete	3	9.7	4	14.8	3	11.1	9	18.4
Completed	28	90.3	23	85.2	24	88.9	40	81.6

Table 2. Chapter 1 Background Characteristics by Ethnicity and Gender

	Ethnicity						Gender						Two-Way ANOVA								
	Non-Hispanic White			Hispanic			Men			Women			Ethnicity			Gender			Ethnicity X Gender		
Continuous	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*F*	*p*	$\eta^2 p$	*F*	*p*	$\eta^2 p$	*F*	*p*	$\eta^2 p$
Age, years	58	19.09	0.88	76	18.83	0.86	58	19.17	1.01	76	18.76	0.71	1.76	0.187	0.013	**6.49**	**0.012**	**0.048**	0.64	0.426	0.005
Depressive Symptoms (CES-D; 0-60)	57	14.33	8.87	72	15.76	8.87	56	12.77	8.09	73	16.95	9.06	0.28	0.596	0.002	**6.83**	**0.010**	**0.052**	0.23	0.636	0.002
Perceived Stress (PSS; 0-40)	58	17.86	5.89	76	18.66	6.71	58	15.55	5.82	76	20.42	5.96	0.00	0.986	0.000	**21.90**	**< .001**	**0.144**	0.38	0.540	0.003
Trauma Frequency (ETISR)																					
Total (0-27)	57	5.53	3.38	70	7.56	4.96	56	6.68	3.77	71	6.62	4.91	**6.90**	**0.010**	**0.053**	0.25	0.617	0.002	0.05	0.819	0.000
General (0-11)	57	2.42	1.94	70	2.80	1.94	56	2.52	1.85	71	2.72	2.02	1.23	0.271	0.010	0.23	0.629	0.002	1.08	0.300	0.009
Physical (0-5)	57	2.07	1.72	70	2.31	1.73	56	2.87	1.63	71	1.68	1.62	2.02	0.158	0.016	**19.20**	**< .001**	**0.135**	0.76	0.385	0.006
Emotional (0-5)	57	0.86	1.33	70	1.67	1.82	56	1.18	1.54	71	1.41	1.76	**7.24**	**0.008**	**0.056**	0.13	0.717	0.001	0.00	0.951	0.000
Sexual (0-6)	57	0.18	0.57	70	0.77	1.49	56	0.11	0.37	71	0.82	1.51	**5.31**	**0.023**	**0.041**	**8.97**	**0.003**	**0.068**	2.32	0.130	0.019
Perceived Ethnic Discrimination (GEDS)																					
Recent (17-102)	57	21.26	4.75	72	27.21	9.63	56	24.55	8.80	73	24.60	8.09	**18.20**	**< .001**	**0.127**	0.46	0.498	0.004	0.00	0.948	0.000
Lifetime (17-102)	57	22.16	5.63	72	29.36	11.57	56	25.80	9.67	73	26.47	10.39	**18.22**	**< .001**	**0.127**	0.09	0.760	0.001	0.03	0.864	0.000
Stress Appraisal (17-102)	57	20.07	8.31	72	32.64	17.46	56	24.70	15.16	73	28.92	15.52	**22.53**	**< .001**	**0.153**	0.74	0.393	0.006	0.00	0.962	0.000
Perceived Ostracism (OES; 8-56)	57	13.40	5.93	72	13.01	6.53	56	13.70	6.94	73	12.79	5.69	0.07	0.786	0.001	0.64	0.426	0.005	0.31	0.581	0.002
Stigma Consciousness for Ethnicity (10-70)	57	31.88	10.20	72	35.76	11.17	56	32.25	10.64	73	35.42	10.94	2.83	0.095	0.022	1.60	0.209	0.013	1.07	0.303	0.008
Negative Personality Traits (NEM)																					
Total (0-36)	57	10.98	4.90	72	10.36	5.57	56	10.32	4.98	73	10.88	5.50	0.56	0.454	0.004	0.51	0.476	0.004	0.02	0.900	0.000
Aggression (0-12)	57	3.37	2.34	72	2.50	1.82	56	3.91	2.14	73	2.10	1.71	3.54	0.062	0.028	**26.83**	**< .001**	**0.177**	2.69	0.104	0.021
Alienation (0-12)	57	2.21	2.24	72	2.40	2.48	56	2.00	2.37	73	2.56	2.36	0.06	0.806	0.000	1.62	0.206	0.013	0.01	0.931	0.000
Stress Reaction (0-12)	57	5.40	3.10	72	5.46	3.51	56	4.41	3.20	73	6.22	3.22	0.10	0.748	0.001	**10.67**	**0.001**	**0.079**	1.21	0.273	0.010
Emotion Regulation Tendencies (ERQ)																					
Reappraisal (6-42)	58	28.98	5.00	76	30.62	5.52	58	29.97	4.91	76	29.87	5.69	3.48	0.065	0.026	0.13	0.719	0.001	0.47	0.493	0.004
Suppression (4-28)	58	15.31	5.35	76	15.41	4.52	58	15.98	5.00	76	14.89	4.76	0.06	0.811	0.000	2.03	0.157	0.015	1.35	0.248	0.010
Coping Behavior Tendencies (COPE)																					
Self-Distraction (2-8)	58	6.09	1.39	76	6.16	1.33	58	5.95	1.32	76	6.26	1.37	0.01	0.945	0.000	1.68	0.197	0.013	0.00	0.965	0.000
Active Coping (2-8)	58	6.07	1.52	76	6.09	1.35	58	6.36	1.36	76	5.87	1.44	0.16	0.689	0.001	**4.43**	**0.037**	**0.033**	0.38	0.539	0.003
Denial (2-8)	58	2.47	0.80	76	2.49	0.89	58	2.47	0.82	76	2.49	0.87	0.03	0.870	0.000	0.03	0.870	0.000	0.24	0.627	0.002
Substance Use (2-8)	58	2.57	1.09	76	2.53	1.24	58	2.71	1.33	76	2.42	1.04	0.00	0.984	0.000	2.06	0.154	0.016	0.45	0.504	0.003
Emotional Support (2-8)	58	4.88	1.82	76	5.25	1.95	58	4.55	1.94	76	5.50	1.76	0.50	0.482	0.004	**8.09**	**0.005**	**0.059**	0.63	0.430	0.005
Instrumental Support (2-8)	58	5.43	1.93	76	5.37	1.94	58	5.02	1.95	76	5.68	1.87	0.18	0.669	0.001	**4.81**	**0.030**	**0.036**	1.84	0.178	0.014
Behavioral Disengagement (2-8)	58	2.83	1.26	76	2.87	1.19	58	2.60	0.99	76	3.04	1.34	0.00	0.973	0.000	**4.93**	**0.028**	**0.037**	2.44	0.121	0.018
Venting (2-8)	58	4.21	1.54	76	3.89	1.35	58	3.81	1.53	76	4.20	1.36	2.34	0.129	0.018	3.30	0.072	0.025	0.04	0.841	0.000
Positive Reframing (2-8)	58	5.34	1.57	76	5.59	1.42	58	5.45	1.48	76	5.51	1.50	0.66	0.417	0.005	0.00	0.982	0.000	1.22	0.272	0.009
Planning (2-8)	58	5.90	1.54	76	6.18	1.49	58	6.21	1.44	76	5.95	1.57	1.50	0.223	0.011	1.56	0.214	0.012	0.36	0.547	0.003
Humor (2-8)	58	5.66	1.93	76	5.03	1.88	58	5.83	1.94	76	4.89	1.82	1.92	0.168	0.015	**6.24**	**0.014**	**0.046**	0.23	0.630	0.002
Acceptance (2-8)	58	5.71	1.41	76	5.86	1.26	58	6.05	1.25	76	5.59	1.36	0.77	0.382	0.006	**5.35**	**0.022**	**0.040**	2.54	0.113	0.019
Religion (2-8)	58	4.91	2.41	76	5.20	2.03	58	4.71	2.28	76	5.36	2.11	0.16	0.688	0.001	2.37	0.126	0.018	0.18	0.676	0.001
Self-Blame (2-8)	58	5.26	1.76	76	5.29	1.93	58	5.07	1.81	76	5.43	1.89	0.00	0.966	0.000	1.41	0.238	0.011	0.49	0.486	0.004

