ANXIETY AND AFFECTIVE RESPONSES TO ACUTE MODERATE INTENSITY PHYSICAL ACTIVITY (WALKING): EFFECTS OF VARYING DURATIONS

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ABSTRACT

Anxiety affects approximately 40 million American adults each year (Kessler, Chiu, Demler, and Walters, 2005; National Institute of Mental Health [NIMH], 2009). However, the dose-response research investigating the antianxiety and affective benefits of acute bouts of exercise indicates that multiple dose-response issues remain unresolved. The purpose of this study was to investigate the anxiolytic and affective responses following an acute bout of moderate intensity walking of different durations (30, 10 and 5 minutes) on a moderately fit, non-clinically anxious population. This study also sought to test the duration of effect by assessing post-exercise responses immediately and at 20 and 40 minutes post-exercise. This is the first study to include the analysis of four specific covariates (trait anxiety, fitness level, enjoyment of activity, and sex) when examining psychological responses to walking. One of the main findings of the current investigation was that a main effect of time was observed for the majority of variables. While some measures showed favorable (anxiety, tense arousal, calmness, tension, tranquility, physical exhaustion, affective valence, and revitalization) other measures ultimately showed unfavorable (positive affect, perceived activation, energetic arousal, energy, and positive engagement) responses following the cessation of exercise. Secondly, although several measures were affected by exercise duration (tranquility, physical exhaustion, and affective valence), the majority were not. Finally, of the four covariates, only fitness (positive affect, energetic arousal, and energy) and sex (positive affect, revitalization, energy, and calmness) influenced the exercise-affect relationship.

DEDICATION

I would like to dedicate this dissertation to my parents, Louise and Melvin Billingsley. It is only because of their belief in my abilities, their willingness to allow me to find my own path in life, and their continued prayers for me that I was able to complete this project. They have provided me with a wonderful example of how to live, showing me through their actions that you must work hard to achieve your goals. Although this process took longer than expected, their love, support, and encouragement motivated me to keep working, and today, I have achieved my goal. I would not be here today without you. I love you both very much.

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LIST OF ABBREVIATIONS AND SYMBOLS

α	Type I error rate
AD ACL	Activation-Deactivation Adjective Check List
ALS	Anxiety Likert Scale
BMI	Body mass index
EFI	Exercise-Induced Feelings Inventory
FAS	Felt Arousal Scale
FS	Feeling Scale
HR	Heart rate
kg	Kilogram
MET	Metabolic equivalent
mL	Milliliter
p	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
PAES	Physical Activity Enjoyment Scale
PANAS	Positive And Negative Affect Schedule
RPE	Rating of perceived exertion
SE	Standard error
STAI	State-Trait Anxiety Inventory
$\dot{V}O_2$	Oxygen uptake
$\dot{V}O_{2max}$	Maximal oxygen uptake

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CHAPTER 1

INTRODUCTION

A myriad of physical health benefits are associated with aerobic exercise including: decreased risks for coronary heart disease; hypertension; certain types of cancer; and obesity (Center for Disease Control and Prevention [CDC], 2010; Kesaniemi, et al., 2001; Pate, et al., 1995; U.S. Department of Health and Human Services [USDHHS], 2008). Although heart disease and cancer are the leading causes of death among American adults (USDHHS, 2010), mental illness is the most debilitating disorder, affecting one-fourth of the adult population (Reeves, et al., 2011). Anxiety is the most common form of mental disturbance among American adults (Gum, King-Kallimanis, and Kohn, 2009; Kessler, et al., 2005), affecting approximately 40 million people each year (Kessler, et al., 2005; NIMH, 2009). Moreover, recent data indicates that rates of anxiety are increasing (Gum, et al., 2009), both among women, who more frequently suffer from anxiety than men (Herring, Lindheirmer, and O'Connor, 2013; NIMH, 2009; Reeves, et al., 2011) and among younger individuals. Recent survey data suggests that the incidence of anxiety experienced in people between 15 and 24 years of age is 40% higher than in people between 25 and 54 years of age (Kessler, et al., 2007). More specifically, it has been reported that some 42% of college students suffer from anxiety, making it the most common psychological problem affecting this particular population (American Psychological Association, 2013; NIMH, 2009). Despite these compelling statistics, depression is the most frequently studied mental illness in the exercise psychology literature; anxiety has received comparatively less attention (Asmundson, et al., 2013; Martinsen, 2008; Ströhle, 2009).

Investigations examining the effect of physical activity on anxiety and affective responses have reported an inverse dose-response relationship, such that as participation in physical activity increases, symptoms of anxiety decline (Da Silva, et al., 2012; Goodwin, 2003; Herring, et al., 2013; Kesaniemi, et al., 2001; Ströhle, 2009). Specific antianxiety responses associated with an acute bout of exercise include: significant reductions in state anxiety (Cox, Thomas, and Davis, 2000; Tate and Petruzzello, 1995); positive affective responses such as increased tranquility, positive engagement, and revitalization and decreased physical exhaustion (Barnett, 2012; Focht, 2013, 2009); increased perceived activation (Focht, 2013); increased pleasant feeling states (Parfitt, Rose, and Burgess, 2006); and reduced negative affective responses (Choi, Van Horn, Picker, and Roberts, 1993; Petruzzello and Landers, 1994). From a recent review of literature, Herring, et al. (2013) report that mentally and physically healthy adults who engage in aerobic exercise report less intense and less frequent feelings of anxiety.

Exercise is just one of the modalities utilized in the treatment of anxiety. Other treatments include cognitive and behavioral therapy and medications (Black, 2006; Taylor, Abramowits, and McKay, 2012). Although success has been seen with these treatment options, there are logistical limitations for both, specifically and predominantly, cost and access (Black, 2006; Gum, et al., 2009). Neither of those barriers applies to physical activity which is both free and easily accessible for most people (Kesaniemi, et al., 2001; Pate et al., 1995; USDHHS, 2008).

The use of exercise for the treatment and alleviation of anxiety is considered by many exercise psychology professionals to be a viable, practical, and successful option (Herring, et al., 2013; Petruzzello, Landers, Hatfield, Kubitz, and Salazar, 1991; Wipfli, Rethorst, and Landers, 2008). In a recent meta-analysis, Wipfli, et al. (2008) compared exercise with other anxiety treatments, such as those previously mentioned, in both clinical and non-clinical populations. With the exception of pharmacotherapy, other treatments of anxiety were at best equal—if not inferior—to exercise.

The most current physical activity recommendations encourage regular engagement in short duration, relatively low-to-moderate intensity activities, such as brisk walking (American College of Sports Medicine [ACSM], 2013; Haskell, et al., 2007; USDHHS, 2008). In addition to the cost-free nature of walking, when compared to all other exercise modalities, research has determined that walking is the most easily accessible, the safest, and the most preferred mode of physical activity (Booth, Bauman, Owen, and Gore, 1997; Kerr, et al., 2006; Simpson, et al., 2003; USDHHS, 1996). As walking is generally performed at low-to-moderate intensities, this mode is less likely to induce the negative affective responses often experienced during higher intensity exercise (Bixby, Spalding, and Hatield, 2001; Ekkekakis and Petruzzello, 1999). Additionally, lower intensity exercise, like walking, appears to produce the greatest positive results in altering anxiety and affective states and is more generalizable than moderate- and high-intensity exercise (Reed and Ones, 2006).

However, walking is often overlooked and underappreciated as exercise and "…specifically with respect to affective outcomes, the lack of appreciation for the potential benefits associated with walking seems to be pervasive among researchers" (Ekkekakis and Petruzzello, 1999, p. 349). These same researchers suggest that the lack of appreciation is due in part to "the absence of methodologically sound studies examining low intensity and short duration exercise stimuli" (p. 349). This point is illustrated by the fact that running and cycling are the most frequently chosen modes investigated in the exercise psychology literature. Results from the existing investigations into the dose-response relationship between acute bouts of walking and antianxiety and affective responses show increased positive affective valence and activation (Van Landuyt, Ekkekakis, Hall, and Petruzzello, 2000); increased energetic arousal and pleasure (Ekkekakis, Backhouse, Gray, and Lind, 2008); and increased revitalization, positive engagement and tranquility (Focht, 2013).

In addition to encouraging regular engagement in short duration activities, the current physical activity recommendations also endorse the accumulation of multiple short bouts throughout the day as a plausible method of obtaining the recommended daily dose of exercise needed to experience health benefits, including psychological health benefits (ACSM, 2013; Haskell, et al., 2007; USDHHS, 2008). To date, however, investigations of the dose-response effects of acute bouts of walking are limited. Absent in the current literature is a systematic analysis of the antianxiety or affective responses following acute bouts of precisely defined moderate intensity walking of different durations (30, 10 and 5 minutes). Also, the time course of the post-exercise antianxiety and affective responses following acute bouts of walking have not been investigated fully or systematically. Finally, the effect of moderating variables on the relationship between acute bouts of walking and antianxiety and affective responses has not yet been examined. Therefore, the purpose of this study was to address the following specific research aims.

Research Aims:

1. To examine the anxiolytic and affective responses following a 30-minute bout of acute, moderate intensity walking and compare the responses of the longer bout with those of two shorter bouts (10 and 5 minutes) of walking at the same intensity.
2. Examine the duration of the effects by extending the measurement of the post-exercise responses to 40 minutes.

3. To gain a more complete picture of the measured anxiety and affective responses following an acute bout of moderate intensity walking by utilizing a more comprehensive battery of psychological psychometric assessments.
4. To further examine the effect of moderating variables, specifically, sex, fitness level, level of trait anxiety, and enjoyment of the activity, on the relationship between acute bouts of walking and antianxiety and affective responses.

Therefore, the purpose of this study was to test the following hypotheses:

1. Thirty minutes of moderate intensity walking will induce favorable antianxiety and affective responses measured by each of the psychometric instruments.
2. Shorter bouts of walking will produce positive changes in anxiety and affective responses from pre- to post-exercise similar to those following one 30 minute bout of walking.
3. The anxiolytic and affective responses following acute bouts of moderate intensity walking will dissipate by the 40th minute post-exercise, despite the duration of the walk (30, 10 or 5 minutes).
4. Those participants who have lower levels of fitness, higher levels of trait anxiety, and who enjoy the activity will report significantly greater changes in psychological responses from baseline to all time points following the cessation of exercise.

CHAPTER 2

LITERATURE REVIEW

The literature investigating the effect of acute bouts of aerobic exercise on anxiety and affective responses is minimal. The first purpose of this literature review is to define anxiety and affect and to address current literature which has investigated the use of aerobic exercise to mediate these psychological states. The second purpose of the review is to discuss dose-response issues as they relate to the exercise-anxiety/affect relationship. The specific dose-response issues that will be discussed include: duration, intensity, mode, the time course of the post-exercise responses, and possible moderating variables.

Anxiety and Affect Defined

Anxiety can be defined as future directed emotion encompassing specific criteria including an excessive, unpleasant, negative, and unnecessary overreaction to a specific stressor, a future threat, or the anticipation of a future threat. Oftentimes the stressor or threat is one that a non-anxious person would see only as a minor inconvenience (Herring, et al., 2013; Lewis, 1970). The American Psychiatric Association (APA) defines anxiety as "an emotion characterized by feelings of tension, worried thoughts and physical changes like increased blood pressure. People with anxiety disorders usually have recurring intrusive thoughts or concerns. They may avoid certain situations out of worry. They may also have physical symptoms such as sweating, trembling, dizziness or a rapid heartbeat" (2013). In some individuals, somatic complaints such as high blood pressure, problems concentrating, and muscle tension have been cited as physical manifestations of the psychological disorder (Deslandes, et al., 2009; Endler and Kocovski, 2001; Nolen-Hoeksema, Wisco, and Lyubomirsky, 2008).

Most anxiety disorders consist of excessive worry (Barlow, 2002). Worry is defined as uncontrollable, intrusive, negative affect-laden thoughts and it "represents an attempt to engage in mental problem-solving on an issue whose outcome is uncertain" (Borkovec, Robinson, Pruzinsky, and DePree, 1983, p. 10). Worry is considered to be a maladaptive process of the cognitive system in response to a future threat or danger, "incompatible with successful problem solving" (Mathews, 1990, p. 457). Worrying often causes persistent intrusive thoughts, a disruption in normal adaptive behavior, and unnecessary distress (Andrews, et al., 2010; Mathews, 1990). Additionally, while worrying, an individual often suffers from prolonged and increased negative affect (Girodo and Stein, 1978). In addition to suffering from worry, those with anxiety find it difficult to control their ruminations (APA, 2013). Rumination is defined as "repetitively and passively focusing on symptoms of distress and on the possible causes and consequences of these symptoms. Rumination does not lead to active problem solving…Instead, people who ruminate remain fixated on their problems and on their feelings about them without taking action" (Nolen-Hoeksema, et al., 2008, p. 400). In addition to worry and rumination, anxiety can also lead to feelings of restlessness, uneasiness and apprehension, fatigue and irritability, difficulty concentrating, sleep disturbances, fearfulness and uncertainty, and fear and tension (APA, 2013; Conn, 2010; Nolen-Hoeksema, et al., 2008). Due to the impairment and distress, those who suffer from anxiety often exhibit decreased activity levels and withdrawal (Martinsen, 2008). The disabling effects of anxiety span a broad spectrum from mild interruptions in daily life to complete incapacitation effecting normal emotional, social, and occupational functioning (APA, 2013; Endler and Kocovski, 2001).

Anxiety negatively impacts an individual's overall psychological well-being. "Anything which impairs or distorts this unity of functioning (mind or sanity) impairs or distorts the being and existence of the person, and is the primal stimulus to existential anxiety" (Thorne, 1966, p. 130). This distortion of psychological well-being, anxiety, is most commonly discussed according to its two dimensions, differentiated by Spielberger (1966) as trait anxiety and state anxiety. State anxiety is the more acute, variable, or transitory facet of anxiety that can be easily influenced moment-to-moment based on external factors. While relaxed and calm would describe the absence of state anxiety, the symptoms used to describe someone suffering from state anxiety include: worry, apprehension, nervousness, tension, and dread (Endler and Kocovski, 2001; Herring, et al., 2013). Trait anxiety, on the other hand, is the chronic and more stable facet of anxiety that represents a generalized predisposition to react and respond to a stimulus as threatening or dangerous (Endler and Kocovski, 2001; Herring, et al., 2013).

Although trait anxiety can be influenced by external factors, such as exercise (Herring, et al., 2013), due to its biological basis, investigators have concluded that a change in trait anxiety takes ample time, and therefore, longitudinal treatment modalities are necessary to mitigate trait anxiety (Petruzzello, et al., 1991). On the other hand, research has indicated that state anxiety, in both clinically anxious and non-clinical populations, can be transiently mitigated following acute exercise (Ekkekakis and Petruzzello, 1999; Petruzzello, 2012; Petruzzello, et al., 1991). As the researchers intend to examine the effects of acute bouts of exercise, only investigations into the effects of exercise on state anxiety will be included in this review.

In addition to being a heterogeneous disorder, it is believed that anxiety exists on a continuum and that it can be measured based upon the severity of the disorder (Endler and Kocovski, 2001). In a greater sense, many researchers consider anxiety, specifically state anxiety, to be a disturbance in affect. Affect and the affective domain, the most general of the feeling states, can be positive or negative (Ekkekakis and Petruzzello, 1999; Watson, Clark, and Tellegen, 1988). Positive affect is defined as the positive aspects of an individual's personality, including relaxation and calmness as well as enthusiasm, alertness, and energy (Watson, et al., 1988). Low positive affect includes sadness and lethargy, while high positive affect is characterized by pleasurable engagement, high levels of energy/revitalization, tranquility, and full concentration (Ekkekakis and Petruzzello, 1999; Hobson and Rejeski, 1993). Negative affect is defined as feelings of distress and tension as well as fatigue and boredom (Watson, et al., 1988). High negative affect includes negative states such as fear, nervousness, contempt, disgust, and anger, while low negative affect includes serenity and calmness (Ekkekakis and Petruzzello, 1999; Hobson and Rejeski, 1993). According to this model, high negative affect and low positive affect are often associated with anxiety (Tellegen, 1985). Therefore, when discussing the effects of exercise on anxiety, those investigations into the effect of exercise on both positive and negative affective responses are included.

Although it seems that the two dimensions are negatively correlated or opposites, they are actually uncorrelated and therefore independent dimensions of affect, often represented by the circumplex model (Russell, 1980; Watson and Tellegen, 1985). "According to the circumplex, the affective space is defined by two bipolar and orthogonal dimensions: an affective valence dimension and an activation dimension" (Ekkekakis, Hall, Van Landuyt, and Petruzzello, 2000, p. 249). The 'affective valence' dimension represents the degree to which a person is experiencing pleasant or unpleasant feelings and the 'activation' dimension represents the level of engagement of the individual. Pleasantness is described by feeling such as happy, pleased, satisfied, and content; while unpleasantness is described by feelings such as unhappy, sad, blue, grouchy, and lonely. Strong engagement is represented by words such as aroused, surprised, and astonished; while disengagement is represented by words such as still, inactive, calm, and quiet. The different combinations of positive and negative affect, affective valence, and activation allow for the following:

- *High positive affect* or *activated pleasant affect:* includes both positive activation or strong engagement and positive valence or pleasant feelings; referred to as high energetic arousal or excitement; described as active, peppy, and elated; a state characterized by energy, excitement, and enthusiasm
- *Low positive affect or unactivated unpleasant affect:* includes both negative activation or disengagement and negative valence or unpleasant feelings; referred to as low energetic arousal or depression; described as sluggish, sleepy, and dull or drowsy; characterized by boredom, fatigue, or depression
- *Low negative affect or unactivated pleasant affect:* includes negative activation or disengagement and positive valence or pleasant feelings; referred to as low tense arousal or contentment; described as calm, relaxed and at rest; characterized by relaxation and calmness
- *High negative affect* or *activated unpleasant affect:* includes positive activation or strong engagement and negative valence or unpleasant feelings; referred to as high tense arousal or distress; described as nervous, jittery, hostile, fearful, and distressed; characterized by tension and distress

Therefore, as high negative affect and low positive affect are associated with anxiety, so too are activated unpleasant affect or high tense arousal as well as unactivated unpleasant affect or low energetic arousal, respectively. Hence, when discussing investigations of the effect of exercise on anxiety, those investigations who report affective valence and activation are also included. Additionally, some researchers incorrectly describe positive or negative affect as positive or negative mood; however, the reverse is true, as mood is a subset of affect (Berger and Motl, 2000). Therefore, investigations into the effect of exercise on changes in mood may also be included.

Exercise as a Treatment for Anxiety

The modalities used in the treatment of anxiety and anxiety symptoms are numerous and varied (Black, 2006; Taylor, et al., 2012). Most commonly, treatments include psychotherapy, pharmacology, and psychopharmacology. The more common psychotherapy techniques used include cognitive, behavioral, and relaxation therapies as well as biofeedback and hypnosis. Pharmacological treatments include antidepressant agents such as selective serotonin reuptake inhibitors (SSRIs) and monoamine oxidase inhibitors (MAOIs) for longer duration or state anxiety. For more acute or state anxiety discomfort, anti-anxiety medications, such as benzodiazepines and beta-blockers are prescribed. Psychopharmacology is a combination of the two previously mentioned treatment modalities (Black, 2006; Taylor, et al, 2012). Although success has been seen with the aforementioned treatment options, the side effects of the medications used in the treatment of anxiety can lead to negative physical health conditions (including weight gain; sexual dysfunction; and elevated blood sugar, cholesterol levels and blood pressure) as well as negative psychological symptoms, like suicidal ideations (Black, 2006; Gardner, Baldessarini, and Waraich, 2005). Additionally, there are logistical limitations for the above treatment options, specifically and most predominantly, cost and access (Black, 2006; Gum, et al., 2009).

However, neither of these barriers applies to physical activity, which in many forms is both free and easily accessible (Kesaniemi, et al., 2001; Pate et al., 1995; USDHHS, 2008). In most cases, participation in physical activity will have a positive impact on physical health rather than a negative impact (Kesaniemi, et al., 2001; Pate et al., 1995; USDHHS, 2008). The use of exercise for the treatment and alleviation of anxiety is considered by many exercise psychology professionals to be a viable, practical, and successful option (Herring, et al., 2013; Petruzzello, et al., 1991; Wipfli, et al., 2008). In a recent meta-analysis, Wipfli, et al. (2008) compared exercise with other anxiety treatments, such as those previously mentioned, in both clinical and non-clinical populations. Results suggest that, with the exception of pharmacotherapy, other treatments of anxiety were at most equal, if not inferior, to exercise.

Multiple investigations into the effect of physical activity on psychological states have reported that there is an inverse relationship, such that as participation in physical activity increases, the symptoms of anxiety decline (Da Silva, et al., 2012; Goodwin, 2003; Herring, et al., 2013; Kesaniemi, et al., 2001; Ströhle, 2009). The literature has produced ample evidence supporting this idea across both clinical and non-clinical populations (Conn, 2010; Bartley, Hay, and Bloch, 2013; Herring, et al., 2013). The literature also supports this conclusion across both chronic exercise training (Conn, 2010; Wipfli, et al., 2008) and acute bouts of exercise (Ekkekakis and Petruzzello, 1999; Reed and Ones, 2006). Specifically, an acute bout of exercise can improve psychological well-being resulting in significant reductions in state anxiety (Tate and Petruzzello, 1995); improved mood states (Steptoe and Cox, 1988); positive affective responses, such as increased tranquility, positive engagement, and revitalization and decreased physical exhaustion (Barnett, 2012; Focht, 2013, 2009); increased perceived activation (Focht, 2013); increased pleasant feeling states (Parfitt, et al., 2006); and reduced negative affective responses (Choi, et al., 1993; Petruzzello and Landers, 1994).

Various exercise modalities have shown conclusive positive effects on affective states. One exception involves anaerobic modes of exercise, specifically weight training, where results are less conclusive. Some studies report reduced anxiety (Bibeau, Moore, Mitchell, Vargas-Tonsing, and Bartholomew, 2010; McGowan, Pierce, and Jordan, 1991) and others report no effect on anxiety (Berger and Owen, 1988; Garvin, Koltyn, and Morgan, 1997; Koltyn, Raglin, O'Connor, and Morgan, 1995; Raglin, Turner, and Eksten, 1993). Still others report results that were intensity dependent, such that higher intensity bouts of anaerobic exercise did not reduce anxiety (Bartholomew and Liner, 1998; Focht and Koltyn, 1999). However, studies investigating acute bouts of aerobic exercise (Bahrke and Morgan, 1978; Cox, Thomas, Hinton, and Donahue, 2004; Daley and Welch, 2003, 2004; Ekkekakis, et al., 2008; Hansen, Stevens, and Coast, 2001; Nabetani and Tokunaga, 2001) have found that each mode of exercise is useful in mitigating the negative effects of anxiety (Ekkekakis and Petruzzello, 1999; Petruzzello, et al., 1991).

Dose-Response Issues

Although convincing, the literature concerning the dose of exercise necessary to elicit a psychological response is nowhere near as vast as the literature investigating physiological benefits of exercise (Asmundson, et al., 2013; Martinsen, 2008). In fact, when discussing the benefits of engaging in exercise for mental health, one report on dose-responses issues stated that the panel of experts involved in the symposium found "no dose-response relationship between physical activity and depression and anxiety" (Kesaniemi, et al., 2001). Campbell and Hausenblas (2009) stated that the lack of an established relationship could be due to the fact that “the dose-response of exercise needed to obtain the psychological benefits of exercise is controversial” (p. 788). One major difficulty in including affective recommendations in exercise prescription is that, to date, “extant studies do not allow any definitive statement to be made regarding the form of the dose-response relationship” (Hall, Ekkekakis, and Petruzzello, 2002, p. 49). Dunn, Trivedi, and O’Neal, (2001) suggest that the lack of evidence to support the dose-response relationship is due to “a lack of studies rather than a lack of evidence” and that “a dose-response relation does, however, remain plausible” (p. S587).

