EXPOSURE TO THREATENING ENVIRONMENTS, THREAT-RELATED ATTENTION BIAS, AND PAIN

A Thesis

by

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ABSTRACT

The study here was designed to examine the relationship between lifetime exposure to threatening environments, related attention biases, and sensitivity to pain. There is little understanding of the mechanisms that lead certain people to experience greater pain than others in response to a given stimulus. There is evidence that there are disparities in pain sensitivity among various sociodemographic groups (e.g., sex, race), and that attentional vigilance towards pain can enhance pain sensitivity. Participants included healthy volunteers. We hypothesized that people with greater lifetime exposure to threatening environments would demonstrate greater attentional biases to threat in the lab, report greater pain vigilance, and be more sensitive to physical pain stimuli. The findings did not support our original hypotheses; interpretations and suggestions for future work are discussed.

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INTRODUCTION

Racial disparities in pain in the United States are well-documented across various contexts, and profound (Green et al., 2003). A potential mechanism contributing to racial pain disparities in the United States may be the varying environmental contexts in which that individuals from different races grow up. Individuals from all backgrounds experience several types of physical, social, and emotional threats from their environment throughout their lifetime, though minority socio-demographic groups may be more likely to experience all types of threats than others. In this paper, we conceptualize threat as environmental, social, and physical factors that are likely to have psychological and physiological impacts. There has been an emergence of research relating stress experiences to health broadly – including pain sensitivity (Burke, Finn, McQuire & Roche, 2017). Furthermore, findings from animal research suggest that stress and threat can lead to enhanced pain (Madden IV, Akil, Patric & Barchas, 1977; King et. al, 1996).

In human research, perceived physical threats (e.g. threat to life, cumulative adversity, and threat of injury; Holbrook, Hoyt, Stein, & Sieber, 2001; You & Meagher, 2016; You & Meagher, 2018) and social threats (e.g. stereotype threat, perceived discrimination in healthcare, lack of physician trust; Aronson, Burgess, Phelan, & Juarez, 2013; Mathur et al., 2016; Haywood et al., 2014; Doescher, Saver, Franks & Fiscella, 2009) have been found to contribute to enhanced pain, and may also contribute to pain disparities seen across race. Additionally, social threats have been suggested as potential sites of intervention to combat health disparities (Burgess, Warren, Phelan, Dovidio, & van Ryn, 2010). Furthermore, researchers have posited that environmental toxic threats such as community stress, exposure to pollutants, reduced access to community resources, and high residential segregation yielding high concentrations of poverty

(Williams & Collons, 2001; Williams & Jackson, 2005; Gee & Payne-Sturges, 2004). These same environmental threats may also facilitate and maintain racial disparities in health (Fig 1c).

The effect of threat on physiology has also been empirically examined. Laboratory studies have documented the relationship between social threat (i.e. racism) and physiological effects (Fang & Myers, 2001; Guyll et al., 2001, Harrell et al., 2003, McNeilly et al., 1995; Tull et al., 2005) such as increased blood pressure, heart rate reactivity, and cortisol levels that may be acutely adaptive but can repetitively lead to negative health outcomes, including enhanced pain. Experimental studies have found that eliminating social threat, via the protective effect of social support, is related to reduced sensitivity to experimental pain (Brown, Sheffield, Leary, & Robinson, 2003). In groups more likely to experience threatening environments (i.e. African Americans with chronic pain), social threat (e.g. perceived racial discrimination) is known to significantly predict clinical pain (Goodin et al., 2013; Mathur et al., 2016), and may be a factor that contributes to widely documented racial pain disparities (Fig 1b).

A pertinent question is - what links threatening events to physiological pain sensitivity? A potential mechanism by which threat relates to pain is attention bias towards the threats that are prevalent in one's life. Individuals more likely to experience threat from their environment may pay more or less attention to threat from their surroundings. Attention may be a mediator between experiencing threat and enhanced pain – however the direction of this mediation is unknown. It is possible that individuals that are accustomed to encountering threatening stimuli more readily attend to threatening stimuli (e.g. are more vigilant), or are avoidant to threatening stimuli. Both of these cognitive strategies could be understood as functional strategies of addressing threat. Attention is a potential mediator of pain, however, it could function in either direction. The vigilance vs. avoidance question has been studied in various contexts, and results differ across type of stimuli (i.e. pain threat, social threat) and participant characteristics (i.e. fearful of pain, anxious, depressed), and have been explored with both dot probe and modified Stroop tasks (Heim-Dreger, Kohlmann, Eschenbeck, & Burkhardt, 2006; Mogg, Bradley, Miles & Dixon, 2004; Roelofs, Peters, van der Zijden, Thielen & Vlaeyen, 2003; Bar-Haim, Holoshitz, Edlar, Frenkel, & Muller, 2010).

This question may be especially pertinent for minority demographic groups, as they are potentially more likely to experience threat, and also more likely to experienced enhanced pain. Prior studies have found that self-reported and demonstrated pain vigilance (increased tendency to attend to pain cues from the environment), are linked to increased pain both in the lab and within everyday life (Crombez, Van Damme, & Eccleston, 2005; Lautenbacher et al., 2009; Keogh, Ellery, Hunt & Hannent, 2001). In a study exploring vigilance and avoidance towards experimentally induced pain, Keogh and colleagues found that males who were vigilant were more tolerant to pain and reported less subjective pain, than males who were avoiding pain (Keogh, Hatton, & Ellery, 2000), but these attention mediations were not found in women participants. Taken together, these findings may suggest attention may play a role in pain experience differently in different sociodemographic groups, though the mediation of attention in the relationship between race and pain is not well understood. Understanding if attention mediates the relationship between threat and pain also allows for growth of targeted interventions that would help combat racial pain disparities. Evidence supporting the use of attentional bias modification techniques (ABM) have been accumulating in recent years, and recent studies have found that small changes in attention biases towards affective pain stimuli (physical threat) following training are associated with increased pain tolerance (Todd et al., 2016), suggesting that training individuals to direct their attention towards affective pain-related stimuli may help improve pain sensitivity.

Beyond attention behaviors toward *pain* stimuli, attention bias related to threat broadly may also relate to pain. Thus far attention to threat has been primarily studied in terms of social threat and pain-threat. What is unknown is if threat-related attention biases related to threatening lived environments (i.e. lack of resources, lack of perceived safety, violence) are related to processing of pain. Researchers have studied the relationship between neighborhood contexts and health outcomes, however diversity of methods across these studies yields inconclusive findings. Potential causal pathways have been suggested linking neighborhood factors (e.g. environment-related stressors, environmental quality, limited sources) to higher vulnerability to negative physical health outcomes (e.g. poor health and disease; Ellen, Mijanovich, & Dillman, 2001; Geronimus, 1992), as well as negative mental health outcomes (e.g. stress and depression; Cutrona, Wallance & Wesner, 2006). Individuals growing up in lower socio-economically advantaged neighborhood contexts are more likely to feel threatened (e.g. perceived racial discrimination from law enforcement, high perceived neighborhood strain; Feldman & Steptoe, 2004; Stewart, Brunson & Simons, 2009), and these perceived threats may impact the attention processing of these individuals in the face of these threats (Fig 1a).

