INTEROCEPTIVE AWARENESS AS IT RELATES TO EATING DISORDERS RISK IN COLLEGE WOMEN: DOES VASOCONSTRICTION INCREASE CARDIAC AWARENESS?

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ABSTRACT

The purpose of this study was to determine whether a subclinical eating disorder sample of college women exhibit interoceptive deficits psychologically and physiologically compared to healthy college women. Additionally, the effect of vasoconstriction (due to brief exercise) on cardiac awareness was investigated. Twenty five college women completed a psychological measures as well as a heartbeat perception task before and after walking on stairs for two minutes. Results indicate that this subclinical eating disorder sample exhibited interoceptive deficit as measured by a psychological scale, but did not exhibit altered interoceptive abilities as measured by a physiological task compared to the low risk sample. These findings suggest that interoceptive deficits related to identifying emotional states may be more defining in those with eating disorder risk than is interoceptive deficits related to identifying physiological states. Clinical and research implications of these findings are discussed.

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CHAPTER I

Introduction

Human beings' perception of sensation historically has been categorized into five separate types: exteroceptive (physical touch), interoceptive (visceral), proprioceptive (position), chemoreceptive (smell and taste), and teloreceptive (visual and auditory) (Craig, 2002). Craig (2002; 2003) argues interoception is in fact the interpretation of all bodily signals, not just visceral sensations. It is distinguished by its use in evaluating and maintaining homeostasis, too. Specifically, a distinction is made between the accurate detection of bodily sensation and the interpretation or perception of that sensation.

The somatosensory cortex, located at the postcentral gyrus, detects sensation whereas the interoceptive cortex—comprised of the right anterior insular cortex and ventral medial nucleus of the thalamus—interprets that sensation. Interpretation occurs with input from and to homeostatic afferent and efferent fibers, respectively. This cyclical process contributes to the interpretation of a sensation and explains how the same sensation can be perceived negatively or positively. For example, Craig (2002) presents the dichotomy of cooled water on the body: it is refreshing when the body is overheated, but unbearable when the body is cold. In both instances the sensation of the water is detected; it is, however, the homeostatic state of the body that impacts the interpretation of the water.

The Role of Interoception in Emotion

The detection of body signals affects the resulting reaction or response to that signal—is the cool water pleasant or unappealing? Craig (2007) referred to this phenomenon as homeostatic emotion, which Damasio (1994) called background emotion. The feelings of the body are determined based on the homeostatic state of the body at a given instance. These are separate, but similar to the emotional feelings one experiences. Interestingly, the brain regions for interpreting attitudinal feelings can be the same as those responsible for interpreting bodily sensation (Zaki, Davis, & Ochsner, 2012). In a two-part investigation, Zaki et al. (2012) evaluated emotional processing and heartbeat detection in the same population of adults. In one part, participants were presented emotional videos during functional magnetic resonance imaging (fMRI). In the other, participants performed a heartbeat detection task during an fMRI. Imaging revealed activation in the anterior insula during both tasks; this was the first study to demonstrate this area is involved in both tasks (Zaki et al., 2012).

It is this overlap in emotional processing—between attitudinal and physiological feelings—that muddles interoceptive awareness literature. As with many lines of research, different studies will measure interoceptive awareness in a similar population, but arrive at alternate, and on occasion opposing, conclusions. For this reason, it is important to evaluate the *type* of interoceptive awareness evaluated: emotional or physiological. Much of the literature has relied on two methods of evaluating interoception. The first method typically involves self-report measures such as the Private Body—Public Body Consciousness Scales (Fenigstein, Scheier, & Buss, 1975) or the Objectified Body Consciousness Scale (McKinley & Hyde, 1996). These measurement tools evaluate the processing of attitudinal emotions. The second method involves introspection on visceral sensation, such as a heartbeat perception task, using the Mental Tracking Method (Schandry, 1981) or water loading. These physiologically based measures require participants to mentally track their physiological state, which is then compared to actual recordings.

It is unclear, however, if the physiological perception tasks are a measure of detection or interpretation of detection. Theoretically, one would assume the task would qualify as a detection task. But Zaki et al. (2012) demonstrated areas of the brain responsible for interpreting emotional situations are involved in the heartbeat perception task. This suggests there is a possible discrepancy between what is purportedly measured and what is actually measured in detection tasks. Further, accuracy in detection tasks is reported as a percentage correct without a directional explanation of over- or underestimation. These inconsistencies need to be further investigated.

Interoceptive Abilities in Eating Disorders

It has been proposed that individuals with restrictive eating disorders have diminished interoceptive abilities (Bruch, 1962). Bruch (1962) states several of her patients, diagnosed with anorexia nervosa shared perceptual and emotional disturbances evidenced by their altered body image and inability to identify emotional states.

Thompson, Berg, and Shatford (1987) found lower interoceptive awareness scores for college women with bulimia nervosa than those who were symptom-free or bulimic-like. Further, bulimic-like participants had lower awareness than the symptom-free participants. Thompson et al. (1987) measured interoceptive awareness using the original Eating Disorder Inventory from Garner, Olmstead, and Polivy (1983).

Interoceptive awareness research in eating disorder populations often utilizes the interoceptive awareness subscale of the Eating Disorder Inventory (Garner et al., 1983). Depending on the version of the EDI, it measures interoceptive awareness or deficits; despite the difference in subscale name, a higher score indicates lower awareness. The EDI-1 and EDI-2 measure interoceptive awareness; the EDI-3 measures interoceptive deficit. Although the scale name is different on the EDI-3, there is applicability with the EDI-2 as items are shared. The newer title is more reflective of the lack of awareness (or deficit) found in eating disorder populations. Regardless of the name, these subscales assess the ability to identify emotional states; they are, however, more a measure of attitudinal awareness than physiological awareness. More recently, researchers have examined interoceptive abilities in those with or recovered from restrictive eating disorders utilizing a variety of methods (e.g., Klabunde, Acheson, Boutelle, Matthews, & Kaye, 2013; Matsumoto et al., 2006; Pollatos et al., 2008; Zonnevylle-Bender et al., 2005). These more recent studies examine the ability to accurately assess both physiological and emotional feelings.

Zonnevylle-Bender et al. (2005) found incongruence between reported stress levels and physiological responses to stress in adolescent females with anorexia nervosa when compared to age matched healthy controls. Stress levels were manipulated using a public speaking test and math challenge test. Heart rate and cortisol saliva levels were monitored throughout the study, with heart rate measured continuously and cortisol sampled at eight different intervals during the 2 hour study. In addition to these physiological measures, various psychological constructs were evaluated using the Toronto Alexithymia Scale (TAS-20), the Social Phobia and Anxiety Inventory (SPAI), the Beck Depression Inventory (BDI), the Profile of Mood States (POMS), and the Speilberger State Anxiety Inventory (STAI). The TAS-20, SPAI, and BDI were only completed once prior to the stress inducing tests. The STAI was completed twice: once just before the oral presentation and once immediately after the math test. The POMS was completed at each of the eight intervals.

As might be expected, Zonnevylle-Bender et al. (2005) found significant differences between the groups on the TAS-20, BDI, and SPAI with the individuals with anorexia nervosa scoring higher than the healthy control group on each measure. Interestingly, the group of women with anorexia nervosa reported higher levels of anxiety on the POMS than the healthy control group; however, changes in heart rate and cortisol levels did not reflect this difference. Specifically, the clinical group exhibited lower change in heart rate and showed lower cortisol levels in response to the stress tests compared to the healthy controls, but the participants reported higher levels of tension on the POMS. Zonnevylle-Bender et al. (2005) attribute this discrepancy between perceived and recorded physiological arousal in the clinical participants to a reliance on external, situational cues. They suggest the clinical participants relied on situational demands instead of their own bodily states to report anxious feelings.