The idea of including the exercise dose-psychological response recommendations into exercise prescription is beginning to encounter less resistance and garner more attention from investigators (Ekkekakis, Parfitt, and Petruzzello, 2011). As one group of researchers emphasized, the state of the current literature is beginning to suggest that including the affective response to exercise should be considered just as heavily as exercise safety and effectiveness (Ekkekakis, et al., 2011). In order to determine concrete exercise recommendations concerning psychological health, exercise psychologists have begun to investigate specific exercise dose issues, specifically mode, duration, and intensity, necessary to elicit responses. In this regard, there are several important questions that must be answered. (Can shorter acute bouts of exercise produce similar positive psychological benefits to longer duration bouts of exercise? If so, what is the minimal duration necessary to see results? Within what intensity range should the exercise be performed to produce the greatest benefits? Are there minimum or maximum intensity thresholds? Do different exercise modalities produce different responses?). Therefore, the remainder of this literature review will discuss dose-response issues (specifically, duration, intensity, and mode of exercise) when investigating the antianxiety and affective responses following an acute bout of aerobic exercise.

In order to do so, a few terms must be defined. Dose refers to "the energy expenditure in physical activity" (Kesaniemi, et al., 2001). Duration is defined as the total number of minutes of physical activity or exercise per session. Intensity is defined as the level of effort expended while performing the physical activity or exercise session, and it can be measured in either absolute or relative terms. Mode simply refers to the type of physical activity or exercise performed. An acute bout is defined as physical activity or exercise performed one time. Acute effects are those "health related changes that occur during and in the hours after physical activity" (Kesaniemi, et al., 2001)

Duration

Two studies completed in the seventies caused the exercise psychology community to hold tight to the idea that short duration activities were ineffective at producing antianxiety effects (Morgan, Roberts, and Feinerman, 1971; Sime, 1977). Morgan, et al. (1971) randomly assigned 36 university students to one of three conditions: 17 minutes of treadmill walking at 3 mph at 0% grade, 17 minutes at 3 mph at 5% grade, and 17 minutes of rest. During all exercise conditions, heart rates were kept under 150 bpm. Results indicated no significant differences in anxiety levels post-exercise when compared to the rest control measured by the IPAT Anxiety Battery (Scheier and Cattell, 1960). Similar results were found by Sime (1977), in that no significant changes in state anxiety were reported following 10 minutes of low-to-moderate intensity treadmill walking 5 minutes post exercise measured by the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, and Lushene, 1970). These findings prompted Dishman (1986) to propose the notion of the '20 minute minimal threshold.' This threshold suggested that an exercise session duration must meet or exceed 20 minutes to induce beneficial effects on psychological states including anxiety (Dishman, 1986). Similarly, other researchers have suggested that the optimal duration range should be set between 20-30 minutes (Berger, 1994; Berger and Owen 1988; Morgan, 1985). This duration threshold was promoted in the early physical activity recommendation which called for continuous physical activity performed in durations of at least 30 minutes (ACSM, 1990; ACSM, 1993) and was strictly adhered to for some time when studying psychological changes produced by exercise. However, existing research provides supporting evidence for psychological benefits following both long and short durations of acute activity.

A number of studies have found reductions in anxiety during and following acute bouts of exercise of durations ranging from 25 to 75 minutes (Barabasz, 1991; Crocker and Grozelle, 1991; Maroulakis and Zervas, 1993; McGowan, et al., 1991; Pierce and Pate, 1994). One such study investigated the effects on state anxiety in 163 younger and older women (aged 16-56) following 30, 45-60, and more than 60 minute bouts of various modes of exercise at a fitness club using the STAI. Results indicated that the 45-60 minute bout produced greater antianxiety effects compared to the 30 minute bout, but researchers noted that those effects were nullified in bouts exceeding 60 minutes (Guszkowska, 2009). Acevedo, Gill, Goldfarb, and Boyer (1996) reported similar results, specifically, decreased positive affect and increased negative affect, measured by the Feelings Scale (FS; Hardy and Rejeski, 1989), following durations greater than 60 minutes in 12 male distance runners who ran for two hours on a treadmill at 70% VO_{2max}. Petruzzello and Landers (1994) measured both induction of positive affective and alleviation of negative affective states, using the State Anxiety Inventory (SAI; Spielberger, et al., 1970) and the Positive and Negative Affect Schedule (PANAS; Watson, et al., 1988), before and at multiple time points after the cessation of exercise (ie. 0, 5, 10, 20, and 30 minutes post-exercise) in a study completed by 16 males who engaged in 15 and 30 minutes of treadmill running at 75%

VO_{2max}. While both durations of exercise produced no change in positive affect and equal reductions in state anxiety, reductions in negative affect were reported following only the longer of the two durations.

Other research suggests that the exercise duration has no effect on the elicitation of psychological benefits during acute bouts of aerobic activity (Butki and Rudloph, 1997; Levinger, Levinger, Coutts, Woods, and Gilleard 2005; Petruzzello and Landers, 1994; Rudolph and Butki, 1998). For example, an investigation into the affective responses to exercise in 23 physically active participants compared 15 and 30 minutes of acute cycle ergometery at 70% age adjusted HR_{max} (Daley and Welch, 2004). Both cycling protocols, regardless of duration, demonstrated equally significant improvement in affective responses from baseline to post-exercise measurements. These included increased positive well-being, decreased psychological distress, and decreased fatigue, measured by the Subjective Exercise Experiences Scale (SEES; McAuley and Courneya, 1994). Focht (2013) found similar results following an investigation into the affective responses to exercise in an overweight and obese female population (n = 23) when he compared 10 and 30 minutes of acute treadmill walking at a light-to-moderate intensity. Both walking protocols, regardless of duration, demonstrated equally significant improvement in affective responses both during and from baseline to 0 and/or 10 minutes post-exercise measurements compared to the quiet rest control. These included increased affective valence, perceived activation, revitalization, positive engagement and tranquility and decreased physical exhaustion, measured by the FS, the Felt Arousal Scale (FAS; Svebak and Murgatroyd, 1985), and the Exercise-induced Feeling Inventory (EFI; Gauvin and Rejeski, 1993), respectively. In two identical studies, researchers measured affective responses, using the SAI-Y in the first (Butki and Rudolph, 1997) and the SEES in the second (Rudolph and Butki, 1998), following 10, 15, and 20 minutes of moderate intensity treadmill running (equivalent to a 13 RPE rating) in 36 moderately active females. Results from both investigations indicated substantial reductions in state anxiety, specifically decreased psychological distress and increased positive well-being, regardless of duration. Similar results were found when 15 males, whose mood was assessed using the Mood Checklist Short-form 1 (MCL-S1; Nowlis, 1965), ran on a treadmill at self-selected intensities (estimated at 80% HRmax) in two acute bouts of 10 and 15 minutes (Nabetani and Tokunaga, 2001). Both durations produced similar positive effects with regard to psychological mood, specifically increased pleasantness, increased relaxation, and decreased anxiety. A meta-analysis on the anti-anxiety effects of exercise examined acute bouts of 0-20 minutes, 21-30 minutes, 31-40 minutes, and 40 minutes or more in duration and concluded that there was no observable difference for time (Petruzzello, et al., 1991). The researchers summarized their findings by stating that the antianxiety effects of activity are elicited from acute bouts of exercise, regardless of their duration (Petruzzello, et al., 1991).

Conversely, other researchers have suggested that shorter durations are better than longer durations (Blanchard and Rodgers, 1998; Hansen, et al., 2001). Blanchard and Rodgers (1998) compared the mood states, measured by the EFI, of 69 female runners assigned to either an acute bout of running on an indoor track for 25 or 40 minutes at 70% HHR or a 10 minute context control group. Results indicated that the 25 minute bout of exercise produced significantly greater positive affective changes and increased positive well-being compared to the 40 minute bout. Similar results were reported by Rudolph, et al. (1998) when 40 moderately active participants completed each of three conditions: treadmill running for 10 and 20 minutes at a moderate intensity, measured by RPE, and a 20 minute rest control. While significant reductions in state anxiety, measured by the State Anxiety Inventory-Form Y (SAI-Y; Spielberger, Gorsuch, Lushene, Vagg, and Jacobs, 1983), were found following both duration exercise bouts compared to the control group, the shorter of two exercise durations, 10 minutes, produced greater reductions than did the longer of the two bouts, 20 minutes. In another study, 14 females completed each of four conditions: cycling for 10, 20, and 30 minutes at 60% of their estimated VO_{2max}, and a 30 minute quiet rest control (Hansen, et al., 2001). Contrary to the investigators' hypothesis, the longer durations did not produce significant improvements in measured psychological markers beyond those seen for the 10 minute condition, measured by the Profile of Mood States (POMS; McNair, Lorr, and Droppleman, 1971; 1992).

Although exceptionally short durations as short as 4 minutes have produced positive antianxiety responses (Thayer, 1987; Thayer, Peters, Takahashi, and Birkhead-Flight, 1993), most investigators have benchmarked the lower end of the duration dose-response spectrum at 10 minutes (Hardman, 2001). This was almost certainly done in an effort to remain consistent with the most current physical activity recommendations which suggest that activity can be performed in durations as short as 10 minutes (Haskell, et al., 2007; Nelson, et al., 2007; Pate, et al., 1995; USDHHS, 2008). At this dose, multiple studies have provided evidence indicating that shorter bouts of acute activity, as short as 10 minutes, can produce psychological health benefits (Butki and Rudolph, 1997; Ekkekakis, et al., 2000; Focht, 2013, 2009; Hansen, et al., 2001; Nabetani and Tokunaga, 2001; Rudolph and Butki, 1998; Van Landuyt, et al., 1998). These benefits include increased positive well-being, positive affect, and arousal as well as decreased tension, psychological distress, and negative affect.

Duration Fractionalization: Accumulation of Multiple Discontinuous Bouts

The most recent meta-analysis investigating acute aerobic exercise on positive affect, specifically affective valence and activation, provides support for all durations up to 60 minutes, beyond which reductions in positive activated affect are reported (Reed and Ones, 2006). The authors note that the largest effects were seen for durations between 30 and 35 minutes. These conclusions provide further evidence against the previously suggested 'duration threshold' and provide supporting evidence for the effectiveness of acute activity of short durations in alleviating anxiety. However, while multiple investigations have examined the psychological effects of acute bouts of exercise by comparing a short bout of activity with that of longer duration of the same intensity, these comparisons have always been between two different total durations, 15 versus 30 minutes for example. Despite the urging of Reed and Ones (2006), who stated that investigating the changes associated with repeated bouts of acute exercise is a very important unanswered question in the literature, to date, there have been no investigations directly comparing the antianxiety and affective responses following an acute bout of duration fractionalized activity with that of a continuous bout of equal duration. Duration fractionalization is the division of a single continuous bout of exercise into multiple discontinuous sessions of exercise whose total duration equals that of the continuous bout (Kesaniemi, et al., 2001). The accumulation of multiple shorter bouts throughout the day has been stated as a plausible method of obtaining the recommended dose of exercise in the current physical activity recommendations (Haskell, et al 2007; Nelson, et al 2007, Pate, et al., 1995; USDHHS, 2008). However, there have been relatively few investigations into duration fractionalization.

The current research suggests that "several short (≥ 10 min) exercise sessions per day at the same intensity…appear generally as effective as a single session of the same total duration" (Kesaniemi, et al., 2001). However, a recent review of literature comparing the health benefits of continuous versus accumulated exercise has suggested that "the empirical evidence to support splitting a continuous bout of activity into several shorter bouts is not extensive or unequivocal" (Murphy, Blair, and Murtagh, 2009, p. 36). The vast majority of the fractionalization investigations have examined the effects of the different duration patterns on physical health outcomes, such as cardiorespiratory improvements, body fat percentage, excess post-exercise oxygen consumption, and blood lipid profiles, rather than psychological health outcomes, such as anxiety (Garber, et al., 2011). Additionally, all of the investigations that have included psychological outcomes when comparing the effects of accumulated discontinuous activity versus continuous activity have investigated chronic rather than acute effects.

The few studies that have investigated duration fractionalization and included psychological well-being as one of the outcome variables have all been longitudinal and each as produced conflicting results. Schachter, Busch, Peloso, and Sheppard (2003) state that they measured psychological well-being, specifically affect, using the Arthritis Impact Measurement Scale (AIMS2) in their 16 week study in which 143 sedentary women with fibromyalgia were randomly assigned to one of three conditions: continuous bouts (30 min/day) or fractionalized bouts (2 x 15 min/day) of low-impact aerobics 3-5 days per week or the no exercise control group. Results of the investigation showed that, among those who adhered to the exercise protocol, improvements in psychological well-being were seen in the continuous exercise group only. Conversely, in a cross-over study design, Murphy, Nevill, Neville, Biddle, and Hardman (2002) found that when 21 participants walked 5 days/week for 6 weeks, both the continuous walks (30 min/day) and fractionalized walks (3 x 10 min/day) produced similar decreases in tension/anxiety measured by the POMS. Contrariwise, Osei-Tutu and Campagna (2005) found that fractionalized walking (3 x 10 min/day) for 8 weeks was more effective than the continuous walking (30 min/day) and the non-exercise control conditions in reducing total mood disturbance and tension-anxiety measured by the POMS among the 40 sedentary participants. There are multiple limitations to these studies when extrapolating their results to the discussion of the anti-anxiety effects of duration fractionalization. Primarily, all of the studies are training studies; no literature was found investigating the psychological effects of accumulated versus continuous bouts of acute exercise. Additionally, none of the aforementioned studies used measurement indexes which specifically measured anxiety or affect, such as the STAI, PANAS, EFI, or AD ACL.

These longitudinal studies are only included in this discussion because, as previously stated, to date there has been no investigation into the psychological effects of acute bouts of duration fractionalized activity. The 2011ACSM Position Stand states that, “the evidence comparing the effectiveness of long versus short bouts of exercise for improving…mental health is meager and inconclusive” (Garber, et al., 2011, p. 1339). Therefore, systematic investigation into the psychological effect of the accumulation (duration fractionalization) of acute bouts of activity is warranted, as there is “a dearth of research comparing the short-term effects of moderate-intensity exercise performed in a continuous and accumulated pattern” (Murphy, et al., 2009, p 41).

Intensity

The majority of the literature examining the effects of physical activity on psychological health focuses on the intensity dose-response relationship (Barabasz, 1991; Blanchard, Rodgers, Spence, and Courneya, 2001; Cox, Thomas, Hinton, and Donahue, 2006; Osei-Tutu and Campagna, 2005). Much like the notion of the ‘20 minute duration threshold,’ previous researchers have suggested that exercise must be performed at or above the ‘moderate-to-intense or vigorous intensity threshold’ (set between 60-70% VO_{2max}) to experience the psychological benefits of physical activity (Dishman, 1986; Raglin and Morgan, 1985). Therefore, much of the literature concerning the effects of exercise on psychological well-being reflects this intensity threshold (Cox, et al., 2004, 2006; Daley and Huffen, 2003; Daley and Welch, 2003; Tate and Petruzzello, 1995). Conversely, other research has investigated the exact opposite, suggesting that if the goal of the bout of exercise is to enhance psychological states, including reducing anxiety and increasing positive affect, lower intensity levels not only suffice but are preferable (Ekkekakis, et al., 2000; Ekkekakis, et al., 2008; Hall, et al., 2002; Lind, Ekkekakis, and Vazou, 2008; Parfitt, et al., 2006; Steptoe and Bolton, 1988; Steptoe and Cox, 1988).

Multiple studies have found reductions in anxiety following acute bouts of exercise performed at high intensities. Tate and Petruzzello (1995) examined the effect of two acute bouts of cycling for 30 minutes at intensity levels of 55% and 70% VO_{2max} in 20 male and female participants on state anxiety and affect. Measurements were taken pre, during, and up to 30 minutes post exercise using the STAI and the Activation-Deactivation Adjective Check List (AD ACL; Thayer, 1989). The high intensity bout proved to be more beneficial in mediating negative psychological states, as significant reductions in state anxiety post exercise were produced only following the 70%VO_{2max} bout. Additionally, positive affective responses, specifically increased feelings of energetic arousal, were experienced for a longer duration post exercise cessation following the high intensity exercise versus the moderate intensity condition. In a more recent investigation into the effect of high intensity exercise on state anxiety, anxiety levels were measured by the STAI at baseline and up to 90 minutes post exercise cessation in 24 active women who were randomly assigned into one of three groups: 33 minutes of treadmill running at either 60 or 80% VO_{2max} or a sedentary control group (Cox, et al., 2004). Although both intensity doses induced significant reductions in state anxiety compared to the control group, the higher intensity bout produced significantly lower state anxiety levels than did the moderate intensity bout. However, differences were observed between intensity groups during the four measurements taken post exercise. The high intensity group reported the greatest reductions in state anxiety between 5 and 30 minutes post exercise; only the moderate intensity group experienced anxiety reductions between 30 and 60 minutes post exercise; and at 90 minutes post exercise, the high intensity condition again produced greater reductions in state anxiety.

Other investigations have produced evidence suggesting that the intensity of the bout has no effect on the post-exercise antianxiety effect of exercise. The results of a study conducted by Bixby, Spalding, and Hatield (2001) indicated undifferentiated significant reductions in anxiety following 30 minutes of recumbent cycling at both high (ventilatory breakpoint) and low (75% of the ventilatory breakpoint) intensity in 32 high and low fit participants. Levels of anxiety, measured by the SAI, were taken at baseline, at the initiation of exercise, at 10, 20, and 30 minutes during, and at 10, 20, and 30 minutes post-exercise. Similar results were reported by Raglin and Wilson (1996) when fifteen, healthy male and female participants cycled at three intensities (40, 60, and 70% of VO_{2peak}) for 20 minutes. Analysis of anxiety levels, measured by the STAI-Y1, taken before and 5, 60 and 120 minutes post-exercise, produced equal reductions in state anxiety following all three bouts of exercise regardless of intensity, although it was noted that the effect was delayed immediately following the high intensity condition.

Conversely, many researchers have made the case for the effectiveness of intensities below the moderate-to-vigorous intensity threshold. These researchers have shown positive results following an acute bout of low intensity activity as well as negative effects during or following an acute bout of high intensity activity. An early study exploring the effect of intensity on anxiety during acute aerobic exercise used an adaption of the POMS and the trait subscale of the STAI to measure the psychological states of 32 fit and unfit females immediately before and following four 8 minute bouts of cycling, two bouts of high intensity (100 W) and two bouts of low intensity (25 W) cycling (accompanied by either music or metronome) (Steptoe and Cox, 1988). Researchers found that only the low intensity sessions resulted in positive improvements in psychological responses of vigor and exhilaration, while the high intensity sessions produced significantly increased negative psychological responses, specifically tension and anxiety. A review of the literature, performed by two of the leaders in the field of exercise psychology, indicated that exercise performed at intensities as low as 30% of VO_{2max} has produced reductions in state anxiety (Ekkekakis and Petruzzello, 1999). A more recent study supporting the effect of lower intensity activity on anxiety was performed by Blacklock, Rhodes, Blanchard, and Gaul (2010). Both low and moderate intensity cycling (30-35 and 60-65 % HRR, respectively) produced similar reductions in anxiety, measured by the SAI-Y1, in 50 female participants. Similar results were found by Blanchard, Rodgers, Spence, and Courneya (2001) when comparing acute bouts of 30 minutes of cycling at moderate and high intensities (50 and 80% of age-predicted MHR, respectively) in 24 fit and unfit females. Although both intensities did increase positive well-being, the effects were significantly greater following the moderate intensity bout. Additionally, although there was no change in psychological distress following the moderate intensity bout, psychological distress was greater post-exercise compared to baseline levels following the higher intensity bout. Likewise, in a study of 21 females who cycled for 10 minutes across three intensities (40, 60, and 75% VO_{2max}), Oweis and Spinks (2001) reported that the higher intensities resulted in increased negative affect post-exercise, measured by the AD ACL short form (Thayer, 1989) and the FS.

The most current review of literature concerning the dose-response relationship between exercise intensity and affect suggests that an inverse relationship exists, such that as intensity increases, positive affect decreases during and immediately following the cessation of the exercise (Ekkekakis, et al., 2011). The researchers state that "there are pleasant changes at sub-threshold intensities for most individuals, large inter-individual variability close to the ventilatory or lactate threshold, and homogeneously negative changes at supra-threshold intensities" (p. 642). Furthermore, a recent meta-analysis on positive activated affect following acute bouts of aerobic exercise concluded that, when compared to high intensity (60-85% VO_2 reserve) and moderate intensity (40-59% VO_2 reserve), lower intensity exercise bouts (15-39% VO_2 reserve) produced almost twice the effect size (Reed and Ones, 2006)

Mode

Various exercise modalities have been shown to elicit a positive effect on anxiety and affective states. Although the effectiveness of anaerobic modalities is still ambiguous, the current literature almost unanimously provides support for the effectiveness of aerobic modalities. However, despite all of the aforementioned evidentiary support, to date, one specific mode of aerobic exercise has not been seen as markedly superior to others in mediating the effects of anxiety (Campbell and Hausenblas, 2009; Petruzzello, et al, 1991; Yeung, 1996). However, multiple justifications exist to support walking as the "preferred" mode of exercise in the reduction of anxiety (Ekkekakis and Petruzzello, 1999).

Walking for the Treatment of Anxiety

According to a review by Morris and Hardman (1997), "walking is the most common weight bearing activity…the most natural activity and the only sustained dynamic aerobic exercise that is common to everyone…and, having low ground impact, is inherently safe…and the main option for increasing physical activity in sedentary populations" (p. 307). Walking is considered a suitable activity for both active and sedentary populations. Research has shown that those who suffer from anxiety disorders are usually sedentary or low fit individuals (Sareen, et al., 2006) as they often suffer from other comorbid disorders (arthritis, cardiac disease, and pulmonary diseases such as asthma) which may prevent them from engaging in moderate-to-high intensity exercise (Katon, Lin, and Kroenke, 2007). Additionally, the most current physical activity recommendations for the general population encourage regular engagement in short duration, relatively low-to-moderate intensity activities (Garber., et al., 2011; USDHHS, 2008), such as walking, which is the most popular mode of physical activity among American adults (Ekkekakis, et al., 2008; Simpson, et al, 2003). However, it has been said that walking is often overlooked and underappreciated as exercise and that, "specifically with respect to affective outcomes, the lack of appreciation for the potential benefits associated with walking seems to be pervasive among researchers. This can be attributed to…the absence of methodologically sound studies examining low intensity and short duration exercise stimuli" (Ekkekakis and Petruzzello, 1999, p. 349).

Additionally, while walking is usually performed at a moderate intensity, it "…can be effective at relatively low intensity" (Morris and Hardman, 1997, p. 322). The ACSM has stated that intensity is "the most important exercise prescription variable" (ACSM, 2006, p. 161), in that moderate intensity exercise is associated with increased exercise adherence as well as a lower frequency of cardiovascular incidences and musculoskeletal injuries. A leader in the exercise psychology literature has stated that when examining affective responses following bouts of exercise, intensity should be considered a key moderator (Ekkekakis, 2003). The moderate intensity level of walking implies that this mode is less likely to induce negative affective responses experienced during exercise as opposed to higher intensity exercise modes (Bixby, Spalding, and Hatield, 2001; Ekkekakis and Petruzzello, 1999). If negative affective responses are induced during the exercise bout, according to Hall, et al. (2002), these during-exercise negative effects may be mentally paired with engaging in physical activity and possibly prevent future participation in such activity. Thus, the positive affective response to lower intensity exercises, such as walking, promotes enjoyment and thereby adherence, as “people participate in programs they enjoy” and “the lower intensity effort makes the programs more enjoyable” (Pollock, 1978, p. 59). Finally, and most importantly, as previously stated, lower intensity exercise appears to produce the greatest positive results in altering anxiety and affective states and is more generalizable than moderate and high intensity exercise (Reed and Ones, 2006).

