INDIVIDUAL DIFFERENCES IN VIGILANT BEHAVIOR, ATTENTION BIAS TO EMOTIONS, AND CARDIOVASCULAR CORRELATES

by

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As members of the Master's Committee, we certify that we have read the thesis prepared by: Krystal Shannon Jovel
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Final approval and acceptance of this thesis is contingent upon the candidate's submission of the final copies of the thesis to the Graduate College.

We hereby certify that we have read this thesis prepared under our direction and recommend that it be accepted as fulfilling the Master's requirement.

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DEDICATION

Gracias por siempre apoyarme, abuela.

To my Abuela for always supporting me.

Contents

ABSTRACT

Social vigilance refers to the process of monitoring one's social environment for potential threats or monitoring a threat to determine a change in status that may require coping. Vigilance itself may be an outcome of attentional bias for ambiguous and negative social cues. Recent work has examined the effects of vigilant behavior on cardiovascular reactivity as a potential health-moderating pathway; however, a connection between attention bias and vigilance has yet to be established. The aim of this study was to examine the relationships between individual differences in social vigilance, attention bias for negative social cues, and cardiovascular reactivity. A diverse sample of 96 young adults (55 women) completed an observational laboratory study involving a baseline followed by an attention bias dot-probe task and later a 5-min video observation period. Participants were selected based on outer tertile scores on the social vigilance questionnaire to represent high and low individual differences in social vigilance. An incentive condition was created by informing half the participants that their $5 payment is contingent on their performance in the attention bias task (high incentive) while half are told they will receive payment regardless of performance (low incentive). Thus, the study is a 2 (high, low vigilance) X 2 (Female, male gender) X 2 (high, low incentive) experimental design. The attention bias task is a 15-minute program wherein reaction times to a standardized set of emotional faces is performed. A Tobii eye tracker is used to quantify gaze time, with impedance cardiography and a GE Carescape BP monitor used to assess cardiovascular reactivity throughout the study. Separately, the NH H-Probe(S) type was found to have a decrease in reaction time by 2.3/ms of those in the high incentive condition, $t(935) = -2.01$, $p<0.05$. Individuals in the high-incentive group, told they were to receive $5 dollars had a decrease in reaction time when presented with a happy stimulus. Incentive type and SVQ did not interact to predict reaction time to any stimulus valence-types. There was no interaction between incentive, SVQ, or stimulus valence. Social Vigilance did however predict a lowering of reaction time, quicker responses, for vigilance towards threat equations by 4.408/ms, $t(1066)=-2.072$, $p<.04$. A significant interaction between incentive type, vigilance, and gender was discovered $F(1,65) = 7.99$, $p< 0.01$ for systolic blood pressure during the task. During rest, a significant main effect of vigilance on systolic blood pressure arose at $F(1,61)=5.221$, $p<0.05$. Contributions to the understanding of vigilance as a consequent behavior from attention bias and as a moderating factor of stress effects on cardiovascular reactivity are discussed.

OVERVIEW

Stress is recognized as an important determinant of health including cardiovascular disease (CVD) risk. Robust evidence documents longitudinal relationships between emotional stress and preclinical disease incidence (Jennings et al., 2004; Rozanski, Blumenthal, & Kaplan, 1999), disease progression (Kivimäki & Steptoe, 2018; Moreno-Smith, Lutgendorf, & Sood, 2010), acute events (Bartrop, Buckley, & Tofler, 2016), post-event survival (Frasure-Smith, Lespérance, & Talajic, 1995), and disease-specific and all-cause mortality (Panaite, Salomon, Jin, & Rottenberg, 2016). The extant literature supports the conception that stress is a causal health mechanism has moved from folklore to fact.

Researchers are increasingly interested in the role psychosocial stress plays in health. Psychosocial stress refers to experiences stemming from social factors including romantic relationships, work conflict, and discrimination among others. For example, substantial research documents relationships between marital discord and greater risk of preclinical cardiovascular disease, acute cardiovascular events, and early mortality (Eaker, Sullivan, Kelly-Hayes, D'Agostino, & Benjamin, 2007; Smith, Baron, & Caska, 2014). Likewise, perceived discrimination is associated with a similar cardiovascular disease risk, course, and outcomes (Lewis et al., 2006; Panza et al., 2019). These social factors are deemed ecologically valid as they can and do occur in daily life and thus, the frequency of exposure is a plausible determinant of disease.

One pathway by which stress may affect health is through direct physiological reactivity of the cardiovascular system. The reactivity hypothesis posits that longer, larger, and more frequent physiological responses to stress increase risk of disease (Kamarck & Lovallo, 2003; Lovallo, 2005). One process by which physiological reactivity may be more chronically activated in daily life is through vigilance of the social environment. Social vigilance refers to the act of monitoring the social environment for potential interpersonal challenges or threats as well as monitoring change in status of a perceived threat (Gump & Matthews, 1998; Smith, Ruiz, & Uchino, 2000). Recent work by Ruiz and colleagues demonstrates associations between greater social vigilance and higher daily blood pressure. This preliminary work may help to understand how stress translates into disease risk through an ecologically valid biobehavioral mediator.

Importantly, the tendency to be socially vigilant may be evoked by attentional processes, including attention bias for negative social stimuli. Adaptive social survival may be driven by first identifying potential threats and then vigilantly monitoring for a change in status that may necessitate coping. The aim of this study is to examine the relationships between individual differences in social vigilance, attention bias for negative social cues, and cardiovascular reactivity. In this study, facial affective pictures are paired with an attention dot-probe task paradigm to assess interference driven attention biases and corresponding physiological reactivity. A monetary incentive will be used to test interaction effects. We predicted that individuals higher in dispositional social vigilance will exhibit greater attentional bias to negative affect cues with corresponding effects on cardiovascular responses. These effects are expected to be greater still under high incentive conditions.