	Ethnicity				Gender				Chi-Square			
	Non-Hispanic White		Hispanic		Men		Women		Ethnicity		Gender	
Categorical	*N*	*Median or %*	*N*	*Median or %*	*N*	*Median or %*	*N*	*Median or %*	χ^2	*p*	χ^2	*p*
Current												
Household Income (1-9)	58	9	74	6	58	8.5	74	7	**37.53**	**< .001**	10.54	0.308
Subjective Social Status, U.S. (1-9)	58	6	74	5	58	5	74	5	**18.96**	**0.015**	10.07	0.26
Childhood												
Household Income (1-9)	47	9	64	7	49	8	62	7.5	**28.24**	**< .001**	11.21	0.13
Father's Education (1-9)	57	7	74	5.5	57	7	74	6	**29.29**	**0.001**	9.28	0.412
Mother's Education (1-9)	58	7	74	6	58	7	74	6	**35.63**	**< .001**	9.64	0.292
Subjective Social Status, U.S. (1-9)	58	6	74	4	58	6	74	5	**34.94**	**< .001**	**18.35**	**0.019**
Trauma Symptom - Disturbance Yes (ETISR)	57	29.80%	70	70.20%	56	26.80%	71	45.1	**6.87**	**0.009**	**4.49**	**0.034**
Trauma Symptom - Dissociative Yes (ETISR)	57	10.50%	70	27.10%	56	14.30%	71	23.9	**5.49**	**0.019**	1.85	0.174

