THE INFLUENCE OF ANTICIPATORY PROCESSING ASSOCIATED WITH ANXIETY ON EMOTIONAL STATES, PHYSIOLOGICAL RESPONSES, AND BALANCE CONTROL

by

CAROLYN GEH

B.A., Simon Fraser University, 2006

A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

(Human Kinetics)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

August 2009

ABSTRACT

Falls and fear of falling is a crucial health care problem facing the elderly population. Although it is known that peoples ability to maintain their balance become impoverished under conditions of postural threat, the role of anticipatory anxiety in the cognitive mechanisms that lead to such changes in state anxiety and balance control is not fully understood. Applying Clark and Wells (1995) model of anticipatory cognitive processing, this study aimed to explore how anticipatory anxiety influences the perceptions of emotional states, physiological responses, and balance control in young, healthy female adults, and whether personality predispositions to experiencing anxiety accounts for some differences in these responses. A social learning paradigm was employed to induce anticipatory anxiety in the participants through the use of video observations of other people experiencing anxiety under similar conditions faced by the participants.

The sample for the current study consisted of twenty six young, healthy female adults recruited from the university population. In a 2 (Threat versus Non-threat condition) x 2 (Bin time 1 versus Bin Time 2) fully repeated measures design, the following results were obtained: (1) Perceptions of fear and state anxiety were significantly higher in the threat condition compared to the non-threat condition. These increased levels of self-reported state anxiety and fear were also found to be significantly influenced by Trait Anxiety. (2) Changes in physiological arousal, including systolic and diastolic blood pressure, mean arterial pressure, and galvanic skin conductance was significantly higher in participants in the threat condition compared with the non-threat condition. Changes in galvanic skin conductance (though not other physiological

variables), were found to be affected by Trait Anxiety. (3) No differences were found between the threat and non-threat condition for the frequency and amplitude (in both AP and ML directions) of postural sway. Subsequently, these differences were not pronounced when balance variables were examined as an effect of trait anxiety differences between groups dependent on threat condition.

Table of Contents

List of Tables

List of Figures

Acknowledgements

I would like to extend my deepest gratitude to my supervisors Dr. Peter Crocker and Dr. Mark Carpenter for their guidance and encouragement during my degree. Peter, your sense of humor, wisdom, scientific rigor, and, questions made my learning process challenging, yet such a pleasure each day. Mark, thank you for your patience with me while I felt and found my way around the lab. Your excitement about anxiety and balance was contagious and sparked my initial interest for my chosen thesis. For this, I thank you.

To Dr. Mark Beauchamp. I could not have asked for a better and more apt committee member. Your approach, questions, and involvement was so valuable to the success of my degree. Thank you.

To Val and Amber, your support and friendship will no doubt last with me forever.

Ma and Pa, even though you're far across the oceans, I would not be here if not for your unconditional love, patience, and encouragement. I can never thank you enough for being my parents.

Finally Steve, for every encouraging smile, hug, reassurance that I would finish, endless listening to my non-stop chatter some days, and everything else, thank you. You make every day brighter than it is.

Dedication

To Mama and Papa

CHAPTER I: INTRODUCTION

1.1 Statement of the Problem

Falls and fear of falling has been recognized as a debilitating problem amongst the aging population (Thomas & Heaney, 2005). In the last two decades, research spanning medicine, epidemiology, and experimental work has continued to grow at an accelerating pace in an effort to understand how falls occur and to reduce the number of falls that occur each year.

Research looking at the complex relationship between postural instability and fear of falling points to the involvement of a host of psychological, physiological, social, and neurological factors. These factors function as antecedents to increased anxiety, whereby anxiety reactions increase postural instability, while awareness of increased unsteadiness in turn provokes further anxiety (Yardley, 2004). In fact, laboratory work amongst multi-age samples clearly indicate that anxiety is a key factor in aggravating postural imbalance, thus leading to a higher risk of falls (Maki, Holliday, & Topper, 1991, Davis, Campbell, Adkin, & Carpernter, 2009). Extensive experimental work with young, healthy populations demonstrate that when individuals are placed under conditions of postural threat, their ability to maintain their balance becomes impoverished (Davis et al., 2009).

However, there is a need for further work to understand the cognitive processes that are associated with anxiety and how these might function as mechanisms that lead to a deterioration in the ability to control one's balance.

1.2 Aim of Research

Using Clark and Wells (1995) model of anticipatory cognitive processing, this study aims to apply its key components of ruminative thought processing and worry about future discourse as the cognitive mechanisms that might influence subsequent multiple psychological, physiological, and balance responses. In addition, this study also aims to explore the role of Trait Anxiety as a possible factor in influencing psychological, physiological, and balance responses.

CHAPTER II: REVIEW OF LITERATURE

2.1 Fear of falling

2.1.1 Definition and Epidemiology

Injuries and death due to falls is a major phenomenon facing our elderly population. Fear of falling was identified and described as an individual's perceived efficacy to carry out an everyday basic task without falling (Powell & Myers, 1995; Tinetti, Richman, & Powell, 1990). The prevalence of fear of falling is a debilitating phenomenon that affects patients with postural instability and gait disturbances, as well as elderly people who have previously fallen.

Epidemiological studies indicate that the annual incidence rate of falls among elderly over the age of 65 years living in the community is approximately 30%, and over 50% among individuals living in institutions. The rates are higher for those older than 75 years. Each year, at least 10 percent of older people suffer a serious injury caused by a fall, such as a fracture, joint dislocation, or severe head trauma (Afken, Lach, Birge, & Miller, 1994; Lach, 2005; 2006; Sattin, Lambert, Devito, 1990; Tinetti, Richman, & Powell, 1990). Furthermore, co-morbidities such as Type II diabetes, hypertension, Parkinson's disease, vestibular disorders, and impaired vision further increase the likelihood of an elderly person suffering from a fall (Anders, Dapp, Laub, von Renteln-Kruse, & Juhl, 2006; Bloem, Steijns, & Smits-Engelman, 2003; Franchignoni, Martignoni, Ferriero, & Pasetti, 2005; Yardley, 2004).

With the increase in our aging population and with increased life expectancy of retirees, the importance of maintaining mobility and physical independence is becoming ever more critical. Falls are associated with functional limitations and are likely indicative of declines in personal confidence, decreased mobility as a direct result of injury or self-imposed restrictions in activity and loss of personal autonomy (Lach, 2006; 2005; King & Tinetti, 2005; Tinetti, Richman, & Powell, 1990; Vellas, Wayne, Romero, Baumgartner, & Garry, 1994; Yardley, 2002; 2004;). The possible cycle of inactivity as a result from fear of falling may cause a negative downward spiral of events that may exacerbate age related changes and further increase the risk of future falls and other health problems. Fear of falling is associated with aversive outcomes such as depression, poor life satisfaction, decreased social contact, and an overall reduced quality of life (Jorstad, Hauer, Becker, & Lamb, 2005; Lachman, 2006; Li, Fisher, Harmer, McCauley, & Wilson, 2003; Yardley & Smith, 2002; Zijlstra, Van Eijk, Kempen, Van Haastregt, & Tennstedt, 2004). Considering the possible grave consequences of falls, it is not surprising that fear of falling is of imminent concern to health care professionals, researchers, and the elderly population.

Due to this pressing health care concern, many studies have attempted to improve the understanding of how falls occur, and how fear of falling and emotions such as fear and anxiety affect the ability to keep the human balance system in a state of equilibrium. The understanding of how falls occur is important especially at crucial times when the balance system is challenged, perturbed, or when an individual allows intrusive anxious thoughts to affect their ability to carry out tasks of daily living. Thus, predicting who is at risk of falling, and identifying the underlying causes of fear of falling amongst the elderly population is required so that a preventative approach to falls can be implemented.

2.2 Emotions

2.2.1 Distinguishing between anxiety and fear.

To understand the complexity of fear of falling, there needs to be a clear understanding of the emotions so frequently discussed interchangeably in the literature. These emotions are fear and anxiety. Anxiety is generally defined as a vague, unpleasant emotional state with qualities of apprehension, dread, distress, and uneasiness (Averill, 1973; Lazarus, 1991). Anxiety is frequently distinguished from fear by its hallmark ambiguity, and uncertain, existential threat (Lazarus, 1991; Spielberger, 1983). Fear involves threats that are sudden and concrete, involving the potential for imminent physical harm from clear and present danger (Lazarus, 1991). It assumes a specific feared object, person, or event. Fear is a direct, focused response to a specific event or object, and an individual is usually consciously aware of it. For example, most people will feel fear if they hear a gunshot across the street, hear the subsequent screams and see people scrambling to take cover.

A large body of empirical work in rodents, amphibians, reptiles, bees, primates, and humans, as well as observations from predator-victim relationships in the wild support the view that fear is a more *primitive* reaction than anxiety (Damasio, 1998; Ledoux, 2000). Ledoux suggests that the operation of fear occurs in a lower, more primitive brain system, unlike other emotional processes (e.g., sadness) which involve more highly evolved brain regions such as the prefrontal cortex.

The distinction between fear and anxiety is also supported by research observations by McNally (1990) and Hibbert (1984) in that panic patients (when they suffer from an episode of a panic attack) seem threatened by bodily harm and experience an intense freezing response or a desire to escape or attack the feared target. On the other hand, anxiety patients were observed to be threatened by personal inadequacy, and an inability to cope when they are anxious. The emphasis on existential threat in anxiety is also consistent with Spielberger's (1983) empirical findings that anxious persons, more so than others, are faced with threats to their self esteem but do not perceive physical dangers as any more threatening than do persons with a lower personality predisposition to anxiety (trait anxiety). Spielberger (1983) thus supports Lazarus (1991) that anxiety, at least in the trait sense, is predominantly an existential emotion.

Anxiety is often unfocused, vague, and nebulous. It is hard to pin down to a specific cause (Lazarus, 1991). Anxiety is a multisystem response to a perceived threat and is often accompanied by a combination of biochemical changes in the body. Sometimes anxiety being experienced in the present may stem from an event or person that produced pain and fear in the past (e.g., personal history and memories, and environmental and social context surrounding it), but the anxious individual is not always consciously aware of the original source of the feeling. It is the remoteness of anxiety that makes it difficult for people to compare their experiences of it. Whereas most people will be fearful in physically dangerous situations, and can agree that fear is an appropriate response in the presence of clear and present danger, anxiety is often triggered by objects or events that are unique and specific to an individual. An individual might be anxious because of a unique meaning or memory being stimulated by present circumstances and not because of some immediate danger. The ambiguous nature of anxiety is the primary factor which prevents the elaboration of clear action patterns to handle the situation effectively (Lazarus, 1991).

When attempting to study the emotions of fear and anxiety as either an antecedent or consequence of falls, it is not enough to say that one type of emotion leads to falls or arises as a consequence of falls. On one hand, numerous cross sectional and qualitative studies have shown that anxiety surrounding falls is apparent amongst the elderly (Andresen, Wolinsky, McGaugh, 2000; Frank & Patla, 2003; Miller, Wilson, Malmstrom, & Miller, 2006; Speechley & Tinetti, 1991; Tinetti & Williams, 1998). Common anxious cognitions include thoughts about losing their independence from a fall, and constant worry about the possibility of physical injury, even when there is no immediate reason to think a fall is likely. On the other hand, laboratory studies have shown that in states of fear or anxiety, balance control is compromised and individuals report heightened levels of fear and anxiety (Adkin et al., 2000; 2002; Brown, Polych, & Doan, 2006; Carpenter, Adkin, Brawley, & Frank, 2006; Maki, Holiday, & Topper, 1991). Thus, both fear and anxiety may be pivotal in aiding our understanding of the emotions underlying falls. In addition, understanding the role of individual personality differences and varying environmental cues and factors that impact both the emotions may help clarify their roles in fear of falling.

2.2.2 Personality and Emotions

2.2.2.1 Trait Anxiety. A large body of evidence suggests that personality plays an important role on how people appraise and cope with stressful situations (Carver & Scheier, 1990a; Costa & McCrae, 1985; 1987; Costa, Fleg, McCrae, & Lakatta, 1982; McCrae, 1990). Although personality can be characterized by many dimensions (Costa and McCrae, 1985), this research project will focus on a specific personality trait known as trait anxiety. Trait anxiety refers to an enduring characteristic of a person that can be used to explain an individual’s behavioral consistencies, and determines the likelihood that a person will experience anxiety in stressful situations (Spielberger, 1983). Spielberger’s extensive work on anxiety suggests that individuals who are highly trait anxious have a tendency to experience events as anxiety provoking to a greater degree than individuals who are low in trait anxiety (Spielberger, 1983; McNally, 1994). Individuals high in trait anxiety tend to create imagined negative outcomes about otherwise neutral events, and invest large amounts of cognitive effort to ruminative worry and apprehensive thoughts (Spielberger, 1983). Highly anxious individuals also tend to engage in biased information processing, creating spontaneous and distorted images of a variety of possible negative events that may occur (Clark & McManus, 2002; Mellings & Alden, 2000; Westberg, Lundh, & Jönsson, 2007). Such biased processing is likely to generate and maintain anxiety and also modulate behavioral responses, such as safety behaviors that are likely to prevent improvement. For instance, a safety behavior would be to stay away from walking by the same sidewalk that one has experienced a fall. These safety behaviors in can negative beliefs because if the feared catastrophe does not happen, then the nonoccurrence might be attributed to the individual’s own safety and avoidance behavior (Clark & McManus, 2002).

Although strong support has been found for a moderating effect of trait anxiety on perceived state anxiety, the support for effects of trait anxiety on physiological responses during anxious situations is fairly poor (Mauss, Wilhelm, & Gross, 2004). Finally, trait anxiety has not yet been investigated in terms of its effects on changes in balance control in a highly aversive or stressful situation.

2.2.3 Anticipatory Processing of Anxiety

To investigate the emotional processing mechanisms that may lead to a decrease in the ability to maintain balance, there needs to be an effective way to probe both the emotion and balance system. This research project will attempt to manipulate the anticipatory cognitive processing associated with anxiety as a mechanism to influence both emotional states and balance control.

According to Lazarus (1991), anxiety denotes an anticipatory emotion due to its core relational themes- apprehension and uneasiness about the future (Lazarus, 1991; Ledoux, 1995). Signals preceding aversive events often serve to forecast impending danger, threat, or otherwise undesired outcomes. Negative ruminative thought processing and worry are often labeled key components of anxious anticipation. However, depending upon various factors such as individual personality and possible outcomes, the cognitive processes of worry and anxious apprehension can function as a double edged sword. On one hand, anxiety can prompt one to engage in preparatory behavior for a future negative event. While, on another hand, anticipatory processes such as negative thoughts about the future and oneself can serve to create distress that may persist into the negative situation itself. Therefore, the anticipation of aversive events involve multiple affective and cognitive constituents including detection of threat, the regulation of unpleasant emotions, selective attention, autonomic activation, and the initiation of motor systems to prime the organism for action or withdrawal (Butler & Matthews, 1987; Dvorak-Bertsch, Curtin, Rubinstein, & Newman, 2007; Nitschke et al., 2006).

In a model of social phobia put forth by Clark and Wells (1995), extreme anticipatory anxiety was described to be a common feature of social phobia and social anxiety. Indeed, numerous studies have confirmed that individuals scoring high in trait social anxiety frequently report that the anticipation of a negative future event is worse than the event itself (Eckman & Shean, 1997; Hinrichson & Clark, 2003). According to Clark and Wells' (1995) model of anticipatory anxiety, anxious individuals who engage in anticipatory processing do so by retrieving and dwelling on negative information and constructing negative images about the anticipated situation. Mansell and Clark (1999) reported that highly anxious individuals were more likely to recall negative words relating to their observed self when anticipating giving a public presentation compared to low anxious individuals. In another pilot study looking at highly anxious individuals (Hinrichsen and Clark, 2003), high socially anxious individuals reported thinking significantly more than low socially anxious individuals about ways in which they could get out of the situation if they had become too anxious and about ways in which they could avoid having to go into the situation. These findings point to evidence that given a choice, highly anxious individuals are more likely to disengage from an anticipated negative situation compared to low anxious individuals (Hinrichsen and Clark, 2003; Spielberger, 1983; Vassilopoulos, 2004; 2005). Records from semi-structured interviews also lead Hinrichsen and Clark (2003) to find that thoughts of catastrophisation were frequently present amongst highly anxious individuals.

Most work investigating physiological responses in response to anticipatory anxiety has been based on a framework of social phobia (Cornwell, Johnson, Berardi, & Grillon, 2006; Eckman & Shean, 1997). When anticipation of public speaking was compared to anticipation of a neutral event (Cornwell et al., 2006), the authors found that anticipation of public speaking elicited stronger physiological responses relative to anticipation of the neutral event. These studies, taken together indicate that anticipatory processing of a feared future event may in fact hamper peoples' ability to effectively cope and deal with the upcoming event.

Although several cognitive models have provided detailed descriptive accounts of potentially adverse types of processing during and after anxiety provoking events (e.g., Clark & Wells, 1995; Eckman & Shean, 1997; Leary & Kowalski, 1995; Mellings & Alden, 2000), several studies have specifically focused on anticipation prior to the feared event or stimuli (Brown & Stopa, 2007; Hinrichsen & Clark, 2003; Vassilopoulos, 2004). Specifically, these studies examined the influence of anticipatory processing on *socially* anxious situations. Moreover, to the best of my knowledge, anticipatory processing has not yet been extended to the study of why individuals develop a fear of falling, and whether or not anticipatory processing might be a salient contributor to the mechanism of falls and fear of falling.

2.2.4 Anticipatory processing through social observation

The capacity to anticipate negative emotional states and circumstances is central to an individual's successful adaptation, leading to behavioral, emotional, and physiological adjustments in preparation for, or prevention of aversive outcomes. One way to elicit anticipatory processing of anxiety in a person may be by way of using social observation of others experiencing anxiety. Bandura (1977) observed that this type of vicarious learning poses as an efficient way of learning. For emotional states such as fear, learning by observing others is associated with fewer risks than learning through direct aversive experiences. Recent work has shown that the act of observing others can invoke ruminative thoughts about the possibilities of harm to ones' own self, especially if they are already aware that the possibility of a similarly aversive event occurring to them is in the near future. To date however, only a small number of studies have employed social observations of other people as a paradigm for implementing anticipatory processing of anxiety in individuals (Olsson, Nearing, & Phelps, 2007).

Recent work on social learning of emotions supports the suggestion that social observations of others allows the observer to experience the emotions of the observed (de Gelder, 2006; Olsson, Nearing, & Phelps, 2007; John, Chesler, Bartlett, & Victor, 1968; Kavaliers, Choliers, & Coldwell, 2001). Sociocultural environments provide people with myriad ways of attaining emotional information, such as social observation and verbal communication (Ekman, 1982; Olsson, Nearing, & Phelps, 2007). In a recent investigation by Olsson and colleagues (2007), human participants observed a movie of another person receiving a shock and were subsequently told that they would also receive the same aversive treatment later. In this study, the authors investigated how fear could be acquired indirectly through social observation with no actual experience of the aversive event. The authors demonstrate that fear acquired indirectly through social observation (watching someone else being submitted to an aversive event), recruited key brain regions in the same way when subjects were subsequently placed in an analogous situation. Thus, from this study it appears that neural mechanisms and pathways can be recruited and activated even when one is merely observing other people in distress. The need to experience these aversive events themselves does not appear necessary. The brain regions recruited during the experience of anxiety that have been identified by Olsson and colleagues (2007) and others (Ohman & Mineka 2001) via functional magnetic resonance imaging include the amygdala, anterior cingulate cortex, and anterior insula. The findings from Olsson and colleagues (2007) provide initial evidence that the amygdala, a region known to be a critical site for the expression and acquisition in conditioned fear (Ledoux, 1995; Phelps & Ledoux, 2005) is similarly recruited in observational learning of fear.

2.2.5 Facial Expressions and Body Language

Investigators have strongly agreed that facial expressions serve as powerful non-verbal communicative displays crucial for social cognition and an efficient mechanism for rapid transmission of affective information to other organisms concerning predators, defensive behavior of outgroup members, and even unfamiliar environments (Zajonc, 1965; Bandura, 1977; Ekman, 1982). Researchers have shown that infant monkeys (Klinnert, Emde, Butterfield, & Campos, 1987), cats (John et al., 1968) and humans (Mineka & Cook, 1993) rapidly learn to display fear of objects which their mothers have expressed fear and disgust. Gerull and Rapee (2002) showed that toddlers under two years of age showed greater expression of fear and their avoidance of fear-relevant stimuli (a rubber snake or a rubber spider) after witnessing their mother display a negative (i.e., fearful or disgusted) facial expression. Findings from Olsson et al. (2007) indicate that fear learning through social observation rely on associative learning mechanisms supported by neural processes similar to those underlying classical fear conditioning. In this study, participants showed a robust fear response following observation of other people in a state of fear, supporting previous reports of comparable behavioral, psychological and physiological (Olsson and Phelps, 2004) expressions of fear following observational learning.

Proponents of evolutionary biology have long argued that emotions are adaptive in the sense that they prompt an action that is beneficial to the organism, given its environmental circumstance (Darwin, 1859; Ekman, 1982). Our ability to quickly identify body language can also tell one a general 'story' of the emotional state of another individual (de Gelder, 2006). De Gelder (2006), in her review of the neurobiology of emotional body language, emphasize that whole-body signals, as much as facial expressions are automatically perceived and understood by observers. Further, several studies propose that people are able to rapidly perceive and extract the overall configuration of the whole body and identify its' parallel emotional meaning (de Gelder, 2006). Advocates of emotion research regard facial and bodily movements to be theoretically as well as descriptively important as they are components of the action or action tendency of an emotional state, whether the action is intentional or purely expressive. Although there may be sources of noise such as the operation of social display rules, emotions are often, if not always revealed in the face (Lazarus, 1991; Ekman, 1982).

In summary, when people observe other people experiencing negative affective states (such as distress or fear), they might think, "That could also be me." This type of adaptive functioning is appropriate and holds relevance when attempting to study falls in a laboratory setting that hold up to ecological validity. Social relationships and groups holds high value to all human beings (Bandura, 1977), including elderly persons (Beauchamp, Carron, McCutcheon, & Harper, 2007). The existence of this value implies that watching someone else suffer or feel pain as a result from a fall may in fact garner empathic feelings within an individual. These empathic feelings may extend to feelings of anxiety in an individual. Numerous studies show that we learn from watching others' facial expressions, and people are very good at interpreting emotions just by observation. The fact that somebody else's emotional state may evoke emphatic responses and may be perceived as potentially relevant to our own future well-being or harm may be important to aiding in our safety. Based on the model of anticipatory processing and the work on anxiety and social observation, this study will employ the use of video clips to induce an anticipatory anxiety state in participants.

The current study proposes to employ the use of videos containing clips of actors experiencing distress from being subjected to a shock while having to perform a simple balance task. Distress of the actors in the video will be portrayed through the use of facial expressions, body language, and vocalizations. Participants will be told that they might also receive a shock to the same degree as that of the actors in the video while having to perform a simple balance task of three minutes quiet standing. The purpose of the video and instruction is to induce participants to feel anxious apprehension and anticipate the negative event that is looming ahead.

