THE EFFECTS OF EXERCISE ON BODY VIGILANCE

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by
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Abstract

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Somatic sensations are a core component of the experience of anxiety symptomology, and accumulating research suggests that body vigilance, or the degree to which one perceives and attends to bodily sensations, may serve as an important vulnerability factor for the development and maintenance of anxiety pathology, particularly panic disorder. Specifically, increased awareness of body sensations has been proposed to relate to anxiety sensitivity (i.e., fears of anxiety sensations) and contribute to panic attacks. Consistent with some contemporary models of anxiety disorders, research suggests that individuals who experience recurrent panic attacks exhibit biases toward threat-relevant cues (i.e., panic relevant sensations), and interventions that reduce attention to threat-relevant stimuli may reduce anxiety and panic symptomology. Physical exercise has been shown to exert anxiolytic and anti-panic effects, presumably in part via exposure-generated reductions in fear of relevant physiological sensations. However, recent research suggests that exposure-based interventions generate reductions in vigilance for threat information, and changes in threat vigilance appear to precede and predict reductions in anxiety symptoms. The purpose of this study was to examine the effects of regular exercise on body vigilance among individuals with high body vigilance and anxiety sensitivity. Twenty-seven non-exercising participants (77% female; 77 % Caucasian) were randomized to complete 20 minutes of aerobic exercise, resistance training, or rest. Results indicated all conditions demonstrated statistically significant reductions in body vigilance. The results of this study are discussed with regard to their implications in the use of exercise interventions for anxiety and related forms of psychopathology and potential directions for future research.

Keywords: Body Vigilance, Anxiety Sensitivity, Exercise

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Anxiety disorders are some of the most commonly diagnosed mental disorders, with research suggesting that prevalence rates are on the rise (Gum, King-Kallimanis, Kohn, 2009). Approximately one-third of individuals meet criteria for at least one anxiety disorder across their lifetime (Valentiner, Fergus, Behar, & Conybeare, 2014), and anxiety disorders are responsible for a substantial economic burden, with medical costs estimated to be over $6,475 per year per diagnosed individual (Revicki et al., 2012). In addition, 66% of individuals with anxiety disorders report impairment in occupation functioning (e.g., inability to work one day out of the past month due to symptoms; Revicki et al., 2012).

Panic disorder, or PD, is associated with one of the higher rates of service usage among individuals with anxiety disorders (Valentiner et al., 2014). PD is defined largely by the experience of recurrent, unexpected panic attacks, or abrupt surges of intense fear, including pounding heart, sweating, shortness of breath and feeling light-headed (American Psychiatric Association [APA], 2013). Within the United States, the 12-month prevalence rate of PD is estimated at 3 percent, though research suggests PD to be chronic, affecting approximately 5 percent of people at some point during their lives (Valentiner et al., 2014). PD is associated with high levels of social, occupational, and physical impairment, as well as higher rates of suicide (APA, 2013), and medical costs for individuals with PD are estimated to be $1,000 to $3,000 higher than those for individuals with other diagnosed anxiety disorders (i.e. $6,475) (Revicki et al., 2012).

Contemporary Cognitive Models of Panic Disorder

Contemporary cognitive models of panic disorder suggest that information processing biases play a key role in the development and maintenance of panic disorder. Specifically, models suggest that maladaptive schemas (e.g., catastrophic misinterpretation of anxiety sensations, belief that anxiety sensations are dangerous) lead vulnerable individuals to exhibit increased attention to threat-relevant information, interpret ambiguous stimuli as threatening, and remember threat-relevant cues (e.g., Beck & Clark, 1997). Such biases are thought to maintain panic by maintaining the saliency of threat cues (e.g., Clark, 1999). Consistent with the cognitive model of panic, a large body of research has accumulated over the years indicating that individuals who experience panic attacks exhibit a greater tendency to focus on panic-relevant cues, attribute greater threat to ambiguous scenarios, and associate themselves as "being panicked", as compared to individuals who do not experience panic attacks (Teachman, Smith-Janik & Saporito, 2007). Similarly, individuals with known cognitive vulnerability factors for panic disorder, such as anxiety sensitivity (AS; i.e., fear of anxiety sensations), have also been shown to exhibit attentional biases to panic-relevant stimuli (Lilley & Cobham, 2005; McNally, Foa, Donnell, 1989).

Treatment for Panic Disorder

Cognitive-behavioral therapy, or CBT, for panic disorder is based on the premise that maladaptive thoughts lead to maladaptive behaviors, and in attending to and altering dysfunctional thoughts, problematic behaviors will subsequently change. CBT is a common treatment for anxiety disorders and is generally considered the treatment of choice for PD. CBT has been shown to be more effective when it involves exposure, a method that involves repeated confrontation of feared arousal-related sensations (Valentiner et al., 2014). Cognitive models of therapy generally assume that CBT and exposure-based interventions primarily target strategic modes of thinking and explicit beliefs rather than automatic, reflexive thought processes (e.g., Beck & Clark, 1997; Reinecke, Waldenmaier, Cooper & Harmer, 2013). However, recent research suggests that CBT may affect automatic threat processing, which may in turn influence strategic processing of threat-relevant information. For example, Reinecke, Waldermair, Cooper and Harmer (2013) found that a single session of exposure-based therapy generated rapid effects on automatic threat processing (i.e., vigilance for threat information) among patients with panic disorder, and these effects predicted subsequent therapeutic change. Further, a number of studies have shown that interventions that directly target automatic threat processing, such as attentional bias modification (ABM) programs, are effective in changing patterns of attentional selectivity in individuals with heightened anxiety, which subsequently has an effect in lowering anxiety levels (Notebaert, Clarke, Grafton & MacLeod, 2015). Thus, interventions that change or reduce attentional biases appear to be promising in the treatment of panic and other anxiety disorders.

Effects of Exercise on Anxiety Disorders

Aerobic exercise is another form of intervention that has been shown to significantly reduce anxiety symptomology among non-clinical and clinical samples (Newman & Motta, 2007; Raglin, 1997; Martinsen, 2008). For example, inpatients with generalized anxiety disorder exhibited significant reductions in symptoms following an eight-week daily aerobic exercise program and maintained their gains at a one-year follow-up session (Martinsen, 2008). Similar research has been conducted with patients with social anxiety disorder, posttraumatic stress disorder, and obsessive compulsive disorder, with each study indicating that eight to 12 weeks of physical exercise led to significant reductions in anxiety and disorder-specific symptoms (Brown et al., 2007; Jazaieri, Goldin, Werner, Ziv & Gross, 2012; Newman & Motta, 2007). A recent review by Asmundson and colleagues (2013) examining the effects of various exercise types (aerobic, resistance training) and durations (ranging from 1 session to 12 weeks, 20 minutes to 60 minutes sessions) on anxiety disorders (PD, OCD, PTSD, SAD, GAD) concluded that exercise is effective in the reduction of anxiety symptoms across disorders and symptom severity. However, some research suggests that exercise might be particularly effective in individuals with panic disorder.