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 3. Chapter 1 Self-Report Responses to Pictures by Ethnicity and Gender

		Ethnicity						Gender						Two-Way ANOVA								
		Non-Hispanic White			Hispanic			Men			Women			Ethnicity			Gender			Ethnicity X Gender		
Task	Response	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*F*	*p*	η^2p	*F*	*p*	η^2p	*F*	*p*	η^2p
Neutral Images	Valence	54	5.24	0.47	68	5.30	0.84	54	5.30	0.48	68	5.25	0.84	0.24	0.626	0.002	0.26	0.609	0.002	0.25	0.619	0.002
	Arousal	54	1.49	0.64	68	1.79	1.07	54	1.57	0.60	68	1.73	1.11	2.60	0.109	0.022	0.37	0.544	0.003	0.002	0.968	0.000
Negative Images	Valence	54	3.09	0.66	68	2.82	0.84	54	3.21	0.75	68	2.73	0.73	1.84	0.178	0.015	**11.17****	**0.001**	**0.086**	0.589	0.444	0.005
	Arousal	54	4.09	1.54	68	4.62	1.72	54	4.10	1.54	68	4.61	1.73	2.41	0.123	0.020	2.20	0.141	0.018	1.771	0.186	0.015

Note: Significant values after Bonferroni-corrected alpha levels are indicated with a black cell. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 4. Chapter 1 Noxious Stimulus Intensity/Duration Differences by Ethnicity and Gender

	Ethnicity						Gender						Two-Way ANOVA								
	Non-Hispanic White			Hispanic			Men			Women			Ethnicity			Gender			Ethnicity X Gender		
Response	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*F*	*p*	$\eta^2 p$	*F*	*p*	$\eta^2 p$	*F*	*p*	$\eta^2 p$
Heat Pain Tolerance Intensity, °C	52	48.43	1.87	63	48.03	1.73	53	48.97	1.43	62	47.56	1.83	0.27	0.602	0.002	**19.20*** **	**< .001**	**0.147**	0.28	0.597	0.003
Tested Suprathreshold Heat Pain Intensity, °C	56	47.75	0.84	72	47.43	1.10	57	47.77	0.68	71	47.41	1.18	1.97	0.163	0.016	2.87	0.093	0.023	0.345	0.558	0.003
Cold Pressor Pain Tolerance Duration, Seconds	51	87.84	88.03	64	69.45	80.12	52	91.13	88.19	63	66.44	79.05	0.78	0.380	0.007	1.82	0.180	0.016	0.215	0.644	0.002

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 5. Chapter 1 Self-Report Responses to All Noxious Tasks by Ethnicity and Gender