INTRODUCTION

The Concept of Stress

The study of stress originates from the definition of Fight-or-Flight and the concept of Homeostasis, with these terms stress begins to encompass the body's regulation of physiological processes and their interaction with a threat to the commanding organism. Walter B. Cannon (1915) coined these terms after reviewing studies complete by Elliot (1905) on cats that depicts a mammal's response to changes in physiological states and completing their own work. The bodies change in adrenal gland secretion, is what Cannon describes as the process of Fight-or-Flight. It is then during Fight-or-Flight that the body responds to threats to homeostasis. Later, further researcher discovered that the body's need to work towards homeostasis occurs not only during emergencies but also while an individual is engaged in social activities. Further progressing towards the current definition of stress, General Adaptation Syndrome (GAS) encompasses the three stages of responding to a stressor. Initially, the organism experiences the alarm stage, akin to Fight-or-Flight, followed by the resistance stage in which the body attempts to cope with a stimulus (Goldstein & Kopin, 2007). As an example, if an individual were to enter the alarm stage, as they reach a snake hiding underneath a rock on a hike in the Catalina Mountains of Tucson, Arizona, their resistance stage would be described as the body maintaining this state of alarm through preservation of hormone levels. The individual would enter the third stage, the exhaustion stage, once he or she depleted his or her physical energy reserves. Typically, Selye defines this movement into the third stage as stemming from the organism not receiving a break from the stressor and, as a result, the individual would drain the energy reserves necessary to cope with the stressor. When the individual reaches this third exhaustion stage, he or she is susceptible to the long-term, and moreover, negative health-effects of stress. According to the GAS, the "stress" thought of now is created when and individual has reached the exhaustion stage. Everyone can and will experience stress, to what level is based not only on how they perceive their environment but also how they cope with threat.

The homeostatic theory of stress posited 40 years after Selye's definition, states that stress occurs when the subject perceives a threat that will disrupt the homeostasis of the body (Goldstein & Kopin, 2007; Goldstein & Mcewen, 2002). Effectively, stress is the external electrical interference affecting the internal wiring of the body; this said, even simply sustaining homeostasis can be labeled stress.

Building upon the homeostatic theory of stress, the cognitive relational theory of stress (Krohne, 2001; Lazarus & Folkman, 1984) sees stress not just as a threat to homeostasis but as a part of psychological functioning as well. Here stress includes how an individual appraises threat, like that of the homeostatic theory of stress, as well as how individuals cope with stress. Therefore, it is not the external event that is stress but how the individual responds and perceives the event that can be defined as stress, as it is a possible threat to their well-being.

Measuring Stress

Stress, like other psychological processes, can be measured subjectively and objectively. Subjective reports of stress can include direct questions (e.g., are you stressed? how stressed are you?) or questionnaires. The Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983) measures how someone perceives the stress in their life, regardless of what the stressor may be. Consistent with Lazarus and Folkman's conception of stress, it is not just that stress is harmful to the body's ability to maintain homeostasis but that it also interacts with how a person perceives their ability to handle the situation and how he or she psychologically views the stressor. As a result, an individual could score high on a perceived stress scale, though the number of stressors and objective coping ability could differ to someone who scores low – it is the perception that is a major contributing factor.

In addition to perception the amount of "typically" described stressful events can give insight into an individual life. The Holmes-Rahe Stress Inventory (Hobson et al., 1998; Rosch, 2014) measures this dimension as it asks which stressful life events, such as divorce or losing a job, have occurred in the past year. The Daily Hassles scale (Holm & Holroyd, 1992; Kanner, Coyne, Schaefer, & Lazarus, 1981) also functions to identify the number of stress events in ones' life. This scale includes events that may be perceived as minuscule over the course of the year, but these events could conceivably happen daily and have a large cumulative effect of being stressful. Combined, these scales would be able to identify if someone experiences presumably stressful events and the subjective effect of the stressors to the person. Nevertheless, these are all perceptions, from what individuals perceive to be a life stressor, a daily hassle, to how an individual will report their view of stress.

Objective measures of stress are often used complementary or alternatively to perceived stress. These measures typically involve physiological data collection with the idea that a perception must be registered to create a physiological reaction record. Physiological changes including but not limited to pupil dilation, skin conductance, blood pressure, heart rate, stress hormones, and immune functioning are all common objective stress metrics

To standardize the collection and comparison of objective responses, researchers often use a set of "stress-evoking" tasks. These tasks can be physical as in asking a participant to position their foot in an ice bucket like that found in a cold-pressor task (Banoo, Gangwar, & Nabi, 2016; Grosse, Prchal, Puertas, & Coviello, 1993) or by having them complete a hand grip task (Mearns, 2015). Not all stressors are physical and more often researchers use mental tasks to create stress and may use methods like a hand grip task to measure ability after inducing stress. These tasks include the classic Stroop task (Renaud & Blondin, 1997), the Mirror Tracing task (Saab et al., 2001) and the Mental Arithmetic task (Vella & Friedman, 2009). Each of these asks for a higher cognitive load to be expended by the participant and includes the possibility of tripping them up, causing more stress to occur as the individual has now "failed".

Given the ecological relevance of human interaction, a subset of stress tasks exist to attempt to evoke stress through social interaction. The Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993) and Confrontation Role Play (Larkin, Semenchuk, Frazer, Suchday, & Taylor, 1998) tasks are common examples of socially-moderated stress tasks used in the lab. Although these two tasks can incorporate the social aspect of daily life, they are still removed from the daily and natural occurrences of stress. As previously stated, the body works towards maintaining homeostasis not only during emergencies, or those times in which an organism is under threat, but also during social interactions – when a threat is nuanced, and continual monitoring of a situation is needed.

Stress Reactivity

One pathway by which stress may influence health is through acute changes in physiological functioning or reactivity. The stress reactivity hypothesis (Lovallo, 2015) posits that a both magnitude and cumulative duration (length of reactivity episodes, frequency of episodes) leads to wear-and-tear on the body and risk for disease. One way in which to study the stress reactivity hypothesis, and have an objective measure of stress, is to measure cardiovascular reactivity (CVR). CVR typically involves comparison of changes in cardiovascular components compared to some baseline values. Common metrics include blood pressure, heart rate, autonomic components including heart rate variability, as well as stress hormones, and inflammation (Kamarck & Lovallo, 2003).

Vigilance

In addition to standard stressors, awareness of potential stressors in daily life may also be a plausible moderator of chronic reactivity with disease implications. For example, a suspicious person walking by the family home, trying to determine if a partner is upset, or working for a hostile employer are all examples of potential stressors. In each of these examples there may be no specific event, the suspicious walked away, there was not fight with your partner, the boss is out for the day – however, they all require attention to discern a need for action.

Social vigilance refers to the act of monitoring the social environment for potential interpersonal challenges or threats as well as monitoring change in status of a perceived threat (Gump & Matthews, 1998; Smith, Ruiz, & Uchino, 2000; Ruiz et al., 2017). This conceptualization is akin to Lazarus and Folkman's (1984) stress appraisal theory which argues that social environments are monitored for threat, and continually reappraised to inform an individual's behavior and/or coping style. Social vigilance may be automatic and viewed as an ongoing behavior like breathing where it is always happening but can be modulated down during relaxation or up when threat potential increases. Social vigilance may also be specific and effortful. For example, we may become socially vigilant for a specific threat or a specific person's reaction.