Effects of Exercise of Panic Disorder

Of the anxiety disorders, research on panic disorder seems to provide the most support regarding the efficacy of exercise. For example, the prevalence of panic attacks is significantly lower among adults who report engaging in regular physical exercise compared those who do not, an effect that appears to be specific to panic rather inclusive of all anxiety disorders (Goodwin, 2003). Brooks and colleagues (1998) conducted a study that examined the efficacy of exercise compared to a drug treatment and placebo conditions among individuals with panic disorder. Results indicated that aerobic exercise and pharmacological treatment generated significant and comparable reductions in panic frequency and intensity. A recent study by Hovland and colleagues (2013) comparing the efficacy of exercise and CBT as interventions for individuals with panic disorder indicated that physical exercise was more effective than CBT in reducing AS, a known vulnerability factor for PD. Although the exact mechanisms that account for the anxiolytic effects of exercise remain unclear, some researchers have suggested that exercise-induced reductions in AS may be at least partially responsible.

Effects of Exercise on Anxiety Sensitivity

Anxiety Sensitivity can be broadly defined as the fear of sensations commonly associated with anxiety due to belief that these sensations can lead to negative physical, cognitive, or social consequences (Reiss & McNally, 1985). For example, a person with high AS might fear an elevated heart rate (HR) because they believe it increases their risk for having a heart attack. Research has consistently revealed that high AS predicts the subsequent development of panic attacks and other anxiety disorders (Li & Zinbarg, 2007; Maller & Reiss, 1992; Schmidt, Lerew & Jackson, 1997). Common interventions for anxiety disorders include cognitive behavioral therapy (CBT) and exposure therapy; just as these interventions are efficacious in treating various anxiety disorders, they often also result in concurrent reductions in AS (Sabourin, Stewart, Watt, & Krigolson, 2015; Valentiner et al., 2014). In addition, research has consistently indicated that physical exercise reduces AS, presumably by exposure to bodily sensations that people with high AS commonly fear (e.g., elevated HR, respiration, perspiration, visible signs of arousal). Specifically, research suggests that aerobic exercise reduces AS in as little as a single session, higher intensity exercise reduces AS more rapidly than low intensity exercise, and anaerobic exercise generates significant and comparable reductions to aerobic exercise (Broman-Fulks, Berman, Rabian & Webster, 2004; Broman-Fulks, Kelso & Zawilinski, 2015; Broman-Fulks & Storey, 2008). Research also suggests that exercise-induced reductions in AS are associated with decreased reactivity to physiological arousal generated by biological challenge tasks, such as carbon dioxide inhalation (Smits et al., 2008).

Body Vigilance

Whereas AS refers to the *fear* of anxiety-related sensations, body vigilance (BV) is conceptualized as the extent to which an individual monitors and attends to physiological sensations (Keough, Timpano, Zawilinski & Schmidt, 2011). BV has been proposed to serve as an important factor in the etiology and maintenance of PD. Specifically, BV may increase risk of developing PD among individuals who experience a spontaneous panic attack, or false alarm, given their already increased tendency to perceive potential threat-relevant cues (i.e., panic-related physical sensations). In addition, the experience of a spontaneous panic attack may increase BV when the individual learns to fear their bodily sensations. Increased awareness of potential changes in somatic sensations increases the probability of perceiving threat-relevant physiological cues, which may serve to heighten fear and associated arousal, thereby leading to a vicious cycle that can lead to further panic attacks (Schmidt, Lerew, & Trakowski, 1997).

Consistent with the theorized relation between BV and PD, research indicates that individuals with PD report higher levels of BV compared to non-clinical individuals or those with other anxiety disorders (Olatunji, Deacon, Abramowitz, & Valentiner, 2007; Schmidt, Lerew & Trakowski, 1997). In addition, research has demonstrated that AS and BV are uniquely correlated with each other in non-clinical and PD samples (Schmidt, Lerew & Trakowski, 1997). Further, AS is predictive of BV, with higher scores on the physical subscale of the ASI-3 measure being uniquely predictive of BV and elevated levels of internal focus (Zvolensky & Forsyth, 2002). Finally, treatment generated reductions in BV have been shown to be associated with significant reductions in AS among PD patients (Schmidt, Lerew & Trakowski, 1997).

Potential Effects of Exercise on Body Vigilance

In sum, fear of anxiety-related physiological sensations is considered a core component of panic disorder, and accumulating research suggests that BV may serve as a vulnerability factor for the etiology and maintenance of panic disorder. Consistent with contemporary models of panic, research suggests that individuals who experience recurrent panic attacks exhibit biases toward threat-relevant cues (i.e., panic relevant sensations), and interventions that reduce attention on threat-relevant stimuli may reduce anxiety and panic symptomology. Physical exercise has been shown to exert anxiolytic and anti-panic effects, presumably in part via exposure-generated reductions in fear of relevant physiological sensations, though recent research suggests that exposure-based interventions generate reductions in vigilance for threat information, and changes in threat vigilance appear to precede and predict reductions in anxiety symptoms. However, researchers have yet to examine whether physical exercise affects BV. Thus, the purpose of this study is to address this gap in the literature by examining the effects of regular aerobic exercise on vigilance to physiological cues among individuals at risk for PD. Based on the collective findings of previous research, it is hypothesized that participation in a regular physical exercise regimen will reduce attention to physiological sensations among individuals with elevated BV and AS.