2.3 Physiological Arousal

2.3.1 Physiological Response in Anxiety

The study of emotion is incomplete without taking into account the changes that occur at multiple levels. Not all emotion responses are available to the conscious level and thus accessible to self report. In addition, suggestions have been made that the level of reactivity across domains of reported emotional states, behavior, and physiological anxiety may differ within individuals and between individuals (Davidson, 2002). In addition, it has long been known that in moments of stress, organisms exhibit physiological changes that include a redistribution of blood away from the gut and toward the brain and muscle

(Ledoux, 2002). These changes in blood flow account for the alterations in blood pressure and heart rate that occur as well as the alterations in skin conductance and temperature. Therefore, a number of measures typically used for measuring autonomic arousal will be used.

2.3.2 Cardiovascular Responses

Cardiovascular reactivity is a psychophysiologial construct referring to the magnitude, patterns, and, or, mechanisms of cardiovascular responses associated with exposure to psychological stress (Turner, Sherwood, & Light, 1992). It refers to the propensity for an individual to exhibit alterations in cardiovascular activity during exposure to external, predominantly psychological stimulus. Systolic blood pressure, diastolic blood pressure, and heart rate provide convenient indices that are amenable to quantification in terms of deviations from a reference baseline state.

2.4 Balance Control in Humans.

2.4.1 Biomechanics of Balance

To study and understand falls, it is critical to understand the other physical mechanisms involved in balance control. The maintenance of a stable posture is extremely important for humans in order to carry out basic tasks such as walking and standing. Considering that two thirds of our body mass is located two thirds of body height above the ground places continuous demand on our system to remain stable (Winter 1995). Further, as humans age and various physical systems deteriorate, these demands further propagate and at times lead to a breakdown of the balance system, resulting in falls and injury. Three major sensory systems are involved in balance and posture control in humans. The vision system, vestibular system, and somatosensory system work in unison to resolve the sense of position and velocity of body and head in space (Winter, 1995).

The vast majority of research in the fear of falling literature has attempted to investigate the relationship between fear of falling and postural control during quiet stance. In order to assess this elementary posture, researchers analyze the movement of centre of gravity (COG) and the centre of pressure (COP) (Horak, Esselman, Anderson, & Lynch, 1984). Despite previous muddlement surrounding the equivalence of COG and COP (Okubo, Watanobe, Takeya, & Baron, 1979), these two variables are not the same (Winter, 1995; Winter, Patla, & Frank, 1990). The centre of mass (COM) of a person is the point where the total body mass in which the weighed average of the centre of mass of each body segment in 3D space meets. The centre of gravity is the vertical projection of the COM on the ground, measured in meters. Net centre of pressure excursions in the anterior-posterior (AP) and medial-lateral (ML) directions is a time varying signal that is readily recorded from a single force plate. Mathematically, the centre of pressure is the point on a body where the net pressure force of the body acts through this point, causing a force and no moment about that point. Put another way, COP refers to the point location of the vertical ground reaction force vector (Winter, 1995). Increasing plantarflexor activity moves the COP anteriorly while increasing the activity of invertors moves the COP laterally. The centre of pressure during quiet standing times the ground reaction force is equal to the moment-of-force generated by the ankle muscles (Winter et al., 1990). The COP represents the net neuromuscular response of the central nervous system to modify displacements in COM. The time lag between COP-COM (or error signal) is highly correlated with the horizontal acceleration of COM meaning that when the COP is ahead of the COM, the horizontal acceleration is backwards, and when the COM is ahead of the COP, the horizontal acceleration is forward (Winter, 1995). The difference between COP and COM have prompted early researchers in posturography to model human balance during quiet standing as an inverted pendulum. This inverted pendulum model has been validated for healthy adults in quiet standing (Winter et al., 1998; Gage, Winter, Frank, & Adkin, 2004; Winter, Prince, Frank, Powell, & Zabjek, 1996).

2.5Fear of Falling Studies

Since the time of Caelius Aurelianus , a 5th century Roman physician who noted that fear is associated with incidents of acute vertigo with his observation that patients “*sedere volentibus timor*, or exhibit a [fear to move]”, researchers have found evidence for the effects of fear and anxiety on alterations in balance control (Frank, 2006). In a hallmark study by Maki, Holliday, & Topper (1991), elderly individuals who reported a fear of falling were found to differ on their control of balance from elderly individuals who did not report a fear of falling. Elderly individuals with a fear of falling displayed significantly larger amplitudes of sway compared to those who did not report fear of falling. However, factors other than fear, such as aging effects in an elderly sample make it difficult to delineate whether changes in centre of pressure parameters were due to self reported fear or variability in physiological decline from aging effects.

Other studies have since employed young, healthy adults to clearly delineate the influence of anxiety as a cause or consequence of fear of falling. Carpenter, Frank, and Silcher (1999) examined the control of quiet stance when standing on an elevated platform under various conditions of reduced visual and vestibular inputs. Under conditions of postural threat (i.e., standing on an elevated platform), young participants displayed increased frequency and decreased amplitude of sway. However, this observation was different from the findings of Maki et al. (1991) who observed an increased amplitude of sway in fearful compared with non-fearful individuals. Nonetheless, this observation prompted the authors to suggest that under conditions of postural threat, individuals make modifications to the control of posture through changes in ankle stiffness. The hypothesis for a stiffening strategy was later verified by Carpenter, Frank, Silcher, & Peysar (2001) via kinetic and kinematic parameters during quiet stance under increasing levels of postural threat (i.e., increasing height of the standing platform).

Other researchers have also confirmed that the central nervous system employs a tighter control over posture when the threat to balance is greatest and the potential consequences of a fall are more severe (Brown, Polych, & Doan, 2006; Carpenter et al., 2006). The combined changes of a reduced variability and increased frequency of postural sway, concomitant co-contraction of ankle joint agonist and antagonist muscle pairs (Carpenter et al., 2001), results in a tighter regulation of centre of mass.

Davis and colleagues (2009) observed that individuals who reported a robust fear response from standing at extreme heights adopted a different strategy from that observed in the previous studies (Brown et al., 2006; Carpenter et al., 1999; Carpenter et al., 2001). Davis and colleagues observed an increase in frequency *and* amplitude variability, suggesting that there may be differential effects of fear and anxiety on posture control. These observations were strictly observed in the few individuals who reported an incapacitating fear response. From these results and others (Simeonov and Hsiao, 2006), it appears that under conditions of self reported intense levels of fear, the inverted pendulum model seems to break down.

These findings replicate the early study by Maki and colleagues (1991) with fearful elders who displayed larger amplitudes of sway compared to those who were not fearful.

A majority of the fear of falling studies employed a height paradigm as a source of postural threat. However, Azevedo and colleagues (2005) found that anxiety induction through the use of negatively valenced pictures also succeeded in altering posture control. When viewing pictures with emotionally negative content (e.g., mutilation) relative to neutral or pleasant content (e.g., sports, furniture), individuals displayed a decrease in amplitude variability and an increase in frequency of sway in the medial-lateral axis. The pattern of amplitude modulation observed by Azevedo and colleagues (2005) was markedly similar to the posturography studies employing a height paradigm as a source of postural threat and anxiety. Subsequently, Fachinetti, Imbiriba, Azevedo,Vargas, & Volchan (2006) replicated the findings from Azevedo et al. (2005), showing that the mere picture of body mutilation caused individuals to adopt a muscle stiffening strategy. This rigid posture was interpreted by the authors to be a “freezing-like” reaction to distressing stimuli, similar to fear immobilizing behavior observed in animals encountering threat or danger in the wild (Ledoux, 1995; Darwin 1859). This reduction in body sway was also accompanied by significant heart rate deceleration (bradycardia) (Fachinetti et al., 2006).

Despite robust findings of changes in posture from Azevedo and colleagues (2005), other authors have presented different results. Stins and Beek (2007) employed a paradigm similar to that of Azevedo et al. (2005) and Fachinetti et al. (2006). However, images were presented randomly and not in blocked order. The posturography findings in this study only partially replicated the results of Azevedo and colleagues (2005). Specifically, Stins and

Beek (2007) found that participants employed a tighter control of posture in one-legged stance, but not two-legged stance. However, the minimal effects of affective picture viewing on posture found in this study were likely due to insufficient sampling duration of centre of pressure displacement (Carpenter, Frank, Winter, & Peysar, 2001).

2.6 Attentional Demands and Posture Control

Attentional theorists studying posture control posit that peoples' ability to maintain their posture become impoverished when attention capacity is depleted. Proponents of attentional theories in posture control suggest a dual task methodology to assess the attentional demands necessary for performing a primary task (posture task). Dual task methodologies function under the underlying assumptions that, there is limited central processing capacity in an individual. Performance of a task requires part of the limited processing capacity within the central nervous system, and if two tasks both share the limited central processing capacity and if this processing capacity is exceeded, the performance of one or both tasks becomes impoverished (Kahneman, 1973; Lajoie, 1993). The extent to which the performance on either task declines indicates the interference between the attentional processes controlling the two tasks (posture control and secondary task). For example, Stelmach, Zelaznik, and Lowe (1990) found that, when a simple mathematical addition task was performed concurrently with an arm-swinging task, postural recovery following the arm-swinging task produced a larger sway range for elderly participants compared to young healthy participants. Lajoie and colleagues (1993) later found that in a reaction time task, standing and walking required larger demands to attentional capacity compared to sitting, and that the attentional cost for walking was also significantly greater than for standing. In addition, the authors found that the attentional cost for walking using a small base of support were significantly larger than when participants employed a larger base of support. The conclusion that greater attentional demands were required in the small base of support condition was based on longer reaction times in the respective walking conditions (small base of support and large base of support).

Employing similar methodologies, other authors have demonstrated that the mechanisms for regulating postural stability interact with higher level cognitive systems and share similar attentional resources (Maki & McIlroy, 1996; Teasdale, Bard, Larue, & Fleury, 1993; Woollacott & Shumway-Cook, 2000). These findings suggest that the attentional demands of balance control vary depending on the complexity of the balance task and the type of secondary task being performed. However, attentional control theories do not take into account other factors that influence posture control and central processing, such as individual personality differences (e.g., neuroticism), levels of anxiety and fear at a given time, and past experiences. In addition, the fear of falling studies conducted to date have yet to investigate how balance control changes in response to anticipation of an aversive event.

2.7 Neuroanatomy of Anxiety and Balance

2.7.1 Neuroanatomy of Anticipatory Anxiety

Recent findings from rapid event related functional magnetic resonance imaging (fMRI) studies have indicated several key anatomical structures that are involved when individuals anticipate being exposed to aversive visual stimuli (Lang, 1995). These areas include the dorsal amygdala, anterior insula, dorsolateral prefrontal cortex, and anterior cingulate cortex (Nitschke, Sarinopoulos, Mackiewicz, Schaefer, & Davidson, 2006; Simmons, Strigo, Matthews, Paulus, & Stein, 2006). These brain areas appear to be critically involved in both anxiety and anticipatory processing. Ntischke and colleagues found that activation of the amygdala, insula, anterior cingulate cortex, right dorsolateral prefrontal cortex, and the right orbitofrontal cortex of individuals *anticipating* highly aversive pictures were similar to when the same individuals were being exposed to the aversive pictures. The association of right dorsolateral prefrontal cortex activation with withdrawal-related negative affect was observed across participants (Nitschke et al., 2005; Simmons, Matthews, Stein, & Paulus, 2004).

The joint activation of the anterior cingulate cortex and insula was also reported in other forms of aversion, such as the anticipation of an electric shock or noxious thermal stimuli (Chua et al., 1999; Ploghaus, Tracey, Gati, Clare, Menon, Matthews, & Rawlins, 1999). These two brain regions have been identified as critical areas for the integration of sensory, affective, cognitive, autonomic, and motor responses (Critchley, Rotshtein, Nagai, O'Doherty; Mathias, & Dolan, 2005; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004; Nitschke et al., 2006). Widespread efferent and afferent projections of the anterior cingulate cortex and insula to autonomic and behavioral response sites suggest the joint function of these two brain regions (i.e., anterior cingulated cortex and insula) on anticipatory cognitive processing and anxiety.

2.7.2 Anxiety and Balance Links

The recent upsurge of evidence from neuroscience indicates that neuroanatomical structures responsible for the control of human balance are also closely associated with emotion processing (Balaban & Thayer, 2001). The amygdala, a region known for the processing of fear and anxiety stimuli, send projections to the basal ganglia via the limbic loop, also known as the anterior cingulate basal ganglia-thalamocortical circuit. The basal ganglia also participate in complex networks that influence the descending motor systems and emotion regulation via the motor channel and limbic channel respectively (Alexander & Crutcher, 1990; Blumenfeld, 2002).

Balaban and Thayer (2001) and Balaban (2002) suggest that the amygdala, anterior cingulate cortex, basal ganglia, and orbitofrontal cortex are all involved in the sensation and perception of gravitoinertial accelerations, and receiving afferent information about movement relative to a gravitoinertial frame (Porter & Balaban, 1997). Under normal conditions, the brain receives consistent sensory input and self-object information to allow humans to perceive themselves in a gravity-based upright, egocentric frame of reference (Dharani, 2005). This, frame of reference is referred to as the gravitoinertial frame of reference. Interestingly, Ledoux's (2002) observation, as well as a number of other investigators (Charney and Deutsch, 1996), indicate that these very regions (amygdala, anterior cingulate cortex, and orbitofrontal cortex), also contribute to expressions of negative emotions, particularly fear and anxiety.

Balaban (2002) also identified that balance-anxiety linkages involve integrated activity of the vestibulo-parabrachial network (PBN), coeruleo-vestibular network, and raphe-nuclear-vestibular network (Balaban, 2002). Recent anatomical studies in rodents reveal that the PBN has clear reciprocal connections with the central nuclei of the amygdala, the infralimbic cortex, and hypothalamus (Balaban & Thayer, 2001; Moga, Herbert, Hurley, Yasui, Gray, & Saper, 1990). In primates, the vestibulo-recipient region of the PBN were demonstrated to have a robust response during whole body rotations, indicating that the PBN may relay information about body motion to pathways mediating autonomic and affective responses, including anxiety. Due to its prominent role in the formation of conditioned fear responses, the PBN has been widely cited as a substrate for panic and anxiety disorders (Balaban, 2002).

Clinical data corroborate the findings in neuroanatomical studies that anxiety and balance control are tightly coupled. Yardley, Britton, Lear, Bird, and Luxon (1995) reported an association between vestibular abnormalities and phobic avoidance. In other studies Jacob, Furman, Durrant, & Turner (1997; 1996) reported that agoraphobics and panic disorder patients had more vestibular abnormalities than healthy control patients. Similarly, Allevi and colleagues (1997) found a significant relationship between the presence of dizziness at the time when panic and agoraphobic patients were suffering an episode of panic attack.

2.7.3 Role of the Amygdala in Fear and Anxiety

Neurobiological studies in fear conditioning have placed a large emphasis on the amydala, a group of subnuclei located in the medial temporal lobe. The amygdala has been recognized to play a pivotal role in fear and the detection and organization of responses to natural dangers in vertebrates, including reptiles, birds, all varieties of mammals, including humans (Ledoux, 1995; 2000; 2002).

In terms of anatomical projections, rodent studies reveal that sensory information arrives in the lateral nucleus of the amygdala (LA) from the thalamus and sensory cortex, and serves as the sensory interface of the amygdala (Amaral, 1983; 2003; Ledoux, Farb, &

Ruggiero, 1990). The LA sends direct and indirect projections to the central nucleus of the amygdala (CA) (Pare, Smith, & Pare, 1995), which in turn projects to brainstem and hypothalamic regions that are important for mediation of autonomic and endocrine responses. The amygdala also projects to regions that are important for the regulation of behavioral expressions of fear (Davis & Whalen, 2001), such as the ventral tegmental area. The basal ganglia, an area known for its crucial role in motor outputs (Blumenfeld, 2002), receives mediating inputs from the basal nucleus of the amygdala.

Laboratory experiments with rodents now show that fear conditioning depends critically upon the transmission of sensory information about the conditioned stimulus and unconditioned stimulus to the amygdala (Fanselow & Ledoux, 1999; Ledoux, 2000). The LA also receives nociceptive information and has been proposed to be a site for forming associations between conditioning stimuli of fear and unconditioning stimuli.

Imaging data (Olson and Phelps, 2004) corroborate the evidence that the amygdala is similarly recruited during the acquisition and expression of fear when individuals observe other people partake in an aversive and threatening experiment. A hallmark study with brain damage patients who had undergone unilateral temporal lobotomy with large areas of the temporal lobe (including the amygdala) removed, clearly indicated that the patients exhibited impaired fear conditioning (LaBar, Phelps, Spence, and Ledoux, 2000; 2003; 1995). Lesions in monkeys confirm that the amygdala is also crucial for the acquisition and appropriate display of fear in social and novel situations (Ledoux, 2002; 1995).

Most compelling is the extensive work by McGaugh and colleagues who have implicated the amygdala in the emotional amplification of explicit memory (Cahill, 2000;

Cahill & Alkire, 2003; McGaugh, 2004; 2002a; 2002b; 2000; McGaugh, Vazdarjanova, & Roozendaal, 2000; McGaugh, Roozendal, & Cahill, 1999). Under stressful conditions, the central amygdala initiates a release of glucocortioids (including ACTH and cortisol) from the adrenal gland that return to the brain. The amygdala is an important target of such feedback (McGaugh, 2004). The effects of cortisol potentiate the amygdala, causing it to amplify its response to fear stimuli, and modulate the consolidation of explicit memories being formed during emotional arousal (McGaugh, 2004; Cahill, Babinsky, Markowitsch, & McGaugh, 1995; Cahill, Prins, Weber, & McGaugh, 1994.). The result of this occurrence is that the amygdala now has an enhanced response to emotional experiences. Later, the memories are more easily retrieved and the details of the original experience are more readily available. Although original work was conducted in rodents, these findings have also been confirmed in humans with selective bilateral lesions of the amygdala. Adolphs and colleagues (1997) and Cahill and colleagues (1995) found that memory for emotionally arousing material was not enhanced in lesioned patients, compared to normal controls. Thus, the stimuli that caused an elevated stress response in the first place might, on a later occasion, lead to an increased aversive or pathological response, rather than an adaptive response (Ledoux, 2002; Phelps & Ledoux, 2005). To tie the notion of how these important neural mechanisms relate to fear of falling, take an example of an elderly person who has fallen. Her experience is described as psychologically and physically traumatic. Thus, the next time this elderly person is exposed to the same conditions (e.g., icy sidewalks), her experience will be of much greater anxiety and fear.

2.7.4 Summary of Neuroanatomical studies and Implications to the Current Study

The current study will investigate how anticipatory processing of emotions might serve as a mechanism to influence balance control, physiological responses, and emotional states. Clinical data (Allevi et al., 1997; Jacob et al., 1996; 1997; and Yardley et al., 1995) and findings from neuroanatomical studies may provide researchers with some insight as to the underlying neural mechanisms that subserve the link between anxiety and falls in the elderly population. Despite the mounting evidence of neuroanatomical studies that find critical brain regions for fear, anxiety, and balance markedly overlap, it is crucial to acknowledge that fear of falling and the debilitating consequences from this phenomenon involve a complex host of environmental, predispositional, social, and cognitive factors (as discussed in the earlier sections of this literature review), and should not be attributed solely to structures in the brain.

Neuroanatomical studies that have found specific regions responsible for anticipating a variety of aversive stimuli may provide implications to how negative affect (such as fear or anxiety) are associated with loss of balance. Behavioral strategies for regulating anxiety and fear might, therefore, most appropriately be targeted at reducing the anticipatory processes.

2.8 Fear of Pain

Though fear of falling has clearly been identified as a serious health care problem in the elderly, this phenomenon is logically inherent and relevant to older age groups. Young and healthy cohorts usually do not suffer debilitating fear related to consequences from falls as they usually possess high confidence in their ability to maintain balance without falling. Further, they tend to have less adverse outcomes if they do fall. Young, healthy adults also do not suffer from effects of aging, such as decreased musculoskeletal strength, poor vision, pharmacological side effects, and slowed reaction time. Conversely, these deleterious effects of aging are directly associated with increased fall risks and fear of falling in the elderly. As a result, studying *actual* falls and fear of falling in the lab with young, healthy cohorts poses a problem as these worries are not at the forefront of concern for young individuals.

Considerable empirical findings suggest that other unpleasant emotional states, such as those related to pain, contain similar qualities to the unpleasant emotional states of both anxiety and fear. Recent evidence suggest that fear of pain and fear of falling, although distinct, are related constructs. In fact, most work has found in the area of pains and falls have found that elderly individuals who report high levels of fear of falling also report high levels of fear of pain (Hadjistavropoulos, Martin, Sharpe, Lints, McCreary, & Asmundson 2007; Williams, Hadjistavroupoulos, Asmundson, 2005) One of the common feared consequences of falls reported amongst seniors is the experience of pain related to injuries and disabilities (Jorstad et al., 2005; Yardley & Smith, 2002). Similarly, young adults consistently report high levels of fear of pain when they suffer from musculoskeletal injuries and are at risk for falls (McCracken et al., 1993a). Therefore, although falls are not a primary concern for young, healthy adults, a universally relevant aversive experience, such as that of pain may be a source of anxiety for this population age.

Further evidence lending support to the relationship of fear of pain and fear of falling demonstrate that there is a strong correlation between anxiety sensitivity and fear of pain. Anxiety sensitivity is the fear of anxiety-related bodily sensations that typically arise from subjective beliefs that an event or stimulus will have harmful consequences. For example, chronic low back pain patients reporting high anxiety sensitivity also report having greater avoidance, pain-related cognitive anxiety, and pain-related fear (Asmundson & Norton, 1995). The findings persisted even though the comparison group did not differ in pain severity. One perspective to explain the relation between anxiety and pain (McNeil & Brunetti, 1992), is how generalized anxiety can exacerbate the subjective experience and expression of pain. In addition, McNeil and Brunetti (1992) demonstrated that physiological responses and verbal reports to pain imagery showed similar patterns of response to fear imagery. When individuals combined pain and fear imagery, no added response effect was observed. Further, pain-related anxiety has been found to influence the prediction of pain experiences, and self reports of anxiety during physical examinations (McCracken, Gross, Sorg, & Edmands, 1993a).

Recent discoveries from neuroimaging studies have implicated that the neural mechanisms of the affective dimensions of pain overlap significantly with areas known for the processing of fear and anxiety. The neural mechanisms involved in pain unpleasantness include cortical areas such as the anterior cingulate cortex, insular cortex, and amygdala (Price, 2007; Ploghaus et al., 1999). As discussed in the previous section of this literature review, these very regions share parallel importance in mechanisms of anticipatory processing associated with anxiety. Laboratory investigations employing the use of graded nociceptive stimuli indicate that there is a variable response for the extent of activation in terms of spatial distribution and magnitude of the cingulate cortex, insular cortex, and amygdala. This stimulus response relationship may be due to the differences in pain intensity and subjective unpleasantness of pain.