Social Vigilance is a common and adaptive behavior, however, sustained social vigilance or hyper-social vigilance, may connote greater disease risk including through cardiovascular reactivity. Importantly, social vigilance may be determined by both environmental threat conditions as well as individual differences. Theoretically, individuals who are higher in dispositional social vigilance may attend to more candidate stimuli, perceived more threats, and more frequently engage in monitoring of those perceived threats than individuals who are lower in dispositional social vigilance. A key determinant then of individual differences in social vigilance may be attentional bias.

Attention Bias

Attention bias is the inclination or predisposition to attend to emotional stimuli of one valence over another (i.e. positive or negative). Attention bias for negative cues is linked with depression (Hommer et al., 2014; Li et al., 2016), Post-Traumatic Stress Disorder (Iacoviello et al., 2014), and anxiety in general (Grafton, Watkins, & Macleod, 2012; Macleod, Mathews, & Tata, 1986); all disorders that afflict over 61 million adults in the US (Mundy & Hofmann, 2007). These attentional differences may be the first step in a cascade of cognitive effort focused on appraisal and complemented by behavioral vigilance. Attention bias itself may reflect a sensitivity for threats or potential threats and may be moderated by contextual circumstances and individual differences.

Researchers typically use reaction time tasks such as a dot-probe tasks to assess attention bias. The dot-probe task presents two stimuli such as images at a time for typically 500ms, followed by target under one of the images (Mogg & Bradley, 2016). The participant is required to appropriately respond to the target by pressing one of two keys on a keyboard with the response time assessed. Average response time for specifically valanced stimuli is determined with differences interpreted as bias. For example, a study may be interested in testing bias for negative emotional expressions. Pairs of faces with positive, negative, or neutral expressions are presented (e.g., positive-neutral, positive-negative, neutral-negative). A symbol is then placed under one picture or the other. The participant views the pairs of faces then responds to the symbol location as either left or right (top or bottom). If the participant is negatively biased, then they would be more likely to look at the negative affect picture first. In trials where the symbol occurred under the negative picture their reaction time should be fast. In trials with a negative affect picture but where the symbol occurred under the neutral or positive picture, their reaction time should be slower as their attention is pulled to the negative picture.

Currently there are three ways in which these differences scores for attention bias are calculated (Starzomska, 2017). Above is the historical way in which attention bias is measured, by measuring reaction time of two differently valanced images within the same trial. The second, the vigilance-avoidance model encompasses initial orientation towards a stimulus and uses an incongruent threat trial versus a congruent threat trial for calculating bias (Cisler, Bacon, & Williams, 2009). This is completed by subtracting the reaction time from an incongruent threat trial and a congruent threat trial; giving a classification of either “vigilance towards threat,” and “avoidance from threat”. Another way in which scholars have measured attention bias includes both “vigilance” and “difficulty disengaging from threat”. The major differences between the prior way of measuring attention bias and these newer classifications lies within the comparing trials and attention patterns. In this new form a congruent trial as before with a neutral and threat image is used, with the target appearing behind the threat image. However, what this result is compared to is a neutral image reaction time in an all neutral trial. Vigilance is classified as a shorter reaction time to a threat image in a neutral-threat (congruent) trial compared to neutral images in an all-neutral (congruent) trial. Difficulty disengaging from threat is a longer reaction time to a neutral image in a neutral-threat trial compared to a neutral image in an all-neutral trial.

Given the conceptual characterization of social vigilance as scanning the social environment for potential threats, attentional sensitivity or bias for negative affect may be an important catalyst for this biobehavioral stress pathway.

Current Study

The goal of this study was to experimentally test relationships between dispositional social vigilance, attentional bias for affective expressions, and cardiovascular reactivity using a dot-probe task. Participants were pre-screened for high/low social vigilance through the Department of Psychology’s mass testing. A 2 (high/low dispositional social vigilance) X 2 (Gender) X 2 (high/low incentive) was used to test specific vigilance differences and interactions with incentive. Following a baseline procedure, participants completed multiple trials of facial affect pictures paired with a standardized dot-probe task. At the conclusion, all participants are shown a video for a resting period of 5 minutes. Eye tracking, blood pressure, and autonomic activity were assessed during each phase.

I hypothesize that:

1) higher dispositional social vigilance will be associated with greater attentional bias for negative faces relative to neutral or happy faces.
2) higher dispositional social vigilance will be associated with greater cardiovascular reactivity during the two tasks (dot-probe, video).
3) higher dispositional social vigilance will interact with higher incentive resulting in the highest levels of bias and reactivity.

METHODS

Sample

Participants were screened for dispositional social vigilance and gender from the mass testing battery used in the Introductory Psychology Courses at the University of Arizona. Specifically, students scoring in the upper and lower tertile of the full Social Vigilance Questionnaire (SVQ) and fitting the gender targets were invited to participate. High vigilance is categorized as a score of ≥33, and low vigilance a score of ≤28.

Procedure

Preparation. Following informed consent physiological recording sensors are placed on the participant. Three electrodes were placed onto the upper torso to capture the ECG signal. An additional 4 sensors were placed to capture the impedance signal. In addition, a standard occluding blood pressure cuff was placed on the upper non-dominant arm. Participants were then seated 45-90cm away from the eye tracker that is attached to a 24-inch computer monitor.

Eye-tracking calibration and baseline. Eye location and visual gaze were assessed with a Tobii X2-60 sampling at 60Hz. Participants had free head movement after completing a five-point calibration prior to baseline and again preceding the attention task. The calibration task consists of visually tracking a ball across the screen. All participants then underwent a 10-min "vanilla" baseline task to allow for acclimation to both the laboratory environment and equipment (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992). The task involves examining and rating pairs of pictures followed by a preference rating. Pictures are presented on the computer monitor for 60 seconds each for ten sets

Incentive manipulation. Following the baseline and recalibration, an incentive manipulation was delivered by the research assistant. First, participants were told about the attention task and that their response time and accuracy is noted. Participants within each block were randomized to either the high/contingent incentive or low/non-contingent incentive condition. Participants in the high incentive condition were told that they were eligible to receive $5 contingent on their performance on the task. Participants randomized to the low incentive condition were told that their payment was not contingent on their performance. As the instructions were displayed on the presentation screen participants were handed a faux "Department of Psychology Reimbursement Agreement" form in which they were asked their likelihood of receiving payment.

Attention task. The attention task involving multiple dot probe trials followed the manipulation. Time ranged from 12 to 18 minutes depending on the participants response speed. The task would automatically end after 18 minutes in the rare case of subjects having not completed the trials by that time.