It is unclear if those with anorexia nervosa are interpreting their state as more anxious—perhaps due to a reliance on external cues—or if they are more sensitive to a change in state. Although their bodies responded with a less intense change in physiological arousal, they could have overly or misinterpreted that change in physiological state.

Assessing detection of such physiological cues, Pollatos et al. (2008) also found diminished interoceptive abilities in females with anorexia nervosa—restricting and binge/purge subtypes—compared to age matched, healthy controls. Interoceptive abilities were assessed using a heartbeat perception task and the interoceptive awareness subscale of the EDI-2. Additionally, the BDI, STAI, and TAS were used to measure depression, anxiety, and alexithymia, respectively. A strong, positive correlation was found between interoceptive awareness and TAS scores, however, Pollatos et al. (2008) explain, "the self-reported data on interoceptive awareness as measured by the EDI are confounded with anxiety and depression" (p. 385). The participants with anorexia nervosa had a significantly lower mean accuracy score on the heartbeat perception task than the healthy control participants, even after controlling for depression and anxiety. A negative correlation between interoceptive awareness (as measured by the EDI-2) and body mass index was found; this suggests a lower BMI, as might be seen in someone with anorexia, is associated with more deficit in interoceptive abilities. Pollatos et al. (2008) concluded these results indicate a reduced capacity to accurately detect cardiac sensations among those with anorexia nervosa.

These deficits in interoceptive awareness are not necessarily permanent. Matsumoto et al. (2006) compared various psychological factors and regional cerebral blood flow changes in adult women before and after recovery from anorexia nervosa. The Japanese versions of the EDI, Eating Attitudes Test, Self Rating Depression Scale, and State Trait Anxiety Inventory were used to measure depression, anxiety, eating disorder attitudes and behaviors both before and after inpatient behavioral therapy in a sample of Japanese adult women with anorexia nervosa. Compared to before treatment, scores on the SDS and STAI were significantly lower after recovery as were scores on the EAT. Interestingly, the interoceptive awareness subscale was the only subscale on the EDI to show significant improvement following recovery. Following recovery, single photon emission computed tomography (SPECT) revealed increased blood flow in the following regions: right dorsolateral prefrontal cortex, medial parietal cortex including precuneus, and the posterior cingulate cortex compared to before treatment activity. Matsumoto et al. (2006) conclude these regions are involved in the improvement of interoceptive abilities in patients with anorexia nervosa.

This improvement in awareness, however, was measured by a self-report survey and was not based on an evaluation of their perception of physiological sensations. In a similar study, Klabunde et al. (2013) examined interoceptive awareness in women recovered from bulimia nervosa and healthy controls, but utilized an applied interoceptive task (i.e., the heartbeat detection task) rather than self-report measures. The heartbeat detection task came from Schandry (1981); accuracy scores on the task were compared. They found lower interoceptive abilities in the women recovered from bulimia nervosa compared to healthy control females. The groups showed no differences between respiration, sitting heart rate, or sitting blood pressure, suggesting differences in threshold could exist between the healthy females and females recovered from bulimia nervosa rather than intensity of cardiac signals. Klabunde et al. (2013) suggests the deficit could exist prior to and possibly contribute to the development of bulimia nervosa, but also note further research is necessary to determine if this hypothesis is supported.

There are a few factors that could have contributed to the findings of Matsumoto et al. (2006) and Klabunde et al. (2013). First, the studies utilize different clinical populations, with Matsumoto et al. (2006) examining females recovered from anorexia nervosa and Klabunde et al. (2013) utilizing a population recovered from bulimia nervosa. Additionally, Klabunde et al. (2013) report a difference in age between the clinical and control groups. Age could be a significant confound, as Khalsa, Rudrauf, and Tranel (2009) demonstrated interoceptive awareness—as measured by the heartbeat perception task—declines with age. In fact, in their study age predicted 30% of the variance seen in heartbeat detection accuracy.

Manipulating Interoceptive Awareness

Several researchers have demonstrated interoceptive abilities can be manipulated in healthy populations (e.g., Ainley, Maister, Brokfeld, Farmer, & Tsakiris, 2013; Herbert, Muth, Pollatos, & Herbert, 2012; Pollatos, Herbert, Kaufmann, Auer, & Schandry, 2007; Vögele, Hilbert, & Tushen-Caffier, 2009).

Herbert, Herbert, et al. (2012) evaluated the effect short-term fasting had on interoceptive awareness in healthy females. Interoceptive awareness was evaluated using both a heartbeat detection task and asking about felt hunger on a Likert scale. Additionally, cardiac activity was assessed using various cardiodynamic assessments (e.g., cardiac output, index of contractility, stroke volume). Mood states were evaluated using the profile of mood states (POMS) and the self-assessment manikin (SAM). Assessments were conducted at three or four time frames: once at a pre-screening, once at days one and two of fasting, and once about 3 weeks later. Only electrocardiogram, impedance cardiogram, and the interoceptive awareness tasks were completed at follow up. Results revealed fasting led to higher accuracy on the heartbeat detection task, greater felt hunger, higher arousal during heartbeat perception, and a greater negative mood state on the second day of fasting than on any of the other days. As might be expected, fasting also was associated with an increase in all cardiodynamic measures except for stroke volume.

The results of Herbert, Herbert, et al. (2012) suggest an altered homeostatic state—seen at the second day of fasting compared to the other days of assessment—can influence interoceptive awareness of both physiological and attitudinal sensations.

Hunger is a unique feeling that is associated with both a distinct set of physiological sensations and an attitudinal representation. As expected, felt hunger had a positive relationship to fasting; the longer participants went without food, the more intense felt hunger became. Similarly, the more stressed the body became (as a result of fasting), the more accurately the participants experienced cardiac sensations. Although intriguing, it is unclear what is related to the improvement in accuracy seen at day 2: Is it related to digestive distress or cardiac distress? Both digestive and cardiac distresses were present during the interoceptive tasks on day 3, but not on any other day. This is likely due to the role of the autonomic nervous system.

The autonomic nervous system works to maintain homeostasis and is comprised of the parasympathetic and sympathetic nervous systems. As an individual moves away from homeostasis, sympathetic nervous system activity increases to process the stress, or conversely, parasympathetic nervous system activity decreases. Similarly, the parasympathetic nervous system can increase in activity—or, conversely, the sympathetic nervous system activity could decrease—but does so to return the body to a state of homeostasis; it calms the body in a time of recovery from stress.

The role of autonomic regulation has been compared between bulimic and healthy control females. Vögele et al. (2009) found females with restricting type bulimia to exhibit greater sympathetic inhibition compared to both females with nonrestricting type bulimia nervosa and healthy controls. Participants were categorized based on *DSM-IV* diagnoses and blood serum levels of glucose, prealbumin, insulin like growth factor

(IGF-1), thyroid stimulating hormone (TSH), and leptin. Blood serum levels were used to identify whether or not a participant was in a state of malnutrition. In addition to blood serum levels, participants' heart rate, electrodermal activity, and mood were monitored throughout the study. Mood was assessed using Likert scale questions. The experimental aspect of the study involved a LARA task (from Thum, Boucsein, Kuhmann, & Ray, 1995), which requires participants to complete a visual search for a specified number of targets; it has been shown to reliably alter cardiac activity (Thum et al., 1995).