			Ethnicity						Gender						Two-Way AN(C)OVA								
			Non-Hispanic White			Hispanic			Men			Women			Ethnicity			Gender			Ethnicity X Gender		
Modality	Task	Response	*N*	*Mean*	*SD*	*N*	*Mean*	SD	*N*	*Mean*	*SD*	*N*	*Mean*	SD	*F*	*p*	η^2p	*F*	*p*	η^2p	*F*	*p*	η^2p
Heat	Heat Pain Series Task, 41°C	Pain Intensity (VAS, 0-10)	58	2.49	1.50	73	2.32	1.39	57	2.26	1.15	74	2.50	1.62	0.58	0.447	0.005	1.29	0.259	0.010	0.70	0.404	0.005
	Heat Pain Series Task, 44°C	Pain Intensity (VAS, 0-10)	58	4.04	1.87	73	4.46	1.87	57	4.04	1.79	74	4.46	1.93	1.32	0.253	0.010	1.26	0.264	0.010	0.60	0.441	0.005
	Heat Pain Series Task, 47°C	Pain Intensity (VAS, 0-10)	58	5.38	1.77	73	6.07	1.77	57	5.31	1.56	74	6.12	1.89	3.57	0.061	0.027	5.60*	0.020	0.042	1.17	0.282	0.009
	Suprathreshold Heat Pain Task - # α < .05 / 12 outcomes = .004	Pain Intensity (VAS, 0-100)	52	63.57	20.96	67	64.66	20.10	54	62.21	19.55	65	65.81	21.08	0.01	0.917	0.000	0.88	0.350	0.008	1.96	0.165	0.017
		Pain Unpleasantness (VAS, 0-100)	52	62.51	24.17	67	67.10	21.66	54	62.53	23.55	65	67.23	22.12	1.07	0.303	0.009	1.36	0.246	0.012	3.31	0.071	0.028
		Valence (SAM, 1-9)	52	2.89	1.02	67	2.77	1.18	54	2.97	1.00	65	2.71	1.18	0.21	0.650	0.002	1.79	0.183	0.015	2.04	0.156	0.018
		Arousal (SAM, 1-9)	52	5.67	1.94	67	6.36	1.67	54	5.95	1.87	65	6.15	1.79	**4.84***	**0.030**	**0.041**	0.31	0.578	0.003	2.83	0.095	0.024
		Diverting Attention	52	9.50	8.88	67	11.97	8.48	54	8.52	7.95	65	12.86	8.87	1.02	0.315	0.009	**5.89***	**0.017**	**0.049**	0.42	0.520	0.004
		Catastrophizing	52	6.46	6.61	67	10.43	7.47	54	7.30	7.45	65	9.86	7.11	**7.40***	**0.008**	**0.061**	2.10	0.150	0.018	0.03	0.861	0.000
		Ignoring Pain Sensations	52	10.85	7.42	67	11.09	7.35	54	12.15	8.25	65	10.02	6.42	0.15	0.696	0.001	2.89	0.092	0.025	0.79	0.377	0.007
		Reinterpreting Pain Sensations	52	4.67	5.24	67	67.00	6.18	54	6.11	5.80	65	6.62	6.13	**6.87***	**0.010**	**0.057**	0.06	0.804	0.001	0.00	1.000	0.000
		Coping Self-Statements	52	18.25	4.96	67	19.24	3.85	54	18.54	5.16	65	19.03	3.63	1.53	0.219	0.013	0.36	0.550	0.003	**4.37***	**0.039**	**0.037**
		Hoping / Praying	52	2.42	3.49	67	4.48	5.06	54	2.50	3.86	65	4.48	4.89	**4.36***	**0.039**	**0.037**	3.82	0.053	0.032	0.19	0.667	0.002
		Active Coping	52	43.27	15.76	67	50.01	16.81	54	45.31	16.71	65	48.52	16.56	3.88	0.051	0.033	0.33	0.568	0.003	1.67	0.199	0.014
		Passive Coping	52	8.88	8.28	67	14.91	10.83	54	9.80	9.87	65	14.34	10.10	**8.61**	**0.004**	**0.070**	3.79	0.054	0.032	0.11	0.747	0.001
	Heat Pain Tolerance Task - # α < .05 / 4 outcomes = .01	Pain Intensity (VAS, 0-100)	52	81.89	13.21	63	83.72	15.67	53	84.54	12.47	62	81.49	16.12	0.78	0.378	0.007	2.63	0.108	0.023	1.87	0.175	0.017
		Pain Unpleasantness (VAS, 0-100)	52	76.70	22.30	63	83.25	17.78	53	79.64	20.66	62	80.85	19.82	3.06	0.083	0.027	0.06	0.812	0.001	2.26	0.135	0.020
		Valence (SAM, 1-9)	52	2.51	1.32	63	2.05	1.02	53	2.24	1.26	62	2.27	1.12	**4.76***	**0.031**	**0.041**	0.19	0.668	0.002	0.18	0.669	0.002
		Arousal (SAM, 1-9)	52	6.70	1.97	63	7.56	1.79	53	7.50	1.68	62	6.89	2.06	8.48**	0.004	0.072	3.27	0.073	0.029	1.84	0.177	0.016
Mechanical	Von Frey Series, 180g	Pain Intensity (VAS, 0-100)	52	28.24	20.39	65	36.22	24.28	53	32.42	22.18	64	32.89	23.63	3.50	0.064	0.030	0.08	0.785	0.001	0.11	0.743	0.001
	Von Frey Series, 300g	Pain Intensity (VAS, 0-100)	52	38.87	22.40	65	51.44	27.63	53	44.29	24.22	64	47.15	27.68	6.47*	0.012	0.054	0.01	0.936	0.000	0.09	0.761	0.001
Cold	Cold Pressor Task - # α < .05/ 12 outcomes = .004	Pain Intensity (VAS, 0-100)	51	71.08	20.14	64	74.66	22.24	52	74.83	19.67	63	71.62	22.63	0.76	0.384	0.007	1.61	0.208	0.014	0.16	0.689	0.001
		Pain Unpleasantness (VAS, 0-100)	51	80.69	20.91	64	82.58	20.76	52	83.56	18.67	63	80.24	22.38	0.28	0.597	0.003	1.27	0.262	0.011	0.73	0.394	0.007
		Valence (SAM, 1-9)	51	2.63	1.33	64	2.22	1.24	52	2.44	1.29	63	2.37	1.30	2.52	0.115	0.022	0.02	0.894	0.000	1.99	0.161	0.018
		Arousal (SAM, 1-9)	51	6.88	1.93	64	7.33	1.98	52	7.37	1.92	63	6.94	1.98	1.60	0.208	0.014	3.43	0.067	0.030	1.10	0.298	0.010
		Diverting Attention	51	8.71	8.32	64	8.56	8.38	52	7.29	8.20	63	9.73	8.32	0.07	0.791	0.001	3.01	0.086	0.027	1.35	0.248	0.012
		Catastrophizing	51	9.35	7.97	64	12.78	8.70	52	10.60	8.37	63	11.81	8.67	3.40	0.068	0.030	0.01	0.910	0.000	0.03	0.860	0.000
		Ignoring Pain Sensations	51	11.43	7.77	64	11.50	8.37	52	12.44	7.43	63	10.67	8.54	0.35	0.555	0.003	0.55	0.458	0.005	0.06	0.801	0.001
		Reinterpreting Pain Sensations	51	5.71	6.31	64	8.56	7.46	52	7.79	7.48	63	6.89	6.78	**5.75***	**0.018**	**0.050**	0.99	0.321	0.009	2.78	0.098	0.025
		Coping Self-Statements	51	16.14	6.31	64	17.33	5.12	52	17.98	6.06	63	15.83	5.21	3.39	0.068	0.030	3.60	0.060	0.032	1.43	0.234	0.013
		Hoping / Praying	51	1.00	2.25	64	3.42	4.72	52	1.90	3.88	63	2.71	4.09	10.07**	0.002	0.084	0.30	0.583	0.003	0.05	0.830	0.000
		Active Coping	51	41.98	17.55	64	45.95	20.34	52	45.50	18.73	63	43.11	19.61	2.40	0.124	0.021	0.21	0.649	0.002	2.52	0.116	0.022
		Passive Coping	51	10.35	8.43	64	16.20	11.30	52	12.50	9.98	63	14.52	10.90	**7.53****	**0.007**	**0.064**	0.02	0.900	0.000	0.00	0.955	0.000