Thirty-six images from the MacArthur NimStim database showcasing happy, neutral and anger emotions were used. Images included men and women and a mix of race and ethnicities with each actors face displaying an emotion (Tottenham et al., 2009). The NimStim database has previously been used in other attention bias protocols, the sizing and placement follows that of Schofield et al (2012). The images are displayed – one on the top of the screen, one on the bottom, for either 1500ms or 400ms for eye-tracking and attention results, respectively. Then a brief image of an "<" or ">" on the top or bottom of the screen is immediately shown. Participants were instructed to quickly identify the direction of arrow by tapping on the designated Left/Right button on the adjoined mouse. Participants completed a practice sequence for which a completion rate of 70% is set in order to move on. Participants who failed to complete the practice after two attempts were excused. Once the participants finished the attention task, they are told that their data would be scored and that they could watch a split screen video feed. The video lasted five minutes and is noted as "rest", physiological data continued to be recorded during this period.

At the conclusion participants completed final measures, were debriefed, the use of deception explained, and credit and payment disbursed.

Measures

<u>Questionnaires</u>

Social Vigilance. The Social Vigilance Questionnaire (SVQ, Ruiz et al., 2017; in-progress). This scale is used to assess an individual's propensity for social vigilance, as defined by their behavioral promotion of vigilance for other's reactions, vigilance for self, and vigilance for threats. The social vigilance questionnaire has been used in both community and laboratory samples asking questions assessing vigilance for social threat: "I watch for people that I don't trust", vigilance for others reactions to self: "I notice and pay extra attention to people who may disapprove of me", and vigilance for self: "I am cautious about what I say around others" (Ruiz et al., in prep). Composed of 10 questions the SVQ is a Likert style questionnaire ranging from Almost never (1) to Almost always (5). The SVQ has been tested in two populations, a general college sample and in a community sample. Polling over 3000 undergraduates for the college sample reports a CFI = .97, and RMSEA = .08 and aided researchers in identifying the final 10-item 3 factor SVQ model. In a community sample of 300 adults the SVQ reports a CFI = .96, RMSEA = .09.

Mood. Positive and Negative affect was assessed twice during the study; pre- and post-attention task. This study used a modified PANAS asking a total of 18 emotion words: Calm, Annoyed, Unashamed, Tense, Humiliated, Friendly, Nervous, Angry, Uncomfortable, Anxious, Irritated, Ashamed, Relaxed, Warm and Kindhearted, Proud, Worried, Mortified, and, Aggravated.

Free recall. Participants are given 8 spaces in which to record their thoughts during the rest period. Recall is used as both a manipulation check and to identify cognitive patterns that may further describe the physiological and cognitive interactions that occur during the attention task and rest periods.

<u>Objective Measures</u>

Eye-tracking. Eye location and visual gaze were assessed with a Tobii X2-60 sampling at 60 Hz. Participants had free head movement after completing a five-point calibration prior to baseline and again prior to attention task. Participants are seated 45-90 cm away from the eye tracker that is attached to a 24-inch computer monitor allowing calibration to occur while seated comfortably and allowing for variation due to glasses, droopy eyelids, and height. Tobii Studio Pro software (3.4.6) was used for collection of visual fixation data.

Cardiovascular functioning. Cardiovascular data was collected with a dual impedance cardiograph system (Mindware Technologies). Impedance cardiography is a psychophysiological recording technology which allows for examination of heart rate and its autonomic determinants. Comparable to ECG, it further breaks down the electrical signal into its spectral components and conjoins it with measurement of blood flow to derive continuous measures HR, the autonomic branches, stroke volume, cardiac output, ejection fraction, ejection time, respiration, and interactions between these variables. Blood Pressure was recorded using a GE Carescape V100 Blood Pressure Monitors. Blood Pressure is measured at discrete times every 90-seconds during the attention and rest periods.

Calculated Variables

Attention bias and reaction time. Reaction time is operationalized as the amount of time it takes for a participant to respond to the probe when behind the chosen target stimulus, i.e. when the probe is behind a negative/neutral image. This is known as the mean reaction time. Only single participant trials with correct answers ($k = 25,408$) were included (incomplete trails, $k = 6,632$) and those participants whose reactions times fall outside 2 standard deviations in the Neutral-neutral trial are excluded ($n = 1$). Secondly, in order to determine attention bias towards negative stimuli the mean reaction time of the congruent neutral trial minus the reaction time of the incongruent threat trial will determine vigilance or difficulty disengaging from threat. This is compared to two other attention bias equations looking within trial.

Physiology change scores. All change scores are created for each time segment during the task and rest portions of the study. Using the last four readings of the baseline and subtracting this from the time segment score create a Δscore used for analyses.

Analysis Plan

First, Hierarchical Linear Modeling was used for attention bias analyses, as each participant has Neutral, Threat, and Happy trials nested within each other. The dependent variable for each analysis is mean reaction time. Independent variables include an individual's social vigilance, affect-trial type (NT, NN, NH), incentive type (high or low), and stimulus-trial type of attention (400ms) or stare/eye-tracking (1500ms). Linear regression was then run to determine the predictive effects of social vigilance on vigilance towards threat, disengagement from threat, and attention bias proper.

In describing the analyses, the unstandardized (B), standard error, confidence intervals, eta-squared, and p-values are reported in Tables 2-7. Alpha level was set at $p < .05$ (two-tailed) for each theoretical question and analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp, 2017) and using R version 3.6.1 with RStudio Version 1.2.1335 (Team, 2019). Repeated measures ANCOVA was used to test the association between task and rest timepoints with cardiovascular correlates given incentive and vigilance type. More specifically, I sought to inspect the effect of an attention bias task heart rate blood pressure, etc. and to examine the further compounding effect of vigilance and incentive type. After all change scores are created for the task and rest timepoints a repeated measures ANCOVA was run. Age, BMI and gender are controlled for in each analysis and the baseline of blood pressure, heart rate, and MAP baseline is used as a control.

Current analyses do not include information from eye-tracking as the data is unavailable to the researcher due to COVID-19 pandemic procedures.

RESULTS

Sample Descriptives

Descriptive statistics for the total sample are shown in Table 1. Significant ($p < 0.05$) correlations were found for Age, BMI ($r=0.343$), and baseline MAP ($r=0.350$). Therefore, age was added as a covariate to analyses in addition to previously known covariates.

Reaction Time

HLM and Linear Regression assumes the dependent variable is normally distributive. The traditional Attention Bias formula (ABF) totals were found to not be normally distributed. All reaction times were found to have acceptable skew and kurtosis parameters when grouped by condition type. Homoscedasticity and homogeneity of variance have found to be acceptable. Models were fit using REML due to relatively equal group sizes and therefore model fits were not compared and the full theoretically superior model is reported.