Despite the aforementioned justifications for studying walking for the treatment of anxiety, the most frequently chosen modes in the literature concerning the acute effects of exercise have been running and cycling. However, several studies have provided evidence of improvements in anxiety and affective responses following both low and moderate intensity walking. As previously mentioned, results from the investigation completed by Focht (2013) indicated that both 10 and 30 minute walks a light-to-moderate intensity produced significant improvement in affective responses, specifically increased affective valence, perceived activation, revitalization, positive engagement and tranquility and decreased physical exhaustion from baseline levels to those recorded during, immediately post, and/or 10 minutes post-exercise. In a previous study performed by the same investigator, positive affective responses were reported by 35 active women following two 10 minute walks at self-selected intensities, one in a laboratory and one in an outdoor environment (Focht, 2009). Affective measurements, taken using the FS, the FAS, and the EFI, pre, during, and at 0 and 10 minutes post-exercise, showed significant increases in affective valence, perceived activation, revitalization, and positive engagement and significantly decreased physical exhaustion both during and following the 10 minute walk, while no changes were reported for tranquility. Similar results were found by Kopp, et al. (2012) when the psychological well-being of 16 diabetic patients was measured before, during (5, 10, 15, and 20 minutes), and at multiple time points (5, 10, 15, 20, and 180 minutes) following 20 minutes of brisk paced walking and a 20 minute control (sitting with the option of reading). Results of the comparative investigation showed significant improvements in psychological well-being, measured by the FAS, FS, and the AD ACL, from baseline to post-exercise responses following the brisk walk as compared with the control. Specifically, 5 minutes after the walk, energetic arousal was increased; at 15 and 20 minutes post-exercise, feeling states were increased; and arousal was elevated above baseline levels at all five time points following the walk. Similarly, Ekkekakis, et al. (2000) completed a series of four studies, two in a natural environment versus two in a laboratory environment, investigating the effect of short bouts of walking (10-15 minutes) on affect using a different combination of psychometric assessments (SAI, FS, FAS, PANAS, and AD ACL) during each study. In each of the four studies, the researchers determined that the short bouts of walking, at self-selected paces (14-22% of age predicted HR reserve), regardless of location, were associated with significant and substantial shifts towards higher activation, improved affective valence, and increased energetic arousal, compared to the sedentary controls. Following the positive response immediately post-exercise, affective states began to decline towards baseline levels by the 10 or 15 minute post-walk assessment time point. In a more recent study, Ekkekakis, et al. (2008) showed that a 15 minute brisk walk in a natural environment had little effect on affective responses when 12 older adults were assigned to complete either a15 minute brisk walk outdoors or 15 minutes of rest. Responses to the AD ACL, the FS, and the FAS were recorded pre, during (at minute 5, 10, 15), and following (5, 10, and 15 minutes post). Results of the walking condition indicated that there were no changes in affective valence or perceived activation post-exercise; energetic arousal was elevated at all three time points during the walk (including the measurement taken at 0 minutes post) but there were no significant changes measured post-walk; and participants experienced a slight increase in tense arousal 15 minutes post-exercise.

While multiple investigations have examined the effect of an acute bout of walking, the durations have generally been limited to between 10 and 20 minutes. The one aforementioned study that did investigate a longer duration walk (30 minutes) did so using only overweight, sedentary females, severely limiting the generalizability of the results. Furthermore, only affective responses were investigated while no assessments of anxiety were made. There have been no direct comparisons between the antianxiety and affective responses of multiple duration fractionalized bouts of walking with those of one continuous bout. Therefore, further investigation is necessary to compare the psychological effect following a continuous 30 minute moderate intensity bout of walking with those following multiple duration fractionalized bouts of walking.

Duration of Post-Exercise Response

In addition to investigating the effects short duration of walking, most investigations examining the anxiety-exercise relationship following acute bouts of walking only monitored post-exercise responses for a short duration, between 0 and 20 minutes, and the results are inconsistent (Focht, 2013; Ekkekakis, et al., 2000, 2008; Van Landuyt, et al., 1998). Williams and Raynor (2013) found no change in affect from pre to immediately post-exercise, when 29 low-active females completed two walking sessions. In the first session, participants walked 1/3 of a mile at a blinded, self-selected intensity; in the second session, they continuously walked for a mile (1/3 of a mile for each intensity) at three different intensities (a visible-self-selected, a yoked-self-selected intensity, and an intensity 20% higher than the yoked-intensity) in a counterbalanced order. Though the focus of the investigation was to examine the effect of differing intensities on affective valence, measured by the FS, results indicated no change in affect from pre to post-exercise following the acute bout of walking. Rose and Parfitt (2007) investigated the changes in affective responses in 19 females following 20 minutes of treadmill walking/running at four different intensities from pre to 0, 5, and 10 minutes post-exercise, with non-significant results immediately post and 10 minutes post-exercise. Despite the lack of significance at those two time points, results indicated significant increased perceived activation (arousal) 5 minutes following exercise, measured by the FAS. Furthermore, although the results of all four exercise intensities demonstrated a non-significant increase in affective valence (pleasure), measured by the FS, at 5 and 10 minutes post-exercise, only the two lower intensities produces similar results immediately post-exercise. Daley and Welch (2003) investigated the changes in the affective states of 16 active and inactive females following 20 minutes of treadmill walking/running at both moderate and high intensities. Results from pre to 5 minutes post-exercise showed significantly higher ratings of psychological well-being and significantly lower ratings of psychological distress, measured by the SEES. In a similar investigation, Dunn and McAuley (2000) investigated the affective responses, measured by the SEES and the EFI, of 42 sedentary female participants following 20 minutes of treadmill walking/running at both moderate and high intensities. Changes measured by the SEES were non-significant from pre to immediately post-exercise and significant from pre to 20 minutes post-exercise. Specifically, from pre to immediately post-exercise, non-significant increases in positive well-being were reported following both intensities but non-significant decreases in psychological distress and fatigue were reported following the moderate intensity only. However, from pre to 20 minutes post-exercise, participants reported significantly increased positive well-being as well as decreased psychological distress and fatigue. Additionally, measurements from the EFI indicated significantly increased positive engagement and revitalization and decreased exhaustion from pre to both 0 and 20 minutes post-exercise following the moderate intensity walking as well as significantly higher levels of positive engagement and revitalization at 20 minutes post-exercise following the high intensity running. Finally, although not significant, pre to post-levels of tranquility also showed a positive trend at both post-exercise time points following both intensities.

A handful of investigations have measured the duration of post-exercise responses beyond the 20 minute mark. Parfitt, et al. (2006) compared pre and post-exercise affective responses following 20 minutes of treadmill walking/running at three different intensities, using the FS and FAS, at 10, 20, and 30 minutes post-exercise. Results indicated that the 12 sedentary males experienced significant increases in affective valence (pleasure) from baseline to all three post-exercise time points and increased perceived activation (arousal) until 10 minutes post-exercise. These results suggest that the time course of the psychological responses following acute bouts of walking may extend to 30 minutes post-exercise. Cox, Thomas, and Davis (2000, 2001) extended the post-exercise investigation time to 60 minutes following an acute bout of activity. Specifically, 24 male participants, who regularly participated in vigorous physical activity, completed 30 minutes of either treadmill walking/running or stationary stepping at either a moderate or high intensity. Antianxiety and affective responses were measured pre and at 5, 30, and 60 minutes post-exercise using the SAI and SEES, respectively. The results of the study were broken into two publications based on the two psychometric instruments used to measure psychological changes, specifically, SAI (2000) and the SEES (2001). Analysis of the changes in anxiety following the acute bout of activity showed a statistically significant reduction in state anxiety from baseline at both 30 and 60 minutes post-exercise (Cox, et al., 2000). However, due to the lack of a statistically significant reduction at 5 minutes post-exercise, the researchers stated that "the reduction in SAI, late in recovery, illustrates the delayed anxiolytic effect" (p. 63). In the second publication, analysis of the changes in affective responses following the activities displayed a significant linear trend from baseline to each post-exercise measurement time point for all three subscales of the SEES (Cox, et al., 2001). However, only ratings of psychological distress were significantly less than baseline responses at all three time points post-exercise, while ratings of positive well-being were only significantly higher than baseline at 5 and 60 minutes post-exercise, and ratings of fatigue were only significantly lower than baseline at 60 minutes post-exercise.

Although these studies provide greater insight into the "delayed anxiolytic effects" of exercise following an acute bout of activity by extending the literature regarding the post-exercise effect beyond the more commonly used 20 minute time point, many methodological issues exist. As there are many different aspects of affect, the psychometric instruments utilized in the aforementioned studies, although effective at capturing their respective facets of affect, may not have provided the fullest picture of the affective changes. Absent from the literature are extended post-exercise measurements of key factors of affect including positive and negative affect (measured by the PANAS); positive engagement, revitalization, tranquility, and physical exhaustion (measured by the EFI); and energetic arousal and tense arousal (measured by the AD

ACL). Additionally, only male participants were included in both studies (Cox, et al., 2000, 2001; Parfitt, et al., 2006) and only those who met the current vigorous activity guidelines (participation in 30-60 minutes of vigorous activity three times per week) were included in the investigation completed by Cox, et al. (2000, 2001). These factors limit the generalizability of the results of these investigations to high-fit males. Additionally, the results of Cox, et al. (2000, 2001) suffer further generalizability issues as the 24 participants were randomly assigned to either mode of exercise and either intensity. Therefore, the duration of the post-exercise responses following moderate intensity treadmill exercises were only measured in 6 subjects, a very small sample size.

Other investigations have measured responses beyond the 60 minute post-exercise time point following both walking and cycling (Daley and Welch, 2004; Kopp, et al., 2012; Raglin and Wilson, 1996). However, in each of these studies, measurements were taken after the participants had departed the laboratory and had returned to their daily routines. Although this information is exceptionally generalizable, it is possible that any number of confounding factors could have altered their antianxiety and affective responses at the later measurement time points. The absence of control causes these investigations to lack the systematic investigation necessary to truly isolate the duration of the post-exercise effects of an acute bout of exercise on psychological responses. Therefore, these investigations will not be discussed in this review of literature.

Reed and Ones (2006) summarized the results of their meta-analysis by stating that the post-exercise affective effects immediately increase and then progressively decline over time, lasting up to 30 minutes. Despite the omission of the three aforementioned studies (Cox, et al., 2000, 2001; Parfitt, et al., 2006) from the meta-analysis, their results do provide a bit more detail regarding the time course of the antianxiety and affective responses post-exercise. However, more comprehensive and systematic analyses are warranted. Specifically, the literature is lacking information regarding the duration of antianxiety and affective responses post-exercise in healthy, moderately fit females and males following moderate intensity walking using both a dimensional and categorical or circumplex view of affect.

Moderating Variables

Research has suggested that the degree of change from pre to post-exercise may not depend solely on dose issues. Specifically, moderating variables may have an effect on the antianxiety and affective responses following acute bouts of exercise, further complicating the dose-response issue. Researchers have suggested that psychological responses may also be dependent upon complex interactions between the dose of exercise and modifying factors such as "…biological and psychological individual difference variables, the physical and social environment, the objective and perceived attributes of the exercise stimulus, and several psychological states…" (Van Landuyt, et al., 2000, p. 211). The literature investigating these individual differences purported to moderate the dose-response relationship and explain inconsistencies in the results of previous studies is growing. While some moderating variables, such as self-efficacy and baseline levels of affect, have been thoroughly investigated, others have received less attention. Previous research has suggested that the participant's fitness level (Ekkekakis and Petruzzello, 1999; Morgan, 1997; Petruzzello, Hall, and Ekkekakis, 2001; Reed and Ones, 2006), baseline level of anxiety (Gauvin and Brawley, 1993; Morgan, 1997; Yeung, 1996), and enjoyment of the exercise (Raedeke, 2007; Wankel, 1993) are each moderating variables that may affect the dose-response relationship. The previously mentioned meta-analysis, completed by Reed and Ones (2006), suggested that "such variables may account for a sizable portion of the true variance in post-exercise affective responses" (p. 499). While the inclusion of these important considerations have been examined in studies examining the antianxiety and affective responses involving other exercise modalities, these moderating variables have not yet been investigated during a study of acute bouts of walking.

Summary

Acute bouts of a variety of durations, intensities, and modes of exercise have been shown to induce positive psychological well-being, including reduced anxiety and improved affective responses. However, the dose-response research investigating the antianxiety and affective benefits of acute bouts of exercise is incomplete, as multiple dose-response issues remain unresolved. The current literature examining the dose-response issue of mode, specifically walking, for the reduction of anxiety and mediation of affective response is limited and has almost exclusively been limited to durations of 20 minutes or less. Additionally, to date, no investigation has directly compared the acute effects of exercise duration fractionalization to one continuous bout. Similarly, no study has yet included the analysis of moderating variables, specifically fitness level, baseline levels of anxiety, and enjoyment of exercise, when investigating acute bouts of walking to examine if their presence has an effect on the antianxiety and affective responses following exercise. Finally, the time course of the antianxiety and affective responses post-exercise has not yet systematically been studied beyond 20 minutes.

CHAPTER 3

METHODS

Study Design

This study was a repeated measures cross-over design using healthy, regularly active, college-aged, men and women. The purpose of the proposed study was to comprehensively evaluate the dose-response relationship between an acute bout of moderate-intensity walking and the anxiolytic and affective responses. To investigate the 'dose' portion of the relationship, three exercise durations: 30, 10 and 5 minutes were examined. To investigate the 'response' portion of the relationship, the researchers systematically studied the time course of the anxiolytic and affective responses post-exercise. Volunteers reported anxiety and affective responses, measured comprehensively, prior to, and at multiple time points following participation in each of the three walking trials. Additionally, the effect of moderating variables, specifically a person's fitness level, level of trait anxiety, and enjoyment of activity, on the relationship between acute exercise and anxiolytic and affective responses were examined.

Participant Recruitment and Screening

A power analysis revealed that 20 subjects were necessary to detect a small effect of duration $d = 0.3$, assuming a correlation between the repeated measures of 0.9, $\alpha = 0.05$, and power ≈ 0.8 (Potvin and Schultz, 2000; Park and Schutz, 1999). Interested individuals were screened prior to any testing by completing multiple health screening questionnaires (see Appendix). Participants were asked if they have been diagnosed by a psychologist/psychiatrist with clinical anxiety and if they were taking any anti-anxiety medication. Those diagnosed with anxiety, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-V; APA, 2013), and those currently taking medication for the treatment of anxiety were not eligible to participate in the study.

Male and female college-aged students (19 – 29 years old) were recruited to participate in the proposed study. Subjects had to be healthy enough to participate in physical activity. They had to meet the public health recommendations for moderate physical activity (150 minutes of moderate physical activity per week) (Haskell, et al., 2007), but must not be participating in a regular vigorous exercise training program. This was confirmed by the screening questionnaire for potential healthy subjects (see Appendix). All participants completed two health questionnaires designed to screen for health risks before participation (see Appendix; Physical Activity Readiness Questionnaire (PAR-Q); Thomas, Reading, and Shephard, 1992; ACSM, 2010).

Sources for participant recruitment included a flyer describing the study posted on the multimedia television in Moore Hall, on display boards at the Student Recreation Center and the Ferguson student center, and on Facebook. In addition to the flyer, prospective participants were recruited via word of mouth around The University of Alabama and announcements made in Kinesiology classes. In order to ensure participant safety and compliance with study instructions, only individuals capable of communicating in English were allowed to participate in the proposed study.

Psychological Assessment

To measure both anxiety and affect, multiple paper-and-pencil psychometric assessments were utilized (see Appendix). As baseline levels of anxiety can influence the anxiety/affect-exercise relationship (Gauvin and Brawley, 1993; Morgan, 1997; Yeung, 1996), the State-Trait

Anxiety Inventory (STAI; Spielberger, et al., 1983) was administered. The STAI is both the most highly regarded and the most extensively used instrument when assessing changes in anxiety associated with acute bouts of physical activity (Ekkekakis, Hall, and Petruzzello, 1999). This 40-item instrument asks participants to rate their current feelings on a 4-point Likert-type scale; the sum of all responses produces a total score. Higher scores are associated with greater trait and state anxiety; lower scores are associated with lesser trait and state anxiety. The test-retest reliability of the STAI was found to be a correlation of 0.86 for the Trait section and 0.54 for the State section (Spielberger, et al., 1970). Results of the STAI allowed for the measurement of each participant's level of non-clinical trait anxiety. Unlike the other psychological assessments of this study, the STAI was completed only once, during each participant's initial visit to the exercise physiology laboratory.

To get a complete view of the antianxiety and affective changes experienced following acute bouts of walking, the following assessments were administered prior to the initiation of exercise, immediately following the cessation of exercise, and at 20 and 40 minutes post-exercise. In order to measure state anxiety both pre- and post-exercise, the single item Anxiety Likert Scale (ALS) of current anxiety, which has a 0.78 correlation with the STAI (Davey, Barratt, Butow, and Deeks, 2007) was used. The ALS allowed participants to quickly assess their current level of anxiety by responding to a single item. The ALS asks participants to assess how much anxiety they feel at that moment in time according to a Likert scale ranging from 1 to 5 (1 = not anxious at all, 2 = a little anxious, 3 = moderately anxious, 4 = very anxious, 5 = extremely anxious). Participants were provided with the following instructions: "Please circle the number that shows how anxious you feel at the moment." (Davey, et al., 2007, p. 357). A score of 1 is indicative of low anxiety while a score of 5 is indicative of high anxiety.

As previously mentioned, anxiety is often associated with disturbances in affect, which includes two uncorrelated and independent bipolar dimensions: positive affect and negative affect. More specifically, anxiety is often distinguished by low positive affect (feelings of sadness and lethargy) and high negative affect (feelings of distress and tension) (Tellegen, 1985). To assess changes in both positive and negative affect, the Positive Affect and Negative Affect Schedule (PANAS; Watson, et al., 1988) was utilized. The PANAS is a 20-item scale that asks participants to indicate to what extent they are feeling each of the items listed on the index at the present moment. Responses are based on a Likert scale of 1 to 5 (1 = very slightly/not at all; 3 = moderately; 5 = extremely). Ten of the words correspond to positive affective feelings and emotions (such as excited, enthusiastic, and interested) while the other 10 words correspond to negative affective feelings and emotions (such as irritable, nervous, and scared) allowing for the measurement of both dimensions of affect. Previous research established the reliability of the PA and NA scales reporting Cronbach's alphas ranging from 0.86 to 0.90 and 0.84 to 0.87, respectively, and a -0.09 correlation between the two scales (Watson, et al., 1988). Additionally, the PANAS has previously shown "excellent convergent and discriminant correlations with lengthier measures of the underlying mood factors" (Watson, et al., 1988, p. 1069).

Furthermore, to obtain the fullest picture of the exercise-affect relationship, the Exercise-Induced Feeling Inventory (EFI; Gauvin and Rejeski, 1993) was administered. The 12-item EFI is a multidimensional, bipolar scale measuring four categorical and discrete affective feeling states including positive engagement, revitalization, tranquility, and physical exhaustion. Participants are asked to respond to words (e.g. happy, refreshed, relaxed, worn-out) based on how they feel at that moment in time using a 5-point Likert scale (0 = do not feel; 2 = feel moderately; 4 = feel very strongly). Summing the participant's responses to the three adjectives per category illustrate the four EFI subscales measured. The validity and reliability of the EFI have been previously established (Gauvin and Rejeski, 1993; Gauvin, Rejeski, and Norris, 1996). There has been debate as to whether or not this index casts a net wide enough to capture the wide range of affective states experienced among different populations (Ekkekakis and Petruzzello, 2001). However, as the developers of the EFI designed it to be used for the assessment of the feeling states associated with acute bouts of physical activity of "men and women who exercise with some regularity" (Gauvin and Rejeski, 1993, p. 419), as opposed to other populations. Therefore use with the population of this study was appropriate.

Recent literature (Ekkekakis and Petruzzello, 2002) suggested that to fully measure affective changes in response to acute bouts of physical activity, researchers must include indices which assess the orthogonal, dimensional aspects of the affect circumplex, specifically, affective valence and activation. Therefore, both of these basic, core affective emotional responses were assessed using the Feelings Scale (FS; Hardy and Rejeski, 1989) and the Felt Arousal Scale (FAS; Svebak and Murgatroyd, 1985).

The FS is a single item measure of affective valence (pleasure and displeasure) which asks participants to assess their feeling of pleasure-displeasure at that moment in time according to an 11-point bipolar format, ranging from +5 to -5. Verbal anchors are provided at each odd integer and 0; -5 = very bad, -3 = bad, -1 = fairly bad, 0 = neutral, +1 = fairly good, +3 = good, and +5 = very good. Previous analysis of the FS conducted by Van Landuyt, et al. (2000) resulted in correlations ranging from 0.51 to 0.88 with the valence scales of the Self-Assessment Manikin (Lang, 1980) and from 0.41 to 0.59 with the valence scale of the Affect Grid (Russell, Weiss, and Mendelsohn, 1989).

Similarly, the FAS is a single-item index measuring perceived activation or arousal. The FAS asks participants to assess how aroused they feel at that moment in time according to a 6-point bipolar Likert format, ranging from 1 to 6. A score of 1 is indicative of low arousal (including feelings of relaxation, calmness or boredom) while a score of 6 is indicative of high arousal (including feelings of excitement, anxiety or anger). Again, Van Landuyt, et al. (2000) provided validation of the FAS when correlations ranged from 0.45 to 0.70 with the arousal scale of the Self Assessment Manikin (Lang, 1980) and from 0.47 to 0.65 with the arousal scale of the Affect Grid (Russell, et al., 1989).

To complete the measurement of the dimensional aspects of affect, the Activation-Deactivation Adjective Check List (AD ACL; Thayer; 1967) was administered. This 20-item scale measures the bipolar dimensions of arousal states, including energetic arousal and tension arousal. Adjectives are measured on a 4-point Likert scale (1 = definitely do not feel; 2 = cannot decide; 3 = feel slightly; and 4 = definitely feel). When the scores of the adjectives indicating high energetic arousal are summed, the participant is said to be experiencing active and energetic feelings; low energetic arousal scores are indicative of sleepy and drowsy feelings; high tense arousal scores are indicative of intense and jittery feelings; and low tense arousal scores are indicative of calm and placid feelings. The AD ACL has undergone extensive reliability testing, resulting in Cronbach's alphas higher than 0.80, showing internal consistency among the scales (Ekkekakis, et al., 1999, Ekkekakis, et al., 2000).

Finally, the preference for engaging in an activity has been suggested as a confounding factor in affective changes following an acute bout of exercise (Raedeke, 2007). Therefore, in order to determine the extent to which a participant enjoys engaging in the physical activity, the Physical Activity Enjoyment Scale (PAES; Kendzierski and DeCarlo, 1991) was completed following each bout of walking. Biddle and Mutrie (2008) have stated that the PAES is the only scale available to assess enjoyment of physical activity, and the validity and reliability of the scale were previously established by Kendzierski and DeCarlo (1991).