Herbert, Herbert, et al. (2012) found heart rate and blood pressure elevated during the task but returned to baseline after the trials ended for all groups. Interestingly, though, they found that participants with restricting type bulimia nervosa had higher heart rate reactivity in both increasing heart rate during the task and decreasing heart rate during the recovery period compared to their nonrestricting and healthy control counterparts. It is unclear, however, if this reactivity difference is associated with awareness, which was not assessed in this study.

Pollatos et al. (2007) measured the effect of a handgrip exercise on cardiac state, as well as the relationship between cardiac reactivity with interoceptive abilities and trait anxiety. Heart rate, blood pressure, stroke volume, output, preejection period, and total peripheral resistance index were used as measures of cardiac state. The heartbeat detection task was used as a measure of interoceptive awareness.

Pollatos et al. (2007) found heart rate, blood pressure and total peripheral resistance index elevated during the exercise while the other measures decreased. Changes in heart rate, systolic blood pressure, cardiac output, and preejection period were positively correlated with interoceptive awareness. Using a median split technique on the measures of cardiac activity, the researchers also created cardiovascular reactivity groups. Those with high reactivity exhibited greater accuracy on the heartbeat detection task (i.e., interoceptive awareness) and scored higher on the STAI. Pollatos et al. (2007) deduced a close relationship must exist between interoceptive awareness and sympathetic responses, particularly cardiovascular responses, to physical stress. Although interoceptive awareness was not manipulated, this study does suggest cardiovascular activity could modulate interoceptive awareness.

Stevens et al. (2011) found accuracy on a heartbeat perception task could be increased by speech anticipation. Further, those with high social anxiety performed more accurately on the task than low anxiety participants at both baseline and during speech participation. Importantly, heart rates between high and low anxiety groups were similar. They attributed higher levels of anxiety to the heightened accuracy in perceiving visceral sensations. Stevens et al. (2011) suggest anxious individuals are more sensitive to their body's stimuli, but misinterpret the stimuli as signs of anxiety. Although actual heart rate does increase, it is not clear whether it increased significantly from baseline to anticipation.

Summary and Purpose of the Current Study

Interoceptive awareness is the ability to, not only detect, but also interpret bodily signals (Craig, 2002; 2003). Individuals with eating disorders have been shown to have diminished interoceptive abilities (e.g., Klabunde et al., 2013; Matsumoto et al., 2006; Pollatos et al., 2008; Zonnevylle-Bender et al., 2005). Many measures of interoceptive awareness, however, seem to focus on attitudinal feelings (e.g., Eating Disorder Inventory-3) rather than physiological ones. Cardiac awareness is a form of interoceptive awareness that can be measured using the heartbeat perception task, which involves asking people to estimate their heartbeat without feeling their pulse (Schandry, 1981). Zaki et al. (2012) found emotional processing and heartbeat detection to activate the anterior insula bilaterally, suggesting both of these functions occur in the same area of the brain.

Still, there is a discrepancy in the literature as to whether individuals with eating disorders are misinterpreting their physical stimuli (something that could occur in the insular cortices) or have an altered threshold to the stimuli (something having to do with their somatosensory cortex). The studies involving heartbeat detection tasks utilize an accuracy score for comparison by transforming the number of beats identified into a percent correct. Although useful for determining how accurate a person is in detecting heartbeats, this method does not provide information about the direction of inaccuracy. That is, it remains unclear whether those with eating disorders are overestimating or underestimating their heartbeats. This information seems critical to know: are they having difficulties with detecting the sensation—and thus underreporting heartbeat—or are they misinterpreting other sensations—and thus over reporting their heartbeat?

The current study assessed interoceptive awareness, measured both attitudinally and physiologically, in college women as it relates to eating disorders risk. Further, we examined whether or not manipulating physiological sensation (i.e., heart rate) affects cardiac awareness, as research has shown that cardiac awareness can be manipulated (e.g., Ainley et al., 2013; Herbert, Herbert, et al., 2012; Pollatos et al., 2007; Vögele et al., 2009). Assessments for interoceptive awareness were done both before and after cardiac manipulation from light exercise. It was predicted that college women with elevated eating disorder risk would have greater interoceptive deficit and lower cardiac awareness compared to those with lower eating disorder risk. Additionally, cardiac awareness was expected to increase in both groups after exercise, but it was predicted that the high risk group's awareness would remain lower than the low risk group's awareness. Finally, the direction of estimation on the HBPT by risk group was explored, though not specific hypotheses were proposed.

CHAPTER II

Method

Participants

Twenty-five college women with a mean age of 22.9 years (*SD* = 1.73) participated in this study. Exclusionary criteria include a self-reported history of heart conditions or anxiety disorders in the past 3 months and current use of beta-blockers or anti-anxiety medications. Students at Middle Tennessee State University were recruited by flyer, email, and word of mouth. All means of recruitment described the purpose of the study, exclusionary criteria, and provided an idea of what participation would entail (see Appendix A). The participants were mostly Caucasian, were current MTSU students, and reportedly exercised regularly. Four of the participants reported a history of eating disorders (three personal; one family member). Table 1 provides a summary of demographic information for the full sample and by eating disorder risk group.

Materials

Eating Disorder Inventory 3 (EDI-3). Created by Garner et al. (1983) and revised by Gardner (2004), the Eating Disorder Inventory-3 is a standardized, 91-item self-report questionnaire measuring eating disorder risk behaviors. Item responses range from *always* to *never* for questions like "I don't know what's going on inside me" (Garner, p. 3).

Table 1

Demographic Percentages for the Full Sample and for the Eating Disorder Risk Groups

	Full Sample (n = 25)	High Risk Group (*n* = 15)	Low Risk Group (*n* = 10)
Ethnicity			
African American	16%	20%	10%
Caucasian	76%	73%	80%
Other	8%	6%	10%
Education Level			
Undergraduate	52%	60%	40%
Graduate	48%	40%	60%
Exercise Frequency			
Regular Exerciser	68%	80%	50%
Irregular Exerciser	32%	20%	50%

There are 12 scales on the questionnaire; three are eating disorder specific scales and nine are psychological scales. The three eating disorder specific scales are: Drive for Thinness, Bulimia, and Body Dissatisfaction. The nine psychological scales are: Low Self Esteem, Personal Alienation, Interpersonal Insecurity, Interpersonal Alienation, Interoceptive Deficits, Emotional Dysregulation, Perfectionism, Ascetism, and Maturity Fears. High scores on a scale represent more clinical or problematic patterns (Garner, 2004).

In addition to these scales, six composite scores can be generated. These include: Eating Disorder Risk, Ineffectiveness, Interpersonal Problems, Affective Problems, Overcontrol, and General Psychological Maladjustment. The Eating Disorder Risk composite scale includes the Drive for Thinness, Bulimia, and Body Dissatisfaction clinical scales. Persons with elevated clinical risk typically score within the 67^{th} to 99^{th}

percentiles (T ≥ 57); individuals exhibiting typical clinical risk score between the 25th and 66th percentiles (T = 46 to 56). A confirmatory factor analysis provides significant support for a two-factor model (eating disorder risk and general psychological maladjustment) as well as the individual subtests. Drive for Thinness and Body Dissatisfaction scales are concurrently valid with the Eating Attitudes Test-26 and the Bulimia subscale is concurrently valid with the Bulimia Test-Revised. The EDI-3 can discriminate between an eating disorder diagnosis, different types of eating disorder diagnoses, and nonclinical behaviors (Garner, 2004). The Eating Disorder risk composite has a test-retest reliability of .98. The Drive for Thinness, Bulimia, and Body Dissatisfaction scales have test-retest reliabilities of .95, .94, and .95, respectively (Garner). These three subscales were used to create the two risk groups (high risk, low risk). Any person scoring at or above the typical clinical risk range on one of these three scales was considered to be high risk for eating disorder behavior. Of the full sample, 15 participants were high risk and 10 were low risk.