*Trial differences in reaction time. T*he average reaction time over all trial combinations (valence, attention vs stare) is statistically different than zero, with $\beta = 559.62$, $t(1,979) = 52.12$, $p< 0.001$. The unexplained variance in trial specific intercepts is large at 10168.46 (±100.84). There is significant variation between trial intercepts and 90% of the variance in reaction time is between trials. The unconditional means model as depicted in Table 2 illustrates the reactions times as they vary by individual trials. Comparing our two unconditional models, means and slopes in Table 2 and 3, the AIC, BIC, and Log Likelihoods are all preferred in the unconditional slopes model as each are closer to zero. The likelihood ratio test is distributed as $\chi^2(1) = 2055.98$ with a p-value of <0.0001.

Overall the effect of trial combination on individual reaction time was $F(1,935) = 2.29$, $p<.01$. Breaking this down by each stimulus valence type, effects were found separately for the Neutral Probe (NN-S), NeutralS Probe (NN-S), Happy Probe (NH-A), Happy Probe (NH-S), and the Neutral Probe (NH-S) tasks showing an increase in reaction time between 15.75/ms and 32.96/ms; all t's(1,935)>2.19, $p<.029$. See Table 4. For each of these stimulus types it took longer for an individual to react to the specific probe suggested compared to the neutral condition referenced.

Gender and reaction time. Gender was not found to be a significant predictor of reaction time, $F(1,84) = 0.8147$, $p>.05$.

Vigilance and reaction time. Total Social Vigilance score dichotomized as High-Low did not predict reaction times in any trials regardless of valence or trial type. Figure 1 depicts the distribution of reaction time by vigilance.

Incentive and reaction time. Figure 2 illustrates the distribution of reaction time when grouped by incentive type (high/low). Here we see no statistical difference between the groups, $p>.05$ and are normally distributed. Incentive type did not show any significant reaction with valence-type overall $F(1,935)=1.164$, $p>.05$. Separately, the NH H-Probe(S) type was found to have a decrease in reaction time by 2.3/ms of those in the high incentive condition, $\beta = -2.31$, $t(1,935) = -2.01$, $p=0.05$. Individuals in the high-incentive group, told they were to receive \$5 dollars had a decrease in reaction time when presented with a happy stimulus

Attention formulas and vigilance. Attention bias score calculated in the traditional way (ABF) as a reaction time towards a threat image compared to a neutral image within the same trial was not predicted by social vigilance $F(1, 1066)=0.197$, $p=.657$. Nor did social vigilance predict reaction time for the vigilance-avoidance model, $F(1, 1066)=1.77$, $p=.184$. Social Vigilance did however predict a lowering of reaction time, quicker responses, for vigilance-difficulty disengaging from threat equations by 4.408/ms, $t(1066)=-2.072$, $p<.04$.

Cardiovascular Physiology

Baseline physiology. Gender showed a significant effect on both baseline systolic and diastolic blood pressure and mean arterial pressure (a derivative of SBP and DBP) indicating men on average had higher values (all p's<0.004). Figure 3 shows these differences with each significance of SBP, DBP, and MAP ($p<.0031$). Vigilance and incentive showed no effect on baseline measurements.

Baseline to Task physiology. Average changes in systolic blood pressure (4.07 ± 8.86), diastolic blood pressure (3.08 ± 3.02), mean arterial pressure (4.74 ± 10.7), and heart rate (1.88 ± 4.16) from baseline to task are presented in Figure 4. Each index includes a positive and negative change, therefore blood pressure, heart rate, and mean arterial pressure changed between baseline and task. Interestingly, MAP from baseline to task was not found to be significantly different from zero. All other indexes showed significance from zero.

There were no significant main effects for vigilance, gender or incentive individually on cardiovascular indices, all F's < 2.64 p=n.s.

A significant interaction between incentive type, vigilance, and gender was discovered $F(1,65) = 7.99$, $p< 0.01$ for systolic blood pressure from baseline to task (Table 5). Therefore, highly vigilant men within the high incentive condition showed a statistically significant change in systolic blood pressure from baseline to task.

Baseline to Rest physiology. A significant main effect of vigilance on systolic blood pressure change from baseline to rest presented at $F(1,61)=5.221$, $p<0.05$. Those with high vigilance had greater changes in systolic blood pressure from baseline to rest but no other main effects of vigilance on blood pressure or heart rate. Individually gender and incentive had no effect on cardiovascular indices with all F's < 2.4, p=n.s. Close to significance the interaction between incentive type, vigilance, and gender from baseline to rest can be observed $F(1,61)=3.881$, $p=0.053$, and $\eta^2=0.06$ on systolic blood pressure (Table 6). To conclude, a marginally significant interaction between gender and vigilance on diastolic blood pressure during from baseline to rest appears at $F(1,61)=3.848$, $p=0.054$ (Table 7). However, while on the fence of statistical significance it also does not equate to large effect size ($\eta^2=.003$).

DISCUSSION

Attention Bias and Vigilance

This project aims to assess how social vigilance and incentive type predict attention bias, and the different types of measuring this attention bias in the current literature. Stimulus type did predict reaction type, demonstrating the salience of emotion in each trial and its effect on reaction time. Overall there was a difference in mean reactions time based on valence-type mainly driven by the differences in reaction times in the Neutral Probe Neutral-Neutral Stare condition, the NeutralS Probe Neutral-Neutral Stare condition, the Happy Probe Neutral-Happy Attention condition, the Happy Probe Neutral-Happy Stare condition, and the Neutral Probe

Neutral-Happy Stare Condition. In each of these conditions the participants took longer to respond to their probe compared to the neutral probe of the neutral-neutral attention condition. There was no interaction among social vigilance and incentive type in any of the conditions except one. Interestingly, there was an effect of incentive type of "happy" trials for the stare sub-type, possibly mimicking the effect of positive images disruptive effect on negative appraisal. In the Neutral-Happy Stare condition, in which individuals were asked to respond to the Happy probe when presented for 1000/ms when in the high incentive condition had a reduction in reaction time of 2/ms. Suggesting that as an overtly positive image has been displayed in a stressful condition stimulated by incentive condition participants responded quicker compared to our reference condition.

Individual vigilance towards threat and difficulty disengaging from threat score has been calculated to identify social vigilance relationships to these sums. After completing linear regression to understand these relationships we found only one meaningful relationship between social vigilance and vigilance towards threat measured as an individual's reaction time towards a threatening image compared to that of a neutral image in a truly neutral trial (e.g. NN-N Probe). This evidence suggests that the formulas used for measuring attention bias need to match that of the hypothesis – the current widely used formula is insufficient.