This index asks participants to rate how they feel about the physical activity they were just doing based on 18 bipolar statements. Responses are based on a 7-point Likert scale. Statements range from “I like it,” “I find it energizing,” and “It’s very exhilarating” to “I hate it,” “I find it tiring,” and “It’s not at all exhilarating.” Scores are determined by summing the responses, accounting for reverse scoring of some items. The lower the total score, the more enjoyment the participant experienced from the activity and vice versa. The psychological assessments and measured constructs are summarized in Table 3.1.

Table 3.1: *Constructs Measured by Psychological Assessments*

Psychometric Assessment	STAI	ALS	PANAS	EFI	FS	FAS	AD ACL	PAES
Construct(s) Measured	uni-dimensional measure of trait anxiety	current level of anxiety	positive affect; negative affect	positive engagement; revitalization; tranquility; physical exhaustion	affective valence (pleasure & displeasure)	perceived activation (arousal)	energetic arousal; tense arousal	enjoyment of engaging in physical activity

Physiological Assessment

Participants came to the exercise physiology laboratory on two separate occasions. On the first visit, participants provided written informed consent by reading and signing the informed consent document approved by the University’s Institutional Review Board (see Appendix). Each participant then completed the Physical Activity Readiness Questionnaire (PAR-Q; Thomas, et al., 1992; ACSM, 2010), a medical history questionnaire, and a physical activity history questionnaire (see Appendices for each) to determine if they met the inclusion criteria.

Upon providing informed consent and meeting the inclusion criteria for participation in the study, participants were given the opportunity to ask any questions pertaining to both the study design and their participation in the study. Once it was confirmed that the participants met the inclusion criteria for participation in the study, they provided informed consent, and all questions were answered, participants completed a 24-hour history and the STAI. Upon completion of the psychological assessment, height, weight, body mass index (BMI), and body fat percentage, were measured. Height was assessed to the nearest tenth of a cm and weight was assessed to the nearest tenth of a kg using a digital scale (BWB-800, Tanita Corporation, Tokyo, Japan). BMI was calculated by dividing weight in kilograms by height in meters squared ($kg \cdot m^{-2}$). Body fat assessments were estimated using the Jackson and Pollack 3-site skin fold algorithm (chest, abdomen, and thigh for men; triceps, suprailiac, and thigh for women) (Jackson and Pollack, 1978) using Lange Skinfold Calipers (Beta Technology Incorporated, Cambridge, Maryland). The resting heart rate of participants was assessed through the palpation of the radial artery, and their resting blood pressure was assessed using auscultation of the brachial artery.

Once the descriptive measurements were taken, physiological assessments were conducted. Each participant performed a warm-up and then completed a graded exercise test. The graded exercise test measured maximal aerobic capacity ($\dot{V}O_{2max}$; mL/kg/min). The graded treadmill exercise test is one of the most utilized methods for determining $\dot{V}O_{2max}$ (ACSM, 2014). The results of the test allowed for the precise determination of each participant's fitness level. Additionally, the results of the $\dot{V}O_{2max}$ test allowed each participant's walking intensity to be based on their metabolic profile. This more precise determination of intensity ensured the physiological equivalency of the exercise intensity between participants (Ekkekakis, 2003).

In order to complete the warm-up and the maximal $\dot{V}O_2$ test, the participant were fitted with a mouthpiece which was connected to the metabolic cart. During the exercise, oxygen uptake was measured, expired gases were sampled and data were recorded every 15 seconds by open-circuit spirometry using a metabolic gas analysis system (TrueOne 2400, Parvomedics, Sandy, UT). The metabolic cart was calibrated prior to each test using gases of known concentrations as per manufacture specifications. Calibration of the flow transducer was conducted using a 3.0 liter syringe. To ensure the proper functioning of the various components of the metabolic cart, prior to the start of each test, the participant rested for three minutes while breathing room air so that resting expired gases could be collected and analyzed. Once the investigators were assured of the functioning of the metabolic cart, measurement of $\dot{V}O_2$ began.

Prior to initiation of the test, the exact procedures of the test were explained to each participant. They were familiarized with the Rating of Perceived Exertion scale (RPE; Borg, 1998) and walking on the motorized treadmill. The participant were then fitted with a wireless Polar heart rate monitor (Polar, Stamford, CT) allowing for continuous monitoring of heart rate (HR) during the test. Prior to the start of the test, participants completed a warm up by walking comfortably for 5-10 minutes at a 0% grade. During the warm up, the speed of the treadmill was gradually increased until each participant reached a $\dot{V}O_2$ corresponding to between 4 and 5 METs, or a moderate intensity, defined as an intensity greater than or equal to 3.0 METs and less than 6 METs (ACSM, 2014, p. 165).

In order to determine the necessary $\dot{V}O_2$ for each participant to exercise at this intensity, the investigators took the estimated resting $\dot{V}O_2 \approx 3.5$ mL/kg/min (which is equal to 1 MET) and multiplied it by the number of METs necessary to work in at the prescribed intensity range of the study (resting $\dot{V}O_2 \cdot 4$; resting $\dot{V}O_2 \cdot 5$) (ACSM, 2014). The speed and HR range for each participant were recorded when the necessary VO_2 was reached. The data obtained during the warm-up were used to determine the speed at which each participant completed the three experimental trials so that the exercise intensity of each walking session was precisely controlled at a moderate intensity (between 4 and 5 METs). The combination of the information obtained during the resting $\dot{V}O_2$ measurement and the warm-up was instrumental in equating the amount of work performed by each participant across both experimental trials, so that differences in the antianxiety and affective responses between exercise trials could be attributed to the different durations of exercise.

Upon completion of the warm-up, the graded exercise test began. The Bruce protocol (ACSM, 2014) was used during the graded treadmill exercise test, as it is the most commonly used protocol (Myers, et al., 2009) and it is considered suitable for physically active and younger individuals (ACSM, 2014), i.e., the participants of this study. In addition to continually monitoring each participant's HR, RPE was measured 10 seconds prior to each stage completion.

Participants exercised to volitional fatigue. A test was considered a maximal effort if one of the determinants of maximal effort was observed. These included a respiratory exchange ratio (RER) ≥ 1.1, a plateau in $\dot{V}O_2$ despite an increasing work rate; the achievement of age-predicted maximal HR, and/or an RPE between 17-19 with the appearance of participant exhaustion (ACSM, 2014). If there were any signs or symptoms of exercise intolerance, the test was stopped. Upon completion of the graded exercise test, participants were allowed to cool down by walking at the speed of their choice and 0% grade. The cool-down ended when each participant's HR returned to near pre-exercise, resting levels.

Upon completion of the cool-down, the investigator familiarized the participants with each of the psychological assessments that were used in the three trials. Before leaving the initial session, each participant was instructed to adhere to pre-exercise directives consistent with ACSM guidelines regarding ingestion of food, alcohol, caffeine, tobacco, adequate rest, and proper clothing (ACSM, 2014, p. 56). Participants were also asked to refrain from significant exercise prior to their participation in each trial.

Experimental Trials

Each participant completed three experimental conditions: a 30-minute trial, a 10-minute trial, and a 5-minute trial. All three conditions were performed on the same day with a minimum of two hours and a maximum of five hours in between each trial. The order of the three conditions was counterbalanced between participants. All three conditions required the participant to walk on a treadmill at a moderate intensity, between 4 and 5 METs (previously determined in the warm-up portion of the physiological assessment). Following each bout of walking, participants rested quietly for 40 minutes in the exercise physiology lab, only interacting with the investigators to report their psychological responses.

Prior to the start of and at 0, 20, and 40 minutes following each bout of walking, responses to the psychometric assessments, including the ALS, PANAS, EFI, FS, FAS, and AD ACL, were recorded. To prevent order effects, the order in which the psychometric instruments was administered was counterbalanced between each assessment time point; however, for each participant, the order was the same within each assessment time points (i.e. for each participant: the pre-assessment order was the same, the immediate post-order was the same, etc.) across the three trials.

All three experimental trials were completed on the same treadmill in the exercise physiology laboratory. Each session was completed individually to minimize the potential influence of group dynamics on psychological responses (Turner, Rejeski, and Brawley, 1997). Each session was separated by a minimum of 2 hours and a maximum of 5 hours. The time of day during which each of the experimental conditions was completed was standardized between participants; the first session took place between 6:00-11:00 am; the second session took place between 11:00 am-4:00 pm; and the third session took place between 4:00-8:00 pm.

Upon their arrival to the lab for all experimental conditions, participants reaffirmed their consent prior to the initiation of any exercise. Prior to the start of the first session, participants completed the 24-Hour history questionnaire. Additionally, prior to the start of the second and third exercise trials, participants completed a short survey (see Appendix: Pre-Session Questionnaire) of activities performed in their time outside of the lab. Once consent was reaffirmed and the survey was complete, participants completed the psychometric assessments, were fitted with a Polar HR monitor, and stepped onto the treadmill to begin the walking trial. As the speed necessary for each participant to exercise within the desired intensity range was determined during their initial visit, participants were not allowed to adjust the speed of the treadmill during the trials. Instead, the investigator ensured the comfort of the participant on the treadmill and adjusted the speed of the treadmill at the start of each walking trial.

Upon completion of each bout of walking, the psychometric assessments were administered at 0, 20, and 40 minutes. During the entirety of the three trials, there was minimal interaction between the investigator and the participants until the end of the final rest period. This limited interaction served to minimize the potential moderating effects of social interaction on the measured psychological responses (Turner, et al., 1997).

The procedures for each of the three experimental conditions were identical, with the exception of the duration of the walk, which was either 30-, 10- or 5- min. During the 30-min exercise session, once baseline assessments were recorded, participants were required to first walk at a moderate intensity for 30 min and then rest for 40 min following the walk. The investigator monitored each participant's HR every two min during the walk. Participants were asked to provide responses to the psychological assessments immediately following the last min of the walk by responding to an enlarged version of each assessment displayed in front of them. Following the recording of the final response, participants completed the PASE and were then escorted to a chair in the exercise physiology laboratory. Once seated, participants rested quietly for 40 min. During this time, participants were asked to refrain from any activity that may be anxiety-inducing. Participants were allowed to perform normal, daily tasks that did not require any physical activity or any social interaction (including: reading, studying, doing homework, and using their cell phones (i.e. playing games, using the internet, etc.). Participants were instructed not to engage in any social interactions (phone calls, texts, or emails) and not to use any social media (including but not limited to facebook, twitter, etc.) during the rest periods.

In order to track the time course of the antianxiety and affective responses post-exercise, the psychological assessments were administered and responses recorded at 20 and 40 min post-exercise. Upon completion of the final assessment, participants completed a short survey of activities performed during the rest session (see Appendix: Post-Exercise Rest Period Questionnaire) and were then free to go. The remaining exercise sessions (10- and 5- min) required participants to follow the exact same exercise and rest procedures, each with a shorter walking duration, one equal to 10 min and the other equal to 5 min, such that each of the three durations was completed by each participant.

Statistical Analysis

Data analysis was conducted using SPSS 21 for Windows. For each anxiety and affective variable measured, a separate 3 (condition: 30, 10, 5 min walk) × 4 (time: pre, I-post, 20-post; 40-post) within subjects repeated measures analyses of variance (ANOVAs) was performed. This allowed for the comparison of the three exercise durations as well as an examination of the duration of the anxiolytic and affective responses post-exercise. Additionally, each 3×4 ANOVA was repeated with the inclusion of each of the moderating variables, including: fitness level, baseline levels of anxiety, enjoyment of participation, and sex, as a between subject factor in order to examine if the moderating variable had an effect. All significance tests used an α level of 0.05.

CHAPTER 4

RESULTS

Thirty participants enrolled in the study; however, one participant discontinued participation before completing the walking trials because she was unable to complete the graded exercise test due to shin splints. The remaining twenty-nine participants (22 women) completed the study. All 29 participants completed every required exercise trial of the study as well as all psychometric assessments. Due to a malfunctioning treadmill, one participant completed his three experimental conditions in a different location from the other 28 participants. Although the secondary treadmill was located in a different area of the laboratory, all other conditions remained consistent. Participant descriptive data are shown in Table 4.1.

Table 4.1: *Participant Descriptive Data (Mean ± SD; n = 29)*

Characteristic	Women	Men	Both Sexes
Age (years)	21.1 ± 2.0	22.0 ± 1.0	21.4 ± 1.8
Height (cm)	166.1 ± 5.1	181.2 ± 4.6	169.8 ± 8.2
Weight (kg)	69.2 ± 12.1	76.8 ± 10.5	71.0 ± 12.0
Body Fat %	31.5 ± 6.0	16.2 ± 5.4	27.8 ± 8.8
Self-reported PA (min/week)	171.4 ± 61.3	180.7 ± 28.9	173.6 ± 54.9
$\dot{V}O_{2max}$ *(mL/kg/min)*	35.0 ± 4.8	45.8 ± 3.7	37.6 ± 6.5
Walking Intensity (%$\dot{V}O_{2max}$*)*	46.5 ± 7.2	35.5 ± 0.9	43.9 ± 8.0
Walking Speed (km/h)	5.8 ± 0.2	5.8 ± 0.3	5.8 ± 0.2
*STAI-Trait**	34.2 ± 7.4	35.1 ± 7.4	34.4 ± 7.2

*STAI-Trait: Trait anxiety as measured by the State-Trait Anxiety Inventory (STAI)

In order to comprehensively evaluate the dose-response relationship between an acute bout of moderate-intensity walking and the anxiolytic and affective responses, one purpose of this study was to compare the anxiety and affective responses across three exercise durations: 30, 10, and 5 min. A second purpose of this study was to study the time course of the anxiolytic and affective responses post-exercise by measuring responses prior to each bout of exercise (pre), immediately following cessation of the exercise (Ip), and at twenty min (20p) and forty min (40p) post exercise. A third aim of this study was to include multiple covariates (sex, fitness, trait anxiety, and enjoyment of physical activity) in the analysis of the above mentioned psychometric assessments to determine if their presence had a significant effect on the change in anxiolytic and affective responses following the exercise performed. In order to examine the fitness covariate, researchers categorized participants based on measured $\dot{V}O_{2max}$ into two categories: more fit and less fit. Participants were classified as more fit if their $\dot{V}O_{2max}$ fell into the "good, excellent, or superior" range based on age according to ACSM (2014); specifically, $\dot{V}O_{2max} \geq 45.6$ ml/kg/min for men and a $\dot{V}O_{2max} \geq 39.5$ ml/kg/min for women. Alternatively, participants were classified as less fit if their $\dot{V}O_{2max}$ fell into the "fair, poor, or very poor" range (ASCM, 2014); specifically, $\dot{V}O_{2max} < 45.6$ ml/kg/min for men and a $\dot{V}O_{2max} < 39.5$ ml/kg/min for women.

Only one variable, positive affect, produced a statistically significant main effect of exercise duration ($p = 0.021$). However, analysis of all variables except physical exhaustion indicated a significant main effect of time ($p \leq 0.05$). In addition to the reported main effects, the analyses of feeling states, tranquility, and physical exhaustion each resulted in an exercise duration-by-time interaction effect ($p \leq 0.05$). When covariates were examined, the analyses which included fitness level and sex indicated significant effects on five of the variables under investigation, specifically: positive affect, energy, calmness, revitalization, and physical exhaustion ($p \leq 0.05$). It should be noted that while anxiety, negative affect, revitalization, tranquility, physical exhaustion, feeling states, tension and calmness showed favorable responses at 20p or 40p, other variables including positive affect, activation, energy, and tiredness showed unfavorable responses at 20p or 40p, and there was no effect on positive engagement during recovery. The significant effects can be seen in Table 4.2.

Table 4.2: *Significant Main and Interaction Effects;* ***x*** *= significant at p ≤ 0.05*

	Significant Effects					
	Main		Interaction	Fitness Interaction		Sex Interaction
Variable	**Exercise Duration**	**Time**	**Exercise Duration*Time**	**Exercise Duration**	**Time**	**Time**
Anxiety		x				
Positive Affect	x	x			x	x
Negative Affect		x				
Positive Engagement		x				
Revitalization		x				x
Tranquility		x	x			
Physical Exhaustion			x			
Affective Valence (Pleasure & Displeasure)		x	x			
Perceived Activation (Arousal)		x				
Energetic Arousal		x		X		
Energy[a]		x		X		x
Tiredness[a]		x				
Tense Arousal		x				
Tension[t]		x				
Calmness[t]		x	x[*]			

[a]pole of energetic arousal, as measured by the AD ACL
[t]pole of tense arousal, as measured by the AD ACL
[*]became significant in the presence of the covariate sex

Following are the results for each of the psychometric measurements assessed in the current study.

Analysis of Anxiety assessed by the Anxiety Likert Scale (ALS)

Analysis of the responses to the ALS measuring anxiety produced a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. When the covariates were included in the analysis, there were no significant effects on anxiety.

Effect of Time on Anxiety

There was no significant difference between anxiety levels pre- and immediately post-exercise ($p = 1.00$). However, anxiety at both 20p and 40p was significantly lower than both pre ($p = 0.004$ and $p \leq 0.001$, respectively) and Ip ($p = 0.012$ and $p = 0.005$, respectively). There was no significant difference between anxiety levels at 20p and 40p ($p = 1.00$). These results are displayed in Table 4.3.

Table 4.3: *Anxiety Scores, as assessed by the ALS, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% CI; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	1.62 ± 0.10	1.42	1.83
Ip	1.60 ± 0.13	1.33	1.86
20p	1.25 ± 0.08*	1.10	1.41
40p	1.24 ± 0.06*	1.11	1.37

Note. ALS = Anxiety Likert Scale; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the ALS range between 1-5
There was a significant main effect of time ($p \leq 0.001$)
*$p \leq 0.05$ vs pre & Ip

Analysis of Positive Affect assessed by the Positive and Negative Affect Schedule (PANAS)

Analysis of the responses to the PANAS measuring positive affect produced a significant main effect for time and a significant main effect for duration. There was not a significant exercise duration*time interaction. Including the fitness and sex covariates in the analysis resulted in significant fitness*time and significant sex*time interactions.

Effect of Exercise Duration on Positive Affect

The 30-min walk induced significantly greater positive affect than did the 5-min walk (p = 0.044). No significant difference was found between the 30- and 10- min walks (p = 0.084) or the 10- and 5- min walks (p = 1.00). These results are displayed in Table 4.4.

Table 4.4: *Positive Affect Scores, as assessed by the PANAS, Across the Three Exercise Durations & Collapsed Across the Four Measurement Time Points (Mean ± SE & 95% Confidence Interval; n = 29)*

Exercise Duration		95% CI	
(min)	Mean ± SE	LL	UL
30	29.36 ± 1.38	26.54	32.19
10	27.94 ± 1.37	25.14	30.74
5	27.29 ± 1.32*	24.58	30.00

Note. PANAS = Positive And Negative Affective Schedule; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; Possible scores for the PANAS range between 10-50
There was a significant main effect of exercise duration (p = 0.021)
*$p \leq 0.05$ vs 30

Effect of Time on Positive Affect

Positive affect immediately post-exercise was significantly higher than pre-exercise levels (p = 0.011). It should be noted that the favorable effect of exercise on positive affect did not last; rather, during the rest period, positive affect significantly declined from Ip to both 20p ($p \leq 0.001$) and 40p ($p \leq 0.001$). Levels at 40p were significantly lower than both pre ($p \leq 0.001$) and 20p ($p \leq 0.001$). These results are displayed in Table 4.5.

Table 4.5: *Positive Affect Scores, as assessed by the PANAS, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% CI; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	28.87 ± 1.11	26.60	31.15
Ip	31.03 ± 1.37*	28.23	33.84
20p	27.48 ± 1.49	24.43	30.54
40p	25.40 ± 1.40$^{\Delta}$	22.54	28.26

Note. PANAS = Positive And Negative Affective Schedule; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the PANAS range between 10-50

There was a significant main effect of time ($p \leq 0.001$)

$^{*}p \leq 0.05$ vs pre, 20p & 40p

$^{\Delta}p \leq 0.05$ vs pre & 20p

Interaction Effect of Fitness and Time on Positive Affect

Both more- and less- fit participants experienced an increase in positive affect from pre-exercise to Ip. Positive affect remained elevated above baseline at 20p for more fit participants before returning near baseline at 40p, while it appears as if less fit participants experienced a steep decline in positive affect from Ip to both 20p and 40p. These results are displayed in Table 4.6.

Table 4.6: *Positive Affect Scores, as assessed by the PANAS, by Measurement Time Point & Fitness Level, Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

	More Fit			Less Fit		
		95% CI			95% CI	
Time	Mean ± SE	LL	UL	Mean ± SE	LL	UL
pre	34.10 ± 1.99	30.01	38.19	27.21 ± 1.12	24.91	29.52
Ip	36.62 ± 2.56	31.37	41.87	29.26 ± 1.44	26.30	32.22
20p	35.33 ± 2.56	30.09	40.58	24.99 ± 1.44	22.02	27.95
40p	33.14 ± 2.34	28.35	37.94	22.94 ± 1.32	20.24	25.64

Note. PANAS = Positive And Negative Affective Schedule; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the PANAS range between 10-50

There was a significant fitness*time interaction ($p \leq 0.001$)

Insufficient sample size for individual contrasts

Interaction Effect of Sex and Time on Positive Affect

Both men and women experienced an increase in positive affect from pre to Ip. Positive affect remained elevated above baseline at 20p for men before returning near baseline at 40p, whereas women experienced a steep decline in positive affect from Ip to both 20p and 40p. These results mirror those found for fitness level and may reflect that men were more fit than women (mean $\dot{V}O_{2max}$ = 45.8 and 35.0, respectively). These results are displayed in Table 4.7.

Table 4.7: *Positive Affect Scores, as assessed by the PANAS, by Measurement Time Point & Sex, Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

	Men			Women		
		95% CI			95% CI	
Time	Mean ± SE	LL	UL	Mean ± SE	LL	UL
pre	33.19 ± 2.10	28.89	37.49	27.50 ± 1.18	25.07	29.93
Ip	35.62 ± 2.66	30.17	41.07	29.58 ± 1.50	26.50	32.65
20p	34.62 ± 2.66	29.17	40.07	25.21 ± 1.50	22.14	28.29
40p	33.10 ± 2.34	28.29	37.90	22.96 ± 1.32	20.24	25.67

Note. PANAS = Positive And Negative Affective Schedule; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the PANAS range between 10-50
There was a significant sex*time interaction (p = 0.005)
Insufficient sample size for individual contrasts

Analysis of Negative Affect assessed by the Positive and Negative Affect Schedule (PANAS)

Analysis of the responses to the PANAS measuring negative affect produced a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. When the covariates were included in the analysis, there were no significant effects on negative affect.

Effect of Time on Negative Affect

Examining the effects of exercise on negative affect across the four time points indicated that at 40p, negative affect was significantly less than Ip (p = 0.026) regardless of exercise duration. The difference between pre-exercise levels and levels at 40p approached significance (p = 0.075). These results are displayed in Table 4.8.

Table 4.8: *Negative Affect Scores, as assessed by the PANAS, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
Pre	11.20 ± 0.31	10.57	11.82
Ip	11.12 ± 0.29	10.52	11.71
20p	10.69 ± 0.16	10.36	11.02
40p	10.60 ± 0.15*	10.28	10.91

Note. PANAS = Positive And Negative Affective Schedule; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the PANAS range between 10-50
There was a significant main effect of time ($p = 0.009$)
*$p \leq 0.05$ vs Ip

Analysis of Positive Engagement assessed by the Exercise-Induced Feelings Inventory (EFI)

Analysis of the responses to the EFI measuring positive engagement produced a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. When the covariates were included in the analysis, there were no significant effects on positive engagement.

Effect of Time on Positive Engagement

Positive engagement significantly declined from Ip to both 20p ($p = 0.006$) and 40p ($p = 0.005$). These results are displayed in Table 4.9.