On the basis of neurological evidence, it appears that fear of pain, fear, anxiety, and balance control share similar pathways. This evidence lends support to psychological studies that suggest fear of falling and fear of pain to be related constructs, sharing similar mechanisms and qualities of aversion, avoidance, and apprehension (Williams et al., 2005; Martin, Hadjistavropoulos, & McCreary, 2005). Based on the research evidence that fear, anxiety, and pain share similar pathways and neural mechanisms, the use of pain as a surrogate to actual falls in young, healthy individuals may be a way to tap into how negative emotional states affect balance control. Thus, although fear of falling may not be a primary concern for young healthy adults, related and relevant constructs such as fear of pain can be generalized across this age group, and may be an important predictor of balance control and emotional states.

2.9 Concluding Summary of Literature Review

From the literature, falls and fear of falling are crucial health care problems amongst the elderly. Fear of falling involves many antecedents including the deterioration of balance systems and the extensive influence of fear and anxiety (Yardley, 2004; Yardley & Smith, 2002). Many research studies have found substantial evidence that peoples' ability to maintain balance decline under conditions of postural threat (i.e., standing on elevated platforms) and conditions of negative affect (i.e., viewing negative emotional pictures) (Carpenter et al., 2001; Carpenter et al., 2006; Simeanov & Hsiao, 2006; Azevedo et al., 2005; Fachinetti et al., 2006). Under these stressful conditions, people report being highly anxious and respond behaviorally by altering their centre of pressure displacements. Findings in the literature have also demonstrated that the negative emotional states of fear and anxiety are also related to affective dimensions of pain (Price, 2007; Ploghaus et al., 1999). Since pain is an aversive construct that is experienced across all age groups, and not just the elderly population, using 'pain' as a surrogate to actual falls may provide a way to extend the understanding of how negative emotional states might affect balance control in humans. Recent technology from neuroscience including sophisticated imaging and staining techniques have provided researchers with a vast arsenal of tools to identify regions and pathways in the brain that are involved in the expression and acquisition of fear. These findings are further supported by behavioral and lesion studies in animals and humans (Ledoux, 2000; Phelps and Ledoux, 2005; McGaugh, 2000; 2004). Researchers now know that areas in the brain involved in the processing of negative stimuli associated with pain, fear, and anxiety markedly overlap with areas in the brain that are involved in autonomic arousal and balance control (Balaban & Thayer, 2001; Balaban, 2002).

The vast pool of information that have emanated from the various research areas in psychology, biomechanics, and neuroscience, assist researchers in understanding the mechanisms that lead to fear of falling and actual falls. This is important in comprehending the multidimensional problem of fear of falling in the elderly population. From the literature, a key problem to fear of falling may lie in the negating effects of fear and anxiety on the human balance system. It is clear from previous research studies that under conditions of distress, individuals make modifications to the control of posture. However, it is not known whether or not anticipatory cognitive processes associated with anxiety can cause similar modifications in postural control. The successful manipulation of anticipatory cognitive processes associated with anxiety may be an ecologically valid way to understanding the mechanisms that lead to changes in emotional states, physiological responses, and balance control. The current study aims to manipulate the anticipatory cognitive processes associated with anxiety, and observe subsequent changes in emotional states, physiological responses, and balance control. The manipulation of anticipatory processing was employed through the use of threatening videos. In addition, a signal (consisting of a 100dB tone and LED lights) was used to clearly define a specific and measurable time window before the threat of shock and after the threat of shock. Self report questionnaires of fear and state anxiety will be used to probe changes in emotional states. Galvanic skin activity, beat to beat heart rate, and blood pressure will provide an estimate of changes in physiological responses. Finally, centre of pressure displacements will be used to quantify changes in balance control strategies.

2.10 Statement of Purpose and Hypotheses

2.10.1 Purpose

The present research study examined how anticipatory cognitive processing associated with anxiety might influence the perceptions of emotional states, physiological responses, and balance control. The study was based on Clark and Wells' (1995) model of anticipatory processing in which the key components include ruminative thought processing and worry about future discourse and negative outcomes to one's self. The effect of trait anxiety on anticipatory processing and subsequent emotional, physiological, and balance measures will also be examined.

The sample in the study consisted of young, healthy female adults recruited mostly from the university population. Since most of the studies in the fear of falling literature have focused on young and healthy adults, and norms have been developed for centre of pressure displacements around these adults, the findings in this study had a wide variety of sources against which comparisons may be drawn (Carpenter et al., 1999; Carpenter et al., 2001; Goldie, Bach, & Evans, 1989 and Winter 1995).

Anticipatory processing was manipulated by having subjects watch a video presentation of several people either receiving a shock or not receiving any shock while standing on a force platform for three minutes of quiet standing. The threat condition occurred after watching the people receive the shock; whereas the non-threat condition occurred after watching the people not receive any shock while standing on the force platform.

The signal (100dB tone and LED lights) used to determine two distinct time windows, was programmed to come on at the halfway mark of 3 minutes of quiet standing. The time window before the signal allowed a clear separation between the anticipatory moments before threat of shock and the moments after the threat of shock. These time windows were defined as Bin Time 1 (before threat of shock) and Bin Time 2 (after threat of shock). Defining the two separate Bin Time windows was important as this allowed for comparisons between the Threat Conditions dependent on Bin Times.

2.10.2 Primary Hypotheses

1. Self reported levels of anticipatory cognitive processing associated with anxiety was expected to be higher in the threat condition compared to the non-threat condition.
2. Perceptions of fear and state anxiety would be higher in the threat condition compared to the non-threat condition.
3. Physiological responses (galvanic skin activity, heart rate, and blood pressure) would be higher in the threat condition compared to the non-threat condition. Specifically, physiological responses were expected to be higher in Bin 1 compared to Bin 2 due to

the nature of the anticipatory moments before the threat compared to moments after the threat.

4. Balance control would be modulated in the threat condition compared to the non-threat condition. Frequency of COP sway was expected to increase from the Non-Threat to the Threat condition while amplitude of SD COP was expected to decrease from the Non-Threat to the Threat condition. No specific hypotheses were formulated in terms of how balance control would be modulated as an effect of Bin Time as this was the first study to investigate the effects of anticipatory anxiety on balance.

2.10.3 Secondary Hypotheses

1. High trait anxious individuals were expected to report higher levels of anticipatory cognitive processing associated with anxiety, fear, and state anxiety compared to low trait anxious individuals in the threat condition compared to the non-threat condition.

2. No difference was expected in physiological responses (galvanic skin activity, heart rate, blood pressure) between high trait and low trait anxious individuals.

3. Balance control would be modulated as an effect of Trait Anxiety dependent on Threat Condition. Specifically, frequency of COP sway was expected to increase more in High Trait Anxious individuals compared to Moderate and Low Trait-Anxious individuals, while amplitude of SD COP was expected to decrease more in High Trait Anxious individuals compared to Moderate and Low Trait-Anxious individuals from the Non-Threat to the Threat condition. No specific hypotheses were formulated in terms of how balance control would be modulated as an effect of Trait Anxiety dependent on Bin Time.

4. Self report measures of fear of falling (as indexed by the Falls Efficacy Scale-International and Activities Balance Confidence Scale) were expected to correlate with levels of perceived fear and state anxiety in the threat condition.

5. Self report measures of pain-related anxiety (derived from the Pain Anxiety Symptoms Scale-20) were expected to correlate positively with perceptions of fear, state anxiety, and physiological responses (galvanic skin activity, and blood pressure).

6. Perceptions of balance efficacy were expected to decrease in the threat condition (after watching the threat video) compared to the non-threat condition (after watching the neutral video).

7. Perceptions of fear of falling were expected to increase in the threat condition (after watching the threat video) compared to the non-threat condition (after watching the neutral video).

CHAPTER III: METHODS

3.1 Participants

3.1.1 Determining Sample Size

*S*ample size was calculated assuming a small effect size of 0.3 and an a priori computation of power (Stevens, 1996). To achieve sufficient power (80%), with α error probability set at 0.05, using a repeated measures within factors analysis of variance, it was necessary to have a total of twenty six participants for the study (Stevens, 1996).

3.1.2 *Description of Participants*

The sample comprised of 26 female university students between 19 and 29 years of age with an average age of 22.58 (*SD*=3.53). Participants ranged in height between 1.50 to 178 m with a mean of 1.65m (*SD*=0.08). Weight range for participants was between 50.91 to 79.55kg with an average of 58.54kg (*SD*=8.85).The participants were recruited through posters placed around the university. All participants provided written informed consent to participation upon entering the laboratory.

3.2 Measures

3.2.1 Psychological Measures

3.2.1.1 Fear. Fear was measured using the fear subscale from the Positive and Negative Affect Scale- Expanded version (PANAS-X) (Watson, Clark, & Tellegen, 1988). The PANAS-X scale uses a 5-point Likert Scale, with a total of 6-items. The six items on the fear subscale of the PANAS-X include scared, afraid, frightened, shaky, nervous, and jittery. Facrot loadings of the 6 items on the fear subscale ranged from 0.62 to 0.78. The 6 items were not found to load on any other factor on the PANAS-X. Internal consistency for the fear subscale of the PANAS-X was reported at .88.

3.2.1.2 Trait and State Anxiety. State and Trait Anxiety were measured using the State-Trait Anxiety Inventory (STAI; Spielberger, 1983). The STAI measures two anxiety constructs, state anxiety and trait anxiety. State anxiety is defined as a transient emotional state characterized by consciously perceived feelings of tension and apprehension. Trait anxiety refers to relatively stable individual differences in inclination and sensitivity towards experiencing anxiety (Spielberger, 1983).

The STAI consists of two subscales: state anxiety and trait anxiety. The State subscale of the STAI consists of 20 items. Questions are stated by asking participants how they feel "right now." Participants feelings are rated on a four-point intensity scale, from “not at all” to “very much so”. Example items from the State subscale of the STAI include, “I feel calm” and “I feel worried.”

The Trait subscale of the STAI also consists of 20 items, each probing how participants "generally" feel. Items are rated on a four-point frequency scale, from “almost never” to “almost always.” Example items from the Trait subscale of the STAI include, “I am ‘calm, cool, and collected’, and “I get in a state of tension or turmoil as I think over my recent concerns and interests.”

Reliability coefficients of the STAI assessed from samples of college aged students indicate that, the test-retest coefficients ranged from .65 to .86 for Trait-anxiety, and .16 to .62 for State-anxiety (Spielberger, 1983). This low level of time-sampling stability for the

State-anxiety scale reflects the influence of the transient situational factors that exist at the time of testing. The trait portion of the STAI reported high correlations between other measures of trait anxiety, Taylor Manifest Anxiety Scale, and the IPAT Anxiety Scale, and the Multiple Affect Adjective Check List. These correlations are 0.80 and 0.75 respectively. Internal consistencies ranged from .87 to .90 for the state scale scores, and .86 to .92 for the trait scale scores respectively.

3.2.1.3 Falls Efficacy. Falls efficacy was measured by the Falls Efficacy Scale-International (FES-I). The FES-I is a modified version of the Falls Efficacy Scale, which measures self efficacy in a range of both easy to difficult physical activities and social activities of daily living without falling. Cronbach's alpha of the FES-I was 0.96, and test-retest reliability for the total score was also 0.96 (Yardley, Beyer, Hauer, Kempen, Piot-Ziegler, & Todd, 2005).

3.2.1.4 Daily Activities Balance Confidence. Balance confidence for daily activities was assessed with the Activities-specific Balance Confidence (ABC) Scale (Powell & Myers, 1995). The ABC scale consists of 16-items with each item having a possible rating of 0% (no confidence) to 100% (complete confidence). The total ABC score was found to be highly stable over a two-week period with r =0.92, p<0.001. Cronbach's alpha was 0.92, indicating high internal consistency of the ABC scale.

3.2.1.5 Pain related Anxiety. Pain related anxiety was measured by the Pain Anxiety Symptoms Scale (PASS-20) (McCracken & Dhingra, 2002). The PASS-20 is a 20-item self report instrument, measuring four factorially distinct components of pain-related anxiety. The four subscales include cognitive anxiety, fear, escape/avoidance, and physiological anxiety.

Each item is rated on a 6-point Likert scale, ranging from 0 (never) to 5 (always). Examples of items in the PASS include, “I worry when I am in pain”, “When I sense pain I feel dizzy or faint”, and “I will stop any activity as soon as I sense pain coming.” Summing each subscale will provide a score that can be considered a general measure of pain-related anxiety. The total and subscale scores of the PASS-20, calculated using Cronbach's α showed good internal consistency. The coefficient for the total score was 0.86. Coefficients for each subscale score were as follows: fear of pain, 0.82; escape-avoidance behaviors, 0.72; physiological symptoms of anxiety, 0.77; cognitive anxiety, 0.85.

3.2.1.6 Balance efficacy. Task specific balance efficacy was assessed just before the performance of each session of the quiet standing task (baseline practice, non-threat, and threat condition). Participants were required to estimate their confidence in their ability to balance while standing in each condition (baseline practice, non-threat, and threat condition) for 3 minutes. Balance efficacy for each quiet standing task was rated on a scale between 0 (no confidence) and 100 (complete confidence).

3.2.1.7 Fear of falling. Fear of losing balance or falling was assessed immediately after the performance of each quiet standing task in the threat and non-threat condition. Participants were asked to rate how fearful of falling they felt while standing in the specific condition (non-threat, and threat condition) for the two time periods before the LED lights and after the LED lights. Fear of falling on each quiet standing task was rated on a scale between 1 (not very fearful at all) and 7 (extremely fearful).

3.2.2 Physiological Measures

3.2.2.1 Galvanic Skin Activity. Changes in galvanic skin response (GSR) were recorded in all participants to provide an estimate of the level of physiological arousal caused by anticipatory processing of anxiety in each experimental condition. Participants were fitted with disposable surface Ag/AgCl electrodes on the thenar fascia and hypothenar fascia. Galvanic skin activity was continually recorded throughout the experiment within a range of 0-100 mOhm (2502 Skin Conductance Unit, Cambridge Electronic Design, UK). GSA was recorded throughout the experiment. GSA was A/D sampled at 1 kHz (Power 1401, Cambridge Electronic Design, UK). Data recording was initiated as soon as the experiment begin (i.e., when participants performed the baseline practice standing trial). Surface electrodes remained fitted on the participants and data was recorded throughout the experiment using Spike 2 laboratory software.

3.2.2.2 Heart Rate. Heart rate was also recorded throughout the experiment. Beat by beat heart rate data was obtained throughout the experiment using finger pulse photoplethysmography (Finometer, FMS, Arnhem, Netherlands) placed on the mid-phalanx of the middle digit of the left hand. Beat-by-beat heart rate variability (HR) was obtained throughout all procedures. Data recording was initiated as soon as the experiment begin (i.e., when participants performed the baseline practice standing trial). The finger cuff remained fitted on the participants throughout the experiment. Mean HR was identified and data were analyzed appropriately.

3.2.2.3 Blood Pressure. Both systolic and diastolic blood pressure were recorded throughout the experiment. Beat-to-beat systolic (SBP), diastolic (DBP) were obtained throughout all procedures using finger pulse photoplethysmography (Finometer, FMS, Arnhem, Netherlands) placed on the mid-phalanx of the middle digit of the left hand. The finger cuff remained fitted on the participants and data was recorded throughout the experiment.

3.2.3 Balance Measures

3.2.3.1 Centre of Pressure Displacement Measurements Ground reaction forces and moments were collected with a sampling frequency of 100 Hz for each trial from a force plate (#K00407, Bertec, USA). Forces and moments were low pass filtered using a 5 Hz dual-pass Butterworth filter before calculating COP in the anterior-posterior (A-P) and medial lateral (M-L) directions. As a means to measure the amplitude of COP displacements, the Root Mean Square (RMS) of the unbiased COP signal were calculated in both the A-P and M-L directions. From this unbiased signal, a power spectrum was generated using a fast Fourier transformation to calculate the Mean Power Frequency (MPF) of COP displacements in both A-P and M-L directions. The A-P axis is perpendicular to the edge of the force platform and the M-L axis was parallel to the edge of the force platform.

3.2.4 Manipulation Check. A manipulation check was administered after participants viewed each video (threat video and non-threat video). The purpose of the manipulation check was to examine the level of distress experienced by participants after viewing the video. The questions that were employed as the manipulation check were adapted from the Anticipatory Processing of Anxiety Questionnaire (APAQ) (Vassilopoulos, 2004). Since the APAQ was originally developed based on Clark and Wells' theory of social phobia (Clark and Wells, 1995), five items from the APAQ were carefully modified to suit the current study. These questions were administered after participants watched each video (threat video and non-threat video).

The following introductory paragraph of the questionnaire was the following:

> Please, think about how you felt while you were performing the quiet standing task. It is important that you answer how you honestly felt in the last 3 minutes while performing the standing task. Please, rate how you honestly felt on a scale of 1=not at all, to 7= very much so.

The five questions that were asked are the following:

1. Did you find yourself thinking about the video a lot?
2. Did thoughts about the video keep coming into your head even when you did not wish to think about it?
3. If you did think about the video, over and over again, did you find your anxiety increasing more and more?
4. How negative were your thoughts about the video?
5. How much pain do you think was experienced by the participants in the video?

3.3 Study Design.

The current study employed a repeated measures two group (threat condition, non-threat condition) counterbalanced design.

3.3.1 Threat Condition

In this condition, participants were shown a threat video prior to performing a three minute quiet standing task. The purpose of this video was to induce anticipatory cognitive processing associated with anxiety prior to performing the simple balance task. The video, filmed in the Neural Control of Posture and Movement laboratory where the experiments were conducted, showed several video actors (i.e., laboratory participants and an experimenter) interacting in a laboratory. In the video, the actor experimenter informs the actor participants that she is required to perform a quiet standing task of three minutes on a force plate. The actor experimenter then informs the actor participants that they will receive a mild electric shock on their forearm at some point during the quiet standing task almost immediately after a tone and LED lights appears. When the shock is administered, the actor participants react by displaying facial emotions of distress, fear, and discomfort. Facial characteristics of the actor participants include knitted eyebrows, and pursed lips. Bodily characteristics of the actor participants include tensed shoulders and neck, and a rigid posture. A description of the threat video is provided in the in the Appendix section (Appendix D).

3.3.2 Non-threat Condition

In this condition, participants were shown a neutral video prior to performing a three minute quiet standing task. The neutral video is identical to the threat video, except there is no shock administered to the actors. The actor experimenter informs the actor participant that he or she is required to perform a quiet standing task of three minutes on a force plate while physiological data are collected. A tone and LED light appears at some point during the three minute quiet standing period. However, the participants in the video are told to ignore it and stand as still as possible. A description of the non-threat video is provided in the Appendix section (Appendix D).

3.4 Signal

The purpose of the tone and LED lights were to indicate a time cut-off and signal to the participants as to when they might expect to receive a shock. The tone and LED lights appeared at the half-way mark (i.e., at one minute and half) of the three minute quiet standing task, providing sufficient sampling duration time of force plate data before and after the tone and LED lights are presented. The time frame before the tone and LED lights indicate participants' expectation and anticipation of the shock. The time frame immediately after the tone and LED lights may be interpreted by the participants as a moment of imminent threat. However, shocks were never administered.

3.5 Procedures

Ethical approval was obtained from the Clinical Research Ethics Board of University of British Columbia prior to participant recruitment. The recruitment of participants was carried out through recruitment posters across campus. Volunteer participants were contacted and experimental lab time was set-up for each participant. During the initial contact, participants were informed to abstain from exercise and caffeine no less than 4 hours before the experiment. All experiments were conducted at the Neural Posture and Control of Movement Laboratory at the University of British Columbia.

Upon entering the laboratory, participants were told to sit comfortably and to relax for 15 minutes to bring physiological readings down to individual baseline levels. Participant consent forms were filled out at this time. Participants were then requested to complete a set of measures, consisting of the Trait Anxiety questionnaire, Falls Efficacy Scale, Activities of Balance Confidence scale, Pain-related Anxiety, and baseline State Anxiety. Following the completion of these measures, baseline physiological and balance measures were collected. Baseline measures of COP displacements in the AP and ML direction, heart rate, blood pressure, and galvanic skin activity (GSA) were collected at baseline for three minute of quiet standing on a force plate (#K00407, Bertec, USA).

Since the study was a repeated measures, counterbalanced design; participants were then assigned to start with either the threat condition or the non-threat condition. Conditions were counterbalanced to reduce the possibility of carry-over and practice effects.

In the threat condition, participants watched the threat of shock video. The following set of instructions were read to the participants before watching the threat video.

Instructions to Participants in the Threat Condition.

> You will now watch a video of several people doing an experiment similar to the one you yourself are going to do afterwards. The people in the video are going to perform a three minute quiet standing task on a force plate just as you will afterwards. At some point during the experiment, the people in the video are going to receive a shock on their forearm after a tone and LED lights are presented to them. The shock will appear at anytime immediately after the tone and LED lights are presented. Please, pay attention to the video because in the experiment you are going to do afterwards, you *may* receive a shock of the same degree as the people in the video.

After watching the video, participants completed a manipulation check to ensure that the purpose of the video had been achieved. The following instructions were given to the participants before being instructed to stand on the force-plate.

> You are now going to take part in an experiment similar to the one you just watched. You will be presented with the same tone and LED lights as were presented to the people you saw in the video. Just like the people in the video, the shock may be administered almost immediately after the tone and LED lights have been presented. Please note, that you are to try your best to stand as still as possible even though you know that you might be receiving a shock.

The participants then performed a three minute quiet standing task on a force plate. However, the shock was never administered to the participants. Subsequent to the three minute standing task, participants completed the self report measures of state anxiety, fear, and fear of falling (for the two time periods before and after the LED lights).

In between the two experimental conditions (threat condition and non-threat condition), participants watched an interim movie of about 5 minutes (National Geographic Videoshorts, 2007). The purpose of this interim video was to reduce possible worry and ruminative thoughts about the prior condition, and to reduce any potential confounding carry-over effects from one condition to the following condition.

In the non-threat condition participants watched the non-threat video. The following instructions were given to the participants before watching the non-threat video.

Instructions to Participants in the Non-threat Condition.

> You will now watch a video of several people doing an experiment similar to the one you yourself are going to do afterwards. The people in the video are going to perform a three minute quiet standing task on a force plate just as you will afterwards. At some point during the experiment, a tone and LED lights will appear in front of the participant. They will not pay any attention to this tone and LED lights and simply stand quietly with their hands by their sides looking straight ahead. Please, pay attention to the video because in the experiment you are going to do afterwards, you will also perform the same quiet standing task on the force plate for three minutes.

After watching the non-threat video, participants completed a manipulation check to ensure that the purpose of the video had been achieved. The following instructions were then given to the participants before being instructed to stand on the force-plate:

> You are now going to take part in an experiment similar to the one you just watched. You will stand quietly on the force plate for three minutes with your hands by your side and looking straight ahead. At some point, the same tone and LED lights as those that were presented to the people you saw in the video will appear. But just like the people in the video, you are not to pay any attention to this tone and LED lights. Please note, that you are to try your best to stand as still as possible throughout the three minutes of quiet standing.

The participants then performed the three-minute quiet standing task on a force plate. After performing the quiet standing task, participants completed the self-report measures of state anxiety, fear, and fear of falling (for the two time periods before and after the LED lights).