NOTE: # = analyses controlled for individual's stimulus intensity/duration. If # is present next to the task name, α adjusted for number of outcomes. Significant values after Bonferroni-corrected alpha levels are indicated with a black cell. * *p* < .05, ** *p* < .01, *** *p* < .001

Table 6. Chapter 2 Characteristics by Ethnicity and Sex

	Non-Hispanic White						Hispanic								
	Male			Female			Male			Female					
Continuous	***N***	***Mean***	***SD***	***N***	***Mean***	***SD***	***N***	***Mean***	***SD***	***N***	***Mean***	***SD***	***F***	***p***	$\eta^2 p$
Age, years	29	18.99	1.01	23	18.83	0.717	24	19.04	1.042	39	18.79	0.767	2.469	0.066	0.063
Depressive Symptoms (CES-D) *	29	11.45	7.971	23	17.83	8.809	24	13.5	7.824	39	16.74	8.475	3.503	0.018	0.086
Anxiety Symptoms (BAI) **	29	5.52	6.55	23	12.13	8.308	24	9.21	7.604	39	11.15	8.33	4.027	0.009	0.098
Positive Affect (PANAS)	29	29.41	6.254	23	27.3	7.226	16	30.5	7.51	27	25.85	6.218	2.171	0.097	0.067
Negative Affect (PANAS)	29	14.24	5.242	23	16	4.431	16	14.38	3.364	27	14.74	4.382	0.731	0.536	0.024
Categorical	***N***	**%**		***N***	**%**		***N***	**%**		***N***	**%**		χ^2	***p***	
Subjective Social Status, U.S.													25.642	0.22	
Rung 1	0	0.0		1	4.3		0	0.0		1	2.6				
Rung 2	0	0.0		2	8.7		3	12.5		1	2.6				
Rung 3	1	3.4		3	13.0		4	16.7		7	17.9				
Rung 4	5	17.2		1	4.3		4	16.7		6	15.4				
Rung 5	6	20.7		5	21.7		7	29.2		13	33.3				
Rung 6	7	24.1		4	17.4		2	8.3		9	23.1				
Rung 7	8	27.6		5	21.7		4	16.7		1	2.6				
Rung 8	2	6.9		2	8.7		0	0.0		1	2.6				
Rung 9	0	0		0	0		0	0		0	0				

Abbreviations: BAI, Beck Anxiety Inventory; CES-D, The Center for Epidemiological Studies-Depression; PANAS, Positive and Negative Affect Schedule. * $p < .05$, ** $p < .01$.