Table 4.9: *Positive Engagement Scores, as assessed by the EFI, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	7.14 ± 0.45	6.22	8.06
Ip	7.52 ± 0.48*	6.53	8.51
20p	6.89 ± 0.46	5.94	7.84
40p	6.72 ± 0.47	5.75	7.70

Note. EFI = Exercise-Induced Feeling Inventory; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the EFI range between 0-12
There was a significant main effect of time ($p = 0.004$)
$^{*}p \leq 0.05$ vs 20p & 40p

Analysis of Revitalization assessed by the Exercise-Induced Feelings Inventory (EFI)

Analysis of the responses to the EFI measuring revitalization indicated that there was a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. Including the sex covariate in the analysis resulted in a significant sex*time interaction.

Effect of Time on Revitalization

Immediately post exercise, revitalization scores were significantly higher than pre (p = 0.003), 20p (p = 0.006) and 40p (p = 0.001). These results are displayed in Table 4.10.

Table 4.10: *Revitalization Scores, as assessed by the EFI, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	5.86 ± 0.45	4.95	6.78
Ip	7.02 ± 0.47*	6.05	7.99
20p	6.20 ± 0.54	5.08	7.31
40p	5.90 ± 0.53	4.81	6.98

Note. EFI = Exercise-Induced Feeling Inventory; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the EFI range between 0-12
There was a significant main effect of time ($p \leq 0.001$)
$^{*}p \leq 0.05$ vs pre, 20p & 40p

Interaction Effect of Sex and Time on Revitalization

Revitalization increased from pre- to immediately post-exercise for both men and women. Levels of revitalization remained elevated above baseline at both 20p and 40p for men. In contrast, in women, at 20p revitalization returned to pre-exercise levels, and at 40p, levels had dropped below those measured pre-exercise. These results are displayed in Table 4.11.

Table 4.11: *Revitalization Scores, as assessed by the EFI, by Measurement Time Point & Sex, Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

	Men			Women		
		95% CI			95% CI	
Time	Mean ± SE	LL	UL	Mean ± SE	LL	UL
pre	7.57 ± 0.85	5.84	9.31	5.32 ± 0.48	4.34	6.30
Ip	8.52 ± 0.92	6.63	10.42	6.55 ± 0.52	5.48	7.62
20p	8.81 ± 0.97	6.83	10.79	5.36 ± 0.55	4.25	6.48
40p	8.62 ± 0.92	6.73	10.51	5.03 ± 0.52	3.97	6.09

Note. EFI = Exercise-Induced Feeling Inventory; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the EFI range between 0-12
There was a significant sex*time interaction (p = 0.019)
Insufficient sample size for individual contrasts

Analysis of Tranquility assessed by the Exercise-Induced Feelings Inventory (EFI)

Analysis of the responses to the EFI measuring tranquility indicated that there was a significant exercise duration*time interaction. The main effect of time was significant but there was no significant main effect for exercise duration. When the covariates were included in the analysis, there were no significant effects on tranquility.

Interaction Effect of Exercise Duration and Time on Tranquility

Although all three exercise durations appeared to induce a decline in tranquility from pre- to immediately post-exercise, this was most pronounced for the 30-min walk. Additionally, although all three exercise durations indicated a rebound in tranquility by 20p, this appeared to be most pronounced for the shorter duration (5- and 10- min) walks. Finally, it appears as if only the 10-min walk elicited a continued increase in tranquility between 20p and 40p. These results are displayed in Table 4.12.

Table 4.12: *Tranquility Scores, as assessed by the EFI, by Exercise Duration & Measurement Time Point (Mean ± SE & 95% Confidence Interval; n = 29)*

	30-min			10-min			5-min		
		95% CI			95% CI			95% CI	
Time	Mean ± SE	LL	UL	Mean ± SE	LL	UL	Mean ± SE	LL	UL
pre	9.00 ± 0.44	8.09	9.91	8.55 ± 0.51	7.51	9.59	7.97 ± 0.52	6.90	9.03
Ip	6.76 ± 0.56	5.62	7.90	7.38 ± 0.53	6.30	8.46	6.97 ± 0.59	5.77	8.17
20p	8.97 ± 0.45	8.05	9.88	8.76 ± 0.51	7.71	9.81	8.62 ± 0.56	7.48	9.76
40p	9.17 ± 0.42	8.30	10.04	9.66 ± 0.39	8.85	10.46	8.55 ± 0.60	7.33	9.78

Note. EFI = Exercise-Induced Feeling Inventory; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the EFI range between 0-12
There was a significant exercise duration*time interaction ($p = 0.036$)
Insufficient sample size for individual contrasts

Analysis of Physical Exhaustion assessed by the Exercise-Induced Feelings Inventory (EFI)

Analysis of the responses to the EFI measuring physical exhaustion indicated that there was a significant exercise duration*time interaction. There was neither a significant main effect for exercise duration nor was there a significant main effect for time. When the covariates were included in the analysis, there were no significant effects on physical exhaustion.

Interaction Effect of Exercise Duration and Time on Physical Exhaustion

While there appeared to be an increase in physical exhaustion from pre to Ip with a decline towards baseline at both 20p and 40p following the 30-min walk, the results for both shorter (5- and 10- min) walks were exactly opposite. Immediately following both of the shorter walks, physical exhaustion dropped below pre-exercise levels and increased at 20p and 40p towards baseline levels. These results are displayed in Table 4.13.

Table 4.13: *Physical Exhaustion Scores, as assessed by the EFI, by Exercise Duration & Measurement Time Point (Mean ± SE & 95% Confidence Interval; n = 29)*

	30-min			10-min			5-min		
		95% CI			95% CI			95% CI	
Time	Mean ± SE	LL	UL	Mean ± SE	LL	UL	Mean ± SE	LL	UL
pre	2.62 ± 0.48	1.64	3.60	3.00 ± 0.56	1.85	4.15	3.21 ± 0.57	2.03	4.38
Ip	3.59 ± 0.55	2.45	4.72	2.35 ± 0.40	1.52	3.17	2.03 ± 0.43	1.15	2.92
20p	3.17 ± 0.56	2.04	4.31	2.38 ± 0.49	1.38	3.38	2.59 ± 0.61	1.33	3.84
40p	2.66 ± 0.45	1.74	3.57	2.83 ± 0.52	1.77	3.88	2.97 ± 0.63	1.69	4.25

Note. EFI = Exercise-Induced Feeling Inventory; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the EFI range between 0-12
There was a significant exercise duration*time interaction ($p = 0.027$)
Insufficient sample size for individual contrasts

Analysis of Affective Valence (Pleasure and Displeasure) assessed by the Feeling Scale (FS)

Analysis of the responses to the FS measuring affective valence (pleasure and displeasure) indicated that there was a significant exercise duration*time interaction. The main effect of time was significant but there was no significant main effect for exercise duration. When the covariates were included in the analysis, there were no significant effects on affective valence.

Interaction Effect of Exercise Duration and Time on Affective Valence (Pleasure & Displeasure)

Compared to the 30- and 5- min walks, the 10-min walk elicited different responses to the FS across the four measured time points. Specifically, all three exercise durations elicited an increase in pleasurable feelings from pre to Ip. Additionally, following both the 30- and 5- min walks, affective valence remained elevated above pre-exercise levels at 20p and 40p. In contrast, at 20p and 40p following the 10-min walk, feelings became less pleasurable, falling below pre-exercise levels. These results are displayed in Table 4.14.

Table 4.14: *Affective Valence (Pleasure and Displeasure) Scores, as assessed by the FS, by Exercise Duration & Measurement Time Point (Mean ± SE & 95% Confidence Interval; n = 29)*

	30 min			10 min			5 min		
		95% CI			95% CI			95% CI	
Time	Mean ± SE	LL	UL	Mean ± SE	LL	UL	Mean ± SE	LL	UL
pre	2.79 ± 0.26	2.27	3.32	3.07 ± 0.23	2.59	3.55	2.69 ± 0.29	2.09	3.29
Ip	3.55 ± 0.25	3.05	4.06	3.62 ± 0.22	3.17	4.07	3.17 ± 0.24	2.67	3.67
20p	3.48 ± 0.21	3.04	3.92	3.03 ± 0.27	2.48	3.59	3.14 ± 0.25	2.63	3.64
40p	3.35 ± 0.23	2.87	3.83	2.90 ± 0.29	2.31	3.48	2.90 ± 0.30	2.28	3.51

Note. FS = Feeling Scale; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the FS range between -5 & +5
There was a significant exercise duration*time interaction (p = 0.049)
Insufficient sample size for individual contrasts

Analysis of Perceived Activation (Arousal) assessed by the Felt Arousal Scale (FAS)

Analysis of the responses to the FAS measuring perceived activation (arousal) indicated that there was a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. When the covariates were included in the analysis, there were no significant effects on activation (arousal).

Effect of Time on Perceived Activation (Arousal)

Activation (arousal) scores immediately post-exercise were significantly higher than pre (p = 0.003), 20p ($p \leq 0.001$), and 40p ($p \leq 0.001$). As participants rested post-exercise, activation (arousal) declined. Activation (arousal) at 40p was significantly less than pre, Ip and 20p ($p \leq 0.001$). These results are displayed in Table 4.15.

Table 4.15: *Perceived Activation (Arousal) Scores, as assessed by the FAS, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	2.08 ± 0.13	1.82	2.34
Ip	$2.91 \pm 0.22^{*}$	2.46	3.36
20p	1.78 ± 0.11	1.56	2.00
40p	$1.41 \pm 0.09^{\Delta}$	1.23	1.60

Note. FAS = Felt Arousal Scale; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the FAS range between 1-6
There was a significant main effect of time ($p \leq 0.001$)
$^{*}p \leq 0.05$ vs pre, 20p & 40p
$^{\Delta}p \leq 0.05$ vs pre & 20p

Analysis of Energetic Arousal assessed by the Activation Deactivation Adjective Check List (AD ACL)

Analysis of the responses to the AD ACL measuring energetic arousal indicated that there was a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. Including the fitness covariate in the analysis resulted in a significant fitness*exercise duration interaction.

Effect of Time on Energetic Arousal

Energetic arousal immediately post-exercise was significantly greater than pre-exercise levels ($p \leq 0.001$). However, following the exercise, energetic arousal decreased significantly from Ip to both 20p ($p \leq 0.001$) and 40p ($p \leq 0.001$). The reported levels at 40p were significantly less than those reported pre-exercise ($p = 0.042$) and 20p ($p = 0.044$). These results are displayed in Table 4.16.

Table 4.16: *Energetic Arousal Scores, as assessed by the AD ACL, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

Time	Mean ± SE	95% CI LL	95% CI UL
pre	26.14 ± 0.72	24.67	27.60
Ip	29.59 ± 0.85*	27.85	31.33
20p	25.45 ± 1.10	23.20	27.69
40p	24.03 ± 1.16$^{\Delta}$	21.67	26.40

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40
There was a significant main effect of time ($p \leq 0.001$)
$^{*}p \leq 0.05$ vs pre, 20p & 40p
$^{\Delta}p \leq 0.05$ vs pre & 20p

Interaction Effect of Fitness and Exercise Duration on Energetic Arousal

It appears that the 30- and 10- min walks elicited greater energetic arousal from more fit participants than did the 5-min walk. Conversely, energetic arousal remained relatively consistent for less fit participants across the three exercise durations. These results are displayed in Table 4.17.

Table 4.17: *Energetic Arousal Scores, as assessed by the AD ACL, by Fitness & Exercise Duration, Collapsed Across the Measurement Time Points (Mean ± SE & 95% Confidence Interval; n = 29)*

Exercise Duration (min)	More Fit			Less Fit		
		95% CI			95% CI	
	Mean ± SE	LL	UL	Mean ± SE	LL	UL
30	31.61 ± 2.31	26.86	36.35	25.68 ± 1.30	23.01	28.36
10	29.43 ± 2.07	25.18	33.68	24.71 ± 1.17	22.31	27.10
5	25.11 ± 2.39	20.20	30.01	26.22 ± 1.35	23.45	28.98

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; Possible scores for the AD ACL range between 10-40
There was a significant fitness*exercise duration interaction ($p = 0.001$)
Insufficient sample size for individual contrasts

Analysis of Energy assessed by the Activation Deactivation Adjective Check List (AD ACL)

Analysis of the responses to the AD ACL measuring energy indicated that there was a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. Including the fitness and sex covariates in the analysis resulted in a significant fitness*exercise duration interaction and a significant sex*time interaction.

Effect of Time on Energy

Participants felt the most energetic immediately post-exercise, as scores at Ip were significantly higher than pre ($p \leq 0.001$), 20p ($p \leq 0.001$), and 40p ($p \leq 0.001$). Additionally, at 40p levels of energy significantly declined below levels measured at pre ($p = 0.002$). These results are displayed in Table 4.18.

Table 4.18: *Energy Scores, as assessed by the AD ACL, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	12.26 ± 0.41	11.43	13.10
Ip	14.26 ± 0.46*	13.33	15.20
20p	11.52 ± 0.51	10.47	12.56
40p	10.84 ± 0.55$^{\Delta}$	9.72	11.96

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40
There was a significant main effect of time ($p \leq 0.001$)
$^{*}p \leq 0.05$ vs pre, 20p & 40p
$^{\Delta}p \leq 0.05$ vs pre

Interaction Effect of Fitness and Exercise Duration on Energy

Both the 30- and 10- min walks elicited greater energy scores from more fit participants than did the 5-min walk. Conversely, levels of energy remained relatively constant for less fit participants across the three exercise durations. These results are displayed in Table 4.19.

Table 4.19: *Energy Scores, as assessed by the AD ACL, by Fitness & Exercise Duration, Collapsed Across the Measurement Time Points (Mean ± SE & 95% Confidence Interval; n = 29)*

	More Fit			Less Fit		
		95% CI			95% CI	
Exercise Duration (min)	Mean ± SE	LL	UL	Mean ± SE	LL	UL
30	15.04 ± 1.02	12.94	17.13	11.85 ± 0.58	10.67	13.03
10	14.36 ± 0.98	12.34	16.38	11.33 ± 0.56	10.19	12.47
5	11.61 ± 1.04	9.48	13.74	12.10 ± 0.59	10.90	13.30

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; Possible scores for the AD ACL range between 10-40
There was a significant fitness*exercise duration interaction ($p = 0.001$)
Insufficient sample size for individual contrasts

Interaction Effect of Sex and Time on Energy

Although the increase from pre-exercise to Ip was similar for both sexes, responses differed thereafter. For men, at both 20p and 40p, levels of energy had returned near pre-exercise levels. For women, energy levels dropped below pre-exercise levels at 20p and continued to decline between 20p and 40p. These results are displayed in Table 4.20.

Table 4.20: *Energy Scores, as assessed by the AD ACL, by Sex & Measurement Time Point (Mean ± SE & 95% Confidence Interval; n =29)*

	Men			Women		
		95% CI			95% CI	
Time	Mean ± SE	LL	UL	Mean ± SE	LL	UL
pre	12.33 ± 0.85	10.59	14.07	12.24 ± 0.48	11.26	13.22
Ip	14.33 ± 0.95	12.39	16.28	14.24 ± 0.54	13.15	15.34
20p	12.81 ± 1.02	10.72	14.9	11.11 ± 0.58	9.93	12.29
40p	12.14 ± 1.10	9.89	14.4	10.42 ± 0.62	9.15	11.7

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40
There was a significant sex*time interaction ($p = 0.026$)
Insufficient sample size for individual contrasts

Analysis of Tiredness assessed by the Activation Deactivation Adjective Check List (AD ACL)

Analysis of the responses to the AD ACL measuring tiredness indicated that there was a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. When the covariates were included in the analysis, there were no significant effects on tiredness.

Effect of Time on Tiredness

Participants reported feeling significantly less tired immediately post exercise compared to pre-exercise (p = 0.001). However, this response was not maintained, as participants reported feeling significantly more tired at both 20p and 40p compared to Ip (p = 0.020 and p = 0.001, respectively). These results are displayed in Table 4.21.

Table 4.21: *Tiredness Scores, as assessed by the AD ACL, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	11.26 ± 0.49	10.27	12.26
Ip	9.68 ± 0.53*	8.59	10.77
20p	11.07 ± 0.68	9.68	12.46
40p	11.81 ± 0.72	10.34	13.27

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40
There was a significant main effect of time ($p \leq 0.001$)
*$p \leq 0.05$ vs pre, 20p & 40p

Analysis of Tense Arousal assessed by the Activation Deactivation Adjective Check List (AD ACL)

Analysis of the responses to the AD ACL measuring tense arousal indicated that there was a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. When the covariates were included in the analysis, there were no significant effects on tense arousal.

Effect of Time on Tense Arousal

Significantly more tense arousal was reported immediately post-exercise than pre-exercise ($p \leq 0.001$). Tense arousal decreased significantly from Ip to both 20p ($p \leq 0.001$) and 40p ($p \leq 0.001$). Reported levels at both 20p and 40p were significantly less than pre-exercise levels ($p \leq 0.001$). These results are displayed in Table 4.22.

Table 4.22: *Tense Arousal Scores, as assessed by the AD ACL, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	18.46 ± 0.45	17.55	19.37
Ip	21.05 ± 0.70*	19.61	22.48
20p	16.66 ± 0.41$^{\Delta}$	15.81	17.50
40p	16.23 ± 0.40$^{\Delta}$	15.41	17.05

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40
There was a significant main effect of time ($p \leq 0.001$)
$^{*}p \leq 0.05$ vs pre, 20p & 40p
$^{\Delta}p \leq 0.05$ vs pre

Analysis of Tension assessed by the Activation Deactivation Adjective Check List (AD ACL)

Analysis of the responses to the AD ACL measuring tension indicated that there was a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. When the covariates were included in the analysis, there were no significant effects on tension.

Effect of Time on Tension

There was a non-significant increase in tension immediately post-exercise; however, in the rest period following exercise, tension significantly decreased between Ip and both 20p ($p \leq 0.001$) and 40p ($p \leq 0.001$). The steady decline in tension following the walk produced significantly lower levels at 40p compared to levels recorded pre-exercise ($p = 0.022$). These results are displayed in Table 4.23.

Table 4.23: *Tension Scores, as assessed by the AD ACL, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	6.95 ± 0.34	6.27	7.64
Ip	7.68 ± 0.48*	6.68	8.68
20p	6.31 ± 0.28	5.74	6.88
40p	6.28 ± 0.28$^{\Delta}$	5.71	6.85

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40
There was a significant main effect of time ($p \leq 0.001$)
$^{*}p \leq 0.05$ vs 20p & 40p
$^{\Delta}p \leq 0.05$ vs pre

Analysis of Calmness assessed by the Activation Deactivation Adjective Check List (AD ACL)

Analysis of the responses to the AD ACL measuring calmness indicated that there was a significant main effect for time. There was neither a significant main effect for exercise duration nor was there a significant exercise duration*time interaction. Including the covariate sex in the analysis resulted in a significant exercise duration*time interaction effect on calmness.

Effect of Time on Calmness

Participants felt significantly less calm immediately post exercise compared to pre-exercise ($p = 0.001$). However, calmness increased significantly from Ip to both 20p ($p \leq 0.001$)

and 40p ($p \leq 0.001$). The reported levels at 20p and 40p were both significantly greater than pre-exercise levels ($p = 0.003$, $p \leq 0.001$; respectively). These results are displayed in Table 4.24.

Table 4.24: *Calmness Scores, as assessed by the AD ACL, Across the Four Measurement Time Points & Collapsed Across the Three Exercise Durations (Mean ± SE & 95% Confidence Interval; n = 29)*

		95% CI	
Time	Mean ± SE	LL	UL
pre	13.51 ± 0.36	12.76	14.25
Ip	11.63 ± 0.45*	10.71	12.56
20p	14.66 ± 0.40$^{\Delta}$	13.83	15.48
40p	15.05 ± 0.42$^{\Delta}$	14.19	15.90

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40

There was a significant main effect of time ($p \leq 0.001$)

$^{*}p \leq 0.05$ vs pre, 20p & 40p

$^{\Delta}p \leq 0.05$ vs pre

*Interaction of Exercise Duration*Time on Calmness: Controlling for Sex*

The interaction between exercise duration and time was apparent only when controlling for sex. This interaction suggests that, after controlling for sex, the longer (30-min) walk had the greatest effect on calmness, while calmness was less positively elevated following the shorter (5- and 10- min) walks. These results are displayed in Table 4.25.

Table 4.25: *Calmness Scores, as assessed by the AD ACL, Corrected for Sex, by Exercise Duration & Measurement Time Point (Mean ± SE & 95% Confidence Interval; n = 29)*

	30 min			10 min			5 min		
		95% CI			95% CI			95% CI	
Time	Mean ± SE	LL	UL	Mean ± SE	LL	UL	Mean ± SE	LL	UL
pre	13.61 ± 0.62	12.33	14.88	14.17 ± 0.60	12.95	15.39	13.20 ± 0.66	11.85	14.55
Ip	11.20 ± 0.61	9.96	12.44	12.77 ± 0.65	11.43	14.11	12.52 ± 0.55	11.38	13.66
20p	14.95 ± 0.46	14.00	15.89	14.64 ± 0.49	13.63	15.66	14.58 ± 0.70	13.15	16.02
40p	15.70 ± 0.47	14.73	16.67	15.45 ± 0.53	14.36	16.53	14.53 ± 0.67	13.17	15.90

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40
When controlling for the covariate sex, an exercise duration*time interaction emerged (p = 0.035)

The presence of the significant exercise duration*time interaction when controlling for the variance of sex indicated that the data should be further investigated. When split by sex, the data suggested that unlike women, men responded differently across all three exercise durations at each of the four time points. For women, calmness declined from pre to Ip, increased above pre-exercise levels at 20p and continued to increase between 20p and 40p. Following the 30-min walk, men reported a pattern similar to women; however, responses following the 10- and 5- min walks differed. Following the 10-min walk, men reported feeling less calm at both Ip and 20p before levels rose above baseline at 40p. Following the 5-min walks men reported feeling more calm at all three time points following the exercise. However, it should be noted that the small number of men present in the study made it difficult to make conclusions about men. These results are displayed in Table 4.26.

Table 4.26: *Calmness Scores, as assessed by the AD ACL, split by Sex, by Exercise Duration*Measurement Time Point (Mean ± SE & 95% Confidence Interval; n = 29)*

Exercise Duration (min)	Time	Men			Women		
			95% CI			95% CI	
		Mean ± SE	LL	UL	Mean ± SE	LL	UL
30	pre	13.71 ± 0.87	11.6	15.83	13.50 ± 0.64	12.17	14.83
	Ip	11.86 ± 1.08	9.22	14.5	10.55 ± 0.59	9.32	11.78
	20p	15.57 ± 0.87	13.45	17.7	14.32 ± 0.44	13.41	15.23
	40p	16.71 ± 0.61	15.23	18.2	14.68 ± 0.49	13.65	15.71
10	pre	14.43 ± 0.97	12.05	16.81	13.91 ± 0.60	12.67	15.15
	Ip	13.86 ± 1.34	10.59	17.12	11.68 ± 0.61	10.42	12.95
	20p	14.29 ± 0.84	12.24	16.33	15.00 ± 0.49	13.99	16.02
	40p	15.57 ± 0.53	14.28	16.86	15.32 ± 0.57	14.14	16.5
5	pre	13.71 ± 0.75	11.89	15.54	12.68 ± 0.70	11.23	14.13
	Ip	13.86 ± 0.91	11.63	16.09	11.18 ± 0.55	10.03	12.33
	20p	14.71 ± 0.94	12.4	17.02	14.46 ± 0.72	12.95	15.96
	40p	14.43 ± 1.00	11.99	16.87	14.64 ± 0.68	13.22	16.05

Note. AD ACL = Activation Deactivation Adjective Check List; SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit; pre = pre-exercise; Ip = immediately post-exercise; 20p = 20 min post-exercise; 40p = 40 min post-exercise; Possible scores for the AD ACL range between 10-40

CHAPTER 5

DISCUSSION

Although walking is the most preferred mode of physical activity, to date, the examination of its use in alleviating anxiety and altering affective states in the current literature is limited (Ekkekakis and Petruzzello, 1999). To the best of the author's knowledge, this is the first study to use an extensive battery of psychometric assessments when investigating the effects of an acute bout of moderate intensity walking of different durations (30-, 10- and 5- min) on a moderately fit, non-clinically anxious population. This study also sought to extend existing findings by assessing post-exercise responses immediately and at 20 and 40 min post-exercise. Finally, to the best of the author's knowledge, this is the first study to include the analysis of four specific covariates (trait anxiety, fitness level, enjoyment of activity, and sex) when examining psychological responses to walking.