At the end of the experiment, participants were fully debriefed and asked whether they had believed the instructions given to them throughout the experiment. All participants were debriefed according to ethical standards after each experiment.

CHAPTER IV: DATA ANALYSIS

4.1 Preliminary Analysis

The data were analyzed by first examining the distributions of each variable. Outliers were identified and descriptive statistics were performed for all variables. Reliabilities for all psychological scales using Cronbach's α were calculated. Pearson product moment correlations were conducted on all variables to explore the relationship between psychological variables, physiological variables, and balance variables.

It was pertinent to consider the two time windows (Bin Time 1 and Bin Time 2) as separate levels of a factor when assessing balance and physiological measures. The 0 to 90-seconds before the signal were considered as Bin Time 1 and 90-180 seconds after the signal were considered as Bin Time 2 when assessing balance and physiological measures. Since the signal indicated when the shock could occur, Bin Times 1 and 2 were considered as distinctly separate time windows. This allowed for the clear delineation between the anticipatory moments before the threat of shock and the moments after the threat.

4.2 Identifying Blood Pressure Values for Analysis

In order to identify systolic and diastolic pressure points for analysis peaks (systolic pressure) and troughs (diastolic pressure) were identified in individual blood pressure waveform data using sing Spike 2 laboratory software. No peaks and troughs were identified while the stepwise recalibration in Finapress was taking place as this would have produced erroneous data. In addition, although blood pressure data acquisition with Finapress produced consistent readings of blood pressure within participants, these absolute readings were at times unreliable due to poor calibration at baseline. The poor calibration during baseline was attributed primarily to the equipment. Therefore, relative change values in blood pressure from baseline state were analyzed instead of raw values.

In addition, Mean Arterial Pressure (MAP) was calculated and analyzed to add to the validity of blood pressure variables (Sheel, 2009). MAP represents the average arterial pressure in a cardiac cycle and takes into account the fact that diastolic pressure accounts for two-thirds of the cardiac cycle.

Mean Arterial Pressure was calculated as follows:

$$MAP = [(2 \times DBP) + SBP]/3$$

*Mean Arterial Pressure is expressed as mmHg.

4.3 GSC data analysis

Maximum values for galvanic skin conductance data were identified with Spike 2 laboratory software using cursor expressions in Bin Time windows 1 and 2 for the threat and non-threat condition. The rationale for using a maximum value instead of mean value was supported by the study hypothesis that burst events of skin conductance would occur prior to the threat and immediately after the threat (as signaled by the Signal). In addition, due to the occurrence of burst events, significant data would be lost due to the possibility of larger standard errors and variance from deriving mean values from each 90s bin time window. These justifications for using maximum excursion of GSC were further supported by observing individual participants data in the Spike 2 GSC waveform channel.

4.4 Balance Data Analysis

COP AP graphs for each individual participant for each experimental condition (Threat and Non-threat) were plotted on a line graph and examined for outliers and artifacts. COP AP graph from one participant (Participant 4) indicated possible artifacts in the initial 400ms period of the Threat Condition for Bin Time 1. However, the data from this participant was not identified as an outlier. Therefore, the data was retained in the analysis.

4.5 Hypotheses Testing

To test primary hypotheses 1, and 2, a paired samples t-test was conducted on state psychological variables in the threat and non-threat condition. Primary hypotheses 3 and 4 were tested using a 2 (Threat condition) x 2 (Bin Time) fully repeated measures analysis of variance on physiological variables and balance variables.

Secondary hypotheses 1 was examined using a 3 (Trait Group) x 2 (threat condition) mixed analysis of variance with Trait Group as the between subjects factor and Threat Condition as the repeated measures factor. Secondary hypotheses 2 and 3 were tested using a 3 (Trait Group) x 2 (threat condition) x 2 (Bin Time) mixed analysis of variance with Trait Group as the between groups factor and Threat Condition and Bin Time as repeated measures factors. Secondary hypotheses 4 and 5 were tested by looking at bivariate correlations. Finally, secondary hypotheses 6 and 7 were analyzed using paired samples *t*-tests. Assumptions of normality, sphericity and homogeneity of variance were checked for all variables, where applicable. In order to protect against the risk of committing a Type 1 error, p-values less than 0.01 were used to identify significant differences in all cases.

CHAPTER V: RESULTS

5.1 Missing Data and Outliers

There were missing data for 5 cases for blood pressure and heart rate data due to technical difficulties of the equipment (Finometer PRO) to properly calibrate at baseline state, leaving n=21. In addition, 1 missing case was identified for balance data due to poor connectivity in the BNC connecter cables, leaving n=25. There were no other missing data for all psychological variables, leaving the total n=26.

Boxplots and histograms were inspected for outliers in the data file. There were several outliers in the data file and these outlying data points were checked for error. The 5% trimmed mean for variables containing outliers were also inspected and it was found that the values were not too different to the remaining distribution. Outlying data points appeared to be within the range of possible scores and were not removed from the data file. There were no extreme values for all of the variables.

To assess the normality of scores, skewness, kurtosis, and the Kolmogorov-Smirnov statistic were evaluated for all dependent variables. Kolmogorov-Smirnov statistic for normality was considered normal if p>.05. Trait psychological measures including scores for Activities Balance Confidence (ABC), Pain Anxiety (PASS-20), Falls Efficacy, and Trait Anxiety indicated that data were normally distributed. Baseline scores for State Anxiety and Fear were positively skewed in its distribution. This was expected and not considered atypical as participants were instructed to remain relaxed for 15 minutes before questionnaires for baseline State Anxiety and Fear were collected.

5.2 Descriptive Statistics and Scale Reliabilities

The means and standard deviations of scores from all the psychological scales (N=26) are presented in Table 5.1.

5.3 Scale Reliabilities

Reliabilities for all scale scores using Cronbach's were acceptable, with alpha levels between .69 and .90.

Table 5.1 Means and Standard Deviations for Balance Confidence (ABC), Trait Anxiety (Trait-A), Pain Anxiety Symptoms (PASS), Fear, State Anxiety (State-A), Balance Efficacy, and Fear of Falling (FOF) in the Threat and Non Threat Conditions.

	Mean	Standard Deviation	Score Range	Scale Range
ABC	94.40	4.74	81.50-100	0-100
Trait-A	38.65	7.93	27-53	20-80
PASS	35.50	16.36	12-65	0-100
Fear Threat*	13.00	5.85	6-25	6-30
Fear Non Threat*	7.65	2.43	6-15	6-30
A-State Threat*	41.00	12.38	24-71	20-80
A-State Non Threat*	28.83	7.30	20-46	20-80
Balance Efficacy Threat*	89.42	12.36	50-100	0-100
Balance Efficacy No Threat*	95.38	9.05	70-100	0-100
Fear of Falling PreLED Threat†	2.12	1.34	1-5	1-7
Fear of Falling PostLED Threat†	2.54	1.56	1-7	1-7
Fear of Falling PreLED Non Threat†	1.23	0.59	1-3	1-7
Fear of Falling Post LED Non Threat†	1.12	0.33	1-2	1-7

* p<.001
† Fear of falling was significant at *p*<.05 between threat conditions only

5.4 Tests of Assumptions

Assumptions of normality and homogeneity of variance and variance covariance matrices were examined and met across most dependent variables and both experimental conditions. Where the assumption of sphericity was not met (p>.001), the Greenhouse-Geisser ε-statistic was applied and reported.

5.5 Primary Hypothesis

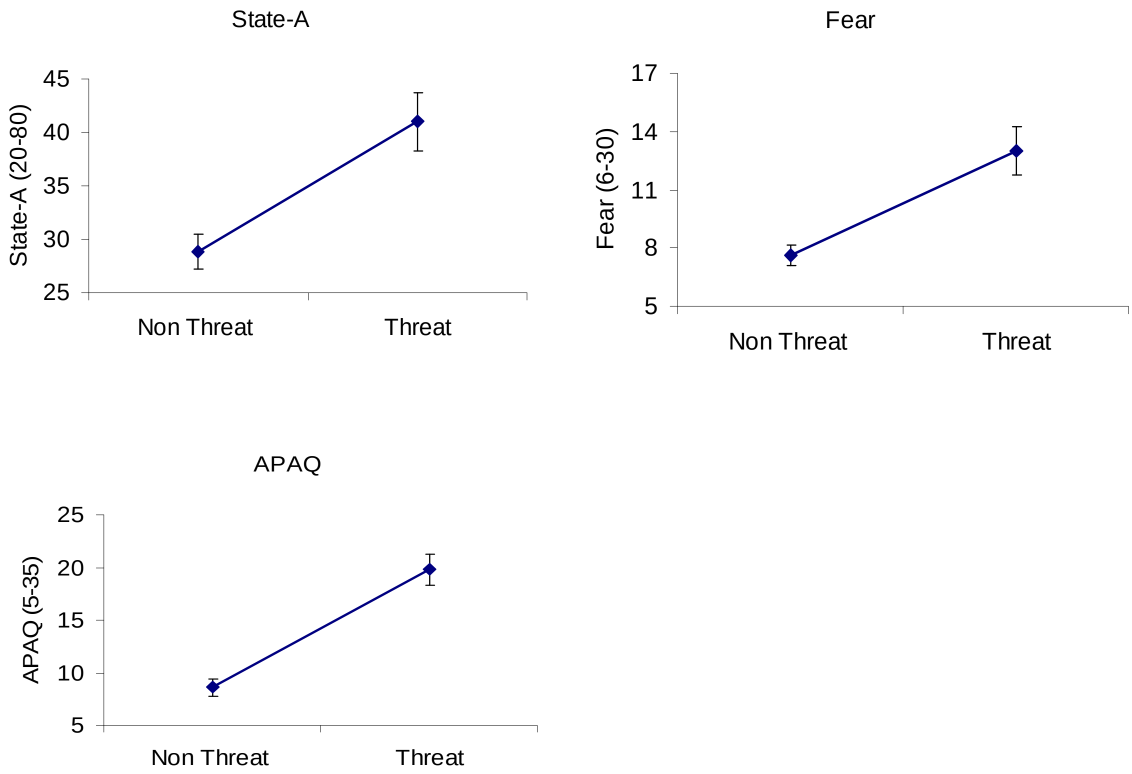
5.5.1 Manipulation Check

To test primary hypothesis (1) that the threat video induced a significant amount of anxiety in participants compared to the neutral video, a paired samples t-test was performed on the Anticipatory Processing of Anxiety Questionnaire (APAQ). It was expected that participants would report significantly higher levels of anxiety and rumination over the threat video compared to the non-threat video and this would in turn cause changes in their emotional, physiological, and biomechanical responses during the subsequent 3-minutes of quiet standing. Mauchly's test indicated that the assumption of sphericity was met ($\acute{\varepsilon}$ =1.00, p<.001). The effect of the manipulation was large, with participants reporting significantly higher anxiety after having watched the threat video (M=19.81, SD=6.84) compared to the non-threat video [(M=8.58, SD=3.80; t(25)=9.20, p<.0001, η^2 =0.77].

5.5.2 Self-Report Measures of Fear and Anxiety

To test primary hypothesis (2) that self-report perceptions of fear and state anxiety would be higher in participants after completing the threat condition compared to the non-threat condition, paired samples t-tests with a Bonferroni correction (p<.01) were conducted on fear scores (PANAS-X) and state anxiety scores (STAI). As expected, results indicate that participants reported higher perceptions of both fear and anxiety after having completed the 3-minute quiet standing trial in the threat condition compared to the non-threat condition [$t(25)= 5.14$, $p<.001$, $\eta^2=0.51$ and $t(25)=6.41$, $p<.001$, $\eta^2=0.62$], respectively. Therefore, the hypothesis that perceptions of fear and anxiety would be affected by the threat condition was supported by the data.

Figure 5.1 State Anxiety, Fear, and APAQ scores for all participants in the Non-threat and Threat Condition.



5.5.3 Physiological Responses

5.5.3.1 Blood Pressure

As hypothesized, ANOVA results revealed a very large main effect of Threat, on SBP and DBP [$F(1,20)= 34.42$, $p<.0001$, Wilk's $\Lambda = .37$, partial $\eta^2 =.63$; $F(1, 20)= 10.24$, $p=.004$, Wilk's $\Lambda = .66$, partial $\eta^2 =.34$; and $F(1, 20)= 30.40$, $p<.001$, Wilk's $\Lambda = .60$, partial $\eta^2 =.60$] respectively (see Figure 5.2). The main effect of bin time and interaction effects for threat condition and bin times were non-significant for SBP and DBP [05F(1,21)= 1.95, $p=.18$, Wilk's $\Lambda = .97$, partial $\eta^2 =.09$ and $F(1,21)= .24$, $p=.63$, Wilk's $\Lambda = .97$, partial $\eta^2 =.01$] and [$F(1,21)= .01$, $p=.92$, Wilk's $\Lambda = .97$, partial $\eta^2 =.00$ and $F(1,21)= 1.1$, $p=.30$, Wilk's $\Lambda = .97$, partial $\eta^2 =.05$] respectively.

5.5.3.2 Heart Rate

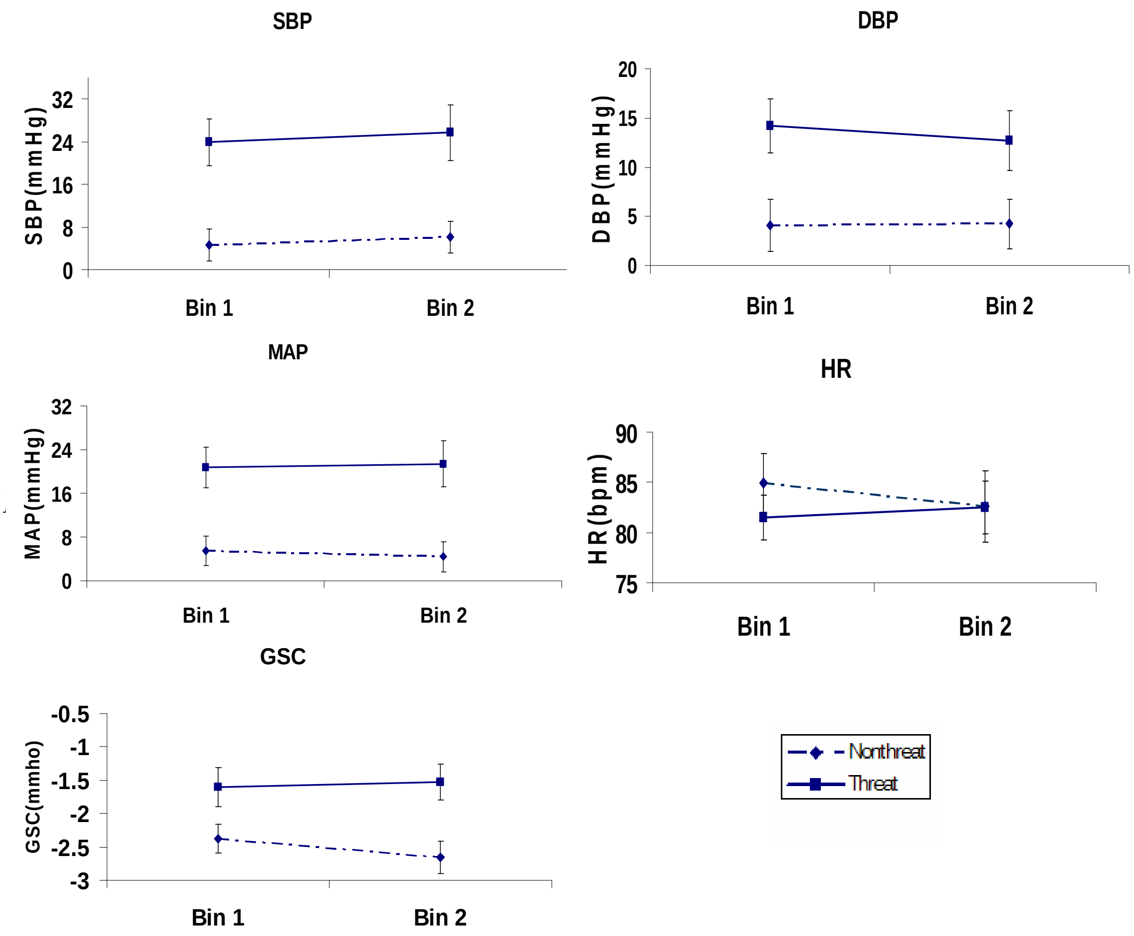
When a 2 (Threat Condition) x 2 (Bin Time) fully repeated measures ANOVA was conducted on mean HR, no main effects of threat condition and bin times were observed on mean HR [$F(1,21)= .54$, $p=.47$, Wilk's $\Lambda = .97$, partial $\eta^2 =.03$ and $F(1,21)= .61$, $p=.44$, Wilk's $\Lambda = .97$, partial $\eta^2 =.03$], respectively. An interaction effect between Threat and Bin Time was observed [$F(1,21)= 4.71$, p=.04, Wilk's $\Lambda = .81$, partial $\eta^2 =.19$; see Figure 3.2]. Results were non-significant after a more stringent $p<.01$ was applied.

5.5.3.3 Galvanic Skin Conductance

A 2 (Threat Condition) x 2 (Bin Time) repeated measures ANOVA was conducted for maximum GSC. Results revealed a significant main effect of Threat [$F(1,25)= 25.75$, $p<.0001$, Wilk's $\Lambda = .49$, partial $\eta^2 =.51$], while a main effect of Bin time was not found

[F(1,25)=2.05, *p*=.17, Wilk's Λ = .93, partial η^2 =.08]. Subsequently, significant interaction effects for Threat conditions and Bin Times on maximum GSC [F(1,25)= 10.50, *p*=.003, Wilk's Λ = .70, partial η^2 =.30; see Figure 5.2] was observed. As hypothesized, these findings indicate that galvanic skin activity was significantly affected by the threatening videos employed in the study.

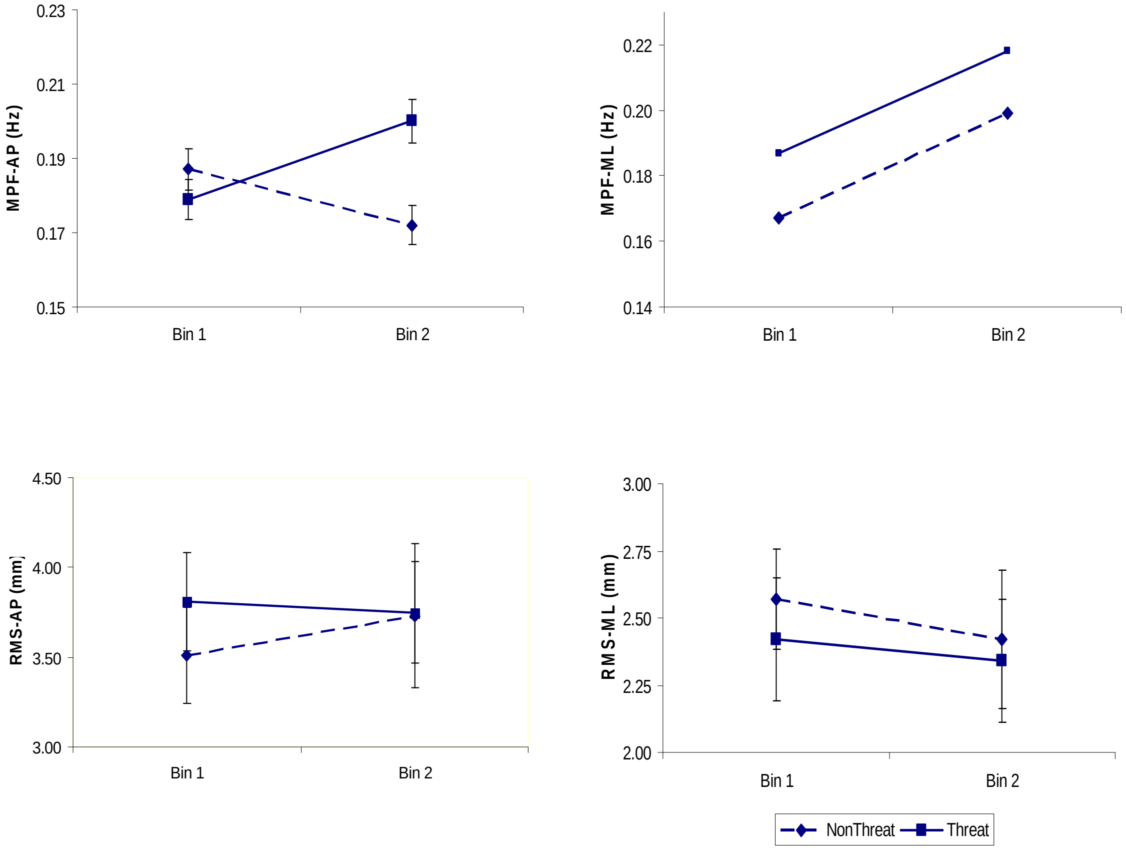
Figure 5.2 Means and standard deviations for SBP, DBP, MAP, HR, and GSC for Non-threat and Threat Conditions in Bin Times 1 and 2



Balance Control

ANOVA results for all posturograpahy data are presented in Figure 3.3. When a 2 (Threat Condition) x 2 (Bin Time) fully repeated measures ANOVA was conducted on balance variables, no main effects for Threat Condition and Bin Time were observed for MPF-AP. A significant interaction effect was observed for Threat Condition and Bin Time on MPF-AP [$F(1,24)= 5.00$, $p=.04$, Wilk's $\Lambda = .83$, partial $\eta^2 =.17$]. However, results were non-significant after a more stringent $p<.01$ was applied. The main effects of threat condition and bin times were non-significant. Turning to MPF-ML, results indicate that there was a significant increase in the frequency of sway from Bin Time 1 to Bin Time 2 [$F(1,24)=4.95$, $p=.04$, Wilk's $\Lambda = .83$, partial $\eta^2 =.17$]. Similarly, results were non-significant after a more stringent $p<.01$ was applied. Main effects for Bin Time and interaction effects of Threat Condition and Bin Time were non-significant for MPF-ML. No significant findings were observed for the variables RMS-AP and RMS-ML. The results from the data did not show support for the threat manipulations having a significant main effect on changes in balance. Thus, contrary to the hypothesis that the frequency of sway would be affected after watching the threatening videos, the analysis from data did not support this case.

Figure 5.3 MPF-AP(Hz), MPF-ML(Hz), RMS-AP(mm), and RMS-ML(mm) for Non-threat and Threat Conditions in Bin Times 1 and 2.



5.6 Secondary Hypotheses

5.6.1 Trait Anxiety and Emotional Response

First, secondary hypotheses 1) predicted that high trait anxious individuals would perceive the threat stimulus (as indexed by the Anticipatory Processing of Anxiety questionnaire), fear, and state anxiety to be more anxiety provoking compared to moderate and low trait anxious individuals in the threat condition (after watching the threat video) compared to the non-threat condition (after watching the neutral video).