Method

Participants

A statistical power analysis (Faul, Erdfelder, Buchner, & Lang, 2009) indicated that a sample of at least 22 would be required to detect if one group's scores change at a rate that was significantly different from another group with a moderate to large effect size, using a mixed model ANOVA ($\alpha = .05$, $f=.50$ $\beta = .80$) with three conditions. As seen in Figure 1, 1,021 prospective participants were screened to obtain the final sample of 27 participants who met inclusion criteria and agreed to participate. To qualify for the study, participants had to be age 18 or older, in good physical health, not currently involved in a regular exercise regimen (i.e., exercising more than once per week), and obtain an elevated score on the BVS (i.e., 15 or higher, above the normative mean; Olatunji, Deacon, Abramowitz, & Valentiner, 2007) and ASI-3 (i.e., 18 or higher; Taylor et al., 2007). The final sample was predominately female (77%) and Caucasian (77%). Chi-square analyses indicated that the three groups were comparable in rates of attrition, as seen in Figure 1. 3 individuals dropped out of both of the exercise conditions, and only one dropped out of the rest condition. Reasons for attrition were obtained by speaking with the individual in person or by e-mail and were stated to be: time commitment required for the study (3, 1 hour sessions a week, for 2 weeks) and difficulty with transportation. Participants were compensated for completing the study with course credit and 20 dollars. Informed consent (Appendix A) was obtained from participants, and the consent process and research protocol were approved by the Institutional Review Board for the Protection of Human Subjects at Appalachian State University (Appendix B).

Measures

Anxiety Sensitivity Index – 3 (ASI-3; Taylor et al., 2007; Appendix C). Anxiety sensitivity was measured by the ASI-3, an 18-item self-report measure designed to assess general AS and three subcomponents representing fears of physical (e.g., “When my chest feels tight, I get scared that I won’t be able to breath properly”), cognitive (e.g., “When my thoughts seem to speed up, I worry I might be going crazy”), and social concerns (e.g., “When I tremble in the presence of others, I fear what people might think of me”). Participants were asked to rate the extent to which they agreed with each statement on a five-point Likert-type scale (0=*very little* to 4=*very much*), scores range from 0 to 72 with higher scores indicating greater AS. The range of scores observed in the present study was from 18 to 61. The reliability and validity of the ASI-3 have been well-established, and there is evidence that the psychometric properties of the ASI-3 have improved over the original ASI (Taylor et al., 2007). The alpha obtained for the ASI-3 in the present study was .82.

The Body Vigilance Scale (BVS; Schmidt, Lerew, & Trakowski, 1997; Appendix D). Body Vigilance was measured by the BVS, a four-item self-report measure designed to assess attentional focus to internal bodily sensations. Three items assess degree of attentional focus (e.g., “I am the kind of person who pays close attention to my internal bodily sensations), perceived sensitivity to changes in bodily sensations (e.g., “I am very sensitivity to changes in my internal bodily sensations), and the average amount of time spent attending to bodily sensations (e.g., “On average, how much time do you spend each day ‘scanning’ your body for sensations?”). Participants were asked to answer the questions in regards to how they have felt in the past week on an 11-point Likert-type scale (0=*not at all like me* to 10=*extremely like me*). The fourth item is composed of 15 separate ratings for attention to specific sensations (e.g., “heart palpitations”, “faintness”, “dizziness”, “nausea”, “sweating/clammy hands”). Participants were asked to rate how much attention they pay to each specific sensation on an 11-point Likert-type scale (0=*none* to 10=extreme). The scores of items one to three are divided by 10. Ratings for the 15 sensations are averaged to present one overall score for item 4. The BVS total score is the sum of the items and ranges from 0 to 40 with higher scores indicated greater BV. The range of scores observed in the present was from 14 to 33. The BVS has shown adequate psychometric properties in non-clinical and clinical samples. The alpha observed for the BVS in the present study was .76.

Procedure

Participation in the study was voluntary. Participants were recruited via Appalachian State University Psychology Department’s online recruitment system. To determine whether prospective participants met inclusion criteria, they completed a brief online survey consisting of a demographic questionnaire, the ASI-3, the BVS, and questions regarding general health. Participants that met inclusion criteria were contacted by e-mail to assess their interest in participating in the longitudinal study. Participants who agreed to take part in the study were randomly assigned to either an aerobic exercise, resistance training, or no-exercise rest condition. Participants assigned to exercise conditions were asked to wear comfortable exercise clothing to sessions. All participants completed a series of six sessions of exercise or rest over a period of two weeks. Following completion of the sixth exercise or rest session, participants were scheduled to return to the lab for a follow-up session approximately two days later to complete a battery of questionnaires, including the ASI-3 and BVS. Upon completion of the study, participants were provided with debriefing information, compensated appropriately, and thanked for their participation.

Regardless of condition, upon reporting to the lab for their first session, participants provided informed consent and completed the Appalachian Screening Questionnaire for Research Involving Exercise to ensure that they were healthy and fit enough to participate in the study. The researcher then assessed the participant's height, weight and age. The participant was then asked to attach a Polar heart rate monitor to themselves (i.e., chest strap around the sternum and watch on wrist) and remain seated for five minutes so the researcher could obtain a baseline HR. At the first session, participants were asked to complete a battery of questionnaires including basic demographic information, the ASI-3, and the BVS during the 5 minutes while they were seated prior to the baseline HR being obtained. Following acquirement of the baseline HR, the exercise or rest portion of the study began.

Aerobic. Each aerobic exercise session consisted of a brief period of stretching, a two-minute warm-up on the treadmill, 20 minutes of fast walking or jogging on the treadmill, a two-minute cool-down period on the treadmill, and a brief period of stretching. During the 20-minute period of aerobic exercise, the researcher recorded the participant's HR and adjusted treadmill speed at two-minute intervals to ensure that the participant's HR remained between an established lower (65% max HR) and upper bound (75% max HR) for aerobic exercise.

Resistance Training. Participants in the resistance training condition received instructions regarding proper form of three resistance exercises (i.e. squats, lateral pull downs, and bench press) and were required to exhibit correct form before beginning each exercise. Participants then completed a brief period of stretching and three sets of each exercise to exhaustion (i.e. they could not do one more repetition) using an estimated weight based on the participant's sex and weight. Each participant was required to perform at least ten repetitions during their first set, and weight was adjusted either up or down if they were able to perform more than 15 repetitions or fewer than 10 repetitions for each subsequent set. Two minutes of rest was provided between each set. During the approximate 20-minute period of resistance training exercise, the researcher recorded the participant's HR before each set/following the two minutes of rest, and immediately following each set.

Rest. Participants assigned to the rest condition were instructed to sit quietly in a chair for 25 minutes, and refrain from using cell phones, other objects, or interacting with the researcher. Consistent with the exercise conditions, control participants wore a heart monitor and had their HR monitored every two minutes.

Results

Preliminary analyses. Independent samples t-test and Chi-square analyses indicated that the three groups were comparable at baseline on all demographics and outcome variables as seen in Table 1.