Understanding how perceived threats across contexts relate to attention may elucidate mechanisms by which environments contribute to large-scale, well-documented health disparities. In this study, we hypothesized that exposure to threatening environments throughout the lifetime is related to increased vigilance when presented with environment-related threatening cues, and consequently greater pain sensitivity in response to lab-controlled pain stimuli (Fig 1). In the context of the United States, identifying as a minority can be associated with higher levels of experienced threat from their external surroundings, society, and others. For example, individuals from low-SES backgrounds report experiencing more physical threat from their environment (Wilson, Kirtland, Ainsworth & Addy, 2004), and women in low-SES neighborhoods report a lack of perceived safety and less ability to be physically active (Bennett, McNeill, Wolin, Duncan, Puleo & Emmons, 2007). Ongoing discussions on intersectionality of identities are also pertinent to the pain disparities discussion, in that cumulative perceived threat from identifying with two or more minority groups (e.g. gender, race, social status) may relate uniquely to enhanced pain. Researchers have found that the intersection of race, sex, and age relates to pain interference in quality of life (Boyd et al., 2016), such that older adults with below-poverty incomes and African-American men are more likely to report that pain interferes with their daily work. However, the intersectionality of minority identities have not been examined with relation to pain in laboratory settings. Given that these threats are systematically more prevalent in certain communities, and therefore more common for certain groups, we secondarily explored intersectionality of racial and gender identity in relation to pain.

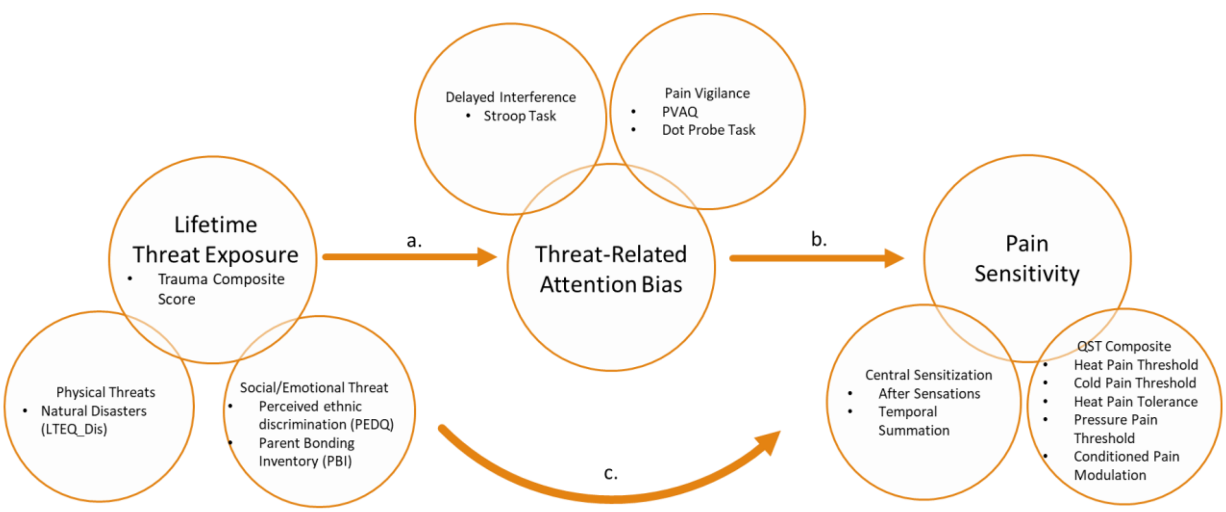

Figure 1. Model of hypotheses.

MATERIAL & METHODS

Participants

Participants for this study were drawn from two samples, one that was for course credit, and another that was paid and included two visits as well as an optional third visit consisting of additional questionnaires. The overall sample included 81 healthy volunteers *(40 F, 41 M, 30 Latinx-American, 39 White-American, 6 African-American, 3 Asian-American, 3 American-Indian)* who participated in this study and were compensated with either class credit or at a rate of $12 per hour. Because not all race groups were adequately powered to examine disparities, the current analyses focuses on Latinx-Americans (LA) and White-Americans (WA), specifically (*30 Latinx-American and 39 WA; 35 female and 34 male; n = 74, mean age = 21.13, SD = 3.59).* Participants were recruited from the Texas A&M University community using the undergraduate subject pool as well as university-wide listserv, and physical flyers located around campus. Everyone was screened for eligibility before signing consent. This study was approved by the Texas A&M institutional review board, and all participants completed a thorough verbal and written informed consent process before starting the study.

Inclusion/Exclusion.

Inclusion criteria were English proficiency, 18-45 years of age, feeling healthy the day of the study visit, and normal or corrected-to-normal vision. Exclusion criteria included current pain, current injury, recent history of chronic pain or major medical/psychiatric illness known to cause pain, color blindness, unmanaged attention deficiencies, or pain-altering medication/substance use within the last 3 days. Individuals participating in the paid study were also excluded for claustrophobia, any metal in the body (e.g. non-removable metal implants, metal dental work), and pregnancy.

Procedure

Participants completed all of the below procedures either in a single 1.5-hour visit, or in two visits that were approximately 1.5 hours each. Participants in the two-visit study were part of a larger study that included additional questionnaires, and an fMRI during their second visit. Participants in the paid study were also offered an optional third visit that consisted solely of questionnaires related to lifetime environmental threat.

After the consent process, participants completed a battery of quantitative sensory testing (QST) procedures, a 3-5 minute buffer task consisting of a puzzle (subject pool study) or a short battery of questions (paid study), attention tasks (Stroop and dot probe tasks in counterbalanced order). It is possible that lab pain may induce vigilance or hypervigilance towards threatening cues, and since research has not yet determined if this occurs, we included a buffer task between our pain measures and attention testing measures.

Participants were then asked to complete a battery of self-report questionnaires at our lab computer. Participants were informed that they can ask any questions if necessary and were given privacy throughout the questionnaires. The study ended with a debriefing process during which participants were encouraged to ask any questions they may have about the procedures they experienced.

Attention Bias Testing

The most widely used paradigms studying threat-related processing bias are the modified Stroop task (Mathews & MacLeod, 1985), and the dot probe task (MacLeod, Mathews & Tata, 1986). We chose to include both Stroop and dot probe for their distinct and complementary strengths. Namely, dot probe has been known to examine detection responses to stimuli, whereas

Stroop tasks assess for information processing and interference in response to various kind of stimuli. The association between the two tasks has been found to be mixed, so using both tasks also allowed us to examine different but potentially overlapping attentional measures. There are mixed findings regarding overall reliability in the dot probe task (Waechter, Nelson, Wright, Hyatt, & Oakman, 2014). However, dot probe tasks emphasizing detection of stimuli appear to be more reliable than differentiation tasks (Salemink, van den Hout, & Kindt, 2007), and dot probe was used in the form of a detection task in this study.