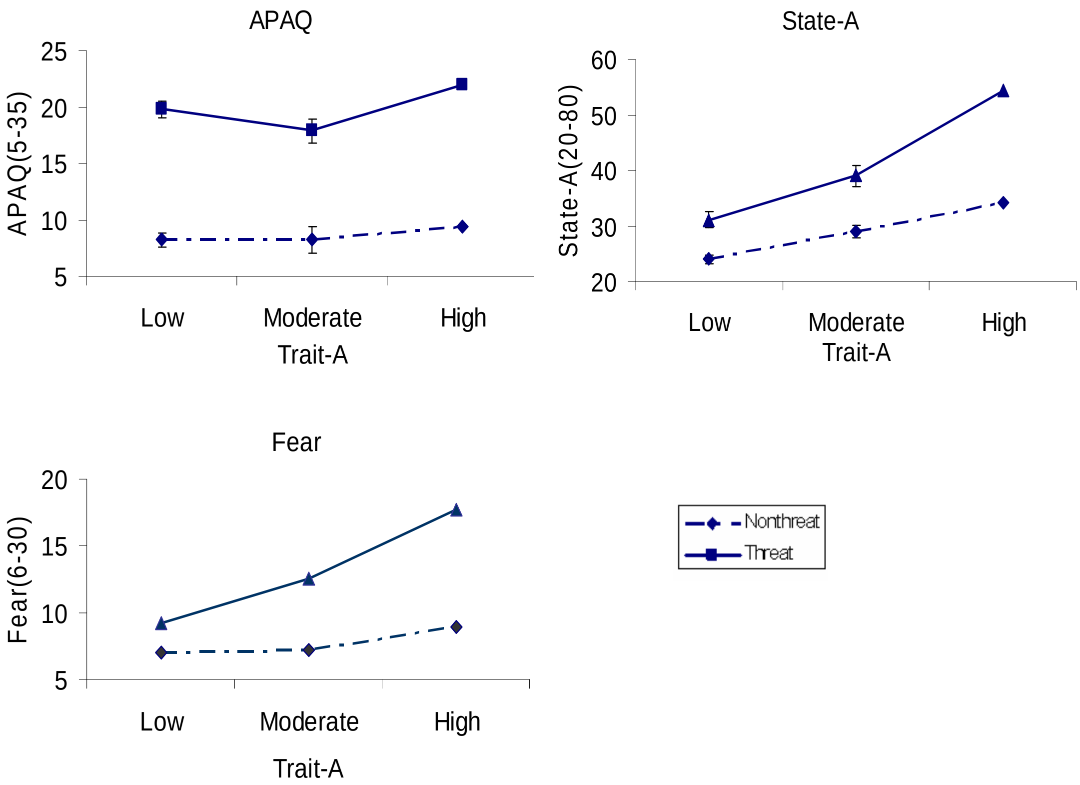
Scores for Trait Anxiety were cutoff at the 33.3rd and 66.6th percentile of the normal distribution to create 3 equal groups of Low (n=8), Moderate (n=9), and High Trait (n=8) Anxiety groups. Means and standard deviations of participant APAQ scores in the Threat and Non-threat condition are presented in Appendix E-2. A 3x2 mixed models ANOVA with (Trait Anxiety Group x Threat Condition) with Trait Anxiety Group as the between groups factor was carried out on APAQ scores. ANOVA results indicate that there was a main effect of Threat ($p<.0001$). The interaction effect of Trait Anxiety Groups and Threat Condition were non-significant ($p=.63$).

Similarly, high trait anxious individuals were expected to report higher scores on measures of fear and state anxiety compared to moderate trait anxious individuals, and moderate trait anxious individuals would report higher scores on measures of fear and state anxiety compared to low trait anxious individuals in the threat condition (after watching the threat video) compared to the non-threat condition (after watching the neutral video).

A 3 (Trait Anxiety Group) x 2 (Threat Condition) mixed models ANOVA with Trait Anxiety as a between groups factor was conducted on scores for Fear and State-A. Simple contrasts were carried out to identify differences between Low Trait-A, Moderate Trait-A, and High Trait-A in reported scores for State-A and Fear. Means and standard deviations for State-A and Fear scores for Low, Moderate, and High Trait-A groups are presented in Tables 3.6-3.7. Looking first at self report State-A, ANOVA results revealed a significant interaction effect for Trait-A Group and Threat Condition (*p*=.009) Subsequently, a main effect of Threat Condition and Trait-A Group was found (*p*<.0001, and *p*<.0001). Contrast results indicate significant differences between the 3 Trait-A Groups (i.e., Low Trait-A, Moderate Trait-A, and High Trait-A) (*p*<.0001Moderate Trait-A participants scored significantly higher on State-A compared to the Low Trait-A participants by 6.39 points (*SE*= 2.79, *p*=.03), while High Trait-A participants scored higher on State-A compared to the Low Trait-A participants by 16.73 points (*SE*= 2.86, *p*<.0001).

Similarly for Fear, there was a significant interaction effect for Trait Trait-A Group and Threat Condition (*p*=.03). However, results were non-significant after a more stringent p<.01 was applied Subsequently, a main effect of Threat Condition and Trait-A Group was found [(*p*<.0001) and (*p*=.006). Turning to look at contrast results, Moderate Trait-A participants did not differ significantly from Low Trait-A participants, showing a slight difference score of 1.78 (*SE*= 1.42, *p*=.22). Whereas High Trait-A participants were found to report significantly higher than Low Trait-A participants by 5.20 points (*SE*= 1.46, *p*=.002). The overall contrast between the three Trait-A groups on fear scores were significant (*p*=.006).

Figure 5.4 State Anxiety, Fear, and APAQ Scores Between Low, Moderate, and High Trait Anxiety Groups in the Threat and Non-threat Conditions.



It was expected in secondary hypotheses 2) that there would be no difference in physiological responses (galvanic skin conductance, heart rate, and blood pressure) between High Trait-A, Moderate Trait-A, and Low Trait-A individuals.

5.6.2 Trait Anxiety and Physiological Response

5.6.2.1 Galvanic Skin Conductance

A 3 (Trait-A Group) x 2 (Threat) x 2 (Condition x Bin Time) mixed models ANOVA with Trait Anxiety as a between groups factor was conducted on scores for Galvanic Skin Conductance, Heart Rate, and Mean Arterial Pressure). Since no prior hypotheses were made for how Trait-A Groups differed on these outcome variables, post-hoc Tukey HSD tests were conducted to parse out any existing differences between Low Trait-A, Moderate Trait-A, and High Trait-A participants.

ANOVA results indicate that the three-way interaction Trait-A x Threat Condition x Bin Time was non-significant (*p=.27).* Similarly, two-way interactions between Trait-A x Threat Condition and Trait-A x Bin Time were non-significant (p=.50 and p=.54). As found in the Primary Hypotheses of this study, Threat Condition x Bin Time remained significant (p=.004). The main effect of Threat was also significant (p<.0001). A main effect of Trait-A Groups on Galvanic Skin Conductance (p=.05) was found. This finding was non-significant after a more stringent p<.01 level was applied. These positive findings on main effect of Trait-A on GSC was in line with the expected hypothesis.

5.6.2.2 Heart Rate

Results indicate that the three-way interaction Trait-A x Threat Condition x Bin Time was non-significant (p=.35). Two-way interactions between Trait-A x Bin Time and Trait-A x Threat Condition was non-significant (p=.09 and p=.82). These findings were in line with the hypothesis. The interaction effect between Threat Condition x Bin Time remained significant (p=.03). The main effect of Threat Condition, Bin Time, and Trait-A Groups were all non-significant (p=.52, p=.32, and p=.13) respectively. No post-hoc tests were conducted as there were no differences in Heart Rate within Trait-A participant groups.

5.6.2.3 Mean Arterial Pressure

When a 3x2x2 ANOVA (Trait-A x Threat Condition x Bin Time) with Trait-A as a between groups factor was conducted on Mean Arterial Pressure, no significance was found between the three-way (Trait-A x Threat Condition x Bin Time) (p=.34) and two-way (Threat Condition x Bin Time, Trait-A x Threat Condition, and Trait-A x Bin Time) interactions (p=.71, p=.35, and p=.28) respectively. Results however indicate that the main effect of Threat Condition was significant (p<.0001). The main effects of Bin Time and Trait-A were both non-significant (p=.38, p=.32, and p=.40). No post-hoc tests were conducted as there were no differences in Mean Arterial Pressure within Trait-A participant groups.

Balance control would be modulated as an effect of Trait Anxiety dependent on Threat Condition. Specifically, frequency of COP sway was expected to increase more in High Trait Anxious individuals compared to Moderate and Low Trait-Anxious individuals, while amplitude of SD COP was expected to decrease more in High Trait Anxious individuals compared to Moderate and Low Trait-Anxious individuals from the Non-Threat to the Threat condition. No specific hypotheses were formulated in terms of how balance control would be modulated as an effect of Trait Anxiety on Bin Time (Secondary hypotheses 3).

5.6.3 Trait Anxiety and Balance Control

Results indicate that the three-way interaction between Trait-A x Threat Condition x Bin Time for MPF-AP, MPF-ML, RMS-AP, and RMS-ML were non-significant (p=.48, p=.04, p=.32, *and* p=.42). Two-way interactions between Trait-A x Threat Condition for all four balance variables (MPF-AP, MPF-ML, RMS-AP) were also non-significant (p=.72, p=.25, p=.39, and p=.09). Similarly effects of Threat Condition x Bin Time for MPF-AP, MPF-ML, RMS-AP were non-significant (p=.05, p=.98, p=.48, and p=.76). Finally, no findings were deemed to be significant for both main effects of Trait and Bin Time (p=.81, p=.72, p=.48, and p=.97) and (p=.80, p=.04, p=.70, and p=.40). No post-hoc tests were conducted as there were no differences in Balance Control within Trait-A participant groups.

5.6.4 Fear of Falling, Balance Confidence, and Emotional Response

We predicted from secondary hypotheses 4) Self report measures of fear of falling and balance confidence for daily activities (as measured by the FES-I and ABC) were not expected to show any relationship with levels of perceived fear and state anxiety.

As predicted, FES-I scores and ABC scores correlated strongly (r=.60, p<.001), while neither FES-I nor ABC scores correlated significantly with self-reported State-A scores and Fear scores [r=.09, p>.05 and r=-.21, p>.05] and [r=.14, p>.05 and r=.21, p>.05], respectively.

5.6.5 Pain Anxiety and Emotional Response

Self report measures of pain-related anxiety (Pain Anxiety Symptoms Scale-20; PASS-20) was expected in secondary hypotheses 5) to correlate positively with perceptions of fear and state anxiety. Contrary to the expected hypothesis, PASS-20 scores showed no relationship with self-report Fear scores (r=.01, p>.05) and State-A scores (r=-.10, p>.05).

5.6.6 Balance Efficacy and Fear of Falling

From secondary hypotheses 6), it was expected that perceptions of balance efficacy would be decreased in the threat condition (after watching the threat video) compared to the non-threat condition (after watching the neutral video), and perceptions of fear of falling was expected to be lower in the threat condition compared to the non-threat condition. Perceptions of balance efficacy in participants between the threat and non-threat conditions were analyzed with a paired samples t-test. Results indicate that balance efficacy (i.e., how efficacious participants felt when carrying out the balance task) significantly decreased in participants from the non-threat condition to the threat condition [$t(25)=-3.10$, $p<.005$, $\eta^2= 0.28$]. In line with these findings, self-report measures of fear of falling were analyzed using 2(threat condition) x (2 bin time) repeated measures ANOVA. Results indicate that regardless of Bin time, quiet standing during the threat condition significantly affected levels of fear of falling in participants [$F(1,25)=5.91$, $p=.02$, Wilk's Λ = .81, partial $\eta^2=.19$]. Interaction effects and main effect of bin time were non-significant [$F(1,25)=1.77$, $p=.20$, Wilk's Λ = .93, partial $\eta^2=.07$ and $F(1,25)=1.46$, $p=.20$, Wilk's Λ = .95, partial $\eta^2=.24$].

Table 5.2 *Bivariate Correlations for Psychological and Physiological Variables*

	Pain Anxiety	**ABC**	**Trait-A**	**Balance Efficacy**	**FOF Bin1**	**FOF Bin2**	**State-A**	**Fear**
GSC Bin1	-.42*							
GSC Bin2	-.40*							
HR Bin1	-.32							
HR Bin2	-.18							
MAP Bin1	.10							
MAP Bin2	.22							
ABC	.29	-						
Trait-A	.20	.06	-					
Balance Efficacy	.24	.05	-.08	-				
FOF Bin 1	**.42***	-.24	.28	.14	-			
FOF Bin 2	.20	**-.55****	.30	.08	.12	-		
State-A	-.10	.14	**.62****	-.31	.23	-.04	-	
Fear	.05	.21	**.44***	.01	.25	-.12	**.71****	-

* *p*<.05

** *p*<.01

Shaded grey boxes indicate where correlational analyses were not performed based on hypotheses

Table 5.3 Bivariate correlations for all Psychological and Balance Variables

	ABC	**Trait-A**	**Pain Anxiety**	**Balance Efficacy**	**FOF Bin 1**	**FOF Bin 2**	**State-A**	**Fear**
MPF-ML Bin 1	.07	.18	.06	**-.42***	.13	-.08	.04	-.12
MPF-ML Bin 2	-.12	-.19	.13	**-.57****	-.13	.02	-.14	**-.48***
MPF-AP Bin 1	-.10	.16	-.13	-.12	.01	.02	.16	.08
MPF-AP Bin 2	-.12	.05	-.16	.07	.21	.29	.31	.22
RMS-ML Bin1	.04	-.26	.34	.30	.25	-.18	-.21	.07
RMS-ML Bin 2	.30	.03	-.06	.25	-.13	-.38	-.20	.14
RMS-AP Bin 1	.21	.02	.39	-.25	-.13	-.34	-.08	-.16
RMS-AP Bin 2	.32	.23	.13	-.09	.04	-.29	.29	**.51****

* p<.05

** p<.01

Table 5.4 Bivariate Correlations for all Physiological and Balance Variables

	GSC Bin1	GSC Bin2	HR Bin 1Bin 1	HR Bin 2	MAP Bin 1	MAP Bin2	MPF-ML Bin 1	MPF-ML Bin 2	MPF-AP Bin 1	MPF-AP Bin 2	RMS-ML-Bin 1	RMS-ML-Bin 2	RMS-AP-Bin 2
GSC Bin1	-												
GSC Bin2	**.84****	-											
HR Bin1	-.30	-.35	-										
HR Bin2	-.16	-.28	**.82****	-									
MAP Bin1	.25	.21	**-.44***	-.48*	-								
MAP Bin2	.19	.15	**-.52***	-.47*	**.82****	-							
MPF-ML Bin1	.01	.15	-.05	.11	-.08	.09	-						
MPF-ML Bin2	-.17	-.02	-.34	-.23	-.17	.06	**.64****	-					
MPF-AP Bin1	.25	-.04	.18	.41	-.08	.03	-.09	-.01	-				
MPF-AP Bin2	-.08	.08	**.59****	.38	-.02	-.15	-.29	**-.42***	.28	-			
RMS-ML Bin1	-.18	-.09	.06	-.02	.14	.13	**-.57****	-.35	-.03	.09	-		
RMS-ML Bin2	.18	-.08	.03	-.05	.32	.08	-.10	**-.42***	-.18	-.04	.34	-	
RMS-AP Bin1	-.31	.00	-.38	-.15	-.10	-.07	.11	.39	-.19	**-.56****	.24	.07	-
RMS-AP Bin2	-.15	-.20	-.23	-.12	.17	.14	-.05	-.18	-.09	-.24	.21	**.52****	-.30

CHAPTER VI: DISCUSSION

6.1 General Findings

The aim of this study was to explore how anticipatory anxiety influences the perceptions of emotional states, physiological responses, and balance control in young, healthy female adults, and whether personality predispositions to experiencing anxiety accounts for some differences in these response systems. This study addressed these aims by employing a social learning paradigm that used video observations of other people experiencing anxiety to induce anticipatory anxiety in the participants.

The general findings from the study were:

1. Perceptions of fear and state anxiety were significantly higher in participants after having completed the 3-minute quiet standing trial in the threat condition compared to the non-threat condition. These increased levels of self-reported state anxiety and fear were also found to be significantly higher in ‘highly anxious individuals’ compared to ‘moderately anxious individuals,’ while ‘moderately anxious individuals’ reported significantly higher scores on state anxiety but not fear when compared to ‘least anxious individuals’ in the threat condition.

2. Changes in physiological arousal, including systolic and diastolic blood pressure, mean arterial pressure, and galvanic skin conductance was significantly higher in participants during the 3-minute quiet standing trial in the threat condition compared with the non-threat condition. Changes in all physiological variables were not affected by personality predispositions toward anxiety.

3. No differences were found between the threat and non-threat condition dependent on bin time for the frequency and amplitude (in both AP and ML directions) of postural sway. Subsequently, these differences were not pronounced when balance variables were examined as an effect of trait anxiety differences between groups dependent on threat condition.

6.2 Validity and Overall Strengths of Study.

The current study offers some unique findings to the literature. This was the first study to employ a social learning paradigm to induce anxiety in participants and observe subsequent changes in emotional states, physiological states, and balance control. One of the core motivations for the study's design was the belief that it would provide insight into how anticipatory processing of anxiety might serve as a mechanism to influence balance control, physiological responses, and emotional states. Most work addressing the issue of anxiety and balance have found that the ability to maintain balance becomes impoverished under conditions of posture *specific* threat (Carpenter, et al., 2001; Davis et al., 2009). A small number of studies have also found that negative valence pictures, such as those of body mutilation, also cause changes in balance parameters. Still, the methods employed in these previous studies involve placing participants in a 'state' of anxiety, while having to complete the balance task. Anxiety experienced prior to beginning a balance task has not yet been examined as a mechanism as to how these subsequent changes in balance occur. One suggestion is that anticipatory thought processes impede the ability to perform a future balance task. A goal of this study was to improve our understanding of how forms of anxiety *other* than that of posture specific threat, or threats invoked during the task, might influence the control of balance. Therefore, we attempted to manipulate anticipatory anxiety by having participants *merely* anticipate a negative and painful event that never actually occurred.

One important rationale for employing the social observation method of video viewing was that it allowed for a highly controlled laboratory procedure that met ecological validity. Since the experience of physical pain is often a result from falls and since neuroanatomical studies provide some evidence for links between neural pathways of pain and anxiety, the methods involved in the current study seem to provide one possible answer to these methodological gaps that are currently standing in the literature.

The findings from the data provide support for the use of threatening videos to induce a state of anticipatory anxiety in participants. The questions from the Anticipatory Processing Questionnaire were asked immediately after participants watched each video. The significantly higher scores reported after watching the threat video compared to the non-threat video provided support for the threat video as a valid social learning paradigm to investigate anticipatory anxiety. Participants also reported increased perceptions of fear (p<.001) and anxiety (p<.001) in the threat condition compared to the non-threat condition. Since the questions from the fear scale and State-Anxiety scale were asked after participants completed the 3-minute quiet standing task (and not after watching the video), this allowed us to conclude that these emotions were experienced during the actual standing task. The extent of how self report emotional states, physiological responses, and changes in balance parameters were affected by the threat manipulation is further discussed in the following section.

6.3 Emotional States, Physiological Response and Balance.

The finding that perceptions of fear and state anxiety were significantly higher in participants after the threat video compared with the neutral video (p<.001 and p<.001), adds to the large body of literature that exists on the power of social observation to induce anxiety responses in people. Recently, Olsson and colleagues (2007) found that watching videos of others in an stressful situation modulated peoples' self-report of anxiety and galvanic skin changes. In the current study, it was expected that trait anxiety would account for some between-participant variance in how they responded to the threat stimulus. However, it was unnecessary to conduct an analysis of covariance using trait anxiety as a covarying factor since the within experimental design inherently accounted for pre-existing variance between participants. Hence, when a three way ANOVA was conducted with trait anxiety as a between-groups factor, a strong interaction was found between the low, moderate, and high trait anxious groups in their emotional perception of anxiety and fear in the threat condition. This result was found in concurrence with a moderately positive correlation between trait anxiety and state anxiety ($r=.62$, $p<.01$) and trait anxiety and fear ($r=.44$, $p<.05$). These findings are not surprising as many researchers have found that higher trait anxious individuals have a tendency to experience higher levels of state anxiety. However, at least from the findings in the current study, trait anxiety did not influence other physiological markers of anxiety associated with arousal (such as heart rate and galvanic skin changes).

6.4 Physiological data.

The findings from hemodynamic and heart rate data from the current study should be interpreted with great caution due to several technical challenges faced during data acquisition. The Finapress equipment that was used to obtain beat-to-beat blood pressure required a careful stepwise calibration process that would account for the height of where the pressure pulse was obtained (at the mid-phalanx) relative to the heart. The technical difficulty that was faced prevented a proper calibration of baseline blood pressure readings for several participants. Therefore to offset possible errors in the data, blood pressure data was analyzed as change from baseline instead of raw values. Since the calibration difficulties with the equipment occurred between participants, this would not have produced error within participants. Other researchers have accounted similar technical difficulties with the equipment that was used in the current study (Querido and Sheel, 2007).

In line with expectations, blood pressure was significantly higher in the threat condition compared to the non-threat condition. A similar pattern of increase in blood pressure was reported by Carpenter et al. (2006) when postural threat was increased. However, this effect was only observed in healthy, older adults and not in healthy, young adults in their study. Contrary to our hypothesis on heart rate, the data showed that participants' heart rates were lower during the anticipatory threat period (Bin Time 1) compared to the post threat period (Bin Time 2) in the threat condition, compared to the non-threat condition. Although several studies have found that animals and humans exhibit a decrease in heart rate in fearful situations (Bradley, Codispoti, Cuthbert, & Lang, 2001), others have found the opposite effect (i.e., an increase in heart rate) from anxiety provoking stimuli (Kriebig, Wilhelm, Roth, & Gross, 2007; Vrana & Rollock, 2002). These inconsistent findings raise concerns over the role of heart rate in this paradigm.

Based on previous research findings on heart rate response to anxiety stimulus, it was expected in the current study that heart rate would increase as a result of the anticipatory anxiety stimulus. This relationship was expected since heart rate and blood pressure have been reported to reflect a combination of sympathetic and parasympathetic activity, and thus both were expected to show linear and systematic activation patterns (Bradley & Lang, 2000). In spite of this and other findings in the literature reporting a linear increase in blood pressure and heart rate variables as a result of anxiety, a closer look at the literature indicates that not all autonomic nervous system (ANS) measures of emotional arousal map onto single dimensions. A meta-analysis by Cacciopo, Bernston, Klein, Poehlmann, & Ito (2000) found that the effects of ANS responses were in fact highly inconsistent across studies. The findings in the current study, with support from other findings (Kriebig et al., 2007), indicate that different measures of physiological arousal can operate independently or even in opposition to each other. Similarly, when correlations were observed in the current study, all measures of blood pressure (SBP, DBP, and MAP) showed moderate positive correlations with each other. On the other hand, a moderately negative correlation between HR and blood pressure variables were found. GSC showed no significant correlations with either HR or BP variables. Given these findings, it may be best to view physiological ANS responses in terms of broader dimensions such as arousal and not possessing linear, organized patterns for specific emotions (such as anxiety), as others have proposed (Mauss & Robinson, 2009; Mauss, Wilhelm, & Gross, 2004).