Table 7. Chapter 3 Characteristics by Ethnicity

	Non-Hispanic White			Hispanic					
Continuous	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*F*	*p*	$\eta^2 p$
Demographic									
Age	51	19.12	0.13	65	18.86	0.11	2.30	0.132	0.02
Mood									
Depressive Symptoms (CES-D; 0 - 60)	51	13.98	8.70	65	15.37	8.23	0.77	0.381	0.007
Perceived Stress (PSS; 0 - 40)	51	17.96	5.86	65	18.34	6.75	0.10	0.752	0.001
Trauma Frequency (ETISR)									
Total (0 - 27)*	51	5.41	3.37	64	7.19	4.81	4.99	0.027	0.042
General (0 - 11)	51	2.33	1.85	64	2.70	1.89	1.11	0.295	0.01
Physical (0 - 5)	51	2.08	1.70	64	2.23	1.71	0.24	0.626	0.002
Emotional (0 - 5)*	51	0.82	1.31	64	1.58	1.80	6.32	0.013	0.053
Sexual (0 - 6)*	51	0.18	0.59	64	0.67	1.36	5.90	0.017	0.05

Categorical	*N*	*Median or %*	*N*	*Median or %*	χ^2	*p*
Demographic						
Gender (Female)	51	45%	65	63%	3.74	0.053
Current						
Current Household Income (1 - 9)***	43	9	60	7	32.61	<.001
Current Subjective Social Status, U.S. (1 - 9)	51	6	64	5	12.95	0.073
Δ Subjective Social Status (-8 - 8)*	51	-1	64	0	19.37	0.022
Childhood						
Childhood Household Income (1 - 9)**	41	9	55	7	25.24	0.001
Father's Education (1 - 9)**	51	7	64	5	27.12	0.001
Mother's Education (1 - 9)***	51	7	64	6	31.31	<.001
Childhood Subjective Social Status, U.S. (1 - 9)***	51	6	64	4	32.72	<.001

Note. Income Coded 1 = less than $5,000, 2 = $5,000 through $11,999, 3 = $12,000 through $15,999, 4 = $16,000 through $24,999, 5 = $25,000 through $34,999, 6 = $35,000 through $49,9997 = $50,000 through $74,999, 8 = $75,000 though $99,999, 9 = $100,000 and greater; **Parent's Education Coded** 1 = Elementary school or less, 2 = Middle school, 3 = Some high school, 4 = High school graduate/GED equivalent, 5 = Postsecondary school other than college, 6 = Some college, 7 = College graduate, 8 = Some graduate school, 9 = Graduate degree; **Abbreviations:** CES-D, The Center for Epidemiological Studies-Depression; PSS, Perceived Stress Scale. * $p < .05$, ** $p < .01$.

Table 8. Chapter 3 Assessment of Temporal Summation of Mechanical Pain at the Metacarpal, Phalanx, and Trapezius Muscle

180g von Frey	*Mean*	*SD*	*t*	*p*	*Cohen's d*
Metacarpal* **			11.69	< .001	1.085
Initial	13.16	12.41			
Peak	30.65	23.4			
Phalanx* **			12.98	< .001	1.205
Initial	16.93	16.03			
Peak	37.84	26.95			
Trapezius* **			12.00	< .001	1.114
Initial	12.48	11.81			
Peak	30.05	21.8			

300g von Frey	*Mean*	*SD*	*t*	*p*	*Cohen's d*
Metacarpal* **			13.94	< .001	1.294
Initial	23.07	20.73			
Peak	44.64	27.34			
Phalanx* **			13.37	< .001	1.242
Initial	26.09	21.92			
Peak	50.31	28.94			
Trapezius* **			14.06	< .001	1.306
Initial	20.44	17.58			
Peak	43.18	25.3			

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 9. Chapter 3 Correlation Matrices