Of the psychological scales, the Interoceptive Deficits scale was of particular interest in this study. Sample items include, "I get confused about what emotion I am feeling" and "I have feelings I can't quite identify." The Interoceptive Deficits scale has a reliability of .93. Nine items cluster into an affective fear set and an affective confusion set (Garner, 2004). The elevated clinical score is between the 67th and 99th percentiles (T ≥ 55). Typical clinical scores range between the 25th and 66th percentiles (T = 42 to 54).

From the EDI-3, the Interoceptive Deficits scale was used as a dependent variable in the current study.

State-Trait Anxiety Inventory (STAI). The State-Trait Anxiety Inventory was created by Spielberger (1983) to measure how a person feels at a given moment as well as how she feels more generally. It consists of 40 self-report items scored from 1 to 4 with higher scores indicating more anxious feelings. For college women, the state and trait anxiety inventories have reliabilities of .93 and .91, respectively. For employed women, the state and trait anxiety inventories have reliabilities of .93 and .92, respectively. The test-retest reliability for females on the trait-anxiety scale ranges between .76 and .77, whereas the state-anxiety reliability ranges between .16 and .31. The STAI is highly correlated with the Taylor Manifest Anxiety Scale ($r = .80$) for college females; this speaks to concurrent validity in the STAI (Spielberger, 1983). The state anxiety score was used in the current study to compare self-reported anxiety between the high and low eating disorder risk groups; ultimately, it was used as a covariate in analyses for this study.

Beck Depression Inventory (BDI-2). The Beck Depression Inventory-2 was created by Aaron T. Beck (1996) to assess depressive symptoms. It consists of 21 self-report items that can be scored from 0 to 3 with higher scores indicative of more depressive symptoms. A score of 0 to 9 suggests minimal depression, 10 to 18 suggests mild to moderate depression, 19 to 29 is indicative of moderate to severe and 30 or higher suggests severe depression. Beck, Steer, and Garbin (1988) report reliabilities from various studies utilizing the BDI-2. Reliability for university students range from .82 to .92; in female undergraduates, the reliability is .82. Concurrent validity is found in the correlation of the BDI-2 with Zung's Self Reported Depression Scale (r = .66 to .78). A sample item includes "I am irritable all the time" (Beck, p. 2). As depression can affect cardiac awareness (e.g., Dunn et al., 2010), the total score on the BDI-2 was used to compare depressive symptoms between the high and low eating disorder risk groups.

Heartbeat Perception Task (HBPT). Although it is primarily a measure of cardiac awareness, the Heartbeat Perception Task appears to be the most commonly used behavioral measure of interoceptive awareness. In the current study, participants were asked to—without feeling their pulse—silently count their heartbeat for a given period of time and then to report the number of times they believed their heart beat. This estimating procedure was repeated with varying amounts of time allotted for heartbeat detection. In this study, randomized 15s, 30s, and 45s intervals were utilized. The participant's heart rate was recorded during each task as a measure of actual heartbeats per time period. Feedback regarding the accuracy of their estimations, however, was not provided to participants.

Heart Rate. Heart rate was measured in beats per minute throughout the experiment via a BioPac Systems MP150 monitor. The heart rate monitor was placed on the left index finger (nondominant hand for the whole sample) of each participant prior to starting the HBPT. It was removed during the exercise session and reattached immediately upon completing the exercise session.

Heartbeat perception was determined by the following transformation (from Pollatos et al., 2008), which includes the mean scores of the three HBPT time intervals that were estimated: $1/3\sum (1 - (|\text{recorded heartbeats} - \text{reported heartbeats}|)/\text{recorded heartbeats}$. Based on this transformation, accuracy scores can vary from 0 – 1, with higher scores representing more accurate estimations; low scores indicate more erroneous estimations.

Personal History Packet. The personal history packet included demographics questions, a brief medical history of the participant and immediate family members, as well as items to evaluate the frequency and use of heart rate monitors during exercise (See Appendix B).

Procedures

Approval from Middle Tennessee State University's Institutional Review Board was provided (Appendix C). Once approval was obtained, participants were recruited from campus using flyers, recruitment emails, and word of mouth. Upon arrival, participants completed an informed consent form detailing the procedures, benefits, and risks involved in this study (see Appendix D). Phase I of the study began with participants completing the Personal History Packet followed by the EDI-3, the BDI-2, and the STAI in a predetermined, randomized order. Any individual indicating a history of cardiovascular problems or anxiety disorder(s) in the last 3 months or currently on beta-blockers or anxiolytic medications were excluded from further participation. Those still qualifying for participation had the heart rate monitor attached to their left index finger while being explained the nature of the heartbeat perception task. They then completed a practice trial of the heart beat perception task to ensure understanding.

Next, the participants entered Phase II of the study. This phase involved a resting session, pre-exercise session, exercise session, and post-exercise session. The resting session involved sitting still in a chair for approximately 5 min. The exercise session involved walking up and down three flights of stairs for 2 min. Both the pre- and post-exercise sessions consisted of three randomized trials of the HBPT. The trial lengths were 15s, 30s, and 45s long. During the HBPTs, a brief break interval was given between each trial to clear the participant's mind of counting; she was, however, asked to remain seated during this time so as to not alter heart rate with physical activity. After completing the three trials of the heartbeat perception task, participants were re-administered the STAI. After completing Phase II, participants were debriefed and thanked for their participation. See Appendix E for debriefing materials.

CHAPTER III

Results

Table 2 provides descriptive statistics for all of the dependent variables for the full sample and for the eating disorder risk groups. As seen, this sample, as a whole, was low risk for depression, anxiety, and eating disorder pathology. For the analyses, two eating disorders risk groups (high risk, low risk) were created using the three EDI-3 subscales (i.e., DT, B, & BD). Any person scoring at or above the typical clinical risk range on one of these three scales was considered to be high risk for eating disorder behavior. Of the full sample, 15 participants were high risk and 10 were low risk. To determine whether anxiety or depression differed between these group, thus should be used as covariates in the hypothesis testing, two separate oneway ANOVAs ($\alpha_{FW} = .05$) were used to compare high and low risk groups' anxiety scores (i.e., STAI-state score before exercise) and depression scores (i.e., BDI-2 total score). The groups differed in levels of anxiety prior to exercise, $F(1, 25) = 10.18$, $MSE = 61.71$, $p = .004$, however, were similar in depression scores, $F(1, 25) = 2.61$, $MSE = 35.52$, $p = .12$. Therefore, STAI state score before exercise was used as a covariate in all subsequent analyses. High and low risk groups also were compared by exercise frequency and change in heart rate (from pre exercise to post exercise). There were no significant group differences in reported exercise frequency, $X^2(1, N = 25) = 2.48$, $p = .13$, or change in heart rate, $F(1, 24) = 0.53$, $p = .47$.