The data obtained from galvanic skin conductance (GSC) showed that the level of physiological arousal was highest during the anticipatory period (Bin Time 1) of the threat condition. This is consistent with other studies examining the effects of anticipatory anxiety (Mauss & Robinson, 2009). These results add to the existing literature that skin conductance is a sensitive measure of physiological arousal. Subsequent to these findings on GSC, results showed that trait anxiety was a significant factor in the activation of skin conductance arousal. When high and low trait anxious individuals were compared on their maximum GSC levels in the non-threat and threat conditions, a difference was observed between high Trait-A and Low Trait-A groups,This finding was contrary to previous work reporting that the effect of trait anxiety on actual physiological activation is small or non-existent (Eckman & Shean, 1997; Edelmann & Baker, 2002; Mauss et al., 2004; Mauss & Robinson, 2009). The fact that there still remains a preponderance of confusion in the literature on how trait anxiety influences anxiety experience and actual physiological activation point to the need for further investigations on this topic.

6.5 Balance Data

Contrary to my hypothesis that the frequency and amplitude of postural sway would be significantly affected by the threat stimulus, no significant changes were observed. Although at a level of non significance (after a more stringent $p<.01$ was applied), the interaction of Threat x Bin Time for MF-AP ($p=.04$) was an interesting observation and bears some discussion. The interaction observed was disordinal, in that during the threat condition, MPF-AP increases from Bin Time 1 to Bin Time 2. However, this superiority reverses, that is, in the non-threat condition, participants record higher MPF-AP in Bin 1 compared to Bin 2. Thus, the main effect of threat in this case cannot be logically interpreted (Stevens, 1999). The observations on balance in this study point to the fact that, more work needs to be done in the area of anticipatory anxiety on the control of balance.

When Trait Anxiety groups (i.e. Low, Moderate, and High Trait-A participants) were used as between groups factor on balance variables, results indicate that the effect of Trait anxiety dependent on threat conditions on balance control were not significantly pronounced. Although the work on the covarying effects of trait anxiety is still at its infancy, some studies are now beginning to show that, at least in elderly participants where a risk of losing balance is of greater concern than young participants, predispositions to experiencing higher anxiety (specifically, a fear of negative evaluation), accounts for some variance in balance changes when being evaluated by a clinician in a clinical experiment setup (Geh, Carpenter, Beauchamp, & Crocker, unpublished data). Clearly, more needs to be carried out in the area of how trait anxiety might modulate changes in the control of balance during threatening situations.

6.6 Balance Efficacy and Fear of Falling

The data from observing simple correlations show that fear of falling in the period after the threat (Bin Time 2) showed a modest negative relationship with balance confidence. Hence, lower levels of balance confidence were associated with higher levels of fear of falling during the post-threat period (Bin Time 2). In addition, self-reported levels of fear of falling in the anticipatory period (Bin Time 1) showed a modest positive relationship with scores on Pain Anxiety. Though in its early stages, some research have indicated that, at least in elderly individuals, fear of pain and fear of falling appear to be related constructs and are both associated with activity avoidance (Williams et al., 2005). Little interpretation should be made from the positive observations found in the simple correlations in the present study as this area still requires much investigation.

One particularly interesting finding was that participants reported significantly higher balance efficacy and lower levels of fear of falling in the non-threat condition compared to the threat condition despite having no change in their actual balance performance. Before participants were asked to stand on the force-plate, they were asked to predict their own balance confidence in the upcoming 3-minute standing task for both the threat and non-threat conditions. Despite finding a significant negative correlation between self reported balance efficacy and changes in MPF-ML from the threat to non-threat condition, participants balance data from the ANOVA analysis showed no difference in balance parameters during the threat condition and the non-threat condition. In addition, contrary to the initial hypothesis of the study, no relationships were found between changes in self-reported fear of falling and change of balance parameters from the threat to the non-threat condition. Further, Davis et al. (2009) had reported that reported fear of falling scores were significantly correlated with changes in RMS-AP between balance tasks performed at ground level versus those performed at extreme heights (Davis et al., 2009). It is not understood why a dissociation in participants' perceptions of their ability to maintain their balance versus their actual balance performance existed in the current study.

One explanation as to why changes in balance parameters were not observed in the present study is the possibility that the anxiety stimulus was not strong enough to prime significant observable changes in balance, although readily affecting other dependent measures such as emotional responses, blood pressure, and galvanic skin conductance. Moreover, despite recent findings in the literature that balance during upright standing is affected during times of anxiety, the mechanisms and changes of the balance system as a result of anxiety is still not fully understood.

6.7 General Discussion

The findings from the current study indicate that emotional perceptions and physiological responses, but not balance parameters, were significantly affected by the threat manipulation. One possible reason for this negative finding with respect to balance parameters is that the threat stimulus of anticipatory anxiety did not prime the motor system involved in balance. In this study, a threat of an electric shock to the forearm was used as the threat manipulation and not as a direct threat to the human balance system. Since the stimulus was focused at a local level in the forearm, there may have been muscle co-activation at the local forearm area, but the ability to maintain normal postural sway was not affected.

In addition, previous studies investigating the role of anxiety on balance control used threat stimuli, including negative affective picture viewing or standing at extreme heights, *while* participants performed a simple upright standing task. Hence the fact that anxiety was invoked during the actual balance task in these studies may have been one contributing factor to changes in balance parameters. The extent to how much the emotion system is probed when shown negative affective pictures have been confirmed in brain imaging studies as well as with physiological arousal indicators such as galvanic skin conductance. Nonetheless, the aim of the current study was to investigate if anxiety invoked *prior* to a balance task would 'carry over' to affect actual balance performance in participants. Although the data confirms that participants did report feeling more anxious and fearful coupled with changes in physiological arousal, it may have been that the threat was not powerful enough to modulate changes in balance parameters.

Another possible reason for this dissociation in response to the threat stimulus is the impact of the values and goals of the individual participants. In a recent unpublished study by Geh and colleagues, older people but not younger people showed a tightening of posture akin to that observed in other fear of falling studies when their balance performance was subject to negative clinical evaluation. The findings in the study by Geh and colleagues support the notion that the emotion system involves complex mechanisms, including personal goals and values (Lazarus, 1999). Lazarus and Folkman (1984; 1999) have found that when people fail to achieve or maintain their desired goals, negative emotions occur as a result. For older adults, the notion of balance can often be at the forefront of concern, whereas balance is usually not a cause for concern for young, healthy adults. Since goals are defined as desired imaginable states that are valuable to the person involved (Lazarus, 1994), it would make sense that the goals at stake for older individuals to perform well during a balance task are far more crucial compared to the young, healthy individuals. In the current study, it may have been that the threat stimulus did not target the relevant goal at stake for the participants. Future studies may benefit from investigating the cognitive processes that take place when an individual performs a balance task and how these appraisals affect anxiety experience.

One final explanation that could account for the dissociated findings between response systems involves the notion of the coherence of systems. One of the long standing debates in the literature on emotions is whether emotions consist of organized patterns. The notion of response coupling and coherence in emotion was first suggested by James (1884) and later promoted by Levenson (2003) and others (Pauls & Stemmlar, 2003). As these authors suggest, the perspective that emotions constitute an organized system makes sense as systems that work in a disparate manner cannot coordinate action to optimize the likelihood that an individual will successfully adapt to challenges in the environment. Even so, the findings of studies that have examined the convergence of response systems do not appear to support this model. Cacciopo and colleagues (2000), Mauss and colleagues (2004), as well as others (Bradley et al., 2001) found that correlations among multiple measures of emotion are usually moderate at best and inconsistent across studies. In the present study, although coherence was found between some variables, namely between emotional experience of fear and anxiety, and between hemodynamic variables, complete convergence between emotional experience, physiology, and balance (neuromechanical) was not found. One possibility raised is that the present as well as previous studies assessed coherence in terms of between-individual correlations, thus comparing response components. However, it might be that within-individual associations of measures across time may be a better measure of how response system coherence might be viable and more accurately denote response system coherence.

6.8 Study Limitations

6.8.1 Measurement of Falls Efficacy and Balance Confidence

The current study as well as most other fear of falling studies, assess fear and concern about different activities of daily living using the FES-I and ABC scales, which were developed for older individuals between 60 and 95 years of age. Although the ABC scale was developed for more highly functioning elderly individuals, these questionnaires remain unsuitable for use with a younger and healthy population, such as that used in the current study. Thus, it is no surprise that scores from the current study for both the FES-I and ABC cluster close to the maximum level. These problems are also pronounced in previous studies using these questionnaires with younger populations. While the FES-I and ABC are valid and reliable measures to sensitively discriminate between different levels of fear and balance efficacy for older populations (Yardley et al., 2005), there may be a need for a more appropriate measure to be developed to discriminate between levels of balance confidence for daily living activities in young, healthy populations for use in the lab. Accordingly, such a measure would have to take into account the fact that balance concerns for younger people differ greatly from older people.

6.8.2 Use of Videos

In the videos, seven graduate students played the roles of participants and an experimenter in a staged experiment that closely mimicked the true experimental setup of the current study. One concern that arises from using graduate students as actors is that the acting skills displayed by these individuals may not have been thoroughly convincing to the participants watching the video. Though confirmation from the manipulation check informed us that significantly higher levels of anticipatory anxiety was experienced in the threat versus the non-threat condition, the methodological strength of future studies may benefit from exploring the use of a better rehearsed script or professional actors in the making of observational videos.

6.8.3 Mean Position of Balance

Although COP was recorded and calculated for AP and ML directions, one other variable not examined in the current study that may of interest is the mean position of COP. Previous work in the fear of falling literature have analyzed the mean position of COP to find that the effects of postural threat on mean position often shifts backward when participants are placed in a high threat condition compared to low threat condition (Carpenter et al., 2001). These studies reporting a significant change in mean position together with an increase in frequency of sway often use high heights to induce postural threat. The question of whether or not mean position shifts as a function of height change (i.e. low to high) and is coupled with an increase in frequency, or shifts independent of frequency may be answered in a study that employs a different postural threat other than high heights. One study analyzing the change in mean position as an effect of increased threat that did not employ high heights as the threat stimulus found no change in mean position (Stins & Beek, 2007). However a significant limitation in the methodology employed by Stins and Beek (2007) deemed their conclusions to require further exploration in this area. Thus, analyzing change in mean position in the current study may have served to provide some insight on whether mean position changes dependent or independent of frequency changes in posture.

6.8.4 Risk of Type II Error

In the current study an a priori power calculation was conducted using power of .80 and alpha level at .05 to determine the level of significance. However, due to the number of hypotheses tested (i.e. eleven in total), a decision to use a more stringent alpha level of .01 was made to reduce the possibility of an inflated family wise Type I error. In doing so however, there was a risk of committing a Type II error (i.e. failing to reject a null hypothesis when it was present). These concerns over the risk of Type I and Type II errors in the current study were addressed by cautioning against the conservative Bonferroni correction and using a $p<.01$ level to identify the level of significance for all dependent measures.

6.9 Study Implications and Future Directions

Despite showing a lack of significant observable changes in actual balance parameters in the current study, the question of whether evaluative reports of fear and anxiety and increased physiological levels as a result of the threat stimulus may still be a concern. The concern that arises is that a chronic feeling of anxiety and heightened physiological arousal from mere anticipation may cause problems other than falls to develop. Recently, Van Boen and Ashworth (2007) reported that people experience more intense emotions during the anticipation of emotional negative events than retrospection about these events.

Similarly, Codispoti and colleagues (2003) showed an increased secretion of the stress hormones cortisol, noradrenaline, and ACTH when participants were shown negative affective pictures. So even though falls and injury from loss of balance may never take place for years, individuals may eventually develop chronic generalized, unhealthy beliefs about falls. Nevertheless, there is a need to garner further evidence through future studies to investigate the role of anticipatory anxiety in mediating further negative beliefs and the development of chronic worry (Kashdan, 2007; Kashdan & Roberts, 2007). Hence, should such a case be made, the negative emotions of fear and anxiety itself should be a target for intervention as the immediate negative effects on other systems (in this study not balance), which may cause deterioration in healthy and later cause deleterious effects on balance over time. Though heightened physiological responses are useful when a threat stimulus is upcoming and real, an unwarranted priming of the system may lead to chronic effects from anticipation.

The present findings lead to suggestions for future work in the area of anticipatory anxiety and its mechanistic influence on emotional experience, physiological changes, and balance control. Future proposed work could employ fear of falling related anticipation rather than more general anticipatory anxiety. One example for such a research design would be to employ the use of confederate actors in experiment performing a balance task and experiencing an actual loss of balance or, demonstrate having to make postural adjustments from manipulated balance perturbations, while experiment participants observe. Such a study would yield good ecological validity and thus, would be worth exploring in future research. The mechanisms of anxiety is a complex process, and a more thorough understanding of what they mean to the control in balance and human physiology and how they influence actual falls to occur will likely require a synthesis of knowledge form many conceptual perspectives.

6.10 Conclusion

In summary, this research is an initial step into understanding the role of anticipatory anxiety on emotional experiences, physiological arousal, and balance control. Though it is evident that anticipatory anxiety causes negative effects on people's emotional experiences and physiological responses, the current findings lead to suggestions for further work in the area of anxiety and its *mechanistic* influence on emotional experiences, physiological arousal, and balance. Though it is known that posture related anxiety leads to a tightening response of the balance system (Carpenter et al., 2001), more investigations are needed into whether there is a causal relationship of how other forms of more generalized anxiety might influence the balance system, and to further evidence about how anticipatory anxiety might play a critical role in influencing unwarranted negative thought processes. Additionally, further knowledge about how different intensities of anxiety as well as personality predispositions to experiencing anxiety might play a role in balance control and physiological responses is essential to aiding the overall research program in anxiety and falls.

References

Adkin, A. L., Frank, J. S., Carpenter, M. G., & Peysar, G. W. (2000). Postural control is scaled to level of postural threat. *Gait & Posture, 12,* 87-93.

Adkin, A. L., Frank, J. S., Carpenter, M. G., & Peysar, G. W. (2002). Fear of failing modifies anticipatory postural control. *Experimental Brain Research, 143,* 160-170.

Adolphs R, Cahill L, Schul R, Babinsky R. (1997). Impaired declarative memory for emotional material following bilateral amygdala damage in humans. *Learning and Memory*. 4, 51–54.

Afken, C.L., Lach, H.W., Birge, S.J. & Miller, J.P. (1994). The prevalence and correlates of fear of falling in elderly persons living in the community. *American Journal of Public Health, 84*, 565-570.

Amaral, D.G. (2003). The amygdala, social behavior, and danger detection. *Annals of New York Academy of Science, 1000,* 337–347.

Amaral, D.G. (1986). Amygdalohippocampal and amygdalocortical projections in the primate brain. A*dvances in Experimental Medical Biology*, *203*, 3–17.

Alexander G.E., Crutcher M.D. (1990). Functional architecture of basal ganglia circuits: neural substrates of parallel processing. *Trends in Neuroscience*, *13*, 266-271.

Allevi, L., Perna, G., Bussi, R., Bertani, A., & Bellodi, L. (1997). Dizziness, panic attacks, and agoraphobia, *European Neuropsychopharmacalogy, 7,* 230.

Anders, J., Dapp, U., Laub, S., von Renteln-Kruse, W., & Juhl, K. (2006). Screening of fall risk in frail, but still independently living senior citizens. *Zeitschrift Fur Gerontologie Und Geriatrie, 39*, 268-276.

Andresen, E. M., Wolinsky, F. D., Miller, J. P., Wilson, M. M. G., Malmstrom, T. K., & Miller, D. K. (2006). Cross-sectional and longitudinal risk factors for falls, fear of falling, and falls efficacy in a cohort of middle-aged African Americans. *Gerontologist, 46*, 249-257.

Asmundson, G.J.G, & Norton, G.R. (1995). Anxiety sensitivity in patients with physically unexplained chronic back pain: A preliminary report. *Behavioral Research Therapy, 33,* 771-777.

Averill, J.R. (173). Personal control over aversive stimuli and its relationship to stress. *Psychological Bulletin, 80*, 286-303.

Azevedo, T.M., Volchan, E., Imbiriba L.A., Rodrigues, E.C., Oliveira, J.M., Oliveria,L.F., Lutterbach, L.G., Vargas. C.D. (2005). A freezing-like posture to pictures of mutilation. *Psychophysiology, 42*, 255-260.

Balaban, C.D., Thayer, J.F. (2001) Neurological basis for balance-anxiety links. *Journal of Anxiety Disorders*, *15,* 53-79.

Balaban, C.D. (2002) Neural substrates linking balance control and anxiety. *Physiology and Behavior, 77,* 469-475.

Bandura, A. (1977). *Social learning theory*. General Learning Press, New York.

Beauchamp, M.R., Carron, A.V., McCutcheon, S., & Harper, O. (2007). Older exercisers' preferences for exercising alone versus in groups: Considering contextual congruence. *Annals of Behavioral Medicine*, *33*, 200-206.

Bloem, B.R., Steijns, J.A.G., & Smits-Engelsman, B.C. (2003). An update on falls. *Current Opinion in Neurology, 16*, 15-25.

Blumenfeld, H. (2002). Neuroanatomy through clinical cases, Sinauer Associates, Sunderland, MA.

Bradley, M.M., Codispoti, M., Cuthbert, B.N., & Lang, P.J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing, Emotion, 1, 276-298.

Bradley, M.M. & Lang, P.J. (2000). Affective reactions to acoustic stimuli. *Psychophysiology.*, 37, 204-215.

Brown, L. A., Polych, M. A., & Doan, J. B. (2006). The effect of anxiety on the regulation of upright standing among younger and older adults. *Gait & Posture, 24*(4), 397-405.

Brown, M. & Stopa, L. (2007). Does anticipation help or hinder performance in a subsequent speech? *Behavioural and Cognitive Psychotherapy , 35, 133-147.*

Butler, G., & Matthews, A. (1987). Anticipatory anxiety and risk perception. *Cognitive Therapy and Research, 11*, 551-565.

Carver, C.S. & Scheier, M.F. (1990). Origins and functions of positive and negative affect: A control-process view. *Psychological Review, 97,* 19-35

Cacioppo, J.T., Bernston, G.G., Larsen, J.T., Poehlmann, K.M., & Ito, T.A. (2000). The psychophysiology of emotion. In Lewis, R.,& Haviland-Jones, J.M. (Eds.), *The handbook of emotion* (2nd ed., pp.173-191). New York: Guildford Press.

Codispoti, M., Gerra, G., Montebarocci, O., Zaimovic, A., Raggi, M.A., & Baldaro, B., (2003) *Psychophysiology, 40,* 863-868.

Cahill, L. (2000). Modulation of long-term memory in humans by emotional arousal: adrenergic activation and the amygdala. Aggleton J.P., ed. *The Amygdala*. London: Oxford Univ. Press, 425–446.

Cahill, L. & Alkire, M. (2003). Epinephrine enhancement of human memory consolidation: interaction with arousal at encoding. *Neurobiology of Learning and Memory,* 79,194–98

Cahill, L., Babinsky, R., Markowitsch, H.J., McGaugh, J.L. (1995). The amygdala and emotional memory. *Nature*, 377, 295–96.

Cahill, L., Gorski, L., Le, K. (2003). Enhanced human memory consolidation with post-learning stress: interaction with the degree of arousal at encoding. *Learning & Memory, 10,* 270–74.

Cahill L, Prins B, Weber M, McGaugh JL. 1994. β-adrenergic activation and memory for emotional events. *Nature, 371,* 702–704.

Carpenter, M. G., Adkin, A. L., Brawley, L. R., & Frank, J. S. (2006). Postural, physiological and psychological reactions to challenging balance: does age make a difference? *Age and Ageing, 35,* 298-303.

Carpenter, M. G., Frank, J. S., & Silcher, C. P. (1999). Surface height effects on postural control: A hypothesis for a stiffness strategy for stance. *Journal of Vestibular Research-Equilibrium & Orientation, 9*, 277-286.

Carpenter, M. G., Frank, J. S., Silcher, C. P., & Peysar, G. W. (2001). The influence of postural threat on the control of upright stance. *Experimental Brain Research, 138,* 210-218.

Carpenter, M. G., Frank, J. S., Winter, D. A., & Peysar, G. W. (2001). Sampling duration effects on centre of pressure summary measures. *Gait & Posture, 13*, 35-40.

Charney, D.S., Deutsch, A. (1996). A functional neuroanatomy of anxiety and fear: Implications for the pathophysiology and treatment of anxiety disorders. *Critical Reviews in Neurobiologgy, 10,* 419-446.

Chua, P. Krams, M., Toni, I., Passingham. R., & Dolan, R. (1999)., A Functional Anatomy of Anticipatory Anxiety. *NeuroImage, 9*, 563-571.

Clark, D., & McManus, F. (2001). Information processing in social phobia. *Biological Psychiatry, 51*, 92-100.

Clark, D., & Wells, A. (1995). A cognitive model of social phobia. In. Heimberg, R.G., Liebowitz, M.R.., Hope, D.A., & Schneier, Social phobiaL diagnosis, assessment and treatment. New York, Guildford Press.

Costa, P. T., Fleg, J. L., McCrae, R. R., & Lakatta, E. G. (1982). Neuroticism, Coronary-Artery Disease, and Chest Pain Complaints - Cross-Sectional and Longitudinal-Studies. *Experimental Aging Research, 8,* 37-44.

Costa, P. T., & McCrae, R. R. (1985). Hypochondriasis, Neuroticism, and Aging - When Are Somatic Complaints Unfounded. *American Psychologist, 40*, 19-28.

Costa, P. T., & McCrae, R. R. (1987). Neuroticism, Somatic Complaints, and Disease - Is the Bark Worse Than the Bite. *Journal of Personality, 55*, 299-316.

Cornwell, B., Johnson, L., Berardi, L., & Grillon, C. (2006). Anticipation inside virtual reality also elicited stronger physiologic responses relative to anticipation of counting. *Biological Psychiatry, 59,* .664-666.

Critchley, H.D., Weins, S., Rotshtein, P., Ohman, A., & Dolan, R.J. (2004). Neural systems supporting interoceptive awarenessm, *Nature Neuroscience, 7*, 189-195.

Critchley, H.D., Rotshtein, P., Nagai, Y., O'Doherty, J., Mathias, C.J., & Dolan, R.J. (2005). Activity in the human brain predicting differential heart rate responses to emotional facial expressions, *NeuroImage, 24,* 751-762.

Damasio, A.R. (1998). Emotion in the perspective of an integrated nervous system. *Brain Research Review, 26,* 83-86.

Davidson, R.J. (2002). Seven sins in the study of emotion: Correctives from affective neuroscience. *Brain and Cognition, 52,* 129-132.

Davis, J.R. Campbell, A.D., Adkin, A.L., & Carpenter, M.G. (2009) Differential effects of fear and anxiety on human balance control. Gait ad Posture,

Davis, M., Whalen, P.J. (2001). The Amygdala: vigilance and emotion. *Molecular Psychiatry, 6*, 13-34.