One of the main findings of the current investigation was that a main effect of time was observed for the majority of variables under investigation. However, it should be emphasized that while several measures showed favorable responses other measures showed unfavorable responses following the cessation of exercise. Secondly, although several measures were affected by exercise duration, the majority were not. Finally, although several measures were affected by the moderating variables of fitness and sex, the majority were not affected by the covariates studied in the current investigation. The following discussion will elaborate on these trends, shown in Table 5.1.

Table 5.1: *Significant Favorable (+) or Unfavorable (-) Responses versus Pre-Exercise Levels (significant at p ≤ 0.05)*

	Post-Exercise Time Point			
Variable	**Ip**	**20p**	**40p**	**Notes:**
Favorable Responses				
Anxiety		+	$+^{*}$	*40p < 20p, $p \le 0.05$
Tense Arousal	-	+	+	
Calmness^{t}	-	+	+	
Tension^{t}		*	$+^{*}$	*20p & 40p < Ip, $p \le 0.05$
Tranquility				Exercise Duration*Time interaction
30	-			
10	-	+	+	
5	-	+	+	
Physical Exhaustion				Exercise Duration*Time interaction
30	-	-		
10	+	+	+	
5	+	+	+	
Affective Valence (Pleasure & Displeasure)				Exercise Duration*Time interaction
30	+	+	+	
10	+		-	
5	+	+	+	
Revitalization	+			
Negative Affect			^{*b}	*decline approached significance ($p = 0.075$) ^{b}40p < Ip; $p \le 0.05$
Unfavorable Responses				
Positive Affect	+	*	$-^{*b}$	*20p & 40p < Ip, $p \le 0.05$ ^{b}40p < 20p, $p \le 0.05$
Perceived Activation (Arousal)	+	*	$-^{*b}$	*20p & 40p < Ip, $p \le 0.05$ ^{b}40p < 20p, $p \le 0.05$
Energetic Arousal	+	*	$-^{*b}$	*20p & 40p < Ip, $p \le 0.05$ ^{b}40p < 20p, $p \le 0.05$
Energy^{a}	+	*	$-^{*}$	*20p & 40p < Ip, $p \le 0.05$
Tiredness^{a}	+			
No Response				
Positive Engagement				

^{t} pole of tense arousal, as measured by the AD ACL

^{a} pole of energetic arousal, as measured by the AD ACL

For the purpose of this discussion, favorable responses are defined as: 1) significant changes that were positive immediately post-exercise and were maintained at 20 or 40 min post-exercise; 2) delayed favorable changes, such that there was either no significant change or a negative change immediately post-exercise but the response at 20 or 40 min post-exercise became positive; 3) positive changes immediately post-exercise with responses that dissipated over time; and 4) positive changes that were non-significant, but approached significance. Unfavorable changes included a positive response immediately post-exercise that became negative at 20 or 40 min post-exercise.

When comparing current results to the literature, the heterogeneity of study methodology should be appreciated. For instance, participant characteristics of many of the previous walking studies differed from those in the current study. Specifically, most of the walking literature has utilized a sedentary or low active, low-fit population. The current study utilized a moderately active (mean self-reported physical activity = 173.6 ± 54.9 min/week), moderately fit (mean $\dot{V}O_{2max}$: 45.8 ± 3.7 and 35.0 ± 4.8 ml/kg/min for men and women, respectively) population. The inclusion of men and women in the current study also differs from most of the current literature which studied only women. Additionally, while most of the walking literature has investigated moderate intensity walking, the method of prescribing the intensity differed significantly across studies. Only one other walking study (Dunn and McAuley, 2000) directly measured the fitness level of each participant and set the walking intensity accordingly. The current study set the walking intensity at between 4-5 METS in order to equate work across participants. However, the majority of the previous studies prescribed a "brisk" walk based on HR and RPE (Kopp, et. al., 2012; Ekkekakis, et al., 2000; Ekkekakis, et al., 2008; Focht, 2009, 2013) and provided little data regarding the walking intensity. A few studies based the walking intensity on blood lactate or predicted $\dot{V}O_{2max}$ (Cox, et al., 2000; Dunn and McAuley, 2000; Parfitt, et al., 2006; Rose and Parfitt, 2007). Additionally, while some studies examined the effects of walking in college-aged individuals similar to the current study (Ekkekakis et al., 2000; Ekkekakis et al., 2008), many used an older population (Dunn and McAuley, 2000; Focht, 2013, 2009; Parfitt, et al., 2006; Rose and Parfitt, 2007; Williams and Raynor, 2013). Also, in contrast to the current study, which was performed in a controlled environment, a few of the studies comprising the comparative literature examined walks in nature (Ekkekakis et al., 2000; Ekkekakis et al., 2008, Kopp et al., 2012). Finally, the different exercise durations and post-exercise measurement time points employed by previous studies make it somewhat difficult to compare current results with the literature.

Effect of Time: Favorable Responses

Anxiety

Consistent with previous literature (Cox, et al., 2000; Ekkekakis et al., 2000), the present findings suggest that an acute bout of moderate intensity walking encourages a positive effect on anxiety. In the current study, the reduction in anxiety at both 20 and 40 min, but not immediately post-exercise, is consistent with results reported by Cox, et al., (2000) who found decreased anxiety at both 30 and 60 min post-exercise but no change at 5 min post-exercise following 30-min of moderate intensity treadmill walking/running. Results of the current study provide further evidence to support the idea of a “delayed anxiolytic effect” (Cox, et al., 2000).

Similarly, results of the current study are consistent with those of Ekkekakis et al. (2000) who measured the anxiolytic and affective responses to either a 10- or 15- min walk across four studies using different psychometric assessments, walking durations, and post-exercise measurement time points ranging from immediate post-exercise to 15 min post-exercise. In both studies III and IV, where anxiety was measured beyond immediately post-exercise (using the SAI) following an acute bout of walking, Ekkekakis et al. (2000) reported no change in anxiety 10 min post-exercise following a 10-min walk (study III) and a significant decrease in anxiety 15 min post-exercise following a 10-min walk (study IV).

Tense Arousal: Tension and Calmness

Similarly, in the current study, a delayed effect for tense arousal was noted. Following an elevation immediately post-exercise, tense arousal declined at both 20 and 40 min post-exercise. Further investigation into the two poles of tense arousal (tension and calmness) revealed that the unfavorable change immediately post-exercise was due to a significant decrease in calmness. However, during recovery a delayed effect of walking became apparent, as tense arousal at both 20 and 40 min post-exercise was significantly lower than baseline. Further investigation into the two poles of tense arousal (tension and calmness) revealed that this decline was due to significantly more calmness reported at both 20 and 40 min post-exercise as well as significantly less tension reported at 40 min post-exercise. The results of the current study are consistent with those reported by Ekkekakis et al. (2000) who found a significant decrease in calmness immediately post-exercise followed by a significant increase in calmness and decrease in tension after 10 min of recovery from a 15-min walk (study III). Similarly, Ekkekakis et al. (2008) reported a slight increase in tense arousal post-exercise measured at three time points (5, 10 and 15 min) following a 15-min walk. Additionally, results of the current study are consistent with the delayed effect of walking on tense arousal reported by Kopp et al. (2012). Although not measured immediately post-exercise, researchers noted decreased tense arousal at each time point measured (5, 10, 15, 20, and 180 min) following a 20-min of brisk paced outdoor walk (Kopp et al., 2012). However, the results of the current study contradict those of Ekkekakis et al.

(2000) who reported no change in tense arousal immediately post-exercise (study I); no change in tense arousal immediately-post or 10 min post-exercise (study II); and decreased tense arousal immediately post-exercise before returning back toward baseline after 15 min of recovery (study IV), following a 10-min walk in each study.

The discrepancy between results of the current study and those of Ekkekakis et al. (2000) could be due to the intensity of the walks. In the previous study, participants were prescribed a "brisk" walk, whereas the current study prescribed a moderate intensity walk between 4-5 METs. It could be that the walking intensity in the previous study was not strenuous enough to elicit a positive, delayed effect on tense arousal, suggesting that there may be an "intensity threshold" that must be met to elicit this particular affective response.

Tranquility and Physical Exhaustion

The current study provides new insight into the extended post-exercise responses of tranquility and physical exhaustion, both captured by the EFI. Positive responses were exhibited for both affective states at 20 and 40 min post-exercise following the shorter (5- and 10- min) walks.

The delayed increase in tranquility followed a significant decrease reported immediately post-exercise. These results contradict both Focht (2009) and Dunn and McAuley (2000), who reported that 10- and 20- min of walking, respectively, had no effect on tranquility. However, these results support those of Focht (2013) who reported significantly greater levels of tranquility 10 min after a 10-min walk but not immediately post-exercise. It is noteworthy that, in the current study, the favorable responses at both 20 and 40 min post-exercise were apparent after the shorter walks (5- and 10- min) but not after the longer walk (30-min). This is in contrast to the same study by Focht (2013) who reported no change in tranquility immediately post but an increase in tranquility 10 min after 30-min of walking. Current study results also contradict the elevated levels of tranquility reported immediately following 20-min of moderate intensity cycling (Barnett, 2012). This may be attributed, in part, to the prescribed exercise intensity, which was 60% of $\dot{V}O_{2max}$ in the study by Barnett (2012) and approximately 45% of $\dot{V}O_{2max}$ in the current study.

In the current study, both of the shorter walks (5- and 10- min) also reduced levels of physical exhaustion at all three time points post-exercise. Previous research has reported that walking has a favorable effect on physical exhaustion. Dunn and McAuley (2000) reported decreased physical exhaustion immediately post and 20 min after 20-min of treadmill walking/running. Similar results were reported immediately and 10 min post-exercise following 10-min of walking (Focht, 2009). Again, it is noteworthy that, in the current study, favorable responses were apparent after the shorter walks but not following the longer (30-min) walk in which physical exhaustion was elevated immediately and 20 min post-exercise before declining toward pre-exercise levels at 40 min post. This is in contrast to that reported by the only other study to directly compare affective responses following acute bouts of walking of different durations (30- and 10- min) (Focht, 2013). Focht reported that both walks resulted in a significant reduction in physical exhaustion immediately and 10 min post-exercise (2013).

Here again, different exercise prescriptions may explain the different results. Sedentary participants in the Focht (2013) study were allowed to adjust the speed throughout both walks to maintain a moderate intensity based on RPE levels, whereas the current study prescribed a moderate intensity speed based on a prescribed MET level (4-5METs) that remained constant throughout. Thus, it may be that participants in the current study were expending more energy leading to an increase in physical exhaustion post-exercise manifested after the longer (30-min) walk. These differing results may indicate that the positive effect of a longer duration moderate intensity walk on physical exhaustion may depend on the speed at which one walks.

Affective Valence (Pleasure and Displeasure)

The effects of walking on affective valence (pleasure and displeasure) in the current study are difficult to explain. Results indicated that affective valence became more pleasant immediately post-exercise for all three exercise durations. However, pleasurable feelings remained elevated above baseline at 20 and 40 min post-exercise for the 30- and 5- min walks but not the 10-min walk.

The literature regarding affective valence is somewhat discordant. Affective valence was elevated immediately and 10 min post-exercise following a 10-min walk (Focht, 2009) and following both 10- and 30- min walks (Focht, 2013). Affective valence was significantly elevated at 15, 20, and 180 min following 20-min of treadmill walking/running but no change was reported at 5 and 10 min post-exercise (Kopp, et al., 2012). Ekkekakis et al. (2000) reported a significant increase in affective valence immediately following 10- (study I) and 15- (study II) min of walking, but these results were not sustained, as levels decreased toward baseline at 10 min post-exercise (study III). In contrast, Ekkekakis et al. (2008) and Williams and Raynor (2013) both reported no change in affective valence immediately following a 15-min walk and a 1-mile walk, respectively. Similar results were found by Rose and Partiff (2007) who reported no change in affective valence at multiple time points (immediately, 5 and 10 min) following a 20-min walk/run at three different intensities (estimated %$\dot{V}O_{2max}$: 60, 76, and 85 mL/kg/min), in an older female population whose estimated $\dot{V}O_{2max}$ was 36 mL/kg/min. Parfitt et al. (2006) reported non-significant increases in affective valence at all three time points (10, 20, and 30 min) following 20-min bouts of treadmill walking/running at two different intensities (estimated

%$\dot{V}O_{2max}$: 39.8 and 54.1 mL/kg/min). It should be noted that, in the current study, affective valence fell during recovery following the 10-min walk, significantly dropping below baseline at 40 min post-exercise. The reason the 10-min walk produced responses different than both the 30- and 5- min walks in the present investigation remains uncertain.

Revitalization

In the current study, revitalization was significantly elevated above baseline immediately post-exercise; however, this positive response was not sustained, as revitalization scores at both 20 and 40 min post-exercise were non-significantly elevated above pre-exercise levels. Focht (2009, 2013) reported increased revitalization immediately and 10 min after both 10- and 30-min walks. However, current results contradict Dunn and McAuley (2000) who reported increased revitalization both immediately post and 20 min post-exercise following 20-min of moderate intensity treadmill walking/running (60% $\dot{V}O_{2max}$). Differing results may be due in part to different fitness levels of the participants and different exercise intensities between studies. Participants were sedentary in the study by Dunn and McAuley (2000) whereas those in the current study were moderately active. Additionally, the exercise intensity (60% $\dot{V}O_{2max}$) was higher in the study by Dunn and McAuley (2000) compared to the present investigation (45% $\dot{V}O_{2max}$).

Negative Affect

Finally, although not statistically significant, the trend over time suggested that negative affect decreased post-exercise (40p < pre, $p = 0.075$). The present findings are consistent with those of Ekkekakis et al. (2000) who reported no change in negative affect immediately following a 10-min walk in nature (study I). However, as extended post-exercise measurements following acute activity are currently absent in the literature, further comparison is not possible.

It should be noted that negative affect responses pre-exercise were consistently on the low end of the 10-50 range of the scale (mean ± SE: 11.2 ± .031), thus there was little opportunity for change. Nevertheless, the current study offers new insight into the post-exertional responses of negative affect following acute bouts of walking.

Effect of Time: Unfavorable Responses

Several affective states under investigation responded unfavorably to acute bouts of moderate intensity walking. Although walking produced an immediate favorable effect on energetic arousal, including energy; positive affect; and perceived activation, the positive responses were not persistent. None of these affective measures were significantly different from baseline at 20 min post-exercise. By 40 min post-exercise, levels of each had significantly dropped below baseline. One possible cause of these unfavorable responses during the recovery is that all forms of social interaction, including social media (Facebook, Twitter, etc), were prohibited. This restriction may have negatively affected the assessment of the following affective responses during recovery.

Energetic Arousal: Energy and Tiredness

Consistent with current results, Ekkekakis et al. (2000) reported increased energetic arousal immediately post-exercise and non-significant elevations above pre-exercise levels 10 min after the cessation of both 10- (study I and II) and 15- min walks (study III) outdoors. Kopp et al. (2012) reported increased energetic arousal 5 min post-exercise and a non-significant change at each of the remaining time points (10, 15, 20, and 180 min) measured following a brisk, 20-min outdoor walk. Ekkekakis et al. (2008) reported no change immediately following a 15-min nature walk. It should be noted that when examined separately, the two poles of energetic arousal (energy and tiredness) responded differently in the current investigation. The overall response of tiredness was favorable, as a significant decline below baseline immediately post-exercise was noted. Conversely, although energy was elevated immediately post-exercise, the response became unfavorable during the recovery, as levels dropped significantly below baseline at 40 min post-exercise, consistent with the post-exercise response of energetic arousal. The extent to which different walking environments may influence energetic arousal remains uncertain.

Positive Affect

Consistent with current results, positive affect was previously found to be significantly elevated immediately post-exercise following a 10-min walk in nature (Ekkekakis et al., 2000; study I). Like investigations of negative affect, extended post-exercise measurements of positive affect are currently absent in the literature. As such, the current study offers new insight into the post-exertional response of positive affect.

Perceived Activation (Arousal)

Previous research results regarding perceived activation (arousal) (Focht, 2009, 2013; Ekkekakis et al., 2000; Parfitt, et al., 2006; Rose and Parfitt, 2007) are supported by those found in the current study. Specifically, those studies report that although walking favorably affected perceived activation (arousal) immediately post-exercise, this effect was not sustained during recovery. Parfitt et al. (2006) reported that while perceived activation (arousal) was significantly higher than baseline 10 min post-exercise, there was no change at 20 or 30 min following 20-min of walking/running. In a similar study, Rose and Parfitt (2007) reported increased perceived activation (arousal) 5 min post-exercise, but reported non-significant increases above baseline immediately post and 10 min post-exercise following a 20-min walk/run. Additionally, Focht (2009 and 2013) and Ekkekakis et al. (2000, study I and III) reported that the significant increase above pre-exercise levels measured immediately following 10-, 15- and 30- min walks dissipated in the 10 min recovery. Conversely, Ekkekakis et al. (2008) reported no change in perceived activation (arousal) immediately following a 15-min walk. Additionally, Kopp et al. (2012) reported that perceived activation (arousal) was significantly elevated above pre-exercise levels at each of the five measured time points post-exercise (5, 10, 15, 20 and 180 min), noting that the greatest increase in perceived activation (arousal) occurred 10 min post-exercise. The results of the current study provide additional support to the notion that although walking may produce an immediate positive effect on perceived activation (arousal), the effect does not last. In fact, in the current study perceived activation (arousal) declined below pre-exercise levels by 40 min post-exercise. As previously stated, this decline in perceived activation (arousal) could have been due to the social isolation felt during the recovery period.

Effect of Time: No Significant Effect

Positive Engagement

Finally, in the current study, there was no noticeable effect of exercise on positive engagement. These results contradict previous literature (Dunn and McAuley, 2000; Focht, 2009, 2013) which reported increased positive engagement following acute bouts of exercise. Focht (2009) reported increased positive engagement immediately post but not 10 min post-exercise following 10-min of walking. Focht (2013) reported increased positive engagement immediately post- and 10 min post-exercise following 10- and 30- min of walking. Similarly, Dunn and McAuley (2000) reported increased positive engagement immediately post and 20 min post-exercise following 20 min of treadmill walk/running. A possible explanation for the lack of a favorable response in positive engagement in the current study may be that participants were not allowed to listen to music while walking, which many participants anecdotally stated was opposite from their normal exercise routines. Additionally, during the recovery, all forms of social interaction, including social media (Facebook, Twitter, etc) were prohibited. This restriction may have negatively affected positive engagement during recovery.

Effect of Exercise Duration

Interestingly, of the variables investigated in this study, only one (positive affect) showed a main effect of exercise duration and only three exhibited an exercise duration*time interaction. The duration of the walk had no bearing on the positive or negative effect exhibited by the majority of variables under investigation. The lack of a significant effect of exercise duration for most of the psychological variables investigated suggests that the duration of the walk was inconsequential for these measures. Although not all study results are in agreement, results of the current investigation regarding walking are consistent with previous literature, investigating other modes of exercise, which has reported that the duration of exercise has no effect on psychological benefits (Butki and Rudloph, 1997; Levinger et al., 2005; Petruzzello and Landers, 1994; Rudolph and Butki, 1998).

*Exercise Duration*Time Interaction*

However, it should be noted that, in the current study, a significant exercise duration*time interaction emerged for tranquility, physical exhaustion, and affective valence (pleasure and displeasure). The interaction suggests that, for both tranquility and physical exhaustion, the shorter duration (5- and 10- min) walks produced more favorable responses post-exercise. Although tranquility decreased below baseline immediately post-exercise following all three walks, the delayed favorable effect of exercise on tranquility was apparent following only the 5- and 10-min walks. Tranquility increased above baseline 20 and 40 min post-exercise following the shorter walks (5- and 10- min), while there was no change in tranquility following the longer (30-min) walk. Similarly, physical exhaustion was reduced at all three time points following the shorter (5- and 10- min) walks, whereas the longer (30-min) walk induced physical exhaustion both immediately post- and 20 min post-exercise. It is possible that the 30-min walk manifested a greater excess post-exercise oxygen consumption and that this may have influenced physical exhaustion responses during recovery.

The interaction for affective valence (pleasure and displeasure) is more difficult to explain. Whereas all three walks increased affective valence (pleasure and displeasure) immediately post-exercise, this response was maintained 20 and 40 min post-exercise following only the 30- and 5- min walks. Conversely, affective valence (pleasure and displeasure) had decreased below baseline 40 min post-exercise following the 10-min walk.

Additionally, when controlling for the variance of the covariate sex, the exercise duration*time interaction became significant for calmness. This interaction suggests that, after controlling for sex, the longer (30-min) walk had the greatest effect on calmness, while calmness was less positively elevated following the shorter (5- and 10- min) walks. When the data were analyzed by sex, it became apparent that the exercise duration*time interaction was due to the substantial increase in calmness reported by males following only the longer (30-min) walk. These results suggest that, whereas females may feel more calmness (and thereby less negative affect) following an acute bout of moderate intensity walking regardless of the duration, this response may be more pronounced in males following longer (30-min) rather than shorter duration (5- and 10-min) walks.

Effect of Moderating Variables

There was no effect of trait anxiety or exercise enjoyment on responses following the exercise. Interestingly, fitness and sex did impact the relationship between exercise and several affective measures (positive affect, revitalization, energetic arousal, energy, and calmness).

Fitness

More fit participants experienced greater positive affect immediately post-exercise and elevations were maintained above baseline during recovery at 20 min post-exercise, while less fit participants experienced a similar initial increase but the decline was more rapid, falling well below pre-exercise levels at 20 min post-exercise. This suggests that the favorable effects of moderate intensity walking on positive affect are more pronounced and experienced over a longer duration post-exercise for more fit participants compared with those who are less fit. Possibly, the exercise intensity was too high for the low fit participants. The fitness*exercise duration interactions for both energetic arousal and energy suggests that more fit participants experienced less energetic arousal and energy following the shortest (5-min) walk compared to the longer (10- and 30- min) walks while the opposite was true for the less fit participants. This suggests that a moderate intensity walk of 5-min may be long enough to induce positive changes in energetic arousal and energy in lower fit participants, while longer duration walks may be necessary to elicit similar responses in more fit participants.

Sex

For both positive affect and energy, males experienced a positive change from pre- to immediately post-exercise and a gradual return towards baseline between 20 and 40 min post-exercise compared to females whose decline was much steeper, dropping below baseline at 40 min post-exercise. The results for positive affect mirror the positive affect results found for fitness and may reflect that in the current study males were more fit than females and thus experienced more pronounced positive affective responses following walking. Additionally, males experienced increased revitalization at all three time points post-exercise in comparison to females, who initially experienced an increase before a decline below baseline over time. These results suggest that males may respond more favorably than females to an acute bout of walking regarding these affective measures.