The modified Stroop task (Mogg, Bradley, Williams & Mathews, 1993) assesses an individual's selective processing of threat information. Studies have found participants to both evade threat processing during the modified Stroop task, as well as attend more to threatening stimuli – both vigilant *and* avoidant reactions to threatening stimuli are indicators of two fundamental coping strategies to threat (Calvo & Eysenck, 2000; Hock & Krohne, 2004). The Stroop Interference task allows us to observe where attentional resources are allocated to individuals that are presented with target words. Individuals that allocate more attention to target words related to pain show an indication of attention bias towards pain. This selective attention task reflects either vigilance or a difficulty in removing fixated attention and recent studies have supported the latter claim (Koster et al., 2004). Prior research suggests that participants demonstrate interference when exposed to threatening or frightening words during the Stroop task (Watts et al., 1986).

Presentation. Both tasks were programmed and presented using Psychtoolbox in MATLAB. The stimuli were presented on a 10.5 x 14-inch Dell Flat Panel Monitor (model 1707FPVt). The keyboard was placed 4 inches from the participant's seat and the computer screen was placed 14.25 inches from the participant's seat. The computer was set at administrative default settings of brightness, contrast, and exposure for all participants. All participants used Sennheiser eH2270 headphones to minimize distracting noise. Both tasks involved usage of a computer monitor and keyboard for response. Following verbal and computerized instruction, participants used the keyboard and corresponding labels on the keyboard to respond to the computerized attention tasks. The order of trials was randomly determined by the program, and recorded, for each participant.

Dot Probe.

Stimuli Validation. Images were selected from the International Affective Picture System (IAPS; Lang, O¨hman, & Vaitl, 1988) and open-access photo sites such as Pixabay. Photos were chosen to reflect threatening scenes and environments (e.g., boarded up windows, littered parks, drug needles on the ground) that would presumably be more or less familiar to individuals based on prior exposure in lived environments. Initially, 150 threatening and 150 neutral were chosen at face value by the first author to include in the dot probe task. Fifteen naïve coders then rated each image on a scale from 1 (not at all threatening) - 10 (extremely threatening). Coders also rated the images on valence [1 (Very Positive) - 10 (Very Negative) where 5 indicated "neutral"], and arousal [1 (Very Relaxed) - 10 (Very Stressed/Aroused)].

Looking at ranges at frequencies, experimenters planned to operationalize types of threat by identifying ranges that reflected where the peaks in frequency were seen. Overt threat was defined as images that evoked moderate-to-high threat (5-10), neutral-to-negative valence (5-10), and moderate-to-high arousal (5-10). Subtle threat was conceptualized as images that evoked moderate-to-high threat (5-10), neutral-to-negative valence (5-10), and low-to-moderate arousal (1-4). Neutral images were considered to evoke low threat (1-4), neutral-to-positive valence (1-4), and low arousal (1-4). Overall means on threat and arousal were low *(m = 4.78; 4.31*) and images that overlapped in high threat and arousal were very limited, therefore the ranges used to select stimuli were broadened to include the appropriate number of stimuli. Stimuli with *either* appropriately high threat or appropriately high valence were included in the 'threat' category. From this data, we chose equal numbers of threatening and neutral images based on mean scores of threat, valence, and arousal (*Table 1*).

Our final image set included 60 stimuli pairs consisting of had 30 subtle threat stimuli (ST), 30 overt threat stimuli (OT), and 60 neutral images (N). These images were equated on luminosity by taking an average histogram distribution of Red, Blue, and Green pixel intensities, and applying the average to all images in our set. Experimenters ensured no images were significantly distorted by this process. Images were also equated for size.

		Subtle Threat	***Overt Threat***	***Neutral***
Threat				
	Mean	5.98	7.51	1.59
	Sd	1.87	1.86	1.24
	Range	1-10	1-10	1-7
Valence				
	Mean	7.09	8.13	3.36
	Sd	1.48	1.31	1.73
	Range	2-10	5-10	1-7
Arousal				
	Mean	4.37	5.95	2.91
	Sd	1.76	1.98	1.46
	Range	1-10	1-10	1-6

Table 1. Stimuli Validation for Dot Probe Task

Task. The 60 stimuli pairs include one threat stimuli, and one neutral (ST-N, or OT-N) and were displayed for 1000 ms, following previous studies with similar stimuli (Mogg et al., 2000) with 500 ms inter-stimulus intervals. Exposure for this short amount of time is likely to reflect initial orienting of attention (Gamble & Rapee, 2009), which is a phenomenon related to hypervigilance for threat (Mogg & Bradley, 1999). Stimuli were counterbalanced for threat and neutral content equally on the left and right sides of the screen.

Participants saw two images that disappeared shortly, and a dot replaced one of the images on each trial. Participants were instructed to indicate the side of the screen on which the dot appeared. Response times were used to determine if participants exhibit bias or vigilance to threatening stimuli.

The Dot Probe task responses were calculated in two ways – RT differences, and error rates. RTs were calculated by averaging RT on all neutral stimuli for each participant and subtracting average RT for all threatening stimuli. The resulting value was referred to as "attention bias". A tendency to respond to the threatening item location faster was interpreted as an attentional bias (i.e., vigilance to threat). A tendency to respond to the threatening item location slower was interpreted as a difficulty in disengaging from threat (i.e., attentional delay). Error rates were also calculated by determining the percentage of incorrect responses in each stimuli condition. Trials with no responses were coded as missing data, and were not included in calculations, but were counted as errors for the error rate calculations. A discrepancy in error rates between neutral and threatening stimuli would inform on whether individuals were more successfully able to process one type of stimuli over the other. Subtle and overt images were not analyzed separately for main analyses due to the little difference in arousal and valence across subtle and overt stimuli. However, analyses of subtle vs overt threat stimuli are planned for future analyses, and discussed in future directions.

Stroop Task.

Stimuli Validation. Fifteen volunteers rated perceived threat of a list of words on a scale of [1 (Not at all threatening) - 10 (Extremely threatening)]. Using the mean scores from this data, we separated words ranked as highly threatening (*m* rating > 6), subtly threatening (4 < *m* rating < 6), low threat/neutral (0 < *m* rating < 4). Neutral words were used as our neutral stimuli for the Stroop task, and threatening stimuli were chosen from the subtly- and highly- threatening categories of stimuli to include a variety of threatening stimuli that are representative of various threatening environments. 102 neutral and 36 threatening words were displayed to participants during the actual task, for 138 trials. Words were displayed on the center of the screen following presentation of the fixation point for 500 ms.

		Subtle Threat	***High Threat***	***Neutral***
Threat				
	Mean	5.65	7.44	2.01
	Sd	2.14	4.40	1.08
	Range	4-7	7-9	1-4

Table 2. Stimuli Validation for Stroop Task

<u>*Task.*</u> Participants in this study performed a modified Stroop task in which participants were presented with words relating to environmental threat and neutral words. The participants first viewed a black screen with a plus sign in the center, followed by a word that appeared in either red, green, or blue. Participants were instructed to indicate the color of the word using three keys on a keyboard that were labeled “R”, “G”, and “B” as quickly as possible. A tendency to respond to the threatening word’s color in a slower manner in comparison to neutral stimuli may indicate a difficulty in disengaging from threat. A tendency to respond to the threatening word’s color in a faster manner than neutral stimuli was interpreted as an avoidance behavior.