Manipulation check: HR. Average heart rates for the three groups were examined in order to assess whether the exercise interventions generated significant exposure to physiological arousal sensations. Based on guidelines by the American College of Sports Medicine and an average participant age for the study of 20 years old, to achieve an average heart rate in the 65%-75% of maximum range for aerobic exercise, an average exercise heart rate of between 130 and 150 was targeted. Results indicated that the average heart rate for the aerobic condition (*M* = 136.64, SD = 7.47) and resistance training condition (*M* = 147.33, SD = 17.96) were within the 65%-75% of maximum heart rate range, while the average heart rate for the rest condition (*M* = 86.90, SD = 19.32) was not. Further, a 3x2 (group x time) repeated measures ANOVA revealed a significant effect for time, F (1, 26) = 131.84, $p < .001$, with a mean sample HR increasing from baseline (*M* = 90.33, *SD* = 9.19) to exercise/rest HR (*M* = 116.64, *SD* = 32.84). The main effect for group, F (1, 26) = 44.64, $p < .001$, and interaction effect, F (1, 26) = 23.15, $p < .001$, were also significant. Post hoc analyses revealed that the aerobic and resistance training exercise conditions exhibited significantly higher HRs during the intervention than the rest condition (see Table 1). Thus, the two exercise interventions generated significant increases in physiological arousal compared with rest. In addition, an independent samples t-test revealed that average heart rates in the aerobic conditions were not significantly different from the average heart rates in the resistance training condition, t(14) = -1.49, p =.16.

Body Vigilance. In order to test the hypothesis that participation in a regular physical exercise regimen will reduce attention to physiological sensations, a 3x2 (group by time) repeated measures ANOVA was computed to compare the effects aerobic exercise, resistance training, and rest had on body vigilance from baseline to post-exercise regimen. Results showed a significant effect for time, F (1, 26) = 6.31, p =. 02, η^2 = .21, with BVS scores decreasing from baseline (*M* = 20.77, SD = 5.76) to post exercise/rest two weeks later (*M* = 17.93, SD = 7.15). However, the main effect for group F (1,26) = .13, p = .88, and interaction effect F (1, 26) = .91, p = .42 were not significant.

Due to the low sample size in the exercise conditions, the aerobic and resistance training conditions were combined in order to provide a more robust analysis of whether exercise was significantly more effective in reducing body vigilance than rest. Combination of the aerobic and resistance training conditions is further justified by the lack of difference in heart rates between the two conditions. A 2x2 repeated measures (group x time) ANOVA on BVS scores revealed a significant main effect for time, F (1, 26) = 7.51, p = .01, η^2 = .34, with BVS scores decreasing from baseline (M = 20.77, SD = 5.76) to post exercise/rest (M = 17.93, SD = 7.15). However, the main effect for group, F (1, 26) = .19, p = .67 and interaction effect F(1, 26) = 1.72, p =.20 were not significant (See Figure 2).

Intensity and Body Vigilance

A correlation was run to examine the relationship between average heart rate during exercise and BVS change scores in order to examine whether level of arousal during exercise predicted change in BVS scores. The correlation between average heart rate during exercise and BVS change scores was not statistically significant, r = .08, n = 15, p = .78 and suggests that level of arousal during exercise did not predict change in BVS scores.

Discussion

In contrast to prediction, results of the study did not indicate that participation in regular exercise was more effective than rest in reducing attention paid to physiological sensations in individuals with high AS and BV. Specifically, individuals in all three conditions reported significant reductions in BVS scores from baseline to post-intervention. The present findings suggest that participation in a regular exercise regimen is not significantly more effective in reducing BV than sitting quietly for a comparable amount of time. Participants in the rest condition were instructed to sit quietly without engaging in any activity. Although this was intended to serve as a control condition, it is possible that 20 minutes of quiet rest several times per week generates significant reductions in BV via relaxation, meditative, or mindfulness processes. A meta-analytic review examined the effects of control conditions for anxiety disorders and found control groups to be associated with significant improvements, with an overall effect size of 0.45 for controls as a whole, and relatively low attrition rates (Smits & Hoffman, 2009). Results of this review suggest control conditions to be unintentionally, and moderately effective, in reducing anxiety symptomology.

Relaxation techniques are often used during treatment for various medical and psychological disorders. Relaxation techniques are considered to be simple and effective, typically involving sitting in a comfortable position, closing of the eyes, relaxing of muscles, and breathing while developing awareness of the breath, for around 10 minutes (Benson, 1975). Research has shown relaxation techniques to be effective in significantly reducing anxiety symptomology in clinical samples who were resistant to pharmacological treatment (Truzoli et al., 2017). In addition, a meta-analytic review showed no significant difference between CBT and relaxation techniques in the treatment and symptom reduction of PD, GAD, Social Anxiety Disorder, and specific phobias (Montero-Marin, Garcia-Campayo, López-Montoyo, Zabaleta-del-Olmo, & Cuijpers, 2017). Further, mindfulness is the practice of intentionally attending to the present moment in an open, observing, and non-judgmental way; mindfulness interventions have shown to be effective in treating anxiety symptoms and decreasing AS (Kabat-Zinn, 2012; Helmes & Ward, 2017; Schoorl, Van Mil-Klinkenberg, & Van Der Does, 2015). Although there is limited research on mindfulness and its effects on BV, preliminary research with young adults with asthma showed mindfulness significantly reduced BV and AS (Kraemer, McLeish, & Johnson, 2015).

Participants in the present study were asked to sit quietly in a chair for 20 minutes while refraining from using cell phones, other objects, or interacting with the researcher while their heart rate was monitored every two minutes. The individuals were not given any instructions on relaxation or mindfulness techniques, however, the control condition did meet several suggestions for relaxation including sitting in a comfortable position and relaxation of muscles for an elongated amount of time. In addition, it may be possible that monitoring of the participants heart rates facilitated an attendance to the present moment. Repeated monitoring of heart rate, every two minutes by the researcher (participants were unable to view their heart rates) may have drawn the participant's attention to their heart rate, attention to sensations in their body (how fast their heart was beating) and how these sensations may have changed from the beginning to the end of the session as they became more relaxed. More research should be done to clarify the impact of regular relaxation, meditation, and mindfulness regimens on BV. In addition, future research may also benefit from assessing what an individual did, or what they were thinking about, while sitting quietly in a control condition.

Results of this study may also suggest that physical exercise is no more effective in reducing attention paid to bodily sensations than rest. Researchers have suggested that though the exact mechanisms that account for the anxiolytic effects of exercise remain unclear, exercise-induced reductions in cognitive vulnerabilities for anxiety disorders, such as AS, may be at least partially responsible which led to the present study examining BV. Research has consistently shown that physical exercise is able to reduce AS (Broman-Fulks, Berman, Rabian & Webster, 2004; Broman-Fulks, Kelso & Zawilinski, 2015; Broman-Fulks & Storey, 2008). This study may suggest physical exercise is not more effective than rest in reducing BV, and that BV may not be a potential mechanism that accounts for the anxiolytic effects of exercise.