Darwin, C. (1859), *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life,* (1st Edition), John Murray, London.

de Gelder, B. (2006). Towards the neurobiology of emotional body language. *Nature Neuroscience, 7,*242-249.

Dharani, N. (2005). The role of vestibular system and the cerebellum in adapting to gravitoinertial, spatial orientation and postural challenges of REM sleep. *Medical Hypotheses*, 65, 83-89.

Dvorak-Bertsch, J.D., Curtin, J.J. Rubinstein, T.J., & Newman, J.P. (2007). Anxiety moderates the interplay between cognitive and affective processing. *Psychological Science, 18,* 699-706.

Edelmann, R. J., & Baker, S. R. (2002). Self-reported and actual physiological responses in social phobia. *British Journal of Clinical Psychology, 41*, 1–14

Ekman, P.S. (1982). *Emotion in the human face*. Cambridge University Press, New York.

Eckman, P.S. & Shean, G.D. (1997) Habituation of cognitive and physiological arousal and social anxiety Behavior Research and Therapy, 35, 1113-1121.

Facchinetti LD, Imbiriba LA, Azevedo TM, Vargas CD, Volchan E (2006) Postural modulation induced by pictures depicting prosocial or dangerous contexts. *Neuroscience Letters*, *410,* 52-56.

Fanselow, M.S., & LeDoux, J.E. (1999). Why we think plasticity underlying Pavlovian fear conditioning occurs in the basolateral amygdala. *Neuron. 23,* 229–232.

Franchignoni, F., Martignoni, E., Ferriero, G., & Pasetti, C. (2005). Balance and fear of falling in Parkinson's disease. *Parkinsonism & Related Disorders, 11*, 427-433.

Frank, J. S. (2006). Fear of falling and postural control. *Journal of the Neurological Sciences, 248*, 327-328.

Frank, J. S., & Patla, A. E. (2003). Balance and mobility challenges in older adults - Implications for preserving community mobility. *American Journal of Preventive Medicine, 25*, 157-163.

Gage, W. H., Winter, D. A., Frank, J. S., & Adkin, A. L. (2004). Kinematic and kinetic validity of the inverted pendulum model in quiet standing. *Gait & Posture, 19*, 124-132.

Geh, C.L.M, Carpenter, M.G., Beauchamp, M.R., & Crocker, P.R.E. Assessed and distressed: Evaluation affects clinical balance performance. Unpublished manuscript.

Gerull, F.C. & Rapee, R.M. (2002). Mother knows best: effects of maternal modeling on the acquisition of fear and avoidance behavior in toddlers. *Behavioral Research Therapy, 40*,279–287 .

Goldie, P.A., Bach, T.M., Evans, O.M. (1989). Force platform measures for evaluating postural control: Reliability and validity. *Archives of Physical and Medical Rehabilitation, 70,* 510-517.

Hadjistavropoulos, T., Martin, R.R., Sharpe, D., Lints, A.C., McCreary, D.R., & Asmundson, G.J.G (2007). A longitudinal investigation of fear of falling, fear of pain, ad activity avoidance in community dwelling older adults. *Journal of Aging and Health,19*, 965-984.

Hibbert, D. (1984). Ideational components of anxiety: Their origin and content. *British Journal of Psychiatry, 144,* 618-624.

Hinrichsen, H., & Clark, D. M. (2003). Anticipatory processing in social anxiety: two pilot studies. *Journal of Behavior Therapy and Experimental Psychiatry, 34*(3-4), 205-218.

Horak, F.B., Esselman, P., Anderson, M.E., & Lynch, A.m. (1984). The effects of movement velocity, mass displaced, and task certainty on associated postural adjustments made by normal and hemiplegic individuals. *Journal of Neurology, Neurosurgery, and Psychiatry, 47,* 1020-1028.

Jacob, R.G., Furman, J.M., Durrant, J.D., & Turner, S.M. (1997). Surface dependence: A balance control strategy in panic disorder with agoraphobia *Psychosomatic Medicine, 59,* 323-330,

Jacob, R.G., Furman, J.M., Durrant, J.D., & Turner, S.M. (1996). Panic, agoraphobia, and vestibular dysfunction. *The American Journal of Psychiatry,* 153, 503-512.

James, W. (1980). *Principles of Psychology,* New York: Holt.

Jorstad, E. C., Hauer, K., Becker, C., & Lamb, S. E. (2005). Measuring the psychological outcomes of falling: A systematic review. *Journal of the American Geriatrics Society, 53*, 501-510.

John, E.R., Chesler, P., Bartlett, F. & Victor, I. (1968).Observation learning in cats. *Science 59,* 1489–1491.

Kahneman, D. (1973). *Attention and effort*. Prentice Hall, Englewood, Cliffs, New Jersey.

Kashdan, T.B., & Roberts, J.E. (2007). Social anxiety, depressive symptoms, and post event rumination: Affective consequences and social contextual influences. *Journal of Anxiety Disorders, 21*, 284-301.

Kashdan, T. B. (2007). Social anxiety spectrum and diminished positive experiences: Theoretical synthesis and meta-analysis. *Clinical Psychology Review, 27*, 348-365.

Kavaliers, M., Choliers, R. & Coldwell, D.D. (2001). Learning from others to cope with biting flies: social learning of fear induced conditioned analgesia and active avoidance. *Behavioral Neuroscience, 115,* 661-674.

King, M. B., & Tinetti, M. E. (1995). Falls in Community-Dwelling Older Persons. *Journal of the American Geriatrics Society, 43*, 1146-1154.

Klinnert, M.D., Emde, R.N., Butterfield, P., Campos, J.J. (1987). Social referencing: the infant’s use of emotional signals from a friendly adult with mother present. *Annual Progress in Child Psychiatry and Child Development, 22,* 427–32.

Kreibig, S. D., Wilhelm, F. H., Roth, W. T., & Gross, J. J. (2007). Cardiovascular, electrodermal, and respiratory response patterns to fear- and sadness-inducing films. *Psychophysiology*, *44*, 787–806.

LaBar, K.S., LeDoux, J.E., Spencer, D.D. & Phelps, E.A. (1995).Impaired fear conditioning following unilateral temporal lobectomy in humans. *Journal of Neuroscience, 15,* 6846-6855.

Lach, H. W. (2005). Incidence and risk factors for developing fear of falling in older adults.

Public Health Nursing, 22(1), 45-52.

Lach, H. W. (2006). Self-efficacy and fear of falling: In search of complete theory. *Journal of the American Geriatrics Society, 54*, 381-381.

Lachman, M. E. (2006). Perceived control over aging-related declines: Adaptive beliefs and behaviors. *Current Directions in Psychological Science, 15*, 282-286.

Lajoie, Y., Teasdale, N., Bard, C., & Fleury, M. (1993). Attentional demands for static and dynamic equilibrium, *Experimental Brain Research, 97,* 139-144.

Lajoie, Y., Teasdale, N., Bard, C., Fleury, M. (1996). Upright standing and gait: Are there changes in attentional requirements related to normal aging? *Experimental Aging Research*, *22,* 185-198.

Lang, P.J. **(**1995). The emotion probe. Studies of motivation and attention. *The American psychologist, 50,* 372-385.

Lazarus, R.S. (1991). *Emotion and Adaptation*. Oxford University Press, New York.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23*, 155-184.

LeDoux, J.E., Farb, C. & Ruggiero, D.A. (1990). Topographic organization of neurons in the acoustic thalamus that project to the amygdala. *Journal of Neuroscience. 10,* 1043–1054.

LeDoux J.E.(1996). *The emotional brain: The mysterious underpinnings of emotional Life*. Simon & Schuster, New York.

LeDoux, J. (2003). The emotional brain, fear, and the amygdala. *Cellular and Molecular Neurobiology, 23*(4-5), 727-738.

Ledoux, J.E. (2002). *Synaptic Self: How our brains become who we are.* Penguin Books, New York.

Li, F., Fisher, K. J., Harmer, P., McAuley, E., Wilson, N. L. (2003). Fear of Falling in elderly persons: Association with falls, functional ability, and quality of life. *Journals of Gerontology Series B: Psychological Sciences and Social Science*, 58, P283-290

Maki, B.E., McIlroy,, W.E. (1996). Influence of arousal and attention on the control of Postural sway. Journal of Vestibular Research, 6, 53-59.

Maki, B.E., Holliday, P.J., Topper, A.K. (1991). Fear of falling and postural performance in the elderly. *Journal of Gerontology, 46,*123-131.

Mansell, W., & Clark, D.M. (1999).How do I appear to others? Social anxiety and processing of the observable self. *Behaviour research and therapy, 37,* 419-34.

Martin, R.R., Hadjistavropoulos, T., McCreary, D.R. (2005). Fear of pain and fear of falling among younger and older adults with musculoskeletal pain conditions. *Pain Research Management, 10,* 211-219.

Mauss I.B., & Robinson, M.D. (2009). Measures of emotion: A review. Cognition & Emotion, 23, 1464-1600.

Mauss, I.B., Wilhelm, F.W., & Gross, J.J. (2004). Is there less to social anxiety than meets the eye? Emotion experience, expression, and bodily responding. *Cognition and Emotion, 18,* 631-662.

McCrae, R. R. (1990). Controlling Neuroticism in the Measurement of Stress. *Stress Medicine, 6*, 237-241.

McCracken, L.M. & Dhingra, L. (2002). A short version of the Pain Anxiety Symptoms Scale (PASS-20): preliminary development and validity. *Pain Research Management, 7*,45-50.

McCracken, L.M. Gross, R.T. Sorg, P.J., & Edmands, T.A. (1993a). Prediction of pain in patients with chronic low back pain: Effects of inaccurate prediction and pain-reated anxiety. *Behavioral Research Therapy. 31*, 647-652.

McGaugh, J.L. (2000). Memory: a century of consolidation. *Science, 287,* 248–51.

McGaugh, J.L.(2002a). Memory consolidation and the amygdala: a systems perspective. *TINS 25*, 456–61.

McGaugh , J.L.(2002b). The amygdala regulates memory consolidation. In: Squire, L.R. Schacter, D. *Neuropsychology of Memory*, (Ed.), New York: Guilford. 3rd edition, 437–449.

McGaugh, JL., Ferry, B., Vazdarjanova, A, Roozendaal, B. (2000). Role in modulation of memory storage, in Aggleton J.P., ed. *The Amygdala*. London: Oxford Univ. Press, 391-23.

McGaugh, J.L. (2004). The amygdala modulates the consolidation of memories of emotionally arousing experiences, *Annual Review of Neuroscience, 27*, 1-28.

McGaugh, J.L., Roozendaal, B. and Cahill, L. Modulation of memory storage by stress hormones and the amygdaloid complex. (1999). In: Gazzaniga, M. (Ed.), *Cognitive Neuroscience*, 2nd edition, Cambridge, MIT Press, , 1081-1098.

McNally, R.J. (1990).Psychological approaches to panic disorder: A review. *Psychological Bulletin, 108*, 403–419.

McNeil, D.W. & Brunetti, D.G. (1992). Pain and fear: A bioinformational perspective on responsivity to imagery. *Behavioral Research Therapy, 30,* 513-520.

Mellings, T. M. B., & Alden, L. E. (2000). Cognitive processes in social anxiety: the effects of self-focus, rumination and anticipatory processing. *Behaviour Research and Therapy, 38*, 243-257.

Mineka, S., & Cook, M. (1993). Mechanisms involved in the observational conditioning of fear. *Journal of Experimental Psychology: General, 122*, 23–38.

Mineka, S., Davidson, M., Cook, M., & Keir, R. (1984). Observational conditioning of snake fear in rhesus monkeys. *Journal of Abnormal Psychology, 93*, 355-372.

Moga, M.M., Herbert, H., Hurley, K.M., Yasui, Y., Gray, T.S., Saper, C.B. (1990). Organization of cortical, basal forebrain, and hypothalamic afferents to the parabrachial nucleus in the rat. *Journal of Comprehensive Neurology, 295,* 624-66.

Nevitt, M.C., Cummings, S.R., Hudes, E.S. (1991). Risk factors for injurious falls: a prospective study. *Journals of Gerontology A: Biological Sciences Medical Sciences, 46*, M164-M170.

Nitschke, J.B., Sarinipoulos, I., Mackiewicz, K.L., Schaefer, H.S., & Davidson, R.J. (2006). Functional neuroanatomy of aversion and its anticipation, *NeuroImage, 29,* 106-116.

Öhman, A. & Mineka, S. (2001). Fears, phobias, and preparedness: toward an evolved module

of fear and fear learning. *Psychological Review, 108*, 483–522.

Olsson, A., Nearing, K.I., & Phelps, E.A. (2007). Learning fears by observing others: the neural systems of social fear transmission. *Social Cognitive and Affective Neuroscience, 2,* 3-11.

Olsson, A. & Phelps, E.A. (2004). Learned fear of "unseen" faces after Pavlovian, observational, and instructed fear. *Psychological Science. 15*, 822–828.

Okubo, J., Watanobe, I., Takeya, T., & Baron, J.B. (1979). Influences of foot position and Visual field condition in the examination for equilibrium function and sway of centre of gravity in normal persons. *Agressologie, 20,* 127-132.

Paré D., Smith, Y., & Paré, J. F. (1995) Intra-amygdaloid projections of the basolateral and basomedial nuclei in the cat: Phaseolus vulgaris-leucoagglutinin anterograde tracing at the light and electron microscopic level. *Neuroscience, 69,* 567-583.

Pauls, C.A., & Stemmlar, G. (2003). Repressive and defensive coping during fear and anger. *Emotion, 3*, 284-302.

Phelps, E.A. & LeDoux, J.E. (2005). Contributions of the amygdala to emotion processing: from

animal models to human behavior. *Neuron, 48,* 175–187.

Ploghoaus, A., Tracey, I., Gati, J.S.., Clare, S., Menon, R.S., Matthews, P.M., & Rawlins

,J.N.P (1999). Dissociating pain from its anticipation in the human brain, *Science, 284,* 1979- 1981.

Powell, L.E., & Myers, A.M. (1995). The activities specific balance confidence (ABC) scale. *Journal of Gerontology: Medical Sciences, 50A,* M28-M34.

Price, D. (2007). Psychological and neural mechanisms of the affective dimension of pain. *Science*, *288*,1769-1772.

Querido, J.S., & Sheel, A.W. (2007). Regulation of cerebral blood flow during exercise. *Sports Medicine, 37*, 765-782.

Sattin RW, Lambert H.A.D., DeVito, C.A. (1990). The incidence of fall injury events among the elderly in a defined population. *American Journal of Epidemiology, 131*,1028-1037.

Sheel, A.W. (2008). *Personal communication,* March 8, 2008.

Simeonov, P., Hsiao, H. (2006). Height, surface firmness, and visual reference effects on balance control. *Injury Prevention,7,*50-53.

Simmons, A., Matthews, S. C., Stein, M. B., & Paulus, M. R. (2004). Anticipation of emotionally aversive visual stimuli activates right insula. *Neuroreport, 15,* 2261-2265.

Simmons, A., Strigo, I., Matthews, S. C., Paulus, M. P., & Stein, M. B. (2006). Anticipation of aversive visual stimuli is associated with increased insula activation in anxiety-prone subjects. *Biological Psychiatry, 60,* 402-409.

Stevens, J. P.(1999). *Intermediate statistics: A modern approach.,* 2nd edition, Lawrence Erlbaum Associates, Mahwah, NJ.

Stins, J.F., & Beek, P.J. (2007). Effects of affective picture viewing on posture control. *Neuroscience, 8,* 83-90.

Speechley, M., & Tinetti, M. (1991). Falls and Injuries in Frail and Vigorous Community Elderly Persons. *Journal of the American Geriatrics Society, 39*, 46-52.

Spielberger, C. D. (1983). *Manual for the State-Trait Anxiety Inventory (STAI)*. PaloAlto, CA: Consulting Psychologists Press.

Stelmach, G.E., Zelaznik, H.N., & Lowe, D. (1990). The influence of aging and attentional demands on recovery fro postural instability. *Aging, 2*, 155-161.

Teasdale, N., Bard, C., Larue, J., & Fleury, M. (1993). On the cognitive penetrability of posture control. *Experimental Aging Research, 19,* 1-13.

Thomas, T., & Heaney, C. (2005). Fear of falling, activity restriction and their psychological consequences in older adults. *Australian Journal of Psychology, 57,* 261-261.

Tinetti, M. E. (2001). Where is the vision for fall prevention? *Journal of the American Geriatrics Society, 49,* 676-677.

Tinetti, M. E. (2003). Preventing falls in elderly persons. *New England Journal of Medicine, 348*, 42-49.

Tinetti, M. E., Doucette, J., Claus, E., & Marottoli, R. (1995). Risk-Factors for Serious Injury During Falls by Older Persons in the Community. *Journal of the American Geriatrics Society, 43*, 1214-1221.

Tinetti, M. E., Inouye, S. K., Gill, T. M., & Doucette, J. T. (1995). Shared Risk-Factors for Falls, Incontinence, and Functional Dependence - Unifying the Approach to Geriatric Syndromes. *Jama-Journal of the American Medical Association, 273*, 1348-1353.

Tinetti, M. E., Richman, D., & Powell, L. (1990). Falls Efficacy as a Measure of Fear of Falling. *Journals of Gerontology, 45*, P239-P243.

Tinetti, M. E., & Williams, C. S. (1998). The effect of falls and fall injuries on functioning in community-dwelling older persons. *Journals of Gerontology Series a-Biological Sciences and Medical Sciences, 53*, M112-M119.

Tokuno, C.D., Carpenter, M.G., Thorstensson, A., Garland, S.J. & Cresswell, A.G. 2007. Control of the triceps surae during the postural sway of quiet standing. *Acta Physiologica, 191,* 229–23

Tokuno,C.D., Taube, W., & Cresswell, A.G. (2009). An enhanced level of motor cortical excitability during the control of human standing. *Acta Physiologica, 195*, 385-395.

Turner, J.R., Sherwood, A., & Light, K.C. (1992). *Individual differences in cardiovascular Response to stress.* Plenum. New York, NY.

Van Boven, L., & Ashworth. (2007). Looking forward, looking back: Anticipation is more evocative than retrospection. Journal of Experimental Psychology: General, 136, 289-300.

Vassilopoulos, S. P. (2004). Anticipatory processing in social anxiety. *Behavioural and Cognitive Psychotherapy, 32*, 303-311.

Vassilopoulos, S. P. (2005). Anticipatory processing plays a role in maintaining social anxiety. *Anxiety Stress and Coping, 18*, 321-332.

Vellas, B.J., Wayne, S.J., Romero. L.J., Baumgartner, R.N., & Garry, P.J. (1997). Fear of falling and restriction of mobility in elderly fallers. *Age and Ageing, 26,* 189-193.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal ofPersonality & Social Psychology, 54,* 1063-1070.

Westberg, P., Lundh, L.G., & Jönsson, P. (2007). Implicit associations and social anxiety. *Cognitive Behaviour Therapy ,36,* 43-51.

Williams, J., & Hadjistavropoulos, T., & Asmundson, G.J.G (2005). The effects of age and Fear of pain on attentional and memory biases relating to pain and falls. *Anxiety, Stress, and Coping, 18,* 53-69.

Winter, D.A., Patla, A.E., & Frank, J.S. (1990**)** Assessment of balance control in humans. *Medical progress through technology,16,* 31-51.

Winter, D. A., Prince, F., Frank, J. S., Powell, C., & Zabjek, K. F. (1996). Unified theory regarding A/P and M/L balance in quiet stance. *Journal of Neurophysiology, 75,* 2333-2343.

Winter, D.A. (1995). Anatomy, Biomechanics, and Control of Balance during Standing and Walking, *Waterloo Biomechanics, Waterloo, ON.*

Woollacott, M. and Shumway-Cook, A. (2002). Attention and the control of posture and gait: a review of an emerging area of research. *Gait Posture,* 16, 1-14.

Yardley, L., Beyer, N., Hauer, K., Kempen, G., Piot-Ziegler, C., & Todd, C. (2005). Development and initial validation of the Falls Efficacy Scale-International (FES-I). *Age and Ageing, 34*(6), 614-619.

Yardley, L., Britton, J., Lear, S., Bird, J., Luxon, L.M. (1995). Relationship between balance system function and agoraphobic avoidance. *Behaviour research and therapy, 33*, 435-439.

Yardley, L., & Smith, H. (2002). A prospective study of the relationship between feared consequences of falling and avoidance of activity in community living older people. *The Gerontologist, 42,* 17-23.

Yardley, L. (2004) Fear of Falling: links between imbalance and anxiety. *Reviews in Clinical Gerontology, 13,* 195-201.

Zajonc, R.B. (1965). Social facilitation, *Science, 149,* 269-274.

Zijlstra, G., Van Eijk, J., Kempen, G., Van Haastregt, J., & Tennstedt, S. (2004). Fear of falling and associated activity restriction in the elderly: Adaptation of an American intervention in the Netherlands. *Gerontologist, 44*, 429-429.

APPENDIX A

Study Consent Form

T H E   U N I V E R S I T Y   O F   B R I T I S H   C O L U M B I A

Osborne Centre Unit I
213 – 6108 Thunderbird Boulevard
Vancouver, BC, Canada V6T 1Z3

Tel: (604) 827-3482
Fax: (604) 822-9451

SUBJECT INFORMATION AND CONSENT FORM

The influence of anticipatory cognitive processing associated with anxiety on emotional states, physiological responses, and balance control

Principal Investigator: Mark G. Carpenter, Ph.D.
School of Human Kinetics
University of British Columbia
Phone: 604 822-8614

Co-Investigators: Carolyn Geh, B.A.
School of Human Kinetics
University of British Columbia
Phone: 604 822-0219

Peter Crocker, Ph.D.
School of Human Kinetics
University of British Columbia
Phone: 604 822-5580

Mark Beauchamp, Ph.D.
School of Human Kinetics
University of British Columbia

Phone: 604 822-4864

Emergency Telephone Number: In the event of an emergency, please call Dr. Mark Carpenter at 604 822 8614 at any time, 24 hours a day, 7 days a week.

1. INTRODUCTION

You are being invited to take part in this research study because you a healthy female adult between the ages of 19-35 years of age.

2. YOUR PARTICIPATION IS VOLUNTARY

Your participation is entirely voluntary, so it is up to you to decide whether or not to take part in this study. Before you decide, it is important for you to understand what the research involves. This consent form will tell you about the study, why the research is being done, what will happen to you during the study, and the possible benefits, risks and discomforts.

If you wish to participate, you will be asked to sign this form. If you decide to take part in this study, you are still free to withdraw at any time and without giving any reasons for your decision.

If you do not wish to participate, you do not have to provide any reason for your decision not to participate, nor will you lose the benefit of any medical care to which you are entitled or are presently receiving.

Please take time to read the following information carefully and to discuss it with your family, friends, and doctor before you decide.

3. WHO IS CONDUCTING THE STUDY?

The study is being conducted by the Neural Control of Posture and Movement Laboratory at the UBC School of Human Kinetics.

4. BACKGROUND

Recent evidence in postural studies has found an increase in instability with increase in fear of falling in people. However, there is reason to believe that other types of anxiety may play a role in simple balance control.