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Non-Hispanic White														
1. Gender	-													
2. CES-D	-.404**	-												
3. PSS	-.509***	.725***	-											
4. Trauma Total	.053	.235	.22	-										
5. Trauma General	-.201	.192	.248	.729***	-									
6. Trauma Physical	.441**	-.055	-.175	.678**	.189	-								
7. Trauma Emotional	-.032	.311*	.279*	.522***	.033	.241	-							
8. Trauma Sexual	-.266	.211	.361**	.315*	.403**	-.134	-.037	-						
9. Current Household Income	-.105	.034	.087	.085	-.068	.258	-.022	-.032	-					
10. Childhood Household Income	.234	.01	-.191	-.099	-.236	.281	-.211	-.187	.159	-				
11. Parent's Education	.107	-.234	-.378**	-.239	-.161	-.033	-.350*	.011	-.105	.227	-			
12. Current Subjective Social Status	.221	-.302*	-.376**	-.123	-.196	.185	-.261	-.036	.233	.324*	.274	-		
13. Childhood Subjective Social Status	.361**	-.245	-.395**	-.074	-.259	.279*	-.125	-.137	.066	.631***	.343*	.657**	-	
14. Δ Subjective Social Status	-.084	-.141	-.082	-.083	.011	-.048	-.212	.094	.231	-.211	.003	.627**	-.176	-
15. Total Mechanical Temporal Summation	.026	.175	.012	-.051	-.008	-.097	-.017	.047	-.139	-.013	.024	.002	.093	-.093
Hispanic														
1. Gender	-													
2. CES-D	-.175	-												
3. PSS	-.291*	.655***	-											
4. Trauma Total	.024	.416***	.327**	-										
5. Trauma General	.071	.314*	.172	.747***	-									
6. Trauma Physical	.255*	.283*	.189	.708***	.337**	-								
7. Trauma Emotional	-.052	.357**	.308*	.765***	.397**	.416**	-							
8. Trauma Sexual	-.267*	.209	.275*	.602**	.308*	.232	.313*	-						
9. Current Household Income	-.088	-.186	-.054	-.156	-.309*	-.091	-.024	.018	-					
10. Childhood Household Income	.05	-.273*	-.154	-.079	-.214	-.015	.016	.019	.755***	-				
11. Parent's Education	.118	-.219	-.142	-.217	-.261*	-.114	-.15	-.064	.404**	.542***	-			
12. Current Subjective Social Status	-.052	-.186	-.08	-.13	-.152	-.117	-.07	-.012	.407**	.516***	.332**	-		
13. Childhood Subjective Social Status	.011	-.269*	-.138	-.204	-.269*	-.121	-.141	-.008	.493***	.553***	.536***	.635***	-	
14. Δ Subjective Social Status	-.068	.147	.091	.122	.183	.033	.106	-.003	-.21	-.157	-.334**	.229	-.607***	-
15. Total Mechanical Temporal Summation	-.054	-.06	.015	-.122	-.039	-.053	-.155	-.107	-.067	.056	.22	-.03	.237	-.329**

Note. Ethnicity Coded 0 = Non-Hispanic Whites, 1 = Hispanics; **Gender Coded** 0 = Women, 1 = Men; **Income Coded** 1 = less than \$5,000, 2 = \$5,000 through \$11,999, 3 = \$12,000 through \$15,999, 4 = \$16,000 through \$24,999, 5 = \$25,000 through \$34,999, 6 = \$35,000 through \$49,9997 = \$50,000 through \$74,999, 8 = \$75,000 though \$99,999, 9 = \$100,000 and greater; **Parent's Education Coded** 1 = Elementary school or less, 2 = Middle school, 3 = Some high school, 4 = High school graduate/GED equivalent, 5 = Postsecondary school other than college, 6 = Some college, 7 = College graduate, 8 = Some graduate school, 9 = Graduate degree; **CES-D** = Center for Epidemiological Studies Depression Scale; **PSS** = Perceived Stress Scale; **Δ Subjective Social Status** = Current Subjective Social Status minus Childhood Subjective Social Status.* $p < .05$. ** $p < .01$ *** $p < .001$.

Table 10. Chapter 4 Influence of Ethnicity and Gender on Contact Heat Evoked Potential Parameters

	Non-Hispanic White				Hispanic				Two-Way ANOVA								
	Men		Women		Men		Women		*Ethnicity*			*Gender*			*Ethnicity X Gender*		
Parameter	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***F***	***p***	***η²p***	***F***	***p***	***η²p***	***F***	***p***	***η²p***
N_2/P_2 Amplitude	15.33	6.59	19.00	9.76	13.17	7.29	18.34	13.89	0.45	0.506	0.006	**4.37***	**0.04**	**0.052**	0.13	0.724	0.002
N_2 Latency	475.59	105.69	484.02	82.51	473.58	95.82	444.48	63.22	1.12	0.294	0.014	0.28	0.600	0.003	0.91	0.342	0.011
P_2 Latency	568.00	115.33	580.75	74.91	568.21	98.79	547.90	68.30	0.63	0.431	0.008	0.03	0.859	0.000	0.67	0.417	0.008

NOTE: * $p < .05$.