Table 2

Descriptive Statistics for All Dependent Variables for the Full Sample and for the Eating Disorder Groups

	Full Sample (n = 25)	High Risk Group (n = 15)	Low Risk Group (n = 10)
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Psychological Measures			
BDI-2	7.36 (6.16)	8.93 (7.17)	5.00 (3.30)
STAI-State pre exercise	44.64 (9.24)	48.73 (6.33)	38.50 (9.77)
STAI-State post exercise	41.52 (9.77)	46.53 (6.44)	34.00 (9.25)
EDI-3 Drive for Thinness	8.08 (7.21)	10.80 (7.57)	4.00 (4.32)
EDI-3 Bulimia	2.64 (2.16)	3.60 (2.16)	1.20 (1.14)
EDI-3 Body Dissatisfaction	12.88 (9.44)	17.14 (9.45)	6.90 (5.55)
EDI-3 Interoceptive Deficit	5.08 (4.47)	7.95 (1.02)[a]	1.08 (1.24)
Cardiac Measures			
Change in Heart Rate	13.88 (12.33)	12.40 (11.77)	16.11 (13.44)
Cardiac Awareness Pre-Exercise[b]	0.64 (0.21)	0.63 (0.06)	0.65 (0.08)
Cardiac Awareness Post-Exercise[b]	0.76 (0.22)	0.70 (0.06)	0.86 (0.08)
Average Agreement for Cardiac Estimations Pre-Exercise[c]	0.37 (0.21)	0.37 (0.06)	0.35 (0.08)
Average Agreement for Cardiac Estimation Post-Exercise[c]	0.24 (0.22)	0.30 (0.06)	0.14 (0.08)

Note. Adj. means and standard errors are reported for High and Low Risk groups for cardiac measures and interoceptive deficits.
[a]n = 14 for the High Risk Group EDI-3 Interoceptive Deficit score. [b]Higher scores represent more accurate Cardiac awareness. [c]Agreement scores ranged from -1 to +1, with scores above zero inidicating underestimations, and negative scores indicating overestimations.

Based on previous research, it was predicted that college women with elevated eating disorder risk would have greater interoceptive deficit (that is, more problematic awareness) compared to those with lower eating disorder risk. Interoceptive deficit was measured by the EDI-3 Interoceptive Deficit subscale. One participant in the high risk group failed to answer all of the Interoceptive Deficit subscale questions to generate a score; thus, her data were not included in this analysis. A oneway ANCOVA ($\alpha_{FW} = .05$) was used to compare high and low risk groups' Interoceptive Deficit scores while controlling for anxiety (i.e., STAI-state score). The high risk group's deficit scores (n = 14, M = 7.95) were greater than the low risk group's deficit scores (n = 10, M = 1.08) when controlling for anxiety, $F(1, 21) = 15.72$, MSE = 12.31, $p = .001$, indicating greater interoceptive deficits in those with higher eating disorder risk compared to those with lower risk.

Secondly, it was predicted that cardiac awareness would increase in both groups after exercise, but that the high risk group's cardiac awareness would remain lower than the low risk group's awareness. Cardiac awareness was measured by accuracy on the heartbeat perception task by activity condition (before exercise, after exercise). Higher scores represent more accurate perception of heartbeats. Because the groups differed on anxiety levels, a 2 x 2 ANCOVA ($\alpha_{FW} = .05$) was used to compare risk groups' (high risk, low risk) accuracy scores across time (before exercise, after exercise) while controlling for anxiety. Results showed no significant interaction between exercise condition and risk group on cardiac awareness, $F(1, 22) = 1.26$, $MSE = 0.04$, $p = .27$, $\eta_P^2 = .05$. Further, there was no significant main effect for exercise condition, $F(1, 22) = 0.01$, $MSE = 0.00$, $p = .94$, $\eta_P^2 = .00$, or for risk group, $F(1, 22) = 1.15$, $MSE = 0.07$, $p = .30$, $\eta_P^2 = .05$.

As the transformation used to compare cardiac awareness scores provides an estimate of percent accuracy, it does not indicate the direction of inaccuracy. To elucidate this information, an estimation of cardiac awareness score was calculated by averaging the agreements for each of the three time trials for each exercise condition. The formula: (actual beats – estimated beats)/actual beats was used to determine agreement. The estimate of cardiac awareness score ranges from -1 to +1, with negative scores indicating overestimations and positive scores indicating underestimations. Before exercise, only one participant (which belonged to the high risk group) overestimated their heartbeats; all other participants made underestimates. After exercise, two participants in the low risk group and one participant in the high risk group overestimated their heartbeats. All other participants made underestimates for their heartbeats after exercise. A 2 x 2 ANCOVA ($\alpha_{FW} = .05$) was performed to compare the high and low risk groups' direction of inaccuracy by exercise condition, controlling for state anxiety. Cardiac estimations were similar before and after exercise, $F(1, 22) = 0.01$, $MSE = 0.04$, $p = .94$, $\eta_P^2 = .00$. The high and low risk groups' cardiac estimations were also similar, $F(1, 22) = 1.15$, $MSE = 0.70$, $p = .30$, $\eta_P^2 = .05$. There also was no significant interaction, $F(1.\ 22) = 1.26$, $MSE = 0.04$, $p = .27$, $\eta_P^2 = .05$.

Finally, correlational analyses were conducted to determine if change in heartrate was related to cardiac awareness before and after exercise while controlling for anxiety (i.e., STAI-state pre-exercise). No significant correlations were found between change in heartrate and cardiac awareness before exercise, $r = .04$, $n = 25$, $p = .43$, or between change in heartrate and cardiac awareness after exercise, $r = -.17$, $n = 25$, $p = .22$.

CHAPTER IV

Discussion

Interoceptive awareness refers to the ability to interpret one's bodily cues (Craig 2002; 2003) for the purposes of maintaining a homeostatic state (Craig, 2007). Previous literature indicates individuals with eating disorders, specifically anorexia nervosa or bulimia nervosa, exhibit altered interoceptive abilities when compared to a healthy sample (e.g., Klabunde et al., 2013; Matsumoto et al., 2006; Pollatos et al., 2008; Zonnevylle-Bender et al., 2005). These studies have used both attitudinal and physiological measures of interoceptive abilities, which results in uncertainty in whether there is difficulty in detecting sensation or difficulty in interpreting those sensations.

The purpose of this study was to determine whether differences in interoceptive abilites exist between a subclinical, at-risk for eating disorders population and a healthy population. Additionally, this study aimed to establish whether vasoconstriction, brought on by light exercise, would alter interoceptive abilities. Further, both psychological and physiological measures of interoceptive abilities were utilized to uncover whether differences exist between the two forms of measurement. As previous literature suggests that eating disorder populations have lower interoceptive abilities than healthy populations, it was predicted that an at-risk sample would also exhibit lower interoceptive awareness. Thus, a final goal of this study was to distinguish which direction inaccuracy occurs and examine whether or not inaccuracy between the at-risk and healthy groups exists. In this study, interoceptive awareness related to emotion was measured by the

EDI-3 Interoceptive Deficit scale; interoceptive awareness related to physiological cues was measured by the heartbeat perception task (Schandry, 1981). The heartbeat perception task was completed when the heart had been at rest and again after elevation. Heartbeat was altered through light exercise as participants walked up and down stairs for two minutes. This alteration in heart rate should result in an increase in heartbeats for a given time interval; this increase in cardiac stimulus was expected to improve cardiac awareness as the stimulus became more easy to detect.