Participant responses were calculated in terms of mean response times (RTs) between neutral and threatening images. Due to experimenter error, all neutral words were repeated while threatening stimuli were only displayed once. Repetition should not have occurred, as seeing repeated stimuli may affect participant response. To account for this experimenter error, responses were analyzed with total numbers of threat and neutral tasks, however RTs to stimuli that were shown twice were removed for the comparison of neutral and threatening averages, and all consequent analyses. If participants did not respond within the 500 ms interval, the screen proceeded to the next stimuli.

The Stroop task responses were calculated in two ways – RT differences, and error rates. RTs were calculated by averaging RT on all neutral stimuli for each participant and subtracting average RT for all threatening stimuli. The resulting value was referred to as “attention bias”. Error rates were also calculated by determining the percentage of incorrect responses in each stimuli condition. Trials with no responses were coded as missing data, and were not included in calculations, but were counted as errors for the error rate calculations. A discrepancy in error rates between neutral and threatening stimuli would inform on whether individuals were more successfully able to process one type of stimuli over the other. Subtle and overt words were not analyzed in the main analyses, however are planned for future analyses and discussed in future directions.

Quantitative Sensory Testing

First, participants completed assessments of static pain - pressure, heat, and cold pain thresholds, and heat pain tolerance in a counter-balanced order. Secondly, participants completed tests of conditioned pain modulation (CPM) and temporal summation (MTS) in a counter-balanced order. Participants were allowed to stop or refuse any procedure at any time. Breaks were built in between the different pain testing procedures and participants were given an opportunity to practice each procedure before testing was conducted.

Cold/Heat Pain Threshold & Heat Pain Tolerance

The Medoc Pathway system and the accompanying thermode surface were used for the measures of cold pain threshold, heat pain threshold, and heat pain tolerance. The thermode was placed on the participant's left volar forearm and experimenters used an ascending method of limits paradigm to assess for cold pain threshold (CPTh), heat pain threshold (HPTh), and heat pain tolerance (HPTo). Between trials, the thermode was moved to a different location of the forearm to avoid overlapping stimulation sites. Participants were asked to click a mouse when the thermode first produced a painful sensation from gradually increasing HPTh or decreasing CPTh temperature from a baseline temperature of 30^{o}C at a 0.5^{o}C/second rate, and this procedure was conducted three times for each measure – CPTh, HPTh. HPTh and CPTh were defined as the average temperature at which the participants reported first feeling pain from the three trials of gradually increasing or decreasing temperatures. Using the same ascending temperatures, participants were also asked to indicate when the pain from the heat first became intolerable, and this procedure was also repeated three times to assess HPTo. HPTo was defined as the average temperature at which participants reported feeling intolerable pain from the gradually increasing temperature.

Pressure Pain Threshold

To assess the pressure pain threshold of participants, we used a digital Somedic algometer placed over the muscle belly of the trapezius muscle of the participant. Participants experienced pressure at a steady application rate of 30 kPA/s until the participant verbally indicated they first felt pain. This procedure was repeated twice on trapezius muscle in adjacent but non-overlapping locations. If the PPTh values were not within 50kPA of one another, the procedure was repeated a third time for accuracy and to account for possible experimenter error.

Pressure pain threshold (PPTh) was measured the average kPA indicated as first being painful on all trials.

Conditioned Pain Modulation (CPM)

During the conditioned pain modulation procedure (CPM), participants were asked to indicate their PPTh on their left shoulder while their right hand was placed in cold water. Participants first placed their right hand in cold water, and after 20 seconds, the experimenter began to apply pressure to the participant's left shoulder while the hand remained in the water. Participants were instructed to focus on the sensations in their shoulder, indicate when they first felt pain resulting from the pressure in their shoulder by verbally saying 'pain". After saying 'pain', participants were asked to remove their hand from the water and rate the current pain and maximum pain in their hand on a scale of 0 (no pain at all) to 100 (the worst pain imaginable). After hand removal, after-sensations (AS) were measured by asking the participants to rate their pain using this same scale at 30-second intervals for a total of 2 minutes. If participants did not report feeling no pain (0) at the end of the 2 minutes, experimenters continued asking for pain ratings at 30-second intervals until the participant reported an absence of pain. This entire procedure was conducted twice.

CPM was calculated by taking an average of the PPTh ratings from both rounds of the CPM procedure, and subtracting the baseline average PPTh found during the initial PPTh test. Positive scores reflect CPM, while negative scores reflect facilitation of the second pain stimulus by the conditioning stimulus.

Mechanical Temporal Summation (MTS)

Mechanical Temporal Summation (MTS) was calculated as the difference between pain ratings in response to a single punctuate stimulus, compared to a sequence of 10 identical stimuli. Weighted probes with a flat contact area of 0.2 mm diameter were used to administer the stimuli, and were administered at a rate of 60 Hz (1/s) to the dorsal surface of the distal phalanx of the middle finger on the participant's right hand. The procedure was repeated using three probes that varied in weight - 128, 256, and 512 mN – in ascending order.

The participants were first stimulated with a single poke with the lightest probe, and then asked to report their pain intensity from the single poke on a scale of 0 (no pain at all) to 100 (the worst pain imaginable). The participants were then stimulated ten consecutive times and asked to rate the peak pain intensity they experienced during the train of 10 pokes using the same aforementioned scale. An average MTS at the 2 heavier weights was used for all analyses.

Survey Measures

Demographic Information

Participants were asked to report their age, sex, ethnicity, place of birth, place of birth of parents, parent levels of education, and history of pain conditions.

Attention Questionnaire

Pain Vigilance. The Pain Vigilance Assessment Questionnaire (PVAQ, McCracken, 1997) includes items such as "When I do something that increases pain, the first thing I do is check to see how much" and "I notice pain even if I am busy with another activity", rated on a 0 (never) to 5 (always) scale. This measure has been shown to have strong internal (Cronbach's alpha = .86) and test-rest reliability (r = 0.80) in clinical (Roelefs, Peters & McCracken, 2003; McCracken, 1997), and in a healthy Dutch population (Roelefs, Peters, Muris & Vlaeyen, 2002).

Lifetime Exposure to Threatening Environments

Questionnaires related to threatening environments were given to participants in the subject pool study in their first session, and to participants in the paid study during the optional third visit. To model lifetime exposure to threat, we included the following self-report questionnaires (n = 26). Self-report surveys were broken down into sub-sections based on content regarding the type of threat that the questionnaires were about – physical threat, social threat, or emotional threat. We also examined self-reported race and SES as a proxy for environmental threat.

Proxy measures of threat – race and SES.

Participants were asked to report their race from a list of provided options, and were also offered options for "Mixed; Parents are from two different groups" and "Other (please specify)."