5. WHAT IS THE PURPOSE OF THE STUDY?

The purpose of the study is to examine the influence of anticipatory cognitive processing on emotional states, physiological responses, and balance control.

6. WHO CAN PARTICIPATE IN THE STUDY?

Healthy young adults between the ages of 19-35 years are being invited to participate.

7. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

If you meet any of the following criteria, you should not participate in this study:

- if you have any neurological or non-neurological causes of balance or cognitive impairment

- if you currently use an additional support device to walk or stand (ie cane, walker, wheelchair, crutch)

- if you cannot support your own weight and maintain an upright posture while standing or walking

8. WHAT DOES THE STUDY INVOLVE?

This study is taking place at the Neural Control of Posture and Movement Laboratory at UBC. A total of 24 young, healthy adult female participants will be enrolled for this experiment.

If you agree to take part in this study, the procedures you can expect will include the following:

Prior to the start of the experiment, you will be asked be seated and to relax for 15 minutes. During this time, it is important that you try to bring yourself to a relaxed state and to breathe in a relaxed manner. Following this rest period, you will be asked to complete three questionnaires about your levels of fear of falling and trait anxiety. You will be asked to remove your shoes (socks are permitted) for the experiment. You will then be fitted with two surface electrodes on the palm of your hand. The surface electrodes will measure any changes in galvanic skin activity. You will then be fitted with a finger cuff that will fit snugly on the third finger of your left hand. This finger cuff is designed to measure changes in blood pressure and heart rate. The finger cuff will be worn during the entire experiment. It is important that once this cuff is fitted that you try to move your hand as little as needed. The finger cuff will not disturb your natural movements in any way. You will be required to complete this experiment under two different experiment conditions. In both conditions, you will watch a short movie of some people doing the experiment that you are going to do afterwards. You will also be asked to fill out three short questionnaires after watching the movie. After filling out the questionnaires, you will complete a simple three minute quiet standing task.

After you perform the first experiment condition, you will sit down and take a 10 minute seated rest. During this period you will watch a short 10 minute video from National Geographic™. After the rest period, you will be required to complete the experiment again in the second condition.

9. WHAT ARE MY RESPONSIBILITIES?

If you decide to take part in this study, you will be required to perform a simple quiet standing task of three minutes, two times. You will also be required to complete five separate questionnaires.

10. WHAT ARE THE POSSIBLE HARMS AND SIDE EFFECTS OF PARTICIPATING?

Some of the movie clips that you will watch in this study may involve watching some people experience mild to moderate levels of pain from a shock. You will be told that you *may* receive the shock. In this experiment, the probability of receiving a shock is equal to not receiving a shock. If you have any concerns about your personal safety, you are more than welcome to speak to the experimenter regarding these concerns. Your participation in this study is completely voluntary and you have the right to revoke your consent at any point during the experiment and withdraw completely from the study, without any need for an explanation.

11. WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?

You will not receive any direct benefit from participating in this study.

12. WHAT IF NEW INFORMATION BECOMES AVAILABLE THAT MAY AFFECT MY DECISION TO PARTICIPATE?

If new information regarding the procedures or risks of this study becomes available, you will be advised of this information.

13. WHAT HAPPENS IF I DECIDE TO WITHDRAW MY CONSENT TO PARTICIPATE?

Your participation in this research is entirely voluntary. You may withdraw from this study at any time. If you decide to enter the study and to withdraw at any time in the future, there will be no penalty or loss of benefits to which you are otherwise entitled, and your future medical care will not be affected.

The study investigators may decide to discontinue the study at any time, or withdraw you from the study at any time, if they feel that it is in your best interests. If you choose to enter the study and then decide to withdraw at a later time, all data collected about you during your enrolment in the study will be retained for analysis. By law, this data cannot be destroyed.

14. WHAT HAPPENS IF SOMETHING GOES WRONG?

You do not waive any of your legal rights against the sponsor, investigators, or anyone else by signing this consent form.

15. CAN I BE ASKED TO LEAVE THE STUDY?

If you are not complying with the requirements of the study or for any other reason, the study investigator may withdraw you from the study.

16. AFTER THE STUDY IS FINISHED

You will not be directly informed of the results of this study. The results will be analyzed and published in a scientific journal.

17. WHAT WILL THE STUDY COST ME?

Participation in this study is completely voluntary and no payment will be given for volunteer participation.

18. WILL MY TAKING PART IN THIS STUDY BE KEPT CONFIDENTIAL?

Your confidentiality will be respected. No information that discloses your identity will be released or published without your specific consent to the disclosure. However, research records and medical records identifying you may be inspected in the presence of the Investigator or his or her designate by representatives of Health Canada and the UBC Research Ethics Board for the purpose of monitoring the research. However, no records which identify you by name or initials will be allowed to leave the Investigators' offices.

19. WHO DO I CONTACT IF I HAVE QUESTIONS ABOUT THE STUDY DURING MY PARTICIPATION?

If you have any questions or desire further information about this study before or during participation, you can contact Dr Mark G. Carpenter at 604 822-8614.

20. WHO DO I CONTACT IF I HAVE ANY QUESTIONS OR CONCERNS ABOUT MY RIGHTS AS A SUBJECT DURING THE STUDY?

If you have any concerns about your rights as a research subject and/or your experiences while participating in this study, contact the ‘Research Subject Information Line in the University of British Columbia’s Office of Research Services’ at 604 822-8598.

21. DISCLOSURE OF POTENTIAL CONFLICT OF INTEREST

There will be no potential conflict of interest for the investigators of this study.

21. SUBJECT CONSENT TO PARTICIPATE

This section of the consent form is not a contract and as such you do not give up any legal rights by signing it.

- I have read and understood the subject information and consent form.
- I have had sufficient time to consider the information provided and to ask for advice if necessary.
- I have had the opportunity to ask questions and have had satisfactory responses to my questions.
- I understand that all of the information collected will be kept confidential and that the result will only be used for scientific objectives.
- I understand that my participation in this study is voluntary and that I am completely free to refuse to participate or to withdraw from this study at any time without changing in any way the quality of care that I receive.
- I understand that I am not waiving any of my legal rights as a result of signing this consent form.
- I have read this form and I freely consent to participate in this study.
- I have been told that I will receive a dated and signed copy of this form.

I have received a copy of this consent form for my own records.

I consent to participate in this study.

___________________	____________________	______________
Subject Signature	Print Name	Date
___________________	____________________	______________
Witness Signature	Print Name	Date
___________________	____________________	______________
Principal Investigator Signature	Print Name	Date

APPENDIX B

Study Questionnaire Package

B-1: Activities Balance Confidence (ABC) Scale

B-2: Falls Efficacy International (FES-I) Scale

B-3: Pain Anxiety Symptoms (PASS-20) Scale

B-4: State Trait Anxiety Inventory (STAI)- Trait Form

B-5: State Trait Anxiety Inventory (STAI)- State Form

B-6: Fear Subscale from Positive Affect Negative Affect (PANAS-X) Scale

B-7: Anticipatory Processing Anxiety Questionnaire (APQ)

B-8: Balance Efficacy

B-9: Fear of Falling

B-1: Activities Balance Confidence (ABC) Scale

Please answer the following questions as honestly and accurately as possible.

How confident are you that you will not lose your balance or become unsteady performing the following activity. Please rate your confidence level between 0-100% with 0%= no confidence at all and 100%=extremely confident.

1. Walk around the house

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

2. Walking up and down stairs

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

3. Pick up a slipper from the floor

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

4. Reach at eye level

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

5. Reach on tiptoes

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

6. Stand on chair to reach

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

7. Sweep the floor

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

8. Walk outside to a nearby car

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

9. Get in/out of car

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

10. Walk across a parking lot

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

11. Walk up and down a ramp

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

12. Walk in a crowded mall

0% 10 20 30 40 50 60 70 80 90 100%

no moderately extremely

confidence confident confident

13. Walk in crowd/bumped

0%	10	20	30	40	50	60	70	80	90	100%
no					moderately					extremely
confidence					confident					confident

14. Walk/stand on escalator holding rail

0%	10	20	30	40	50	60	70	80	90	100%
no					moderately					extremely
confidence					confident					confident

15. Walk/stand on escalator not holding rail

0%	10	20	30	40	50	60	70	80	90	100%
no					moderately					extremely
confidence					confident					confident

16. Walk on icy sidewalks.

0%	10	20	30	40	50	60	70	80	90	100%
no					moderately					extremely
confidence					confident					confident

B-2: Falls Efficacy International (FES-I) Scale

State the level your concern about falling when carrying each activity on a four point scale (1= not at all concerned, 4= very concerned).

1. Cleaning the house	1	2	3	4
2. Getting dressed/undressed	1	2	3	4
3. Preparing simple meals	1	2	3	4
4. Taking a bath or shower	1	2	3	4
5. Going to the shop	1	2	3	4
6. Getting in and out of a chair	1	2	3	4
7. Going up or down stairs	1	2	3	4
8. Walking around outside	1	2	3	4
9. Reaching up or bending down	1	2	3	4
10. Answering the telephone	1	2	3	4
11. Walking on a slippery surface	1	2	3	4
12. Visiting a friend/relative	1	2	3	4
13. Going to a place with crowds	1	2	3	4
14. Walking on an uneven surface	1	2	3	4
15. Walking up or down a slope	1	2	3	4
16. Going out to a social event	1	2	3	4

B-3: Pain Anxiety Symptoms (PASS-20) Scale

1. When pain comes on strong I think that I might become paralyzed or more disabled.

0 Never	1	2	3	4	5 Always

2. I think that if my pain gets too severe, it will never decrease.

0 Never	1	2	3	4	5 Always

3. When I feel pain I think that I might be seriously ill.

0 Never	1	2	3	4	5 Always

4. When I feel pain I am afraid that something terrible will happen.

0 Never	1	2	3	4	5 Always

5. I worry when I am in pain.

0 Never	1	2	3	4	5 Always

6. I find it difficult to calm my body down after periods of pain.

0	1	2	3	4	5

Never Always

7. I will stop any activity as soon as I sense pain coming.

0	1	2	3	4	5
Never					Always

8. I avoid important activities when I hurt.

0	1	2	3	4	5
Never					Always

9. I try to avoid activities that cause pain.

0	1	2	3	4	5
Never					Always

10. When I sense pain I feel dizzy or faint.

0	1	2	3	4	5
Never					Always

11. Pain seems to cause my heart to pound or race.

0	1	2	3	4	5
Never					Always

12. I begin trembling when engaged in an activity that increases pain.

0	1	2	3	4	5
Never					Always

13. Pain makes me nauseous.

0	1	2	3	4	5
Never					Always

14. I go immediately to bed when I feel severe ‘‘pain.’’

0	1	2	3	4	5
Never					Always

15. When I hurt I think about pain constantly.

0	1	2	3	4	5
Never					Always

16. During painful episodes it is difficult for me to think of anything besides the pain.

0	1	2	3	4	5
Never					Always

17. I find it hard to concentrate when I hurt.

0	1	2	3	4	5
Never					Always

18. I can’t think straight when in pain.

0	1	2	3	4	5
Never					Always

19. As soon as pain comes on I take medication to reduce it.

0	1	2	3	4	5
Never					Always

20. Pain sensations are terrifying.

0	1	2	3	4	5
Never					Always

B-4: State Trait Anxiety Inventory (STAI)- State Form

Directions: A number of statements which people have used to describe themselves are given below. Read each statement and then place the appropriate number to the right of the statement to indicate how you feel *right now*, that is, at *this* moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings at best.

1= Not at all

2= Somewhat

3= Moderately so

4= Very much so

1. I feel calm ______
2. I feel secure ______
3. I am tense ______
4. I feel strained ______
5. I feel at ease ______
6. I feel upset ______
7. I am presently worrying over possible misfortunes ______
8. I feel satisfied ______
9. I feel frightened ______
10. I feel comfortable ______
11. I feel self-confident ______
12. I feel nervous ______
13. I am jittery ______
14. I feel indecisive ______
15. I am relaxed ______
16. I feel content ______
17. I am worried ______

18. I feel confused _____

19. I feel steady _____

20. I feel pleasant _____

B-5: State Trait Anxiety Inventory (STAI)- Trait Form

Directions: A number of statements which people have used to describe themselves are given below. Read each statement and then place the appropriate number to the right of the statement to indicate how you *generally* feel.

1= Almost Never

2= Sometimes

3= Often

4= Almost Always

21. I feel pleasant _____
22. I feel nervous and restless _____
23. I feel satisfied with myself _____
24. I wish I could be as happy as others seem to be _____
25. I feel like a failure _____
26. I feel rested _____
27. I am “calm, cool, and collected” _____
28. I feel that difficulties are piling up s that I cannot overcome them _____
29. I worry too much over something that really doesn’t matter _____
30. I am happy _____
31. I have disturbing thoughts _____
32. I lack self-confidence _____
33. I feel secure _____
34. I make decisions easily _____
35. I feel inadequate _____
36. I am content _____
37. Some unimportant thought runs through my mind and bothers me _____
38. I take disappointments so keenly that I can’t put them out of my mind _____

39. I am a steady person _____

40. I get in a state of tension or turmoil as I think over my recent concerns and failures _____

B-6: Fear Subscale from Positive Affect Negative Affect (PANAS-X) Scale

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 you are feeling this way after having watched the video.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

Afraid ___

Scared___

Frightened___

Nervous___

Jittery___

Shaky___

B-7: Anticipatory Processing Anxiety Questionnaire (APQ)

Please, think about how you feel after having watched the video that was presented to you. Please, rate how you honestly felt on a scale of 1=not at all, to 7= very much so.

1. Did you find yourself thinking about the video a lot?

1	2	3	4	5	6	7
Not at all			Moderately so			Very much so

2. Did thoughts about the video keep coming into your head even when you did not wish to think about it?

1	2	3	4	5	6	7
Not at all			Moderately so			Very much so

3. If you did think about the video, over and over again, did you find your anxiety increasing more and more?

1	2	3	4	5	6	7
Not at all			Moderately so			Very much so

4. How negative were your thoughts about the video?

1	2	3	4	5	6	7
Not at all			Moderately so			Very much so

5. How much pain do you think was experienced by the participants in the video?

1	2	3	4	5	6	7
No pain at all			Moderate pain			Very much pain

B-8: Balance Efficacy

Please answer the following question as honestly as possible.

How confident are you in your ability to maintain your balance while standing quietly for three minutes right now. Please estimate your confidence on a scale between 0 (no confidence) and 100 (complete confidence).

0% 10 20 30 40 50 60 70 80 90 100%

No confidence Moderately confident Complete
Confidence

B-9: Fear of Falling

Please answer the following question as honestly as possible.

Please rate how fearful of falling you felt while standing in the previous condition. Please rate how fearful they felt on a scale between 1 (not very fearful at all) and 7 (extremely fearful).

1	2	3	4	5	6	7
Not very Fearful at all			Moderately fearful			Extremely fearful

APPENDIX C

Participant Debrief Form

Debriefing form: The influence of anticipatory thoughts on emotional states, physiological responses, and balance control.

The purpose of the present study was to investigate how anticipatory thoughts associated with anxiety influence emotional states, physiological responses, and balance control. Anticipatory thoughts associated with anxiety can be described as being engaged in negative thought processing and worry about future events and threatening outcomes to one's self.

Several studies have demonstrated that one of the key problems when people exhibit a 'fear of falling' lies in the negative effects of fear and anxiety on the human balance system. Previous studies in our lab have found that under anxiety-invoking conditions, individuals make modifications to the control of their posture. However, it is not yet known whether anticipatory thought processes associated with anxiety can cause similar modifications in postural control. The successful manipulation of anticipatory thoughts associated with anxiety may be a useful way to understand the mechanisms that lead to fear of falling in the real world.

In this study, you were told that you might receive a shock on your wrist similar to the one received by the people in the video you watched. However, because of what we are studying, we had to use some deception in today's study. Contrary to what you were told, the experimenters in this study never intended to administer any shock to you (the participant). We used this deception because we needed you to believe that you were in fact expecting a possible painful shock. We expected that participants who believed that the shock would be painful and unpleasant would experience higher states of anxiety, fear, and display larger changes in their physiological responses and balance control.

Because there are still other students who will participate in this study, it is important that you do not tell anyone about the deception used in this study. If other students found out about what we are really studying and then came to participate in our experiment, we wouldn't be able to trust the results of the experiment because their responses could be biased.

Your involvement in this study is completely voluntary. If you feel uncomfortable with being deceived you are free to withdraw your data from this study without incurring any negative consequences. All the information that you've provided will remain confidential and will not be made available to anyone other that the investigators involved with this study. If you feel as though you have experienced any undue amount of distress or discomfort as a result of participating in this study you may contact UBC counseling services at 604-822-3811.

If you would like any information regarding the results of this study, once it has been completed, you may contact either Dr. Mark Carpenter (mark.carpenter@ubc.ca) or Carolyn Geh (cgeh@interchange.ubc.ca). If you would like to express a concern about this experiment you may contact the Research Subject Information Line in the University of British Columbia's Office of Research Services at 604 822-8598, or if you prefer e-mail, at RSIL@ors.ubc.ca .

In the event that you would like to read more about these and related topics, here are several articles that you might find interesting.

Carpenter, M. G., Adkin, A. L., & Brawley, L. (2006). Postural, physiological and psychological reactions to challenging balance: Does age make a difference? *Age and Ageing*, *35*, 298-303.

Brown, M. & Stopa, L. (2007). Does anticipation help or hinder performance in a subsequent speech? *Behavioral and Cognitive Psychotherapy*, *35*, 133-147.

APPENDIX D

Experiment Videos

D-1: Threat Video

D-2: Non-threat Video

D-1: Threat Video

The Threat Video, filmed in the Neural Control of Posture and Movement laboratory where the experiments were conducted, showed several video actors (i.e., laboratory participants and an experimenter) interacting in a laboratory. In the video, the actor experimenter informed the actor participants that she would be required to perform a quiet standing task of three minutes on a force plate. The actor experimenter then informed the actor participants that they would receive a mild electric shock on their forearm at some point during the quiet standing task almost immediately after a tone and LED lights appears. The actor experimenter also informed the actor participants that they were to try their best to stand as still as possible throughout the three minutes, despite knowing that a shock was to be administered to them. However, shocks were never administered and the actor participants only feigned a reaction to a fake shock. The actor participants reacted to the fake shock by displaying facial emotions of distress, fear, and discomfort. Facial characteristics of the actor participants included knitted eyebrows, and pursed lips. Bodily characteristics of the actor participants included tensed shoulders and neck, and a rigid posture. The purpose of this video was to induce anticipatory cognitive processing associated with anxiety.

D-2: Non-threat Video

The Non-threat Video, filmed in the Neural Control of Posture and Movement laboratory where the experiments were conducted, showed several video actors (i.e., laboratory participants and an experimenter) interacting in a laboratory. In the video, the actor experimenter informed the actor participants that she would be required to perform a quiet standing task of three minutes on a force plate. The actor experimenter then informed the actor participants that a tone and LED lights would appear at some point during the three minutes. No shocks were administered to actor participants in this video and when the tone and LED lights appeared, the actor participants ignored it and continued to stand quietly as still as possible throughout the three minutes. The purpose of this video was to create a control condition for the experiment, where participants would not feel anxious after watching it.

APPENDIX E

Additional Tables

Appendix E-1 : Means and Standard Deviations for Balance Variables: Mean Power Frequency in the Anterior-Posterior (MPF-AP) and Medio-Lateral (MPF-ML) Directions and Root Mean Square in the Anterior-Posterior (RMS-AP) and Medio-Lateral (RMS-ML) Directions.

Appendix E-2: Means and standard deviations of participants APAQ, State Anxiety, and Fear scores in the Threat and Non-threat condition.

Appendix E-1 : Means and Standard Deviations for Balance Variables: Mean Power Frequency in the Anterior-Posterior (MPF-AP) and Medio-Lateral (MPF-ML) Directions and Root Mean Square in the Anterior-Posterior (RMS-AP) and Medio-Lateral (RMS-ML) Directions.

	No Threat		**Threat**	
	Bin 1	**Bin 2**	**Bin 1**	**Bin 2**
MPF-AP (Hz)	.19 (.07)	.17 (.20)	.18 (.08)	.20 (.08)
MPF-ML (Hz)	.19 (.09)	.22 (.10)	.17 (.07)	.20 (09)
RMS-AP (mm)	3.81 (1.37)	3.75 (1.43)	3.51 (1.34)	3.73 (2.01)
RMS-ML (mm)	2.42 (1.14)	2.34 (1.14)	2.57 (.93)	2.42 (1.28)

Appendix E-2: Means and standard deviations of participants APAQ, State Anxiety, and Fear scores in the Threat and Non-threat condition.

	Threat Condition			Non- threat Condition		
Trait-A Group	Low Trait-A (n=8)	Moderate Trait-A (n=9)	High Trait-A (n=8)	Low Trait-A (n=8)	Moderate Trait-A (n=9)	High Trait-A (n=8)
APAQ	19.78 (5.96)	17.89 (5.30)	22.00 (9.15)	8.22 (3.15)	8.22 (3.60)	9.38 (4.93)
State Anxiety	31.11 (5.67)	39.00 (8.53)	54.38 (9.59)	24.00 (3.87)	28.89 (6.74)	34.19 (7.64)
Fear	9.22 (2.99)	12.56 (3.75)	17.75 (7.19)	7.00 (1.12)	7.22 (1.72)	8.88 (3.72)

APPENDIX F

UBC Research Ethics Certificate

The University of British Columbia
Office of Research Services
Clinical Research Ethics Board – Room 210, 828 West 10th Avenue,
Vancouver, BC V5Z 1L8

ETHICS CERTIFICATE OF EXPEDITED APPROVAL: RENEWAL

PRINCIPAL INVESTIGATOR:	DEPARTMENT:	UBC CREB NUMBER:
Mark G Carpenter	UBC/Education/Human Kinetics	H07-01697

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:

Institution	Site
UBC	Vancouver (excludes UBC Hospital)

Other locations where the research will be conducted:
N/A

CO-INVESTIGATOR(S):

Mark R. Beauchamp
Peter Crocker

SPONSORING AGENCIES:

N/A

PROJECT TITLE:
The Influence of Social Anxiety on Posture and Balance Tasks

EXPIRY DATE OF THIS APPROVAL: September 22, 2009

APPROVAL DATE: September 22, 2008

CERTIFICATION:
In respect of clinical trials:
1. The membership of this Research Ethics Board complies with the membership requirements for Research Ethics Boards defined in Division 5 of the Food and Drug Regulations.
2. The Research Ethics Board carries out its functions in a manner consistent with Good Clinical Practices.
3. This Research Ethics Board has reviewed and approved the clinical trial protocol and informed consent form for the trial which is to be conducted by the qualified investigator named above at the specified clinical trial site. This approval and the views of this Research Ethics Board have been documented in writing.

The Chair of the UBC Clinical Research Ethics Board has reviewed the documentation for the above named project. The research study, as presented in the documentation, was found to be acceptable on ethical grounds for research involving human subjects and was approved for renewal by the UBC Clinical Research Ethics Board.

Approval of the Clinical Research Ethics Board by:

[redacted]

Dr. James McCormack,
Associate Chair