Table 11. Chapter 4 Coping Strategy Use to the High Intensity Block by Ethnicity and Gender

	Non-Hispanic White				Hispanic				MANOVA								
	Men		Women		Men		Women		*Ethnicity*			*Gender*			*Ethnicity X Gender*		
CSQ-R	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***F***	***p***	***η²p***	***F***	***p***	***η²p***	***F***	***p***	***η²p***
Diverting Attention (0-30)	8.00	8.21	11.58	10.00	9.90	7.65	13.70	9.27	1.09	0.300	0.013	3.67	0.059	0.044	0.00	0.954	0.000
Catastrophizing (0-36)	5.88	7.62	7.42	5.59	8.60	7.57	13.00	7.92	**6.75***	**0.011**	**0.078**	3.46	0.067	0.041	0.80	0.373	0.010
Ignoring Pain Sensations (0-30)	11.80	8.36	10.63	6.56	12.75	9.08	8.70	6.82	0.08	0.776	0.001	2.31	0.133	0.028	0.70	0.404	0.009
Reinterpreting Pain Sensations (0-24)	5.04	5.15	4.05	5.36	7.10	5.52	7.45	6.55	**4.85***	**0.030**	**0.057**	0.29	0.591	0.004	0.07	0.798	0.001
Coping Self-Statements (0-24)	17.48	5.81	19.37	3.72	19.90	4.41	18.65	4.04	0.69	0.408	0.009	0.10	0.756	0.001	2.35	0.129	0.029
Hoping / Praying (0-18)	1.76	2.47	3.05	4.38	2.95	5.26	6.70	5.48	**6.13***	**0.015**	**0.071**	**6.66***	**0.012**	**0.077**	1.58	0.212	0.019
Active Coping (0-108)	42.32	15.72	45.63	16.29	50.00	18.09	48.15	16.41	1.96	0.165	0.024	0.04	0.842	0.001	0.50	0.481	0.006
Passive Coping (0-54)	7.64	9.03	10.47	7.56	11.55	11.26	19.70	11.49	**9.07****	**0.003**	**0.102**	**6.34***	**0.014**	**0.073**	1.49	0.227	0.018

NOTE: Active Coping = Sum of Diverting Attention, Ignoring Pain Sensations, Reinterpreting Pain Sensations, and Coping Self-Statements. Passive Coping = Sum of Catastrophizing and Hoping / Praying. * $p < .05$, ** $p < .01$.

Table 12. Chapter 4 Correlation Matrix

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Ethnicity	-													
2. Gender	-.068	-												
3. VAS Pain Intensity	.083	-.234*	-											
4. VAS Pain Unpleasantness	.201	-.256*	.819***	-										
5. SAM Valence	-.191	.295**	-.650***	-.717***	-									
6. SAM Arousal	.365**	-.213	.574***	.711***	-.645***	-								
7. CSQ-R Diverting Attention	.127	-.216*	.154	.129	-.119	.11	-							
8. CSQ-R Catastrophizing	.280**	-.21	.373***	.465***	-.456***	.394***	.209	-						
9. CSQ-R Ignoring Pain Sensations	-.037	.165	-.393***	-.308**	.323**	-.235*	-.044	-.328**	-					
10. CSQ-R Reinterpreting Pain Sensations	.234*	.044	-.177	-.113	.123	.11	.217*	.091	.343**	-				
11. CSQ-R Coping Self-Statements	.105	-.048	.052	.06	-.051	.152	.121	.051	.117	.276*	-			
12. CSQ-R Hoping / Praying	.265*	-.278*	.096	.177	-.231*	.185	.181	.481***	-.301**	.173	.045	-		
13. CSQ-R Active Coping	.161	-.036	-.15	-.098	.117	.029	.624***	.003	.600***	.701***	.497***	.027	-	
14. CSQ-R Passive Coping	.316**	-.272*	.307**	.408***	-.426***	.361**	.229*	.922***	-.365**	.141	.056	.783***	.015	-
15. N_2/P_2 Amplitude	-.06	-.221*	.055	.131	-.275*	.081	-.045	.18	-.115	-.088	.067	.068	-.09	.158

Note. Ethnicity Coded 0 = Non-Hispanic Whites, 1 = Hispanics; Gender Coded 0 = Women, 1 = Men. * $p < .05$, ** $p < .01$, *** $p < .001$.