Social vigilance did not at this time predict reaction times towards emotional stimuli, however this may be in part due to the presentation time being short (500-1000ms) and the difficulty of an in-lab assessment mapping onto natural events and behaviors. Seeing however, that there are a few relationships between incentive type and stimuli, and social vigilance and vigilance towards threat is encouraging that this work is headed towards the direction of unpacking the cognitive and behavioral components of attention cascades. This new direction in attention work ideally can be used to identify more meaningful interventions for those with social anxiety, PTSD, and other negative affect attention biases.

Cardiovascular Functioning and Vigilance

Beyond standard stressors, social vigilance may be a plausible moderator of chronic reactivity with disease implications. Branching from Lazarus and Folkman, social vigilance may be automatic and viewed as an ongoing behavior that can be modulated down during relaxation or up when threat potential increases. Social vigilance may also be specific and effortful for a specific threat or individual's reaction. Theoretically, individuals who are higher in dispositional social vigilance may attend to more candidate stimuli, perceive more threats, and more frequently engage in monitoring of those perceived threats than individuals who are lower in dispositional social vigilance.

In the current study vigilance was not shown to predict most cardiovascular indices except for systolic blood pressure. Wherein, individuals with higher social vigilance (3.4 and above) had greater changes from baseline to rest. A significant interaction between incentive type, vigilance, and gender for systolic blood pressure during the task was illuminated. This interaction detailing the changes in blood pressure for a high vigilant male in the high incentive condition. The previous interaction was close to observation during rest. This three-way interaction can be unpacked in multiple ways. Gender plays a role in blood pressure, as does vigilance as shown in prior studies. Still, incentive type may be driving this interaction. When viewing these components separately for systolic blood pressure during task there were no main effects. This task interaction may be capturing a response that weaves together an individual difference of vigilance and randomized condition of incentive in males.

In a 1998 study investigating vigilance and cardiovascular reactivity towards stressors (math and mirror tracing) similarly found an effect of condition on systolic blood pressure. In this study the condition were separated by affect in which the authors believe that the negative search condition showed the greatest reactivity – we may be seeing similar reactions when individuals are high in vigilance *and* in the high incentive condition (Gump & Matthews, 1998). Further this may be capturing an anticipatory response induced after participants have been randomized into incentive condition. Anticipation of a stressor may show changes in vascular parameters that are further affected by the myocardial response – creating an inconsistent vascular response in the results (Zanstra & Johnston, 2011). We see this possibility when viewing the mean arterial pressure during the task for participants. Here the MAP is not significantly different from zero and may be a result of a vascular response competing with a myocardial response.

Limitations

Currently not all physiological, attention, and eye-tracking data can be examined due to the ongoing COVID-19 epidemic. However, these beginning results show promise and more may be revealed in measurements of heart rate variability, cardiac impedance, and gaze time within eye-tracking. Being a laboratory study and one in which, a college sample is used – the results are not generalizable. It could be then that these individual differences may be greater in a less homogenous sample with a mean age greater than 20 years old and not primarily White.

Despite these limitations much has been learned from this study including the need for further research into stress tasks that elucidate a stress response most akin to real life (Waldstein, Neumann, Burns, & Maier, 1998). For in real life a stress response can be activated but may not have the same magnitude as an in-laboratory stressor playing at the edges of stress. Further work can build upon this study by including a more socially relevant task that has been shown to induce a stress response of higher ecological validity.

Future work

Amidst a flurry of pandemic and human rights news it can feel daunting to highlight small victories. However, successes within this project include the use of upper level statistics methods, challenging current ideas of attention bias, and integrating new technology. By using R, an opensource software with a large learning curve, reaction times were analyzed on a grander within group scale. As more data is rendered comparisons between these reactions times and physiological reactions can be made. This includes exploring attention bias beyond traditional methods of measurement, the analyses can expand previous null-hypothesis testing. Furthermore, emerging technology such as Tobii eye tracking, and Mindware's impedance cardiography add to the fields capabilities of moving within lab scenarios to real-world situations and later, interventions. Future work, including extensions of this thesis, should build upon these successes and utilize its lessons learned.

TABLES AND FIGURES

Table 1: Total Sample Descriptives by Vigilance Type

Variable	High Vigilance	Low Vigilance
Participants (n)	49	47
Mean age (years) (SD)	19.63 (3.38)	19.28 (1.54)
Mean BMI (kg/m) (SD)	23.65 (4.68)	23.58 (4.74)
Mean Baseline systolic BP (SD)	108.36 (10.11	109.36 (12.18)
Mean Baseline diastolic BP (SD)	64.99 (6.49)	67.62 (7.15)
Mean Baseline HR (SD)	74.55 (11.11)	77.0 (12.37)
Mean Baseline MAP (SD)	80.86 (7.37)	83.43 (7.61)
Race/Ethnicity		
American Indian or Alaskan Native (n)	3	4
Asian (n)	3	5
Black/African American (n)	0	3
White (n)	30	29
Hispanic (n)	15	16
More than one race (n)	5	3

Table 2: Unconditional Means Model

Predictor	***B***	***SE***	***df***	***T***	***p***	***95% CI***
Intercept	559.62	10.74	979	52.12	<.001	(538.55, 580.69)
Component	**Variance**	***SD***	***P***	***95% CI (for SD)***		
Intercept	10168.46	100.84	<.0001	(86.87, 117.05)		
Error	1101.84	33.19	--			

LL = -5462.03, *AIC* = 10930.07, *BIC* = 10944.98, *ICC* = .90

Table 3: Unconditional Slopes Model

Predictor	***B***	***SE***	***Df***	***t***	***P***	***95% CI***
Intercept	552.94	11.24	968	49.17	<.0001	(552.94, 575.01)
NT-N (A)	4.89	4.94	968	.989	0.322	(-4.80, 14.58)
NT-T (A)	2.13	4.94	968	.432	.666	(-7.56, 11.83)
NT-N (S)	.669	4.94	968	.135	.892	(-9.03, 10.36)
NT-T (S)	2.25	4.94	968	.455	.649	(-7.45, 11.94)
NN-Ns(A)	2.84	4.94	968	.575	.565	(-6.85, 12.54)
NN-N (S)	12.1	4.94	968	2.45	.014	(2.42, 21.81)
NN-Ns(S)	15.2	4.94	968	3.08	.002	(5.53, 24.92)
NH-H(A)	10.9	4.94	968	2.21	.028	(1.20, 20.59)
NH-N (A)	5.86	4.94	968	1.19	.236	(-3.83, 15.56)
NH-H(S)	12.4	4.94	968	2.51	.012	(2.70, 22.09)
NH-N(S)	10.8	4.94	968	2.19	.029	(1.12, 20.49)
Component	**Variance**	***SD***	***P***	***95% CI (for SD)***		
Intercept	10169.79	100.85	<0.0001	(86.88, 117.05)		
Error	1085.90	32.95	--	(31.51, 34.45)		