As expected, the high risk group exhibited more interoceptive deficit on the psychological measure (i.e., the EDI-3 Interoceptive Deficits scale). Those with higher eating disorder risk reported more interoceptive deficit than the low risk group, suggesting they have more difficulty identifying internal emotional states. These findings are consistent with those suggested by other research with nonclinical populations (e.g., Rideout, Thom, & Wallis, 2010). Rideout et al. found college women with nonclinical eating pathology (measured by the EDI-2) to have difficulty with identifying emotion. Emotional awareness was measured using video of social interactions, the Emotion Evaluation portion of The Awareness of Social Inference Test (TASIT), and the Toronto Alexithymia Scale (TAS-20). Specifically, women with elevated Bulimia scores on the EDI-2 and alexithymia scores on the TAS-20 exhibited greater difficulty in identifying emotion (both internally and externally).

Interestingly, however, although the risk groups in the current study showed differences in emotional interoceptive awareness, the high risk group did not display greater interoceptive deficit on the physiological measure (i.e., the heartbeat perception task), suggesting they do not have more difficulty identifying internal physiological states (i.e., heartbeats) compared to the low risk group. This similarity in physiological awareness was evident when considering both their cardiac awareness (i.e., how *accurately* they estimated their heartbeats) as well as their cardiac *estimation* scores (i.e., the overestimations or underestimations). On average, the participants in this study underestimated their heartbeats both before and after exercising.

These findings suggest that, in a subclinical population of women, interoceptive deficits in attitudinal feelings are more apparent than deficits in detecting physiological sensations. It is possible that difficulties in identifying attitudinal feelings exists prior to clinically significant eating disorder behavior; difficulties with detecting physiological sensations may develop after illness onset. According to Craig (2007), who argues that interoceptive awareness is utilized for maintaining a homeostatic state, these findings would be expected. Perhaps a high risk group exists in a relatively homeostatic state whereas a clinically ill population is out of homeostasis. This could be related to a high risk group's ability to accurately identify bodily cues; because they can identify their bodily cues, they are more likely to maintain homeostasis. Still, this is not the only explanation for a lack of differences in physiologically-based interoceptive abilities between the high and low risk samples in this study. It also is possible that the procedures used in this study to assess interoceptive abilities (i.e., a self-report questionnaire and an estimation of a current physiological behavior) access different portions of the brain. It is possible that a physiological assessment—which requires an evaluation of current physiological cues—accesses one pathway in the brain, while the psychological measure—which requires an evaluation of past emotional experiences—accesses a separate pathway in the brain.

Other research has found the heartbeat perception task to be ineffective in measuring physiological interoceptive awareness in eating disorder populations (e.g., Eshkevari, Rieger, Musiat, & Treasure, 2014). Eshkevari et al. (2014) discuss the difficulty in assessing interoceptive awareness in eating disorder populations due to the methodological discrepancies between emotional or attitudinal scales (e.g., EDI-3 Interoceptive Deficits scale) and physiological tasks (e.g., the heartbeat perception task). They note the difficulties that an eating disorder population may have in detecting bodily cues may confound the self-report type measurements of detecting those cues. Thus, Eshkevari et al. (2014) point out the need for an objective measure of physiological interoceptive awareness. It must be noted that the heartbeat detection task utilized by Eshkevari et al. (2014) is different from the Schandry (1981) method of heartbeat perception that was used in the current study. In their study, tones are either aligned or misaligned with heartbeats and participants are asked to report whether the tones are synchronized or not synchronized with their heartbeat. They still reported no group differences. It may be that the physiological awareness is confounded by internal awareness generally, and that regardless of physiological measure they will perform similarly.

Limitations and Future Directions

There were a few limitations to this study. First, there are a few issues with the sample. This study had a fairly small sample size with a total of 25 participants; limits in generalizability to other high risk, but nonclinical samples must be considered. Also, the low sample size of this study limits the statistical power of the analyses. Additionally, the two eating disorder risk groups were unequal in size. Although this was statistically controlled for in the analyses, the outcome could have been influenced by this difference. As the main grouping variable was a clinical elevation on any one of the three clinical scales of the EDI-3, the eating disorders risk groups could be relatively similar in reported eating disorder behaviors. That is, an elevation on one scale by one point could have determined the grouping of a participant into the high risk category.

Second, it is unclear whether there was enough of an increase in heart rate (thus a significant increase in cardiac stimulus) after exercise to influence cardiac awareness. The full sample had a pre exercise heartbeats per minute of 77.49 ($SD = 11.56$) and the post exercise heartbeats per minute of 90.84 ($SD = 18.08$). This increase of roughly 13 beats per minute may not have been enough to increase the detectability of this physiological state. Perhaps exercising for a longer period of time or engaging in another, potentially more strenuous activity may result in more of a heartrate increase and potentially a more discernable physiological state. Additionally, other methods of vasoconstriction could be implemented. For instance, emotionally arousing stimuli (e.g., aversive images or images of a person eating high-calorie or high-fat foods) could be presented to participants to elicit a disgust or arousing response. It would be interesting to compare cardiac awareness before and after this presentation of such potentially arousing images between a high risk and low risk or clinically ill and healthy samples.

Further, given the methods used in this study, it remains unclear whether interoceptive deficits are related to a difficulty in detecting stimuli or interpreting stimuli. Future research should try to clarify or distinguish between these two possibilities. Additionally, future research should look at the role alexithymia may play in interoceptive deficits related to emotional processing. It clear there are both interoceptive deficits (related to psychological variables) as well as alexithymic characteristics in a high risk, but nonclinical population. It remains unclear, however, which factor is contributing to these differences. Finally, future research in *clinical* eating disorder populations should compare both attitudinal and physiological measures of interoceptive abilities.

REFERENCES

Ainley, V., Maister, L., Brokfeld, J., Farmer, H., & Tsakiris, M. (2013). More of myself: Manipulating interoceptive awareness by heightened attention to bodily and narrative aspects of the self. *Consciousness and Cognition, 22,* 1231-1238. doi: 10.1016/j.concog .2013.08.004

Beck, A. T. (1996). *Beck depression inventory (2).* San Antonio, TX: The Psychological Corporation Harcourt Brace & Company.

Beck, A. T., Steer, R. A., & Garbin, M. G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty five years of evaluation. *Clinical Psychology Review, 8*, 77-100. doi: 10.1016/0272-7358(88)90050-5

Bruch, H. (1962). Perceptual and conceptual disturbances in anorexia nervosa. *Psychosomatic Medicine, 24*(2), 187-194. Retrieved from: http://journals.lww .com/psychosomaticmedicine/pages/articleviewer.aspx?year=1962&issue=03000 &article=00009&type=abstract

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews: Neuroscience, 3,* 655-666. doi: 10.1038 /nrn894

Craig, A. D. (2003). Interoception: The sense of the physiological condition of the body. *Current Opinion in Neurobiology, 13,* 500-505. doi: 10.1016/S09594388 (03)00090-4

Craig, A. D. (2007). Interoception and emotion: A neuroanatomical perspective. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of Emotions* (272-290). New York: Guilford Press.

Damasio, A. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Penguin Press.

Dunn, B. D., Stefanovitch, I., Evans, D., Oliver, C., Hawkins, A., & Dagleish, T. (2010). Can you feel the beat? Interoceptive awareness is an interactive function of anxiety- and depression-specific symptom dimensions. *Behavior Research and Therapy, 48*, 1133-1138. doi: 10.1016/j.brat.2010.07.006

Eshkevari, E., Rieger, E., Musiat, P., & Treasure, J. (2014). An investigation of interoceptive sensitivity in eating disorders using a heartbeat detection task and a self-report measure. *European Eating Disorders Review, 22*(5), 383-388. doi: 10. 1002/erv.2305

Fenigstein, A., Scheier, M. F., & Buss, A. H. (1975). Public and private self consciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology, 43*, 522-527.