It is also possible that exercise generates smaller effects sizes on BV than on AS and other potential mechanisms. Although the reduction in BV generated by this study ($\eta^2 = .34$) was not statistically significant, it was relatively comparable to effect sizes observed in similarly designed studies examining the effects of regular low-intensity exercise on AS ($\eta^2 = 0.36$) (Broman-Fulks, Berman, Rabian & Webster, 2004). However, the effect size in the present study was less than reductions in AS observed in studies of the effects of comparable levels of moderate to high intensity exercise ($\eta^2 = 0.60$) (Broman-Fulks, Berman, Rabian & Webster, 2004). Broman-Fulks, Berman, Rabian & Webster (2004) found that high intensity exercise was able to generate greater change in AS scores from baseline to post ($M = 9.14$) as compared to low intensity exercise ($M = 2.88$). They concluded that high-intensity exercise caused more rapid reductions in AS and produced more treatment responders. In the present study, it was found that level of arousal, as measured by heart rate, did not significantly correlate with change in BVS scores. This may suggest that the relationship between exercise and attention paid to physiological arousal exists regardless of exercise intensity.

This study may suggest that exercise functions as an exposure intervention more than an attentional modification intervention, as evidenced by consistent reductions in fear of sensations commonly associated with anxiety in previous research and non-significant reductions in attention paid to physiological sensations in the current study. This study may also suggest that the anxiolytic effects of exercise can be explained by exposure to feared physiological sensations in the absence of negative consequence, as evidenced by consistent reductions in AS in previous research. Additionally, this study may also suggest that the anxiolytic effects of exercise may not be explained by modifying attention to threat relevant stimuli, as evidenced by non-significant reductions in BV. Therefore, the anxiolytic effects of exercise may be better explained by the capability to expose individuals to feared sensations rather than the capability to modify attention. Potential implications for treatment for anxiety disorders may be that exposure to feared sensations may more important for treatment outcomes than attention modification. Further research would benefit from examining other cognitive vulnerabilities for anxiety disorders in order to explore other potential mechanisms, such as distress tolerance.

Alternatively, it is possible that other variables were responsible for the comparable reductions in BV that were observed in the exercise and rest conditions. It is possible that participant's scores on the BVS regressed toward the mean upon measuring them at post intervention. It is also possible that attrition rates between conditions were responsible for the comparable reductions in BV that were observed. Only one participant in the rest condition dropped-out compared to two participants in each the aerobic and resistance training conditions. Attrition rates can threaten internal validity especially when attrition rates are related to condition assignments as more outcome data is subsequently lost for the exercise conditions as compared to rest conditions (Shadish, Cook & Campbell, 2002).Though not specifically indicated in reasons for attrition, attrition rates for the exercise conditions may have been higher given uncomfortable sensations generated by exercise in individuals who were already sensitive to these sensations and who are more aware of them. Attrition from the exercise conditions may be explained as a method of avoidance of anxiety provoking stimuli.

Lastly, research has yet to establish that BVS scores are sensitive to change as a result of short term interventions. BV has primarily been measured at a single time point in order to assess its predictability for, and correlation to, other symptomology (Mclaughlin, McLeish & O'Bryan, 2016; Olatunji et al., 2007). In addition, it is possible, that repeated utilization of the BVS over a two-week period of time may have resulted in potential overlap of reported scores. The BVS asks individuals to rate how sensitive they felt they were to their internal bodily sensations over the past week. In the present study, the participants were asked to complete the BVS three times each week, for a total of two weeks, which does not allow for a full week's time to pass since the participant's last report. Previous research using the same scale, the BVS, utilized the measures repeatedly at different time points throughout a 12-week intervention and indicated that BV was sensitive to change from baseline to post treatment (Schmidt et al., 1997). It would be important for future research to examine how BVS scores change as a result of interventions of different time intervals.

Although this study has several notable strengths, including a randomized control design for a two-week exercise intervention, several potential limitations and directions for future research are worthy of discussion. First, although the sample size exceeded what the power analysis indicated, a larger sample size would have been beneficial in order to increase power. A statistical power analysis (Faul et al., 2009) indicated that a sample of at least 42 would have been required to detect if the exercise condition scores changed at a rate that was significantly different from the rest condition when using the observed effect size and using a mixed model ANOVA ($\alpha = .05$, $f=.34$ $\beta = .80$). Second, the present intervention consisted of six sessions within two weeks. Other research examining the effects of exercise on PD include interventions ranging from 10 to 12 weeks (Broocks et al., 1998; Hovland et al., 2013; Wedekind et al., 2010). It would be important to examine the effects of exercise on BV using a longer intervention.

Third, the present results of the study showed the rest condition, the control condition, to generate significant and comparable results in BV. Further research would benefit from utilizing alternative control conditions that are able to minimize common factors between the control and treatment conditions, such as a relationship with the researcher, in order to minimize potential and unattended benefits of the control condition. Fourth, and lastly, the sample was comprised of a non-selected group of young adults and although the scores on the BVS and ASI-3 were required to be above the mean, it is unclear the extent to which these findings would extend to at-risk or clinical samples. It would be important to replicate these findings among a more diverse clinical sample. Finally, as previously mentioned, the intensity of the aerobic and resistance training interventions was in the moderate range (65-75% age-adjusted predicted maximum heart rate). Although research indicates mild to moderate intensity exercise to be beneficial for reducing anxiety (Tsutsumi et al., 1998), future studies may benefit from examining higher intensity exercise on body vigilance.