Socio-economic status (SES) was assessed in our participants in three different ways. In 11 individuals from the subject pool study, we asked individuals 1) if they were financially dependent on their parents, and 2) if they were first-generation college students. In 67 individuals from the paid study, we asked participants to rate their subjective socio-economic status (Subj SES). To rate their Subj SES, participants were given a drawing of a ladder with 10 rungs that was described as follows: "In our society, there are groups which tend to be towards the top and groups which tend to be towards the bottom. At the TOP of the ladder are the people who are BEST OFF – those who have the most money, most education and most respected jobs. At the BOTTOM are the people who are the WORST OFF – those who have the least money, lease education, and least respected jobs. Please note the numbers beside each rung of the ladder. A '1' on the ladder would represent the lowest or first rung on the ladder and a '10' would represent the highest or top rung on the ladder. Participants were then instructed indicate which rung best represented their family's status 1) when growing up, and 2) currently.

Physical Threat. Exposure to threatening environments were examined using self-report measures that assess experiences with early life adversity (THQ; Hooper, Stockton, Krupnick, &

Green, 2011), traumatic events (LTEQ; Brugha, Bebbington, Tennant, & Hurry, 1985), lack of resources (WHOQOL-BREF; The Whoqol Group, 1998), and family strain (PBI; Parker et al., 1979).

Social Threat. To assess race-related trauma, specifically, participants that identified as non-white were asked to respond to the Race-Based Trauma Stress Symptom Scale (RBTSS) (Carter et al., 2011). All measures were modified to be retrospective in nature and assess participant experience through the age of 18, as well as during current life. Participants were also asked about their experiences with ethnic discrimination (PEDQ) (Brondolo et al., 2005). We also used a measure tapping into perceptions of systematic and larger-scale racism (Nelson, Adams & Salter, 2013).

Emotional Threat. Individual ability to cope with stress, and differing levels of stress may also impact physiological response to threatening or painful stimuli. Participants were asked to complete a well-validated measure of perceived stress, the Perceived Stress Scale (PSS), and the Coping Inventory for Stressful Situations (CISS) (Cohen et al., 1983; Endler et al., 2004).

Additional Questionnaires

Other questionnaires were given but were not analyzed for this thesis. Individuals were asked to complete questionnaires that include items relating to symptoms of depression (CESD; Radolf, 1997) and anxiety (STAI; Spielberger, 1985). These measures were included to account for potential anxiety and depressive symptoms that are known to associate with pain. The CESD represents four subscales of depressive symptomology (Radloff, 1977). The STAI assesses both state and trait anxiety. Additionally, participants were asked about pain catastrophizing (PCS; Sullivan, Bishop & Pivik, 1995), and central sensitivity (PCS; Mayer et al., 2012). These measures examine rumination, magnification and helplessness of pain, and central nervous system level sensitivity, and were included to further examine the pain experiences of participants.

Composite Scores

Trauma Composite Score. The measures of trauma (THQ, LTEQ) were inter-correlated ($r = .507$, $p = .0080$). The total scores on both measures were standardized (z-scored), and the average of these scores was calculated as a Trauma Composite Score. This composite score was used for all analyses.

Pain Composite Scores. The central sensitization index was calculated as the average of the following individually z-scored values: MTS and the after-sensations to CPM. The QST index was calculated as the average of the remaining psychophysical pain measures not included in the central sensitization index (ie, heat and pressure thresholds, heat pain tolerance, cpm). Both calculations for these indices were based on calculations used in previous pain research (Mathur, Kiley, Carroll, Edwards, Lanzkron, Haythornthwaite, & Campbell, 2016). CPM was also analyzed independently.

DATA ANALYSIS

Missing Data

All available data were used, and participants were not excluded due to partially missing data. The majority of participants *(n = 73; 90.3%)* completed all sensory testing and attention behavior procedures. Some participants *(n = 2, 2.46%)* did not complete every trial of every quantitative sensory testing procedure due to rating the maximum (100) level of pain experience before the completion of a procedure, at which the procedure was stopped immediately. For MTS, one participant ended procedures early *(n = 1).* For CPM procedures, some participants removed their hand from the water early due to experience of intolerable pain *(n = 2),* and experimenters proceeded with the remainder of the procedure. Additionally, one participant opted out of the Dot Probe task (Dot Probe, *n = 1*). Additionally, some participants *(n =7)* were unable to complete the Stroop task, or the Dot Probe task *(n = 8)* due to a combination of opting out of the procedure, computer crashes, and participant errors in following instructions. One participant had taken an NSAID (ibuprofen) within the last 3 days of the study, but was included because the average metabolism period for this drug is 24 hours, therefore the physiological effects of the drug on our data was determined to be negligible. One participant *(n = 1)* also a current injury during the study, despite assertion during consent that they were not injured, and was excluded from data analysis. Analyses were conducted using all data available for each analysis, and consequently the n differs across analyses.

RESULTS

Descriptive Statistics

For the subset of participants that were Latinx-American and White-American, baseline characteristics are shown in Table 2. We examined baseline characteristics across gender and race to understand the variances and mean differences in our central constructs – attention, and pain.

		All Participants			**Latinx Participants**			**White Participants**		
		F	*M*	***All***	*F*	*M*	***All***	*F*	*M*	***All***
N		*34*	*35*	*69*	*14*	*16*	*30*	*21*	*18*	*39*
Demographic (M, SD)	Age	*21.7, 4.2*	*20.5, 2.8*	*21.1, 3.6*	*23.7, 5.5*	*20.8, 3.8*	*22.1, 4.8*	*20.9, 3.4*	*20.5, 2.2*	*20.7, 2.8*
	Subj SES	*6.2, 1.7*	*5.6, 1.8*	*5.9, 1.8*	*6.2, 2.0*	*5.8, 2.0*	*5.9, 1.9*	*6.2, 1.5*	*5.3, 1.5*	*5.8, 1.5*
Attention (M, SD)	ST Bias	*.13, .12*	*.12, .06*	*.12, .09**	*.09, .07*	*.09, .06*	*.09, .06*	*.15, .14*	*.14, .06*	*.14, .11*
	DP Bias	*.01, .04*	*.00, .04*	*.01, .04*	*.02, .04*	*.00, .03*	*.01, .03*	*.01, .05*	*.00, .04*	*.00, .04*
	Pain Vig.	*45.9, 13.3*	*45.7, 12.1*	*45.8, 13.1*#	*51.4, 12.9*	*47.3, 15.7*	*49.3, 14.3*	*42.1, 12.5*	*42.7, 11.0*	*42.4, 11.7*
Pain (M, SD)	CS Index	*-.02, .55*	*.05, 1.03*	*.02, .82**	*.21, .56*	*.07, .67*	*.22, .82*	*-.11, .51*	*-.18, .48*	*-.15, .49*
	QST Index	*-.01, .66*	*.06, .54*	*.02, .60*	*.27, .80*	*.23, .56*	*.22, .67*	*-.13, .57*	*-.04, .52*	*-.09, .54*
	CPM	*81.3, 110.5*	*98.9, 121.7*	*90.0, 120.9*	*83.8, 87.5*	*120.3, 134.0*	*103.23, 114.3*	*79.7, 125.6*	*79.8, 130.5*	*79.8, 126.2*

*Table 3. Threat Bias calculated as Neut RT – Threatening RT. *Signifies Latinx ptcpts were significantly different than White participants ($p < .05$).*

Latinx-American participants reported greater pain vigilance, and also experienced greater pain in the laboratory (CS Index scores), than White-Americans. Latinx-Americans were more likely to report pain vigilance than White-Americans, and more likely to demonstrate interference when responding to threatening stimuli (slower RT to threat stimuli on Stroop task than White-Americans). Comparison of means in only Latinx-American or only White-American participants indicated that there were no significant differences across sex in threat, attention, or pain within either race.