Comparison with other walking studies is not possible, as this is the first study to incorporate these covariates into the analysis of the walking-affective response relationship. Whereas Focht (2009) did measure enjoyment of physical activity, these responses were analyzed to examine intent to engage in future exercise rather than measured affective responses. However, other non-walking studies have incorporated these covariates into their investigations. Following are some examples. Petruzzello, Hall and Ekkekakis (2001) reported that more-fit individuals reported greater levels of energetic arousal, specifically increased energy and decreased tiredness, at multiple time points measured post-exercise (0, 10, 20, and 30 min) following 30-min of running at 75% $\dot{V}O_{2max}$ compared to less-fit individuals, supported by the results of the current study. Additionally, Parfitt, Markland and Holmes (1994) reported that there was no difference in affective valence (pleasure and displeasure) measured by the FS between men and women following four min of moderate and high intensity cycling (60 and 90% estimated maximal capacity). In a recent investigation (Magnan, Kwan and Bryan, 2013), although post-exercise measurements were not taken, researchers determined that individuals who were regularly active experienced increased positive affect and decreased negative affect as well as increased tranquility and decreased fatigue in the last min of an acute bout of 30 min of moderate intensity (65% estimated $\dot{V}O_{2max}$) treadmill exercise. Although the current study also found an interaction between fitness and positive affect, the interaction between fitness and the other affective states (negative affect, tranquility, and fatigue) measured in the previous study were not confirmed in the current investigation. However, Raedeke (2007) determined that exercise enjoyment was related to increased positive affective responses but not negative affective responses following participation in a group fitness class, unlike the results of the current study.

Study Limitations

Although the results of the current study extend previous findings regarding affective responses to walking, several limitations should be noted. While the study was a repeated measures cross-over design, the lack of a non-exercise control trial equal in duration to each of the three exercise durations was not included for comparison. Moreover, it would have been helpful to include additional evaluations that allowed the use of social media during either the walk, rest, or the entire trial to demonstrate whether or not its removal affected responses.

Additionally, we attempted to increase internal validity by limiting the influence of external factors; however, these controls may have affected the outcome of the study. Specifically, as all walking and rest periods were completed in a laboratory and not in a natural environment, the results may be less favorable, as the setting would likely not be the choice for most individuals. For instance, Focht (2009) compared equal duration acute walks in both settings and found that the walk in a natural environment produced more favorable results than did the walk in the lab. Additionally, participants in the current study were not allowed to self-select their walking intensity, which previous research has suggested may lead to a more favorable affective response post-exercise (Parfitt et al., 2006; Rose and Parfitt, 2007).

Another possible confounding factor may have been the social isolation experienced by participants during both the walk and the recovery, including restrictions placed on all forms of social media and interaction with the researchers. This deviation from the norm may have negatively affected responses post-exercise. Whereas this restriction was imposed to minimize the previously noted influence of variability in affective responses during exercise due to social factors (Turner, et al., 1997), the effect on affective responses of limiting social media during and following exercise has not yet been studied.

Additionally, multiple participants anecdotally stated that they regularly listen to music while exercising and expressed their disappointment, especially concerning the 30-min walk, when researchers explained that its use was prohibited during the walks. While listening to music was excluded due to the inability to standardize it across all participants as well as its ability to have an effect on psychological states during exercise (Boutcher and Trenske, 1990), its absence may have had a negative impact on responses immediately post-exercise.

Finally, although researchers attempted to include only moderately fit individuals in the study, researchers note that the physical activity screening questionnaire did not specifically control for mode of exercise. The lack of differentiation between the number of aerobic versus anaerobic minutes of exercise performed per week may have led to the inclusion of participants who were less aerobically fit to be enrolled in the study, thereby influencing study results. Those who were less fit walked at a higher percentage of their maximal capacity. As there appears to be an inverse dose-response relationship between exercise intensity and favorable psychological responses to exercise (Ekkekakis, et al., 2011; Reed and Ones, 2006), it is possible that the unfavorable results seen in the current study could be attributed, in part, to the higher exercise intensity at which the less fit participants walked.

Future Directions

To date, few studies have examined walking for the alleviation of anxiety and alteration of affect. Additionally, only one study has previously compared the effect of different durations of walking (Focht, 2013). Currently, little evidence in the literature exists to support the use of walking durations of less than 10 min to induce changes in anxiety and affect. As this study found favorable effects on psychological states following an acute bout of 5-min of walking, further investigations should examine the effects of exceptionally short duration walks (< 10-min). Additionally, much of the current literature has not measured responses post-exercise for a very long duration. Future investigations should systematically evaluate post-exertional responses for a substantial duration (e.g., at least one hour).

Conclusion

The present study used a unique design to investigate the anxiety and affective responses to multiple exercise durations at several time points post-exercise. Most psychological measures exhibited a change over time. While some measures responded favorably to acute bouts of walking (anxiety, tense arousal, calmness, tension, tranquility, physical exhaustion, affective valence, and revitalization), others responded unfavorably (positive affect, perceived activation, energetic arousal, energy, and positive engagement). However, it is possible that these unfavorable responses may be attributed to the design of the study rather than the exercise itself. Additionally, exercise duration was not a major factor influencing the exercise-affective response relationship. However, when there was an exercise duration*time interaction (tranquility, physical exhaustion, and affective valence), it appeared as if the shorter duration walks (5- and 10- min) produced more favorable responses post-exercise than did the longer walk (30-min) for both tranquility and physical exhaustion. Finally, of the four covariates studied in the current investigation, neither levels of trait anxiety nor enjoyment of exercise had any effect on post-exercise responses. Additionally, although the majority of measures were not affected by sex and fitness, these two covariates did affect the results of some of the measures (positive affect, revitalization, energetic arousal, energy, and calmness).

Previous literature has found that exercise is an effective method in altering negative psychological states including both anxiety as well as low positive affective and high negative affective states. However, the current literature, including this study, show that further research is necessary to determine the dose of walking, specifically the preferred duration and intensity, necessary to elicit changes in different populations. Although more research is warranted, the present study suggests that 30-, 10-, and 5- min acute bouts of moderate intensity walking may be effective in positively altering anxiety, revitalization, tranquility, feeling states, tension, and possibly negative affect. Additionally, the shorter walks (5- and 10- min) showed favorable responses for both tranquility and physical exhaustion.

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APPENDIX A

SCREENING QUESTIONNAIRE FOR POTENTIALLY HEALTH SUBJECTS

Screening Questionnaire for Potentially Healthy Subjects

Contact Information:

Name: ____

Cell phone: ____

Home phone: ____

E-mail: ____

Are you available on two separate days, at least 2 but no more than 7 days apart? One time, for about 1 hour, on the first day and then 3 times, for a total of about 4 hours, on a second day (morning, mid-day, and evening)? YES NO

Biographical Information:

Age: ____________ Height: ____________ Weight: ____________

Medical Information:

What medical problems do you have, such as high blood pressure, diabetes, or breathing difficulty? Have you ever been diagnosed with asthma?

____

____

What medications do you take (including herbal supplements and over-the-counter medications)?

____

____

Wellness Information:

Do you smoke? __________________

Have you ever smoked? If yes, when? __________________

Do you participate in physical activity (ie. walking to class, yard work, etc)? If yes, what type?

____

____

Approximately how many minutes of physical activity do you perform in a week? ___________

Have you participated in consistent planned exercise within the past year?

____

Have you ever experienced problems during exercise or physical activity? If yes, please describe.

____

____

Have you ever been diagnosed with anxiety by a psychologist/psychiatrist? _________________

Have you ever been prescribed medication for anxiety? If so, what medication? _____________

____

____

Additional Comments:

____

____

APPENDIX B

PAR-Q FORM

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ____

SIGNATURE ________________________________ DATE ________________________

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) ________________________ WITNESS ________________________

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

APPENDIX C

SELF-ADMINISTERED PRE-EXERCISE MEDICAL HISTORY QUESTIONNAIRE

SELF-ADMINISTERED PRE-EXERCISE MEDICAL SCREENING QUESTIONNAIRE

Date __________________

Name ____
Last First MI

Address ____
Street Apt #

____
City State Zip Code

Contact ____
Home Phone Cell Phone Email

Date of Birth____________________ Age_____________ Sex_________ Ht______ Wt________
MM/DD/YYYY

Occupation ____

Emergency Contact ____
Name Relationship Phone

Mark any of the following that apply to you (adapted from Preparticipation Health Screening and Risk Stratification. In: *ACSM's Guidelines for Exercise Testing and Prescription*, edited by W. R. Thompson, N. F. Gordon, and L. S. Pescatello. Philadelphia, PA: Wolters Kluwer; Lippincott Williams & Wilkins, 2010, p. 18-39.

___Pain, pressure, or other discomfort in chest, neck, jaw, arms, or other areas

___Shortness of breath at rest or with mild exertion

___Dizziness or syncope

___Shortness of break when you lie down or that wakes you up while sleeping

___Swollen ankles, or any unexplained swelling

___Your heart feels like it is skipping beats or racing while at rest

___Pain when walking that is relieved with rest, especially pain in the calf or thigh muscle

___Known heart murmur told to you by a physician

___Unusual fatigue or shortness of breath with usual activities

---

List any medicines, drugs, and herbal products or dietary supplements you are now taking: __________________

____

____

Have you ever experienced bouts of depression or anxiety? Yes _____   No _____

If yes, please describe the duration of the bout:

If you answered yes to the question above, please explain how you normally respond to bouts of depression or anxiety.

Do you have high cholesterol (defined as LDL cholesterol ≥ 130 mg/dL or total cholesterol ≥ 200 mg/dL)? If yes, what are the values? _______________________

Do you know your HDL cholesterol level? If yes, what is the value? _________________________

Explain any significant medical problems you consider important for us to know: ________________________

____

____

Adapted from AHA/ACSM Health/Fitness Facility Preparticipation Screening Questionnaire as shown in: Preparticipation Health Screening. In: *ACSM's Guidelines for Exercise Testing and Prescription*, edited by L. S. Pescatello, R. Arena, D. Riebe, and P.D. Thompson. Philadelphia, PA: Wolters Kluwer; Lippincott Williams & Wilkins, 2014, p. 19-38.

Assess your health status by marking all *true* statements:

History

You have had:

_____ a heart attack
_____ heart surgery
_____ cardiac catheterization
_____ coronary angioplasty (PTCA)
_____ pacemaker/implantable cardiac defibrillator/rhythm disturbance
_____ heart valve disease
_____ heart failure
_____ heart transplantation
_____ congenital heart disease

Symptoms

_____ You experience chest discomfort with exertion
_____ You experience unreasonable breathlessness
_____ You experience dizziness, fainting, or blackouts
_____ You experience ankle swelling
_____ You experience unpleasant awareness of a forceful or rapid heart rate
_____ You take heart medications

Other health issues

_____You have diabetes
_____You have asthma or other lung disease
_____You have burning or cramping sensation in your lower legs when walking short distances
_____ You have musculoskeletal problems that limit your physical activity
_____ You have concerns about the safety of exercise
_____ You take prescription medications
_____ You are pregnant

Cardiovascular Risk Factors

_____ You are a man ≥ 45 years
_____ You are a woman ≥ 55 years
_____ You smoke or quit smoking within the previous 6 months
_____ Your blood pressure is > 140/90 mm Hg
_____ You do not know your blood pressure
_____ You take blood pressure medication
_____ Your blood cholesterol level is ≥ 200 mg/dL
_____ You do not know your cholesterol level
_____ You have a close blood relative who had a heart attack or heart surgery before age 55 (father or brother) or age 65 (mother or sister)
_____ You are physically inactive (i.e., you get < 30 minutes of physical activity on at least 3 days per week)
_____ You have a body mass index ≥ 30 kg/m^2
_____ You have prediabetes
_____ You do not know if you have prediabetes

_____ None of the above

APPENDIX D

24-HOUR HISTORY

24-Hour History

ID ______________
Date ______________
Time ______________

1. How many hours of sleep did you get last night? (please circle one)

   1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 (hrs)

2. How many glasses of water or other beverages have you consumed in the last 24 hours?

   1 2 3 4 5 6 7 8 9 10 11 12 13 14

   List the beverages & amount consumed below:

3. How many hours has it been since your last meal or snack? (please circle one)

   1 **1.5** 2 **2.5** 3 **3.5** 4 **4.5** 5 **5.5** 6 **6.5** 7 **7.5** 8 **8.5** 9 **9.5** 10 **10.5** 11 **11.5** 12 **12.5** 13 **13.5** 14 **14.5** 15 (hrs)

   List the items consumed below:

4. When did you last have each of the following:
   · a cup of coffee or tea?

   · cigarettes?

   · drugs (including aspirin)?

   · alcohol?

   · herbal or dietary supplements?

5. What sort of physical activity did you perform yesterday?

6. What sort of physical activity have you performed today?

7. Has anything unusual, that is out of the ordinary, occurred within the last 24 hours that has **substantially** affected how your feel. Please circle: Yes / No

APPENDIX E

PRE-SESSION QUESTIONNAIRE

Pre-Session Questionnaire

ID ________________
Date ________________
Time ________________
Session # ________________

1. Since your last visit to the lab, how many hours of sleep have you had? (please circle one)

   1 **1.5** 2 **2.5** 3 **3.5** 4 **4.5** 5(hrs)

2. Since your last visit to the lab, how many glasses of water or other beverages have you consumed?
   1 2 3 4 5 6 7 8 9 10 11 12 13 14

   List the beverages & amount consumed below:

3. Since your last visit to the lab, how many hours has it been has since your last meal or snack? (please circle one)

   1 **1.5** 2 **2.5** 3 **3.5** 4 **4.5** 5(hrs)

   List the items consumed below:

4. Since your last visit to the lab, when did you last have each of the following:
   · a cup of coffee or tea?

   · cigarettes?

   · drugs (including aspirin)?

   · alcohol?

   · herbal or dietary supplements?

5. Since your list visit to the lab, have you performed any physical activity? If so, please describe below.

6. Since your list visit to the lab, has anything unusual, that is out of the ordinary, occurred that has **substantially** affected how your feel. Please circle: Yes / No

APPENDIX F

POST-EXERCISE REST PERIOD QUESTIONNAIRE

Post-Exercise Rest Period Questionnaire

ID ______________
Date ______________
Time ______________
Session # ______________

1. Please indicate what activities you did during the 40 minute rest period:

   ______ Rested quietly

   ______ Read

   ______ Studied

   ______ Did homework

   ______ Used the internet

   ______ Played games on your cell phone

   ______ Other: ____

2. Did anything happen in the last 40 minutes that **substantially** affected how you feel?

   Please circle: Yes / No

APPENDIX G

EXPLANATION OF ACSM GUIDELINES FOR PREPARTICIPATION HEALTH SCREENING AND RISK CLASSIFICATION

Explanation of ACSM Guidelines for Preparticipation Health Screening and Risk Classification

American College of Sports Medicine (ACSM) guidelines (1) provide for the classification of individuals into categories based on risk for a cardiac event (i.e., heart attack or sudden cardiac death) during exercise. Use of the guidelines follows the flow chart presented in Figure 1 below using the signs and symptoms of disease shown in Figure 2 and the cardiovascular disease risk factors shown in Figure 3. If the information associated with a cardiovascular disease risk factor (see Figure 3) is unknown, such as in the case of a person simply not knowing his/her cholesterol level or blood sugar, it gets counted as a risk factor. If there are 2 or more such instances, the person gets classified as moderate risk, even though perhaps his/her cholesterol level and/or blood sugar is in a safe range, as would be expected for an otherwise healthy individual aged 19-40 as will be recruited for the proposed study. Therefore, it is preferable to outright exclude only those individuals classified as high risk, and for other individuals determine eligibility on a case-by-case basis depending on whether they meet other exclusionary criteria as described in the protocol.

REFERENCES

1. Preparticipation health screening. In: LS Pescatello editor. *ACSM's Guidelines for Exercise Testing and Prescription*. Philadelphia, PA: Wolters Kluwer; Lippincott Williams & Wilkins; 2014, pp. 19-38.

Figure 1. Logic model for risk stratification.

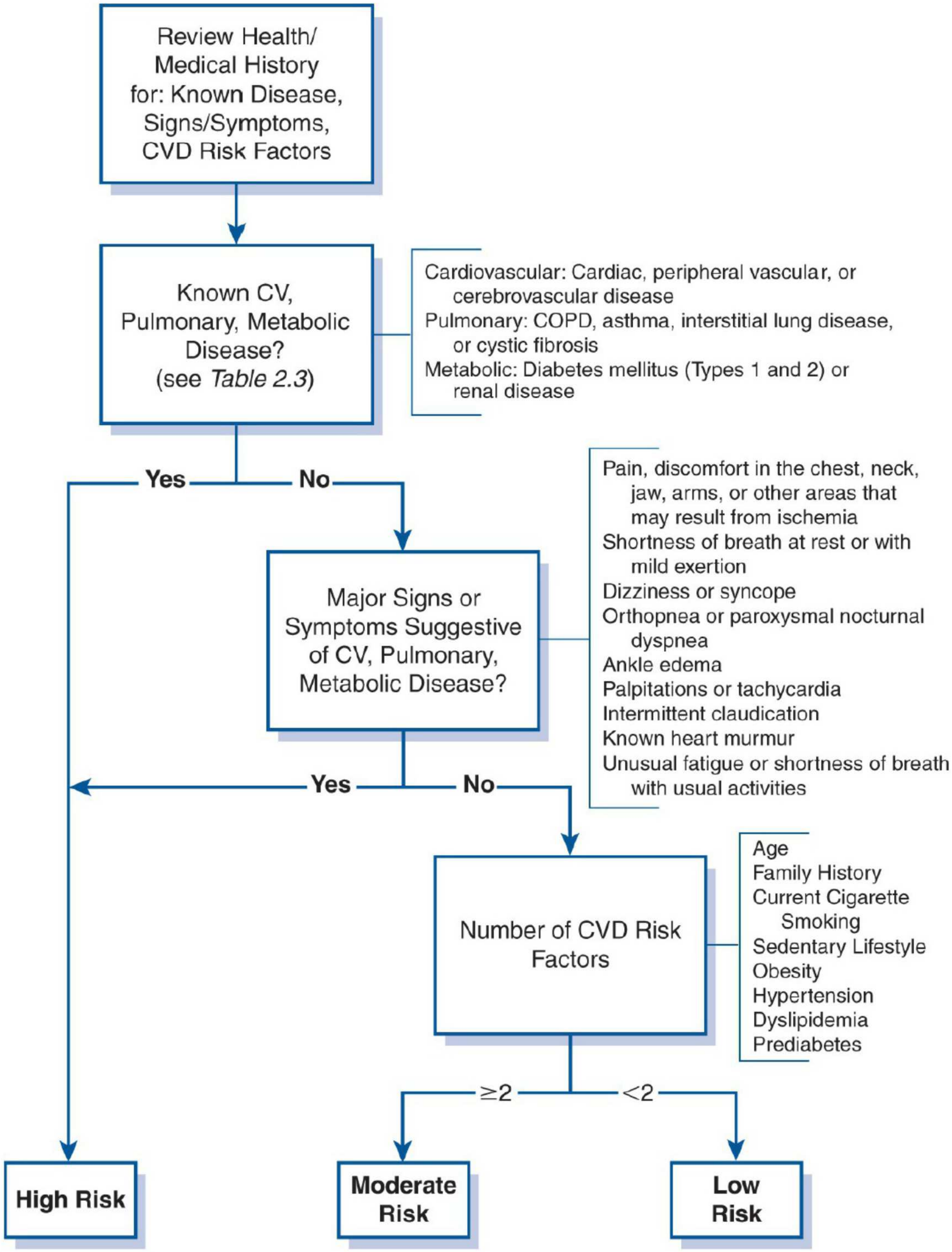

Figure 2. Major signs and symptoms of cardiovascular, pulmonary, or metabolic disease.

TABLE 2.1. Major Signs or Symptoms Suggestive of Cardiovascular, Pulmonary, or Metabolic Disease[a]

Signs or Symptoms	Clarification/Significance
Pain; discomfort (or other anginal equivalent) in the chest, neck, jaw, arms, or other areas that may result from ischemia	One of the cardinal manifestations of cardiac disease, in particular coronary artery disease Key features *favoring an ischemic origin* include the following: • *Character*: constricting, squeezing, burning, "heaviness," or "heavy feeling" • *Location*: substernal, across midthorax, anteriorly; in one or both arms, shoulders; in neck, cheeks, teeth; in forearms, fingers in interscapular region • *Provoking factors*: exercise or exertion, excitement, other forms of stress, cold weather, occurrence after meals Key features *against an ischemic origin* include the following: • *Character*: dull ache; "knifelike," sharp, stabbing; "jabs" aggravated by respiration • *Location*: in left submammary area; in left hemithorax • *Provoking factors*: after completion of exercise, provoked by a specific body motion
Shortness of breath at rest or with mild exertion	Dyspnea (defined as an abnormally uncomfortable awareness of breathing) is one of the principal symptoms of cardiac and pulmonary disease. It commonly occurs during strenuous exertion in healthy, well-trained individuals and during moderate exertion in healthy, untrained individuals. However, it should be regarded as abnormal when it occurs at a level of exertion that is not expected to evoke this symptom in a given individual. Abnormal exertional dyspnea suggests the presence of cardiopulmonary disorders, in particular left ventricular dysfunction or chronic obstructive pulmonary disease.
Dizziness or syncope	Syncope (defined as a loss of consciousness) is most commonly caused by a reduced perfusion of the brain. Dizziness and, in particular, syncope *during* exercise may result from cardiac disorders that prevent the normal rise (or an actual fall) in cardiac output. Such cardiac disorders are potentially life threatening and include severe coronary artery disease, hypertrophic cardiomyopathy, aortic stenosis, and malignant ventricular dysrhythmias. Although dizziness or syncope shortly *after* cessation of exercise should not be ignored, these symptoms may occur even in healthy individuals as a result of a reduction in venous return to the heart.
Orthopnea or paroxysmal nocturnal dyspnea	Orthopnea refers to dyspnea occurring at rest in the recumbent position that is relieved promptly by sitting upright or standing. Paroxysmal nocturnal dyspnea refers to dyspnea, beginning usually 2–5 h after the onset of sleep, which may be relieved by sitting on the side of the bed or getting out of bed. Both are symptoms of left ventricular dysfunction. Although nocturnal dyspnea may occur in individuals with chronic obstructive pulmonary disease, it differs in that it is usually relieved after the individual relieves himself or herself of secretions rather than specifically by sitting up.
Ankle edema	Bilateral ankle edema that is most evident at night is a characteristic sign of heart failure or bilateral chronic venous insufficiency. Unilateral edema of a limb often results from venous thrombosis or lymphatic blockage in the limb. Generalized edema (known as anasarca) occurs in individuals with the nephrotic syndrome, severe heart failure, or hepatic cirrhosis.

Figure 2 (cont.).

TABLE 2.1. Major Signs or Symptoms Suggestive of Cardiovascular, Pulmonary, or Metabolic Disease[a] (*Continued*)

Signs or Symptoms	Clarification/Significance
Palpitations or tachycardia	Palpitations (defined as an unpleasant awareness of the forceful or rapid beating of the heart) may be induced by various disorders of cardiac rhythm. These include tachycardia, bradycardia of sudden onset, ectopic beats, compensatory pauses, and accentuated stroke volume resulting from valvular regurgitation. Palpitations also often result from anxiety states and high cardiac output (or hyperkinetic) states, such as anemia, fever, thyrotoxicosis, arteriovenous fistula, and the so-called idiopathic hyperkinetic heart syndrome.
Intermittent claudication	Intermittent claudication refers to the pain that occurs in a muscle with an inadequate blood supply (usually as a result of atherosclerosis) that is stressed by exercise. The pain does not occur with standing or sitting, is reproducible from day to day, is more severe when walking upstairs or up a hill, and is often described as a cramp, which disappears within 1–2 min after stopping exercise. Coronary artery disease is more prevalent in individuals with intermittent claudication. Patients with diabetes are at increased risk for this condition.
Known heart murmur	Although some may be innocent, heart murmurs may indicate valvular or other cardiovascular disease. From an exercise safety standpoint, it is especially important to exclude hypertrophic cardiomyopathy and aortic stenosis as underlying causes because these are among the more common causes of exertion-related sudden cardiac death.
Unusual fatigue or shortness of breath with usual activities	Although there may be benign origins for these symptoms, they also may signal the onset of or change in the status of cardiovascular, pulmonary, or metabolic disease.