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Table 1. *Demographic characteristics and baseline measures for aerobic, resistance training, and rest conditions.*

	Aerobic (n = 7)			Resistance Training (n = 8)			Rest (n = 12)		
	n(%)	*M*	SD	n(%)	*M*	SD	n(%)	*M*	SD
Age		20.40	1.82		20.63	1.99		20.25	2.05
Gender									
Male	1(14%)			1(12%)			4(33.3%)		
Female	6(86%)			7(88%)			8(66.7%)		
Race									
Caucasian	5(71%)			7(87%)			9(75%)		
Hispanic	2(29%)						1(8.3%)		
Asian							1(8.3%)		
American				1(13%)					
Indian							1(8.3%)		
Other									
Baseline BVS scores		18.80	3.33		19.65	4.53		22.67	7.21
Mean resting HR		91.61	6.24		95.04	8.91		88.08	8.86
Mean exercise HR		136.64	7.47		147.33	17.97		86.90	19.32

Note. The groups did not significantly differ on any of the above variables.
HR, heart rate, BVS, body vigilance scale

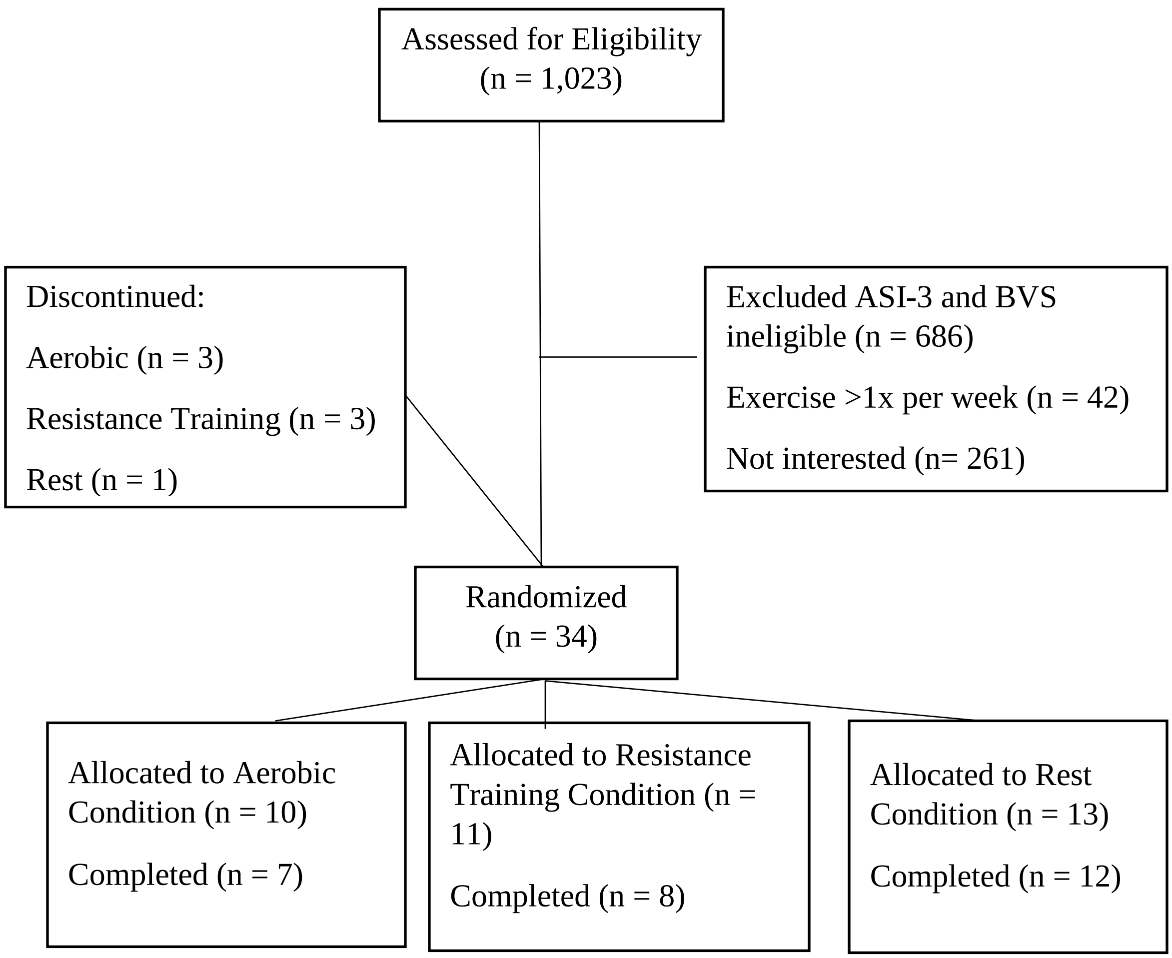

Figure 1. Participant flow.

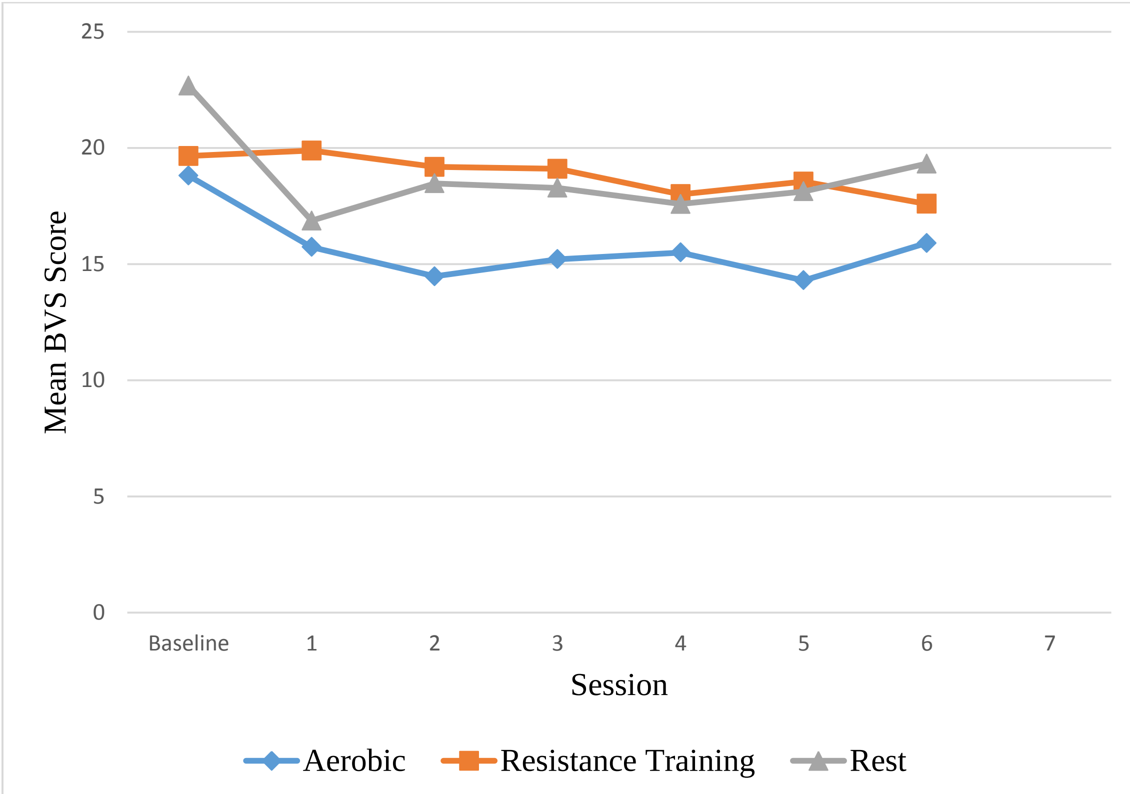

Figure 2. Mean BVS scores in Aerobic, Resistance Training, and Rest conditions

Appendix A: Informed Consent

Institutional Review Board
Approval Date: December 8, 2016_
Expires On: _December 7, 2017__
Study #: _13-0076______
Initials: ______________
Appalachian State University

Appalachian State University

Informed Consent for Participating in
Research Projects involving Human Subjects

Title of study: Psychological Functioning and Health in College Students
Investigators: Joshua J. Broman-Fulks, Ph.D. & Correy Dowd, B.S.