Garner, D. M. (2004). *Eating disorder inventory (3).* Lutz, FL: Psychological Assessment Resources.

Garner, D. M., Olmstead, M. P., Polivy, J. (1983). Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. *International Journal of Eating Disorders, 2*(2), 15-34.

Herbert, B. M., Herbert, C., Pollatos, O., Weimer, K., Enck, P., Sauer. H., & Zipfel. S. (2012). Effects of short-term food deprivation on interoceptive awareness, feelings and autonomic cardiac activity. *Biological Psychiatry, 89,* 71-79. doi: 10 .1016/j.biopsycho.2011.09.004

Herbert, B. M., Muth, E. R., Pollatos, O., & Herbert, C. (2012). Interoception across modalities: On the relationship between cardiac awareness and the sensitivity for gastric functions. *PLoS ONE, 7*(5), doi:10.1371/journal.pone.0036646

Khalsa, S., Rudrauf, D., & Tranel, D. (2009). Interoceptive awareness declines with age. *Psychophysiology, 46,* 1130-1136. doi: 10.1111/j.1469-8986.2009.00859.x

Klabunde, M., Acheson, D. T., Boutelle, K. N., Matthews, S. C., & Kaye, W. H. (2013). Interoceptive sensitivity deficits in women recovered from bulimia nervosa. *Eating Behaviors, 14,* 488-492. doi: 10.1016/j.eatbeh.2013.08.002

Matsumoto, R., Kitabayashi, Y., Narumoto, J., Wada, Y., Okamoto, A., Ushijima, Y., …, Fukui, K. (2006). Regional cerebral blood flow changes associated with interoceptive awareness in the recovery process of anorexia nervosa. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 30*, 1265-1270. doi: 10 .1016/j.pnpbp.2006.03.042

McKinley, N. M. & Hyde, J. S. (1996). The Objectified Body Consciousness Scale: Development and validation. *Psychology of Women Quarterly, 20,* 181-215.

Pollatos, O., Herbert, B. M., Kaufmann, C., Auer, D. P., & Schandry, R. (2007). Interoceptive awareness, anxiety and cardiovascular reactivity to isometric exercise. *International Journal of Psychophysiology, 65,* 167-173. doi: 10.1016/j .ijpsycho.2007.03.005

Pollatos, O., Kurz, A., Albrecht, J., Tatjana, S., Kleeman, A. M., Schöpf, V., Kopietz, R., …, Schandry, R. (2008). Reduced perception of bodily signals in anorexia nervosa. *Eating Behaviors, 9,* 381-388. doi: 10.1016/j.eatbeh.2008.02.001

Rideout, N, Thom, C., & Wallis, D. J. (2010). Emotion recognition and alexithymia in females with nonclinical disordered eating. *Eating Behaviors, 11,* 1-5. doi: 10. 1016/j.eatbeh.2009.07.008

Schandry, R. (1981). Heart beat perception and emotional experience. *Psychophysiology, 18*(4), 483-488. doi: 10.1111/j.1469-8986.1981.tb02486.x

Spielberger, C. D. (1983). *State-trait anxiety inventory for adults.* Redwood City, CA: Mind Garden.

Stevens, S., Gerlach, A. Cludius, B., Silkens, A., Craske, M. G., & Hermann, C. (2011). Heartbeat perception in social anxiety before and during speech anticipation. *Behavior Research and Therapy, 49,* 138-143. doi: 10.1016/j.brat.2010.11.009

Thompson, D. A., Berg, K. M., & Shatford, L. A. (1987). The heterogeneity of bulimic symptomatology: Cognitive and behavioral dimensions. *International Journal of*

Eating Disorders, 6, 215-234. doi: 10.1002/1098-108X(198703)6:2<215::AID -EAT2260060206>3.0.CO;2-J

Thum, M., Boucsein, W., Kuhmann, W., & Ray, W.J. (1995). Standardized task strain and system response times in human-computer interaction. *Ergonomics, 38,* 1342-1351.

Vögele, C., Hilbert, A., & Tushen-Caffier, B. (2009). Dietary restriction, cardiac autonomic regulation and stress reactivity in bulimic women. *Physiology and Behavior, 98,* 229-234. doi: 10.1016/j.phybeh.2009.05.018

Zaki, J., Davis, J. I., & Ochsner, K. N. (2012). Overlapping activity in anterior insula during interoception and emotional experience. *NeuroImage, 62,* 493-499. doi: 10.1016/j.neuroimage.2012.05.012

Zonnevylle-Bender, M., van Goozen, S., Cohen-Kettenis, P. T., Jansen, L., van Elburg, A., & van Engeland, H. (2005). Adolescent anorexia nervosa patients have a discrepancy between neurophysiological responses and self-reported emotional arousal to psychosocial stress. *Psychiatry Research, 135*, 45-52. doi: 10.1016/j .psychres.2004.11.006

APPENDICES

APPENDIX A

Recruitment Materials

Psychology Research Pool.

Title: Interoceptive awareness in college women as it relates to eating disorder risk: Does vasoconstriction increase cardiac awareness?

Brief Description: You will be asked to complete a couple of surveys on eating behaviors, body image, emotions, and demographics as well as monitor your heartbeat without feeling your pulse before and after walking up and down stairs.

Long Description: If you agree to participate, you will complete 3 surveys, your left index finger will be attached to a heart monitoring device, and you will complete the heartbeat perception task (i.e., try and count your heartbeat using nothing more than the feeling in your chest). Then, you will walk up and down a flight of stairs for 5 minutes, at which point you will complete the heartbeat perception task again as well as one of the surveys again. Please bring shoes you are comfortable walking up and down stairs in.

Recruitment Email.

Hello,

My name is Lauren Qualls and I am a graduate student at MTSU working on my master's thesis. I am contacting you because you are a female, 18 years of age or older involved in an MTSU organization or athletic group. I am inviting you to participate in my study to look at the effect of increasing heart rate on cardiac awareness in females as it relates to eating disorder risk. Should you agree to participate, you would complete 3 surveys about eating behaviors, body image, and emotions as well as [monitor your heartbeat without feeling your pulse before and after walking up and down stairs for 5 minutes] [complete the heartbeat perception task (i.e., try and count your heartbeat using nothing more than the feeling in your chest) after walking up and down stairs for 5 minutes]. If you would like more information or are interested in participating in this study, please contact me at lkq2a@mtmail.mtsu.edu or (615) 971-2632.

Thank you for your time and consideration. I hope to hear from you soon,

Lauren K. Qualls

APPENDIX B

Personal History Packet

P__________

Age: __________

Race:
Please select one:

- ☐ African American
- ☐ Asian American
- ☐ Biracial
- ☐ Caucasian
- ☐ Hispanic
- ☐ Other ________________

Year in School:
Identify your year in school.

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior
- ☐ Graduate
- ☐ N/A

Athleticism
Which of the following best describes your exercise habits?

- ☐ I work out two or more times a week, most weeks
- ☐ I work out once a week, most weeks
- ☐ I work out less than once a week
- ☐ I do not work out.

When you work out, what types of activities do you do (check all that apply)?