Socio-economic status (SES) was another demographic variable of interest, and was analyzed as a proxy for environmental threat. In terms of comparison of means, current subjective SES was not found to be significantly different across race or sex groups. Other measures of SES were not analyzed due to small n (11).

Bivariate Relations (Environmental Threat, Attention & Pain)

To assess for the relationship between environmental threat, attention, and pain – the three main constructs in our original hypothesis – bivariate analyses were run to explore the correlational relationships between our variables of interest. Results from the bivariate analysis are categorized in the three sections below, organized by each part of our original hypothesis. In the whole sample, race was significantly correlated with Stroop Task bias, pain vigilance, and central sensitization, such that Latinx race predicted higher delayed interference on the Stroop task, more pain vigilance, and more pain in terms of the CS index. Perceived ethnic discrimination was correlated with conditioned modulation such that individuals who reported greater perceived ethnic discrimination experienced greater pain modulation, and consequently less pain. Furthermore, greater dot probe avoidance was associated with pain vigilance as reported on the PVAQ.

		Environmental Threat				**Attention**			**Pain**	
		Race	*Child SES*	*Trauma*	*PEDQ*	*Stroop*	*Dot Probe*	*PVAQ*	*CS Index*	*QST Index*
Environmental Threat	Race	-	-	-	-	-	-	-	-	-
	Child SES	*.16*	-	-	-	-	-	-	-	-
	Trauma	*-.23*	*?*	-	-	-	-	-	-	-
	PEDQ	*-.05*	*.05*	*-.34^*	-	-	-	-	-	-
Attention	ST Bias	*.26**	*?*	*-.14*	*.19*	-	-	-	-	-
	DP Bias	*-.13*	*?*	*.18*	*.08*	*.10*	-	-	-	-
	PVAQ	*-.31**	*.11*	*.03*	*.03*	*.15*	*.27**	-	-	-
Pain	CS Index	*-.25**	*.15*	*-.06*	*.16*	*-.10*	*.14*	*-.02*	-	-
	QST Index	*-.19*	*-.03*	*.07*	*-.02*	*-.11*	*.05*	*.12*	*.16*	-
	CPM	*-.10*	*-.09*	*-.30^*	*.24**	*.21^*	*.14*	*0.0*	*.31***	*-.30***

*Table 4. *correlation was significant, p<.05; ** correlation was significant p<.01; ^marginal, p<.1; "Trauma" – composite score using LTEQ & THQ totals. ? – there were not enough participants for this analysis to be run. Race: + White, - Latinx.*

Environmental Threat & Attention. We originally posited that increased exposure to lifetime threat may be related to increased vigilance towards threat. Exposure to threat in the form of traumatic events, as measured by a composite score calculated using total scores from the LTEQ and THQ, was not related to either of the attention behaviors in this study *(Dot Probe: n = 27, r = .184, p = .358; Stroop: n = 27, r = -.140, p = .487).* This finding does not support the original hypothesis that environmental threat across the lifetime yields vigilance towards threat using the Dot Probe or Stroop task.

Exploratory analyses were conducted beyond our original hypothesis testing. Maternal care, as measured by the Parent Bonding Inventory, was related to attention behavior in our sample, such that individuals who reported less maternal care during their childhood, also engaged in higher threat vigilance on the dot probe task *(n = 27, r = .411, p = .033)*. This may suggest that children that felt more cared for by their mothers now exhibit more avoidance from threatening stimuli in a laboratory setting, however maternal care was not associated with Stoop behavior in our sample.

Physical threats from the environment, such as exposure to natural disasters, was associated with attention behavior in our sample, such that increased exposure to natural disaster was related to increased threat avoidance on the dot probe task (faster RT to threatening stimuli), in comparison to neutral stimuli *(n = 22, r = .447, r = .037).*

Reported experience with ethnic discrimination, generally, was not found to be related to attention behavior in our sample. However, in the PEDQ subscale related to discriminatory experience at work/school was associated with Stroop task behavior, such that individuals who reported perceiving more ethnic discrimination at work/school engaged in higher threat avoidance on the Stroop task (i.e. faster RT's on threat compared to neutral), compared to neutral stimuli *(n = 73, r = .238, p = .042)*.

Attention & Pain Sensitivity. Pain vigilance, as measured by the Pain Vigilance Awareness Questionnaire (PVAQ), was not significantly associated with pain sensitivity in either of our composite measures – central sensitization *(n = 81, r = -.019, p = .869),* nor QST scores *(n = 81, r = .117, p = .300).* When looking at individual pain measures, pain vigilance was not significantly associated with pain, however there was a marginally significant relationship suggesting that increased pain vigilance is related to lower heat pain tolerances *(n = 78, r = -.199, p = .08).*

In our sample (n = 81), dot probe behavior was not found to be associated with pain composite measures. However, when looking at pain measures individually, the data showed a pattern in the direction of higher Stroop avoidance being associated with higher conditioned pain modulation *(n = 73, r = .212, = .072*), and consequently, less pain.

Environmental Threat & Pain Sensitivity. Using the Trauma composite score, trauma was not found to be associated with individual pain measures, but was found to marginally relate to conditioned pain modulation such that increased trauma predicted decreased modulation *(n = 32, r = -.300, p = .095)*. This relationship was in the hypothesized direction.

Our measures assessing maternal and paternal care were also used to examine the relationship between emotional threat (lack of maternal and paternal care) and pain. Lower maternal care was found to be associated with higher pressure pain *thresholds (n = 32, r = -.376, p = .034)* and lower after sensations following our CPM procedure (n = 32, r = .402, p = .022) meaning less pain, and lower conditioned pain modulation *(n = 32, r = .473, p = .006)* meaning more pain. Paternal care was not found to associate with any of our pain measures.

The natural disaster subscale of the Trauma History Questionnaire (THQ) was used to examine the relationship between physical environmental threats and pain. Increased exposure to natural disaster was associated with lower after-sensations following the CPM procedure *(n = 26, r = -.406, p = .039)* and showed a marginal trend in the direction of decreased central sensitization as measured by the CS index *($n = 26$, $r = -.354$, $p = .076$)* – both of these are consistent with an interpretation of less pain sensitivity. Of potential relevance, the participants in this study completed this questionnaire prior to Hurricane Harvey, or > 6 months following Hurricane Harvey. Other trauma subscales did not appear associated with our composite measures of pain sensitivity.