Participant Name: ______________________________

I. Purpose of the study:

The purpose of this study is to examine psychological functioning and health in college students. During the study, you will be asked to participate in an exercise session involving jogging or walking on a treadmill for 20 minutes.

II. Procedures:

Who can participate?

You must be 18 years old and in good physical health to participate in this study. If you have any physical conditions that would prevent you from exercising, you cannot participate in this study. If you have questions about your health, you will need to get clearance from a health care provider prior to participating in this study. There may be fees associated with this service, for which you will be responsible. Women who are pregnant or planning to conceive during this study are strongly encouraged not to participate in this study.

Description and Explanation of Procedures

If you choose to take part in this study, you will be asked to complete a session consisting of completing a series of questionnaires and an exercise session that will last approximately 20 minutes. The researcher will attach a heart monitor to you, which will be worn as a belt around the torso, with a receiver placed nearby on the treadmill. The exercise session will begin with two minutes of stretching exercises, followed by a two-minute warm up on the treadmill. Then, you will be asked to exercise on the treadmill for a period of 20 minutes at a comfortable aerobic pace. At the conclusion of the exercise, you will be provided with the opportunity to walk slowly on the treadmill for two minutes, and then asked to sit quietly in a chair for five minutes to allow for cool down. Additional questionnaires will then be completed following the exercise session. Next, you will be instructed on vital capacity breathing and complete both a brief inhalation task and a hyperventilation task. During these tasks, anxiety symptoms may be provoked. A third series of questionnaires will be completed following these tasks. The entire session should take approximately 120 minutes to complete. You will be asked not to take any drugs or consume any alcohol for 24 hours prior to the exercise session. You will also be asked to complete a series of questionnaires one week after the exercise session which will take approximately 20 minutes to complete.

When the study is complete and the results have been analyzed, the researcher will attempt to contact all participants of the study to invite them to come in for a debriefing session. In this session, participants will be informed of the findings of the study and given the opportunity to ask questions concerning these findings.

At any time for any reason, you may stop the procedure and withdraw from the study without penalty. You will be monitored at all times to ensure your safety, and the researcher may decide to discontinue the procedure if you display signs of distress.

III. Risks and Discomforts:

Although every effort will be made to minimize the occurrence of problems by screening participants and monitoring heart rate and behavior during the procedures, the possibility of experiencing some discomfort exists. During the completion of the questionnaires related to mood states, you might become uncomfortable or embarrassed. During the exercise session, inhalation and hyperventilation tasks, you may experience increased heart rate, respiration rate, dizziness, and/or perspiration. In the unlikely event of an accident occurring while on the treadmill, other possible discomforts that may be incurred during the exercise session include: skin wounds, bruises, sprains or strains, or pain or discomfort in the chest, neck, or arms. If exhaustion, dizziness or hyperventilation occurs, the procedure will be immediately ceased and you will be asked to sit in a chair until you regain your composure. If the problem continues or an accident occurs in which injuries are incurred, you will be referred to the ASU health center in order for a physician to assess and/or treat you.

IV. Benefits:

The information that you provide in this study may enable researchers to improve their understanding of the effects of physical activity on college students. This will be discussed with you further after you complete the study. You will receive course credit for your participation in this study. Other research and non-research options for obtaining course credit are available. Please see your class instructor for more information.

V. Extent of Anonymity and Confidentiality

All information obtained during this study is confidential. That is, we protect the privacy of subjects by withholding their names and other identifying information from all persons not connected with this study. The researcher will code all questionnaires and data by number and store them in a locked and secure area. Data that we may report in scientific journals or presentations will not include any information that identifies you as a participant in this study. Five years after the final publication of this study, all information and records will be destroyed.

VI. Compensation:

You will receive course credit for your participation in this study. You will receive 2 credits for completing this study. It is important that you complete both sessions in order to receive full credit for your participation in the study. You will not be penalized if you choose not to participate in or withdraw from this study.

VII. Freedom to Withdraw

Participation in this research is completely voluntary. Therefore, at any time for any reason, you may choose to stop and withdraw from the study without penalty.

Liability Statement:

If you experience physical or emotional problems because of your participation, please notify Dr. Broman-Fulks immediately. There will not be money set aside for any participant to receive medical care; however, if any participant needs medical attention, the counseling and health centers on campus will be available for you at no extra cost.

Other Considerations:

If significant new information relating to this study becomes known which may relate to your willingness to continue to take part in this study, this information will be given to you by the investigator.

VIII. Approval of Research

This research project has been approved, as required, by the Institutional Review Board of Appalachian State University.

December 8, 2016 ______ | ______ December 7, 2017 ______
IRB Approval Date | Approval Expiration Date

IX. Subject's Responsibilities

I voluntarily agree to participate in this study. I have to following responsibilities: complete all questionnaires, exercise on treadmill, and to complete the inhalation and hyperventilation tasks.

X. Subject's Permission

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent:

____ Date__________
Subject signature

____ Date __________
Witness (Optional except for certain classes of subjects)

Should I have any questions about this research or its conduct, I may contact:

Correy Dowd (813) 956-5117, dowdcl@appstate.edu
Graduate Student, Clinical Health Psychology Masters Program, Appalachian State University, Boone, NC 28608

Dr. Joshua J. Broman-Fulks, (828) 262-2726, bromanfulksj@appstate.edu
Assistant Professor, Psychology Department, Appalachian State University, Boone, NC 28608

Appendix B
IRB Approval

Appalachian STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
Office of Research Protections
ASU Box 32068
Boone, NC 28608
828.262.2692
Web site: http://researchprotections.appstate.edu
Email: irb@appstate.edu
Federalwide Assurance (FWA) #00001076

To: Correy Dowd
Psychology
CAMPUS EMAIL

From: Lisa Curtin, PhD, IRB Chairperson
RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)
Date: 12/08/2016
Agrants #:
Grant Title:

STUDY #: 13-0076
STUDY TITLE: Aerobic and Anaerobic Exercise and Psychological Functioning
Submission Type: Renewal
Expedited Category: (7) Research on Group Characteristics or Behavior, or Surveys, Interviews, etc.,(4) Collection of Data through Noninvasive Procedures Routinely Employed in Clinical Practice
Renewal Date: 12/08/2016
Expiration Date of Approval: 12/07/2017

Regulatory and other findings:

The IRB determined that this study involves minimal risk to participants.