[a]These signs or symptoms must be interpreted within the clinical context in which they appear because they are not all specific for cardiovascular, pulmonary, or metabolic disease.

Modified from (14).

Figure 3. Cardiovascular disease risk factors for use with ACSM risk stratification.

TABLE 2.2. Atherosclerotic Cardiovascular Disease (CVD) Risk Factors and Defining Criteria (26,31)

Risk Factors	Defining Criteria
Age	Men ≥45 yr; women ≥55 yr (12)
Family history	Myocardial infarction, coronary revascularization, or sudden death before 55 yr in father or other male first-degree relative or before 65 yr in mother or other female first-degree relative
Cigarette smoking	Current cigarette smoker or those who quit within the previous 6 mo or exposure to environmental tobacco smoke
Sedentary lifestyle	Not participating in at least 30 min of moderate intensity, physical activity (40%–<60% $\dot{V}O_2R$) on at least 3 d of the week for at least 3 mo (22,30)
Obesity	Body mass index ≥30 kg · m^{-2} *or* waist girth >102 cm (40 in) for men and >88 cm (35 in) for women (10)
Hypertension	Systolic blood pressure ≥140 mm Hg and/or diastolic ≥90 mm Hg, confirmed by measurements on at least two separate occasions, *or* on antihypertensive medication (9)
Dyslipidemia	Low-density lipoprotein (LDL) cholesterol ≥130 mg · dL^{-1} (3.37 mmol · L^{-1}) *or* high-density lipoprotein[b] (HDL) cholesterol <40 mg · dL^{-1} (1.04 mmol · L^{-1}) *or* on lipid-lowering medication. If total serum cholesterol is all that is available, use ≥200 mg · dL^{-1} (5.18 mmol · L^{-1}) (21)
Prediabetes[a]	Impaired fasting glucose (IFG) = fasting plasma glucose ≥100 mg · dL^{-1} (5.55 mmol · L^{-1}) and ≤125 mg · dL^{-1} (6.94 mmol · L^{-1}) *or* impaired glucose tolerance (IGT) = 2 h values in oral glucose tolerance test (OGTT) ≥140 mg · dL^{-1} (7.77 mmol · L^{-1}) and ≤199 mg · dL^{-1} (11.04 mmol · L^{-1}) confirmed by measurements on at least two separate occasions (5)
Negative Risk Factors	**Defining Criteria**
High-density lipoprotein (HDL) cholesterol	≥60 mg · dL^{-1} (1.55 mmol · L^{-1})

[a]If the presence or absence of a CVD risk factor is not disclosed or is not available, that CVD risk factor should be counted as a risk factor except for prediabetes. If the prediabetes criteria are missing or unknown, prediabetes should be counted as a risk factor for those ≥45 yr, especially for those with a body mass index (BMI) ≥25 kg · m^{-2}, and those <45 yr with a BMI ≥25 kg · m^{-2} and additional CVD risk factors for prediabetes. The number of positive risk factors is then summed.

[b]High HDL is considered a negative risk factor. For individuals having high HDL ≥60 mg · dL^{-1} (1.55 mmol · L^{-1}), for these individuals one positive risk factor is subtracted from the sum of positive risk factors.

$\dot{V}O_2R$, oxygen uptake reserve.

APPENDIX H

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Consent to Participate in a Research Study

Study Title: **Anxiety and Affective Responses to Acute Moderate Intensity Physical Activity (Walking): Effects of Varying Durations**

Investigator: Colleen Geary, MS
Graduate Student
Department of Kinesiology

You are being asked to take part in a research study.

This study is called: ***Anxiety and Affective Responses to Acute Moderate Intensity Physical Activity (Walking): Effects of Varying Durations.*** The study is being done by Colleen Geary, who is a doctoral student at the University.

What is this study about?

This study is being done to investigate anxiety and affective responses to **acute bouts** of moderate intensity walking.

This information is important/useful because the results from the proposed study will provide new and important information on the dose-response relationship between anxiety/affect and exercise and provide information regarding the length of time the response can be experienced following the end of the exercise.

Why have I been asked to take part in this study?

You have been asked to be in this study because you are a healthy man or woman between the ages of 19 and 29 and you are able to perform the things we will be measuring.

How many people will be in this study?

About 30 other people will be in this study.

Participant's Initials _____

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 2-20-15
EXPIRATION DATE: 5-14-16

What will I be asked to do in this study?

You will be asked to report to the Exercise Physiology Laboratory (2^{nd} floor Moore Hall) **on two separate days. You will be asked to come in 1 time on the first day and 3 times on the second day.**

Based on the screening previously completed, if you have met the study criteria and you agree to take part, you wil be asked to do these things:

You will perform the following during your first visit to the lab:

> You will fill out a form that tells us what exercise you did and how much sleep you got during the previous day.
>
> We will measure your height and weight.
>
> You will have your body fat estimated by having your skin pinched at 3 different sites on your body. The thickness of your skin at all the sites will be added together to estimate your body fat percentage.
>
> You will answer some questions regarding how you feel at that moment in time.
>
> You will walk on a treadmill at an easy level for a 5 to 10 minutes to warm-up. During this time, the level of exercise at which you will perform your next visits will be determined. After the warm-up, you will start walking at a slightly harder level. Every few minutes exercise will get harder. You will exercise until you cannot exercise any longer. This exercise test will measure your endurance. While you are exercising during the warm up and the endurance test, you will breathe through a tube connected to a rubber mouthpiece. The tube will be connected to a machine that analyzes the air you expire. You will have your heart rate measured by wearing a strap on your chest.

The first visit will last about 1 hour.

Two to seven days after your first visit, you will come back to the laboratory on a second day. **On this day, you will come to the lab three times, separated by at least 2 hours but no more than 5 hours.**

During your first visit to the lab on the second day, you will fill out forms like you did on the first day that tell us what exercise you did and how much sleep you got the day before.

The three visits to the lab on the second day will include the following:

> Before you begin any exercise, you fill out multiple forms that will ask you about your different feelings at that moment in time.

Participant's Initials _____

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 7-2015
EXPIRATION DATE: 5-14-16

You will wear a strap on your chest so we can measure your heart rate.

The next step depends on what order the trials have been assigned to you. These will be assigned in a random order. They will involve the following:

1. **During one of the three visits on the second day, you will walk on a treadmill for 30 minutes at the pace of a brisk walk.**

2. **During one of the three visits on the second day, you will walk on a treadmill for 10 minutes at the pace of a brisk walk.**

3. **During one of the three visits on the second day, you will walk on a treadmill for 5 minutes at the pace of a brisk walk.**

Immediately after each walk, you will be asked to answer questions regarding how you feel at that moment in time. You will then rest in the lab for 40 minutes. Every 20 minutes, you will again be asked to answer questions regarding how you feel at that moment in time.

At the end of each 40 minute rest period, you will be asked to answer some questions about what activities you did while you were resting.

Each time you come back to the lab on the second day, before you exercise, you will answer some questions regarding what you did when you were not at the lab.

Each one of the three sessions on the second day will take between 1-2 hours to complete, for a total of about 3.5-4 hours on the second day. Visits will be at least 2 hours but no more than 5 hours apart.

In total, the study will take about 5 hours of your time over the next week.

You will be asked at the start of each session if you want to continue with the planned activities. You will mark your initials on a checklist if you want to continue.

Will I receive money to be in this study?

To thank you for your time, you will be compensated with a $20 gift card for completing all parts of the study.

Participant's Initials _____

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 7-20-15
EXPIRATION DATE: 5-14-16

Will being in this study cost me anything?

Being in this study will not cost you anything other than potential travel costs getting to and from the laboratory where you will be tested.

Can the researcher take me out of this study?

The researcher may take you out of this study if she feels that something happens that means you no longer meet the study requirements or if you cannot follow study directions.

What are the benefits (good things) that may happen to me if I am in this study?

You may or may not regard information about your fitness level as well as an estimate of your body fat percentage as a benefit.

What are the benefits to scientists or society?

This study will provide exercise scientists with new and important information on the relationship between the dose of exercise and the psychological responses following exercise as well as provide information regarding how long the psychological responses last following exercise.

Society will benefit by having more information about how much exercise is necessary to improve your psychological well being.

What are the risks (dangers or harm) to me if I am in this study?

The main risk of being in this study is having a cardiac event, such as a heart attack, but this risk is rare. Only about 1 person per year for every 15,000 – 18,000 people dies of sudden cardiac death during exercise.

There is also a risk of feeling lightheaded, nauseous, or even fainting after performing exercise.

There may be unknown risks that could occur, as there are with any study involving exercise.

Participant's Initials _____

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 7-20-15
EXPIRATION DATE: 5-14-16

How will risks be minimized?

Risks will be minimized by:

- Only allowing you to participate in the study if you are healthy and without disease.
- Monitoring your heart rate during exercise sessions.
- Stopping a test if you show any signs or symptoms of impending illness.

Someone trained in CPR will be present for all sessions, and we are only 5 minutes from a hospital if an emergency occurs. In the event that this research activity results in an injury, treatment will be available, including first aid and emergency treatment as needed. Care for such injuries will be billed in the ordinary manner to you or your insurance company. We will not verify whether you have health insurance coverage. Therefore, if you are not covered and you become injured as described above, you will be responsible for any costs you incur for treatment. Neither the Principal Investigator nor the University of Alabama has made provision for payment of costs associated with any injury resulting from participation in this study.

You will be informed if significant new findings arise that might affect your willingness to continue in the study.

How will my privacy be protected?

Your privacy will be protected by asking you medically-related questions in a private room.

During exercise, your privacy will be protected by limiting the entrance of individuals into the laboratory to only those people who are working on the study and/or those people who normally work in the laboratory and have a desk there.

Medically-related information collected about you while you are exercising will not have your name on it.

Participant's Initials _____

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 7-20-15
EXPIRATION DATE: 5-14-16

How will my confidentiality be protected?

Information about you will be kept confidential. Your medical information will be kept in a locked office, and no data sheet with your information will have your name. Your name will be kept on file only to link information between trials. Only study personnel will have access to your information and data. Once all data collection is complete, any information with your name or other identifying information will be destroyed.

Data will be kept indefinitely but will only be accessible by the primary investigator and study personnel. No information will be given to a physician or other entity unless requested for your health and with your written consent. Data used in any publication resulting from the study will not be linkable to you in any way. After all data are collected, analyzed, and included in a research manuscript, data will be de-identified.

What are the alternatives to being in this study? Do I have other choices?

The alternative or other choice is not to participate.

What are my rights as a participant in this study?

Taking part in this study is voluntary—it is your free choice. You can refuse to be in the study. If you start the study, you can stop at any time. There will be no effects on your care or your relations with the University of Alabama.

The University of Alabama Institutional Review Board (IRB) is the committee that protects the rights of people in research studies. The IRB may review study records from time to time to be sure that people in research studies are being treated fairly and that the study is being carried out as planned.

Who do I call if I have questions or problems?

If you have questions about the study right now, please ask them. If you have questions about the study later on, please call the investigator, Colleen Geary, at 205-886-8084 or Dr. Mark Richardson, at 205-348-9180. If you have questions about your rights as a person taking part in a research study, you may call Ms. Tanta Myles, the Research Compliance Officer of the University at 205-348-8461 or toll-free at 1-877-820-3066.

Participant's Initials _____

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 7-20-15
EXPIRATION DATE: 5-14-16

You may also ask questions, make suggestions, or file complaints and concerns through the IRB Outreach Website at http://osp.ua.edu/site/PRCO_Welcome.html. You may email us at participantoutreach@bama.ua.edu.

After you participate, you are encouraged to complete the survey for research participants that is online at the outreach website or you may ask the investigator for a copy of it. Mail it back to the University of Alabama Office for Research Compliance, Box 870104, 152 Rose Administration Building, Tuscaloosa, AL 35487-0104.

I have read this consent form. I have had a chance to ask questions. I understand what I will be asked to do. I freely agree to take part in this study. I will receive a copy of this consent form to keep.

____ ________
Signature of Research Participant Date

____ ________
Investigator Date

____ ________
Witness Date

Re-affirmation of consent:

Visit #	Participant's Initials
2	_____
3	_____
4	_____

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 7-20-15
EXPIRATION DATE: 5-14-16

Participant's Initials _____

APPENDIX I

RECRUITMENT FLYER

Healthy Volunteers Needed

The Exercise Physiology Laboratory at the University of Alabama is Seeking Healthy Individuals to Serve as Research Participants for an Exercise Study on Responses to Moderate-Intensity Walking

To qualify, you must be:

- Between the ages of 19 and 29
- Free of any cardiovascular, pulmonary, or metabolic disease
- Not a smoker
- Not diagnosed with any psychological disorders

Testing requires 4 sessions over 2 days. You will receive information regarding your body fat percentage and aerobic capacity. You will also receive compensation in appreciation for your time and effort (a gift card worth $20).

If you are interested in participating, please contact

Colleen Geary: 205-886-8084 or cgeary@bamaed.ua.edu

APPENDIX J

RATING OF PERCEIVED EXERTION

Rating of Perceived Exertion

6 – No exertion at all

7 – Extremely Light

8

9 – Very Light

10

11 – Light

12

13 – Somewhat Hard

14

15 – Hard

16

17 – Very Hard

18

19 – Extremely Hard

20 – Maximal Exertion

APPENDIX K

ANXIETY LIKERT SCALE

Subject ID: __________________
Session: ___________________

Anxiety Likert Scale

Please circle the number that shows how anxious you feel at the moment.

For Example:

''If you circle '1' you are feeling not at all anxious at the moment. If you circle '3' you are feeling moderately anxious. If you circle '5' you are feeling the most anxious you could ever imagine.''

1	2	3	4	5
not at all anxious	a little anxious	moderately anxious	very anxious	extremely anxious

Davey, H. M., Barratt, A. L., Butow, P. N., & Deeks, J. J. 2007. A one-item question with a Likert or Visual Analog Scale adequately measures current anxiety. Journal of Clinical Epidemiology, 60, 356-360.

APPENDIX L

POSITIVE AND NEGATIVE AFFECT SCHEDULE

The PANAS

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent [INSERT APPROPRIATE TIME INSTRUCTIONS HERE]. Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

______ interested	______ irritable
______ distressed	______ alert
______ excited	______ ashamed
______ upset	______ inspired
______ strong	______ nervous
______ guilty	______ determined
______ scared	______ attentive
______ hostile	______ jittery
______ enthusiastic	______ active
______ proud	______ afraid

We have used PANAS with the following time instructions:

Moment	(you feel this way right now, that is, at the present moment)
Today	(you have felt this way today)
Past few days	(you have felt this way during the past few days)
Week	(you have felt this way during the past week)
Past few weeks	(you have felt this way during the past few weeks)
Year	(you have felt this way during the past year)
General	(you generally feel this way, that is, how you feel on the average)

Watson, D., Clark, L. A., and Tellegen, A. 1988. Development and Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales. Journal of Personality and Social Psychology, 54, 6, 1063-1070.

APPENDIX M

EXERCISE-INDUCED FEELING INVENTORY

Subject ID: ___________________
Session: ___________________

Instructions: Please use the following scale to indicate the extent to which each word below describes how you feel at this moment in time. Record your responses by filling-in the appropriate circle next to each word.

0 = Do Not Feel (DNF)
1 = Feel Slightly
2 = Feel Moderately
3 = Feel Strongly
4 = Feel Very Strongly (FVS)

	DNF	0	1	2	3	4	FVS
1. Refreshed		o	o	o	o	o	
2. Calm		o	o	o	o	o	
3. Fatigued		o	o	o	o	o	
4. Enthusiastic		o	o	o	o	o	
5. Relaxed		o	o	o	o	o	
6. Energetic		o	o	o	o	o	
7. Happy		o	o	o	o	o	
8. Tired		o	o	o	o	o	
9. Revived		o	o	o	o	o	
10. Peaceful		o	o	o	o	o	
11. Worn-out		o	o	o	o	o	
12. Upbeat		o	o	o	o	o	

Gauvin, L. & Rejeski, W. J. 1993. The Exercise-Induced Feeling Inventory: Development and Initial Validation. *Journal of Sport & Exercise Psychology*, 15, 403-423.

APPENDIX N

THE FEELING SCALE

Subject ID: ___________________
Session: ____________________

The Feeling Scale

While participating in exercise, it is common to experience changes in mood. Some individuals find exercise pleasurable, whereas others find it to be unpleasant. Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during exercise.

Please tell me how you feel **at this current moment** using the scale below by circling the appropriate number below.

+5	+4	+3	+2	+1	0	-1	-2	-3	-4	-5
Very Good		Good		Fairly Good	Neutral	Fairly Bad		Bad		Very Bad

APPENDIX O

FELT AROUSAL SCALE

Subject ID: ________________
Session: ________________

FELT AROUSAL SCALE (FAS)

(Svebak & Murgatroyd, 1985)

Estimate here how aroused you actually feel. Do this by circling the appropriate number. By "arousal" we meant how "worked-up" you feel. You might experience high arousal in one of a variety of ways, for example as excitement or anxiety or anger. Low arousal might also be experienced by you in one of a number of different ways, for example as relaxation or boredom or calmness.

1 LOW AROUSAL

2

3

4

5

6 HIGH AROUSAL

APPENDIX P

ACTIVATION DEACTIVATION ADJECTIVE CHECK LIST

Subject ID: ___________________
Session: ___________________

AD ACL Short Form

Each of the words on the back describes feelings or mood. Please use the rating scale next to each word to describe your feelings at this moment.

EXAMPLES

Relaxed **1** 2 3 4	If you circle 1, it means that you *definitely* feel relaxed *at the moment*.
relaxed 1 **2** 3 4	If you circle 2, it means that you feel slightly relaxed *at the moment*.
relaxed 1 2 **3** 4	If you circled 3, it means that the word does not apply or you cannot decide if you feel relaxed *at the moment*.
relaxed 1 2 3 **4**	If you circled 4, it means that you are *definitely not relaxed at the moment*.

Work rapidly, but please mark all the words. Your first reaction is best. This should take only a minute or two.

Subject ID: ___________________
Session: ___________________

1: definitely feel **2** : feel slightly **3** : cannot decide **4** : definitely do not feel

____

active	1	2	3	4
placid	1	2	3	4
sleepy	1	2	3	4
jittery	1	2	3	4
energetic	1	2	3	4
intense	1	2	3	4
calm	1	2	3	4
tired	1	2	3	4
vigorous	1	2	3	4
at-rest	1	2	3	4
drowsy	1	2	3	4
fearful	1	2	3	4
lively	1	2	3	4
still	1	2	3	4
wide-awake	1	2	3	4
clutched-up	1	2	3	4
quiet	1	2	3	4
full-of-pep	1	2	3	4
tense	1	2	3	4
wakeful	1	2	3	4

Thayer, R. E. (1967). Measurement of activation through self-report. *Psychological Reports, 20*, 663-678.

APPENDIX Q

PHYSICAL ACTIIVTY ENJOYMENT SCALE

Subject ID: ____________________
Session: ____________________

Physical Activity Enjoyment Scale

Please rate how you feel *at the moment* about the physical activity you have been doing.

		1	2	3	4	5	6	7	
*	I enjoy it	1	2	3	4	5	6	7	I hate it
	I feel bored	1	2	3	4	5	6	7	I feel interested
	I dislike it	1	2	3	4	5	6	7	I like it
*	I find it pleasurable	1	2	3	4	5	6	7	I find it unpleasurable
*	I am very absorbed in this activity	1	2	3	4	5	6	7	I am not at all absorbed in this activity
	It's no fun at all	1	2	3	4	5	6	7	It's a lot of fun
*	I find it energizing	1	2	3	4	5	6	7	I find it tiring
	It makes me depressed	1	2	3	4	5	6	7	It makes me happy
*	It's very pleasant	1	2	3	4	5	6	7	It's very unpleasant
*	I feel good physically while doing it	1	2	3	4	5	6	7	I feel bad physically while doing it

(cont.)

Subject ID: ___________________
Session: ___________________

	1	2	3	4	5	6	7
* It's very invigorating	1	2	3	4	5	6	7 It's not at all invigorating
I am very frustrated by it	1	2	3	4	5	6	7 I am not at all frustrated by it
* It's very gratifying	1	2	3	4	5	6	7 It's not at all gratifying
* It's very exhilarating	1	2	3	4	5	6	7 It's not at all exhilarating
It's not at all stimulating	1	2	3	4	5	6	7 It's very stimulating
* It gives me a strong sense of accomplishment	1	2	3	4	5	6	7 It does not give me any sense of accomplishment at all
* It's very refreshing	1	2	3	4	5	6	7 It's not at all refreshing
I felt as though I would rather be doing something else	1	2	3	4	5	6	7 I felt as though there was nothing else I would rather be doing

*Item is reversed scored (i.e., 1 = 7, 2 = 6, . . . 6 = 2, 7 = 1).

Kendzierski, D. & DeCarlo, K. J. 1991. Physical Activity Enjoyment Scale: Two Validation Studies. *Journal of Sport & Exercise Psychology*, 13, 50-64.

APPENDIX R: IRB APPROVAL LETTERS

Office for Research

Institutional Review Board for the
Protection of Human Subjects

THE UNIVERSITY OF
ALABAMA
RESEARCH

May 26, 2015

Colleen Geary
Department of Kinesiology
College of Education
The University of Alabama
Box 870312

Re: IRB Protocol # 15-010-ME
"Anxiolytic and Affective Responses to Acute Continuous and Fractionalized Moderate Intensity Walking"

Ms. Geary:

The University of Alabama IRB has received the revisions requested by the full board on 5/19/15. The board has reviewed the revisions and your protocol is now approved for a one-year period. Please be advised that your protocol will expire one year from the date of approval, 5/14/15.

If your research will continue beyond this date, complete the Renewal Application Form. If you need to modify the study, please submit the Modification of An Approved Protocol Form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, please complete the Request for Study Closure Form.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number. Please use reproductions of the IRB approved stamped consent/assent forms to obtain consent from your participants.

Good luck with your research.

Sincerely,

[redacted]

J. Grier Stewart, MD, FACP
Medical IRB Chair

358 Rose Administration Building
Box 870127
Tuscaloosa, Alabama 35487-0127
(205) 348-8461
fax (205) 348-7189
toll free (877) 820-3066

Office for Research

Institutional Review Board for the
Protection of Human Subjects

THE UNIVERSITY OF
ALABAMA
RESEARCH

June 18, 2015

Colleen Geary, MA
Department of Kinesiology
College of Education
The University of Alabama
Box 870312

Re: IRB Protocol # 15-010-ME
"Anxiolytic and Affective Responses to Acute Moderate Intensity Physical Activity (Walking): Effects of Varying Durations"

Ms. Geary:

The University of Alabama Medical Institutional Review Board has reviewed the revision to your previously approved full board protocol. The board has approved the minor change in your protocol.

Please remember that your approval period expires one year from the date of your original approval, 5/14/15, not the date of this revision approval.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants.

Good luck with your research.

Sincerely,

[redacted]

J. Grier Stewart, MD, FACP
Medical IRB Chair

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