LL = -5424.29, *AIC* = 10876.58, *BIC* = 10946.05

Table 4: Statistically Significant Results of Full Model

Predictor	***B***	***SE***	***df***	***t***	***P***	***95% CI***
Intercept	540.99	25.58	935	21.15	<.0001	(490.78, 540.99)
NN-N (S)	23.96	9.98	935	2.40	.017	(4.38, 23.96)
NN-Ns(S)	21.99	9.98	935	2.20	.028	(2.40, 21.99)
NH-H(S)	32.96	9.98	935	3.30	.001	(13.37, 32.96)
NH-N(S)	15.75	9.98	935	2.19	.029	(-3.83, 15.75)
NH-H(S):HI	-2.31	14.28	935	-2.01	.05	
Component	**Variance**	***SD***	***P***	***95% CI (for SD)***		
Intercept	10531.31	102.622	>0.5	(88.10, 119.53)		
Error	1095.37	33.1	--	(31.63, 34.63)		

LL = -5288.79, *AIC* = 10679.58, *BIC* = 10930.83

Table 5: Systolic Blood Pressure during Task

Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	7740.49	1	7740.49	17.93	.000	.216
BMI	31.58	1	31.58	.073	.788	.001
Age	131.48	1	131.48	.305	.583	.005
Baseline SBP^	8253.28	1	8253.28	19.12	.000	.227
Incentive	90.18	1	90.18	.209	.649	.003
Vigilance	485.41	1	485.41	1.13	.293	.017
Gender	1108.42	1	1108.42	2.57	.114	.038
Incentive * Vigilance	1.15	1	1.15	.003	.959	.000
Incentive * Gender	25.35	1	25.35	.059	.809	.001
Vigilance * Gender	147.82	1	147.82	.342	.560	.005
Incentive * Vigilance * Gender^	3448.37	1	3448.37	7.989	.006	.109
Error	28057.8	65	431.66			

Table 6: Systolic Blood Pressure during Rest

Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	368.5	1	368.5	6.17	.016	.092
BMI	43.1	1	43.2	.722	.399	.012
Age	52	1	52	.870	.355	.014
Baseline SBP^	377.2	1	377.2	6.31	.015	.094
Incentive	49.4	1	49.4	.827	.367	.013
Vigilance^	311.9	1	311.9	5.22	.026	.079
Gender	5.2	1	5.2	.086	.770	.001
Incentive * Vigilance	85.1	1	85.1	1.42	.237	.023
Incentive * Gender	21.8	1	21.8	.366	.547	.006
Vigilance * Gender	.16	1	.16	.003	.959	.000
Incentive * Vigilance * Gender	231.9	1	231.9	3.88	.053	.060
Error	3644.6	61	59.75			

Table 7: Diastolic Blood Pressure during Rest

Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	473.46	1	473.46	7.81	.007	.114
BMI	3.50	1	3.50	.058	.811	.001
Age	93.71	1	93.71	1.55	.218	.025
Baseline DBP^	799.81	1	799.81	13.2	.001	.178
Incentive	.618	1	.618	.010	.920	.000
Vigilance	2.13	1	2.13	.035	.852	.001
Gender	9.51	1	9.51	.157	.693	.003
Incentive * Vigilance	102.62	1	102.62	1.7	.198	.027
Incentive * Gender	96.81	1	96.81	1.6	.211	.026
Vigilance * Gender	233.18	1	233.18	3.9	.054	.059
Incentive * Vigilance * Gender	10.43	1	10.43	.172	.680	.003
Error	3696.94	61	60.61			