All approved documents for this study, including consent forms, can be accessed by logging into IRBIS. Use the following directions to access approved study documents.

1. Log into IRBIS
2. Click "Home" on the top toolbar
3. Click "My Studies" under the heading "All My Studies"
4. Click on the IRB number for the study you wish to access
5. Click on the reference ID for your submission
6. Click "Attachments" on the left-hand side toolbar
7. Click on the appropriate documents you wish to download

Approval Conditions:

Appalachian State University Policies: All individuals engaged in research with human participants are responsible for compliance with the University policies and procedures, and IRB determinations.

Principal Investigator Responsibilities: The PI should review the IRB's list of PI responsibilities. The Principal Investigator (PI), or Faculty Advisor if the PI is a student, is ultimately responsible for ensuring the protection of research participants; conducting sound ethical research that complies with federal regulations, University policy and procedures; and maintaining study records.

Modifications and Addendums: IRB approval must be sought and obtained for any proposed modification or addendum (e.g., a change in procedure, personnel, study location, study instruments) to the IRB approved protocol, and informed consent form before changes may be implemented, unless changes are necessary to eliminate apparent immediate hazards to participants. Changes to eliminate apparent immediate hazards must be reported promptly to the IRB.

Approval Expiration and Continuing Review: The PI is responsible for requesting continuing review in a timely manner and receiving continuing approval for the duration of the research with human participants. Lapses in approval should be avoided to protect the welfare of enrolled participants. If approval expires, all research activities with human participants must cease.

Prompt Reporting of Events: Unanticipated Problems involving risks to participants or others; serious or continuing noncompliance with IRB requirements and determinations; and suspension or termination of IRB approval by external entity, must be promptly reported to the IRB.

Closing a study: When research procedures with human subjects are completed, please log onto our system at https://appstate.myresearchonline.org/irb/index_auth.cfm and complete the Request for Closure of IRB review form.

Websites:

1. PI responsibilities:
http://researchprotections.appstate.edu/sites/researchprotections.appstate.edu/files/PI%20Responsibilities.pdf

2. IRB forms: http://researchprotections.appstate.edu/human-subjects/irb-forms

CC:
Joshua Broman-Fulks, Psychology
Aimee Tolbert

Appendix C

ASI-3

Please circle the number that best corresponds to how much you agree with each item. If any items concern something that you have never experienced (e.g., fainting in public) answer on the basis of how you think you might feel *if you had* such an experience. Otherwise, answer all items on the basis of your own experience. Be careful to circle only one number for each item and please answer all items.

	Very Little	A little	Some	Much	Very much
1. It is important for me not to appear nervous.	0	1	2	3	4
2. When I cannot keep my mind on a task, I worry that I might be going crazy.	0	1	2	3	4
3. It scares me when my heart beats rapidly.	0	1	2	3	4
4. When my stomach is upset, I worry that I might be seriously ill.	0	1	2	3	4
5. It scares me when I am unable to keep my mind on a task.	0	1	2	3	4
6. When I tremble in the presence of others, I fear what people might think of me.	0	1	2	3	4
7. When my chest feels tight, I get scared that I won't be able to breathe properly.	0	1	2	3	4
8. When I feel pain in my chest, I worry that I am going to have a heart attack.	0	1	2	3	4
9. I worry that other people will notice my anxiety.	0	1	2	3	4
10. When I feel "spacey" or spaced out I worry that I may be mentally ill.	0	1	2	3	4
11. It scares me when I blush in front of people.	0	1	2	3	4
12. When I notice my heart skipping a beat, I worry that there is something seriously wrong with me.	0	1	2	3.	4
13. When I begin to sweat in a social situation, I fear people will think negatively of me.	0	1	2	3	4
14. When my thoughts seem to speed up, I worry that I might be going crazy.	0	1	2	3	4
15. When my throat feels tight, I worry that I could choke to death.	0	1	2	3	4
16. When I have trouble thinking clearly, I worry that there is something wrong with me.	0	1	2	3	4
17. I think it would be horrible for me to faint in public.	0	1	2	3	4
18. When my mind goes blank, I worry there is something terribly wrong with me.	0	1	2	3	4

Appendix D

BVS

This scale is designed to index how sensitive you are to internal bodily sensations such as heart palpitations or dizziness. Fill it out according to how you have felt for the **past week**.

1. "I am the kind of person who pays close attention to internal body sensations."

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					Extremely

2. "I am very sensitive to **changes** in my internal body sensations."

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					Extremely

3. "On average, **how much time** do you spend each day scanning your body for sensations?"

0	10	20	30	40	50	60	70	80	90	100
Never					Half the time					Constantly

4. Rate how much attention you pay to each of the following sensations using this scale:

0	1	2	3	4	5	6	7	8	9	10
none		slight			moderate			substantial		extreme

1. ________ heart palpitations
2. ________ chest pain/discomfort
3. ________ numbness
4. ________ tingling
5. ________ shortness of breath/smothering
6. ________ faintness
7. ________ vision changes
8. ________ feelings of unreality
9. ________ feeling detached from the self
10. ________ dizziness
11. ________ hot flash
12. ________ sweating/clammy hands
13. ________ upset stomach
14. ________ nausea
15. ________ coking/throat closing

Vita

Correy Lynn Dowd was born in Wurzburg, Germany to Kenneth and Jennie Dowd. She graduated from Terry Sandford High School in 2011. The following Autumn she entered Appalachian State University to study psychology. She was awarded the Bachelors of Science degree, graduating with University and Departmental Honors, Magna Cum Laude, majoring in Psychology and minoring in Social Work, in May 2015. In the fall of 2015, she accepted a research assistantship and entered the Master's Clinical Psychology Program at Appalachian State University. In June of 2017, she began her internship at Central Prison in Raleigh, North Carolina. In December of 2017, she will be awarded her Masters of Arts degree. She plans to take a full-time position at Central Prison come January of 2019.