- ☐ Weight lifting
- ☐ Intramural Sports (e.g., soccer, flag football)
- ☐ Run, Jog
- ☐ Walk
- ☐ Aerobics class (e.g., Zumba)
- ☐ Pilates or Yoga
- ☐ Rock climbing
- ☐ Swim
- ☐ Other activity, ____

When you work out, do you use heart rate monitoring devices (e.g., pulse monitor on treadmill, waist monitor, etc.)?

☐ Always ☐ Sometimes ☐ Never

If so, please describe what type of measurement tool you utilize.

Have you had any of the following conditions in the last 3 months?

☐ Heart Condition (e.g., arrhythmia, murmur, tachycardia, bradycardia)
☐ Anxiety Disorder (e.g., Panic Disorder, Generalized Anxiety Disorder)
☐ Other ____

Are you currently on any of the following types of medication?

☐ Beta-blocker (e.g., Propranolol, Sectral, Lopresser)
☐ Anxiolytic (e.g., Xanax, Valium)
☐ Antidepressant (e.g., Prozac)

Please list any medications you currently take on a regular basis. ☐ N/A

Please indicate if you or anyone in your family has ever been diagnosed with any of the following eating disorders.

	You	*Mother*	*Father*	*Sister*	*Brother*	*Other*
Anorexia	☐	☐	☐	☐	☐	☐
Bulimia	☐	☐	☐	☐	☐	☐
Binge Eating	☐	☐	☐	☐	☐	☐

APPENDIX C
MTSU IRB Approval Letter

5/13/2015
Investigator(s): Lauren K. Qualls and Kim U. Ward
Department: Psychology
Investigator(s) Email: lkq2a@mtmail.mtsu.edu; Kimberly. Ward@mtsu.edu

Protocol Title: “Interoceptive awareness in college females as it relates to eating disorder risk: Does vasoconstriction increase cardiac awareness? ”
Protocol Number: 15-317

Dear Investigator(s),
The MTSU Institutional Review Board, or a representative of the IRB, has reviewed the research proposal identified above. The MTSU IRB or its representative has determined that the study poses minimal risk to participants and qualifies for an expedited review under 45 CFR 46.110 and 21 CFR 56.110, and you have satisfactorily addressed all of the points brought up during the review.

Approval is granted for one (1) year from the date of this letter for 100 (ONE HUNDRED) participants.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918. Any change to the protocol must be submitted to the IRB before implementing this change.

You will need to submit an end-of-project form to the Office of Compliance upon completion of your research located on the IRB website. Complete research means that you have finished collecting and analyzing data. Should you not finish your research within the one (1) year period, you must submit a Progress Report and request a continuation prior to the expiration date. Please allow time for review and requested revisions. Failure to submit a Progress Report and request for continuation will automatically result in cancellation of your research study. Therefore, you will not be able to use any data and/or collect any data. Your study expires 5/13/2016.

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to complete the required training. If you add researchers to an approved project, please forward an updated list of researchers to the Office of Compliance before they begin to work on the project.

All research materials must be retained by the PI or faculty advisor (if the PI is a student) for at least three (3) years after study completion and then destroyed in a manner that maintains confidentiality and anonymity.

Sincerely,

Institutional Review Board
Middle Tennessee State University

APPENDIX D
Informed Consent

Principal Investigator: Lauren K. Qualls
Study Title: Interoceptive awareness in college women as it relates to eating disorder risk: Does vasoconstriction increase cardiac awareness?
Institution: Middle Tennessee State University

Name of participant: _______________________________________ Age: ___________

The following information is provided to inform you about the research project and your participation in it. Please read this form carefully and feel free to ask any questions you may have about this study and the information given below. You will be given an opportunity to ask questions, and your questions will be answered. Also, you will be given a copy of this consent form.

Your participation in this research study is voluntary. You are also free to withdraw from this study at any time. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.

For additional information about giving consent or your rights as a participant in this study, please feel free to contact the MTSU Office of Compliance at (615) 494-8918.

1. **Purpose of the study:**
   You are being asked to participate in a research study because we are interested in the effect increasing heart rate has on one's ability to detect heart beat and how that is related to eating disorder risk.

2. **Description of procedures to be followed and approximate duration of the study:**
   If you agree to participate, you will complete 3 surveys about eating behaviors, body image, and emotions as well as a demographics questionnaire. Next, your left index finger will be attached to a heart monitoring device and you will complete the heartbeat perception task (i.e., try and count your heartbeat using nothing more than the feeling in your chest). Then, you will walk up and down a flight of stairs for 2 minutes, then complete some additional assessments. None of your identifiable information (e.g., name) will be collected and all responses will remain confidential.

3. **Expected costs:**
   There are no costs for participation.

4. **Description of the discomforts, inconveniences, and/or risks that can be reasonably expected as a result of participation in this study:**
   It is possible some of the items on the surveys may make you feel uncomfortable, but you do not have to answer anything you are not comfortable answering. You may also feel fatigued after walking up and down the stairs for five (5) minutes.

5. **Compensation in case of study-related injury:**
   MTSU will not provide compensation in the case of study related injury.

6. **Anticipated benefits from this study:**

a) The potential benefits to science and humankind that may result from this study are a better understanding of the interplay of cardiac activity and cardiac awareness as it relates to eating disorder risk.
b) The potential benefits to you from this study are you can learn what it is like to participate in a research study. Other than that, there are no direct benefits to you.

7. **Alternative treatments available:**
   N/A

8. **Compensation for participation:**
   The only compensation is for participants who are receiving research credit for their Psychology course as part of the Research Pool. No other compensation will be offered.

9. **Circumstances under which the Principal Investigator may withdraw you from study participation:**
   If you are at risk for injury (e.g., have a history of cardiac dysfunction), we may withdraw you from the study.

10. **What happens if you choose to withdraw from study participation:**
    You are free to withdraw from the study at any time.

11. **Contact Information.** If you should have any questions about this research study or possible injury, please feel free to contact **Lauren K. Qualls** at **(615) 971-2632** or my Faculty Advisor**, Dr. Kim Ujcich Ward** at **(615)-898-2188.**

12. **Confidentiality.** All efforts, within reason, will be made to keep the personal information in your research record private but total privacy cannot be promised. Your information may be shared with MTSU or the government, such as the Middle Tennessee State University Institutional Review Board, Federal Government Office for Human Research Protections if you or someone else is in danger or if we are required to do so by law.

13. **STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY**
    I have read this informed consent document and the material contained in it has been explained to me verbally. I understand each part of the document, all my questions have been answered, and I freely and voluntarily choose to participate in this study.

__________________ ____

Date Signature of patient/volunteer

Consent obtained by:

__________________ ____

Date Signature

____

Printed Name and Title

APPENDIX E

Debriefing Form

Thank you for participating in my thesis research. Research has shown that individuals with eating disorders have a diminished ability to detect bodily sensations; other research has shown that detection of bodily sensation can be manipulated. Thus, the purpose of this study was to examine the effect increasing heart rate would have one one's ability to detect heart beat. Additionally, I want to see how this relates to level of eating disorder risk. If you wish to learn more about this area of research or want to know about the results of this study, contact me at Lauren.Qualls22@gmail.com.

If anything you read or did in today's study made you feel discomfort or you wish to seek counseling, please contact any of the following organizations:

MTSU Counseling Center: 615-898-2670

MTSU Student Services: 615-898-2988

The Renfrew Center of Tennessee: 1-800-RENFREW (736-3739)

HAVE A GREAT DAY ☺