Figure 1: Reaction time by Vigilance

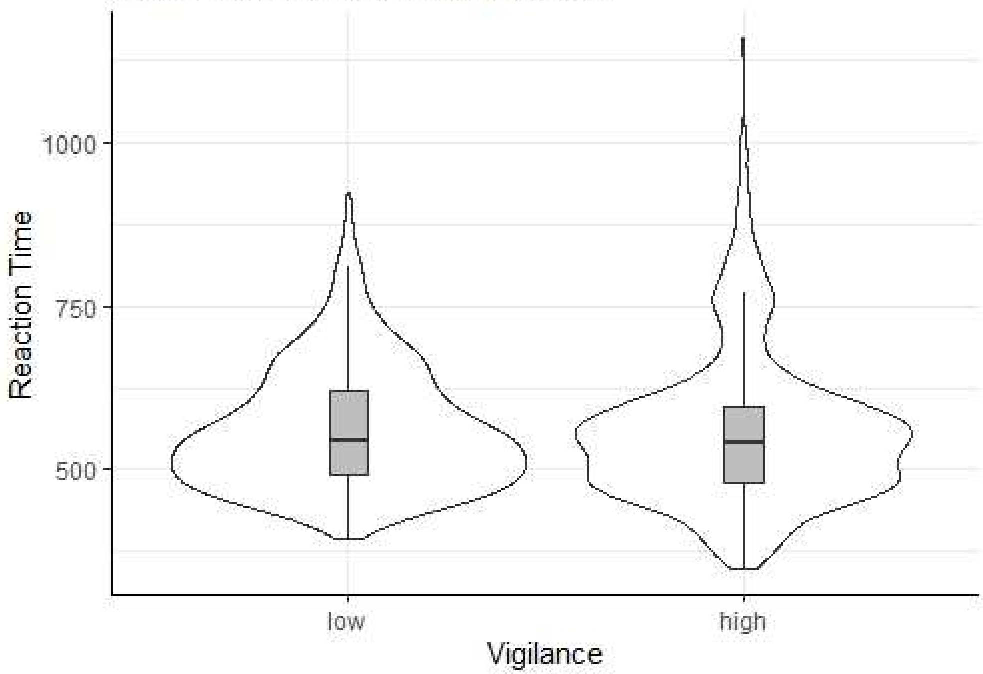


Figure 2: Reaction time by Incentive

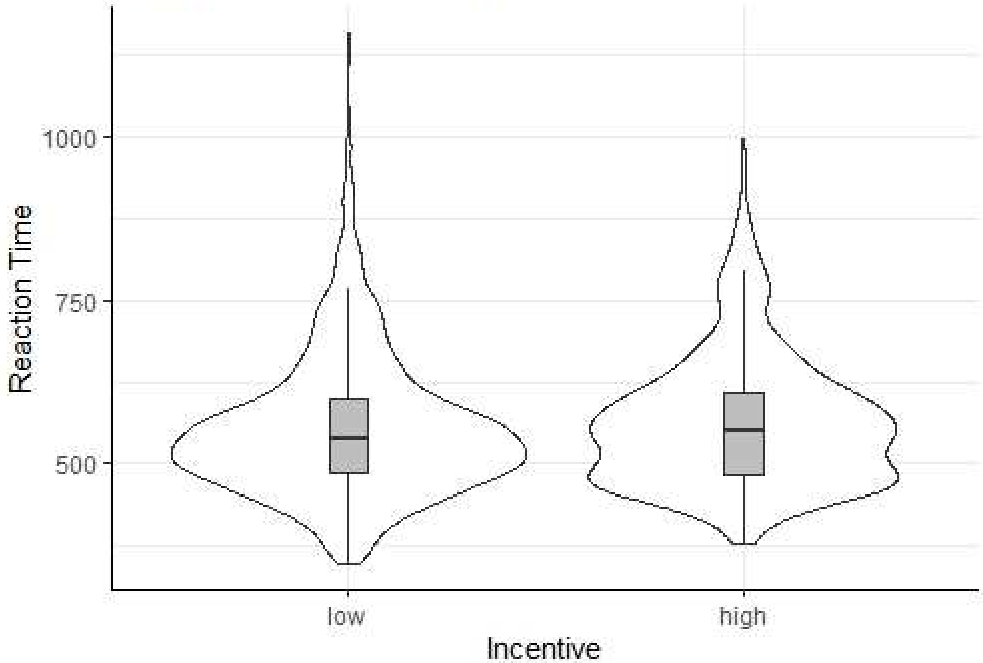
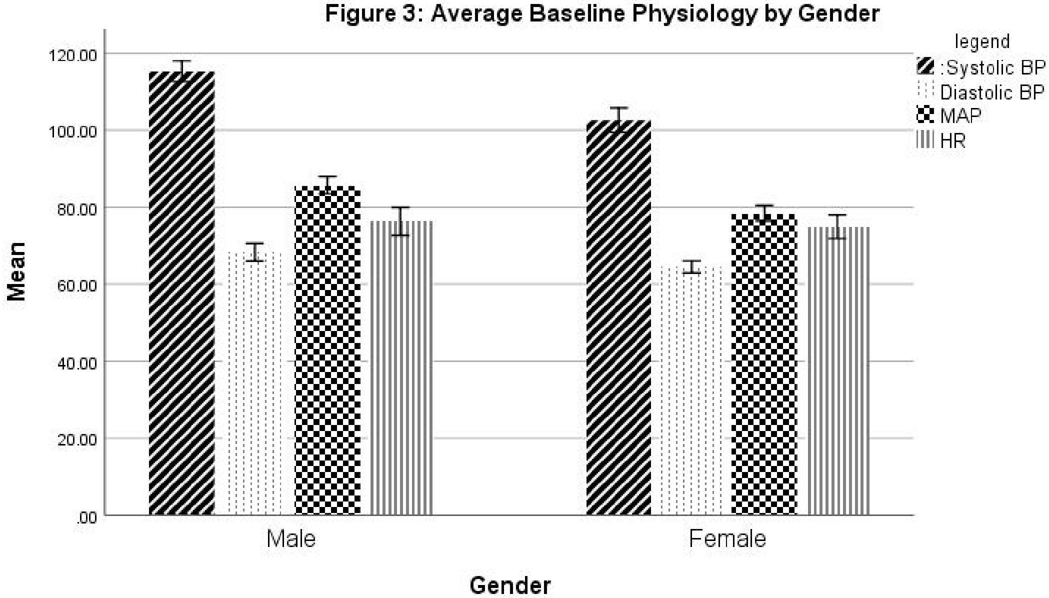


Figure 3: Average Baseline Physiology by Gender

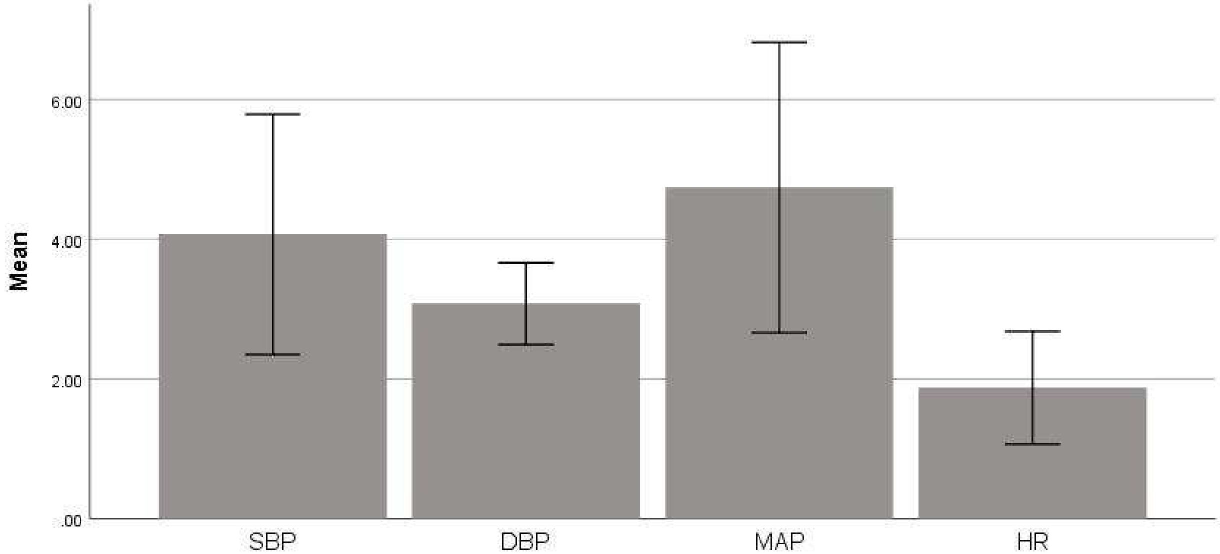


Systolic and Diastolic BP, MAP measurements are in mm/Hg

HR measurements are in bpm

Error bars: 95% CI

Figure 4: Average changes in Physiology from Baseline to Task



Systolic and Diastolic BP, MAP measurements are in mm/Hg

HR measurements are in bpm

Error bars: 95% CI

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