Perceived ethnic discrimination as measured by the Perceived Ethnic Discrimination Questionnaire (PEDQ) was used to examine social threat in relation to pain. Higher total perceived ethnic discrimination was associated with higher conditioned pain modulation in our sample *($n = 81$, $r = .235$, $p = .034$)* – thought to be reflective of a stronger endogenous opioid response, and lower pain sensitivity.

Secondary Analyses

Attention Phenotypes

To better understand the data, we conducted two exploratory analyses. Attention behaviors on the Stroop and dot probe tasks were broken into positive and negative bias phenotypes to assess if participants within positive or negative bias groups were primarily of one race, or sex. In terms of attention phenotype, we broke down attention task respondents into 1 of 3 categories for each attention task. For the Stroop task, respondents were divided based on avg. RT to stimuli into categories of avoidant (A; faster RT to threat stim), neutral (N; no diff in RT), and delayed interference (DI; faster RT to neutral stim). For the dot probe task, respondents were divided based on avg. RT to stimuli into categories of vigilant (V; faster RT to threat stim), neutral (N; no diff in RT), and avoidant (A; faster RT to neutral stim).

Within the Stroop task, only six individuals fell into the "avoidant" category. The majority of participants in both races fell into the "delayed interference" category *($n = 67$)*. With regard to the Dot Probe task, there were nearly twice as many participants in the Avoidant category *(n = 44)* as the Vigilant category *(n = 26)*. While the individuals vigilant on the Dot Probe task were equally male/female and Latinx/White, the majority of White-American individuals were Avoidant on the Dot Probe task.

There were not observable patterns in the phenotypes such that individuals from one race or sex group were primarily demonstrating attention bias in a specific direction. Due to small sub-group sample sizes, additional analyses examining phenotype group differences were not powered and could not be run.

Race, Sex & Pain Experience

LAs reported higher sensitivity in terms of the QST-composite score than WAs in our sample *(t(60)=2.06, p = .04)*, and the Central Sensitization-composite score (*t(60) = 2.02, p = .04)*. In an analysis of variance (ANOVA), there was a significant interaction between sex and ethnicity *(F(2, 74) = 2.91, p = .04)* when examining pain using the Central Sensitization Composite Score, and a marginally significant interaction model with sex and ethnicity when examining group differences on the *(F(2,74) = 1.75, p = .09)* QST-Composite Score, such that Latinx-American females were the most sensitive to pain.

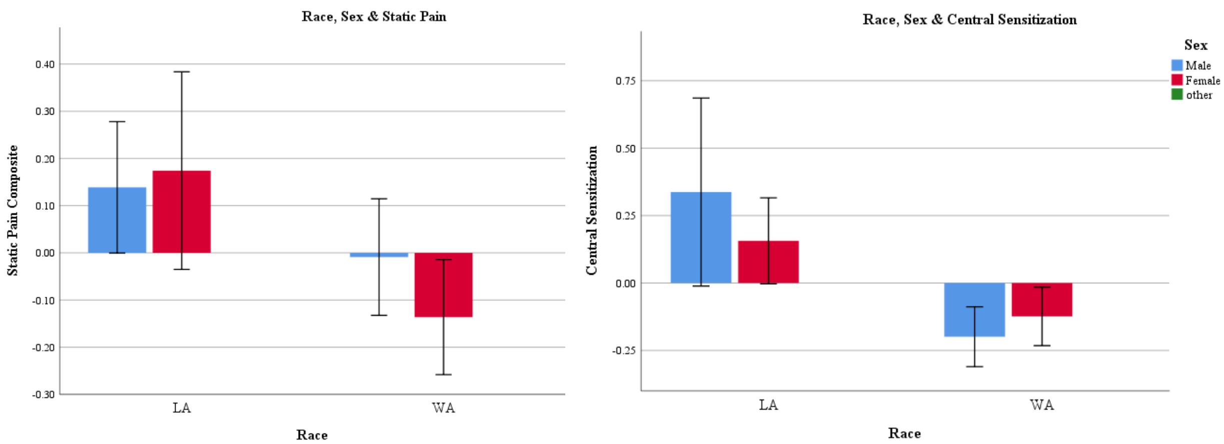

Figure 2. Interaction of race and ethnicity in pain.

SUMMARY

The discussion below is broken down into two components – a discussion of our hypothesized findings, and a discussion on our secondary analyses. Though our original hypothesis was not supported, these exploratory secondary findings shed some light on potential relationships race/sex intersectionality and pain. In the sections below, primary and secondary findings, strengths, limitations, and future directions are discussed.

Discussion of Hypothesized Findings

The findings of our planned analyses indicate that there is not a strong relationship in the hypothesized directions between environmental threat, attention, and pain using our measures in our sample. Patterns in the bivariate correlations, however, indicate that there are small relationships between some of these three constructs in the hypothesized directions, while other relationships are in the opposing direction. Potential explanations of both hypothesized findings and surprising findings, are described below, as well as design considerations and future directions.

Though some of our correlations did yield patterns in the predicted direction, some of our hypothesized patterns were not at all present, and others were in the opposite of the hypothesized direction. Pain vigilance, for example, does not appear related to pain in any way, even when visualizing scatterplots of this data. This finding does not support the hypothesis that pain vigilance is related to increased pain, which has been found in previous studies (Crombez, Van Damme, & Eccleston, 2005; Lautenbacher et al., 2009; Keogh, Ellery, Hunt & Hannent, 2001). The range of pain vigilance in our healthy sample was fairly spread (*range: 12 – 71, m = 47.1, SD = 12.33),* however slightly more constrained in range than in clinical populations *(range: 2-78, m = 45.8, SD = 13.2;* Roelofs, Peters, McCracken & Vlaeyen, 2003*)*. Exploring the same relationships in a larger, more representative community sample with a larger variability in vigilance may offer a more informative insight into the impact of vigilance on pain in healthy individuals. Additionally, given that previous studies have been conducted in clinical populations, it is possible that this relationship does not exist in healthy populations. While vigilance has been shown to relate to pain in clinical populations, it is possible that vigilance functions differently in individuals who are more chronically aware of their own pain due to diagnosis with a pain condition. In proposed models of vigilance, researchers posit that vigilance may serve as an attempt at problem-solving in the face of chronic pain that may or may not be functionally useful (Aldrich, Eccleston & Crombez, 2000). In healthy populations, the need for problem-solving for pain may not be present, thereby vigilance in healthy populations may intrinsically serve a different purpose and function differently. Future work on pain vigilance in healthy populations may consider this question.

The findings additionally did not support our hypothesized relationships between threat and pain. Most of the correlations with CPM were in the direction opposite our hypotheses, however trauma was marginally associated with pain in the hypothesized direction such that individuals with higher reported trauma also less modulation during CPM, and consequently, greater pain. Higher total perceived ethnic discrimination was associated with higher conditioned pain modulation in our sample ($n = 81, r = .235, p = .034$) – thought to be reflective of a stronger endogenous opioid response, and lower pain sensitivity, which is contrary to prior work (Mathur et al., 2016; Goodin et al., 2013), and also contrary to our hypotheses.

Furthermore, attention bias in either task (Stroop and dot probe) did not uniformly and significantly relate to pain. Previous research examining vigilance and avoidance processes related to pain primarily involved stimuli related to pain-threat or social-threat. Given our novel environmental-threat based stimuli have not previously been tested beyond our stimuli validation, our stimuli may not reliably provoke a sense of environmental threat and may not be valid in terms of the desired construct. Future measures of attention bias towards environmental threat should be further studied for preliminary data and perceived threat. Additionally, the directionality of attention bias in both the Stroop and dot probe tasks are still discussed and are not interpreted uniformly across research domains. Further knowledge regarding what these attention biases may mean, in either direction, will provide a more solid foundation upon which to interpret our findings.

Additionally, when looking at attention behaviors via breakdown of attention "phenotypes", there were no observable patterns in the phenotypes such that individuals from one race or sex group were primarily demonstrating attention bias in a specific direction. If planning to further explore attention phenotypes, larger samples of individuals that demonstrate bias in either direction would aid in looking at mean differences across phenotype group, and perhaps additional methods of attention behavior should also be implemented to understand the breadth of attention behaviors that may relate to pain.

Strengths & Limitations

The Latinx population is a growing minority in the United States; however, Latinx Americans are vastly under-studied in the context of health, and pain. The present study included a gender-balanced sample of White- and Latinx- Americans, in attempt to contribute to the goals of conducting experimental work examining disparities between various types of minority and majority American groups, and inclusion of under-represented groups in research, broadly.

Power analysis *($\alpha = .05$, power = .95)* for a hierarchical linear regression to examine mediation of attention between threat and pain indicates that a larger sample *($n = 325$)* would yield a strong statistical foundation for assessing for statistically significant results. Therefore, replicating this study in larger, community samples may enable us to better assess the nuances in our hypotheses relating threat, attention and pain. Many of our findings were not significant in this sample, however examining scatterplots of our data show that there are some patterns in hypothesized directions that may be more assessable in a larger, powered sample. Given that our sample is under-powered, it is not possible to reject our hypothesis, nor reject the null hypothesis.

Furthermore, while Stroop task and Dot Probe task have long been used in the attention behavior realm of cognitive, clinical, and social psychology studies, there have been mixed reviews regarding the reliability and understanding behind findings using these paradigms (Schmukle, 2005; Dear et al., 2011; Strauss, Allen, Jorgenson & Cramer, 2005). It is possible that avoidance and/or vigilance using a computer screen are simplified versions of what avoidance and vigilance may appear like in everyday life when encountering threatening cues.

Future Directions

The existing literature on environmental threat/trauma, attention, and pain is vast and prone to mixed findings. While the original hypothesis of this study was large and over-reaching several aspects of human experience, it may be beneficial to examine each proposed relationship more narrowly. Our hypotheses were motivated largely by observational findings and upon animal research that has established relationships between threat and pain, however this research may not translate to human subjects. Animal research indicates that threat detection modulates pain reactivity (King et. al, 1996), however the threat detection that animals experience in a lab-controlled environment may largely differ on a conditioning level than the 1) threat detection experience in actual lived environments, and 2) threat detection using our two attention tasks.

Studying lived environments is a longstanding challenge for the psychological research community, given the unique factors that are difficult to replicate within a lab. Drawing from other disciplines and borrowing methods such as field study and natural observation may be one day to address the concern of replicating natural threatening environments in the lab. In our planned analyses is also to look to larger national datasets that include markers of threat (e.g. segregation, inequality) and physiological pain sensitivity to better obtain knowledge regarding any patterns seen supporting our hypothesis in a larger, representative sample.

Looking to interventions may be a fruitful way to probe mechanisms between threat and pain physiology in future research. One such mechanism is attention and future studies may consider the role of attention in physiological pain outcomes. Studying the effectiveness of novel approaches such as Attention Behavior Modification (ABM) may offer innovative ways to better understand the mechanisms between attention and pain.

Discussion of Secondary Analyses

Secondary analyses probing intersectional effects of sex and race on pain were also conducted. Assessment of mean differences across race and sex groups indicate that individuals from different socioeconomic backgrounds may differ on environmental threat exposure, attention, and/or pain. In the current sample, analysis of variance suggests that Latinx women are more sensitive to pain in terms of summation and after-sensations (CS index) than their socio-demographic counterparts. This interaction adds to existing knowledge on Latinx disparities in pain, and also indicates a potential intersectionality effect of being part of two minority groups being related to enhanced pain.

Research examining intersectionality of socio-demographic identity, and pain is currently limited (Boyd et al., 2016). Intersectionality is a theoretical framework that considers the impact of perceiving multiple social categories (e.g., race, ethnicity, gender, sexual orientation, socioeconomic status) that may intersect at the micro level of individual experience to compound implications for privilege and oppression at the macro, social-structural level (e.g., racism, sexism, heterosexism). Work in the public health domain has discussed the impact of intersectionality on health, and the significant dearth in the literature examining intersectionality and health outcomes (Bowleg, 2012), with an emphasis on how intersectionality may contribute to well-documented health disparities in women (Weber & Medina, 2003). The current finding supports the theory that being of two minority groups (Latinx and women) relates to enhanced pain on a physiological level.

Strengths & Limitations

As mentioned before, the Latinx population is a growing minority in the United States, and Latinx Americans are vastly under-studied in the context of health, and pain. The present study included a gender-balanced sample of White- and Latinx- Americans, in attempt to contribute to the goals of conducting experimental work examining disparities between different race groups. Within the aim of studying intersectional effects, this study is strong in its recruitment of gender-balanced, race groups that will allow for high-powered group comparison tests upon finishing data collection. The sample is currently limited data collection is ongoing, and is limited to the local area which may also not be representative of the greater United States population but should be fairly representative of mid-sized Southern communities.

Future Directions

While the work on minority pain and intersectionality is expanding, the research on Latinx pain is limited. To further our knowledge of Latinx pain, future research should involve incorporating measures of intersectionality and perceived identity to assess the impact of intersecting minority identity and pain, and look to the growing literature in social psychology, sociology, and health on intersectionality.

Other measures that were not analyzed in the primary and secondary analyses reported above can also be considered for future research. Our measures of perceived stress, and items relating to specific types of environmental threat and trauma could be analyzed independently with relation to pain to better understand if lived experiences beyond cumulative lifetime exposure to environmental threat contribute to enhanced pain physiology. The question of threat, broadly, being related to attention and pain was not answered by our study, however questions of specific types of threat from the environment can still be asked and assessed for in our data.

Conclusions

The data presented here tells us that the potential linkages between early life threat, attention behaviors, and pain sensitivity is complex and varies across socio-demographic groups in ways we do not understand. These linkages furthermore may relate to pain sensitivity and disparities in pain that we see across socio-demographic groups. In the limited sample and analyses presented here, we cannot conclude that environmental threat throughout the life time does or does not impact attention behaviors, and/or pain. However, there are patterns that suggest that intersectional effects of sex and race, in groups that are likely to experience greater threat (i.e. Latinx women), contribute to greater pain.

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