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Anticipation and Avoidance in Social Anxiety: A Psychophysiological Investigation into a Potential Link

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ANTICIPATION AND AVOIDANCE IN SOCIAL ANXIETY: A PSYCHOPHYSIOLOGICAL INVESTIGATION INTO A POTENTIAL LINK

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Cognitive models of social anxiety propose that two factors, avoidance and anticipatory processes, play an integral role in the etiology and maintenance of symptoms. However, social anxiety research has examined anticipatory and avoidance separately, precluding identification of a potential link between these two processes. The current study conjointly examined subjective, behavioral, and psychophysiological measures of anticipation and avoidance within a modified fear conditioning paradigm across high (n = 27) and low (n = 30) levels of social anxiety. For anticipation, anxiety-related differences were exclusively observed in subjective anticipatory fear. For avoidance, anxiety-related differences were observed in the frequency of daily avoidance behaviors, as well as physiological recovery following task-based avoidance. Finally, a psychophysiological link was identified between anticipation and avoidance exclusively in high levels of social anxiety. This relationship was modulated by threat certainty. Anticipatory increases in skin conductance during the anticipation of uncertain threat were associated with greater engagement in daily avoidance behaviors, whereas the opposite relationship was observed during anticipation of certain threat. These results have implications for cognitive models of social anxiety as well as its treatment.

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CHAPTER ONE

INTRODUCTION

Social anxiety disorder (SAD) is characterized by fear of negative evaluation (Rapee & Heimberg, 1997), which produces symptoms that include worrying about upcoming social situations and increased physiological reactivity (e.g. sweating or blushing) to social cues. Like all anxiety disorders, SAD causes significant distress and impairment (DuPont, Rice, Miller, Shiraki, Rowland, & Harwood, 1996). Additionally, epidemiological findings suggest that SAD follows a chronic and unremitting course in the absence of treatment (Grant, et. al, 2005). For individuals with SAD who seek treatment, such as cognitive behavioral therapy (CBT), intention-to-treat analyses from randomized control trials demonstrate a 58% treatment response rate (Heimberg, et. al, 1998). Although treatment may be effective for some individuals, this response rate signifies that current treatment models could be improved through a more comprehensive understanding of the mechanisms underlying SAD.

Cognitive models of SAD posit that two factors, anticipatory processes and avoidance of social situations, play an integral role in maintaining and worsening symptoms (Clark & Wells, 1995). Anticipation is an expectancy period that occurs prior to engaging in a social situation. For non-anxious individuals, this anticipatory period is characterized by expectations of positive outcomes (social interactions) or a focus on the task at hand (public speaking; Clark & Wells, 1995). In contrast, individuals with SAD expect negative outcomes, often recalling past negative experiences as a means to prepare themselves for potential humiliation (Rapee & Heimberg, 1997). As a result, anxiety-related differences in distress emerge during this anticipatory period (Wong & Moulds, 2009). As a means to prevent or reduce distress associated with social situations,

individuals with SAD engage in a variety of avoidance strategies (Clark & Wells, 1995). For example, individuals with SAD may avoid public speaking entirely or distract themselves during public speaking to reduce distress levels. Given that distress emerges during anticipation of social situations, anxiety-related differences in avoidance may be attributable to concomitant differences in anticipatory processes. Although previous work has examined anticipation and avoidance separately in social anxiety (e.g. Hinrichsen & Wells, 2003; Wong & Moulds, 2011), no work has examined the relationship between these components. This proposal aims to examine the relationship between anticipation and avoidance in a fear conditioning paradigm to understand the interplay between these mechanisms in social anxiety.

Anticipation

In non-anxious individuals, anticipation is an adaptive process that serves to recruit necessary resources for upcoming events. For example, anticipation aids in coping with a future event such as a social stressor in several ways (Aspinwall & Taylor, 1997). First, anticipatory processes allow preparative action in the absence of environmental cues. More specifically, mentally simulating a hypothetical stressful event prior to its occurrence facilitates active coping during an event (Rivkin & Taylor, 1999). Second, anticipation increases the salience of an upcoming event, which enhances motivation to prepare for the situation (for a review, see Taylor, Pham, Rivkin, & Armor, 1998). Prior to the event, a student may visualize taking an upcoming exam, thereby making this event more tangible. As a result, this student is more likely to spend time studying the exam material. Third, anticipation provides contextual information about a future event (Hayes-Roth & Hayes-Roth, 1979). For example, a student may visualize potential obstacles that

might arise in travelling to the exam location. This contextual information allows the student to avoid arriving late to the exam, likely improving exam performance. Finally, anticipation produces emotional and physiological reactions similar to those experienced during the event (Richardson, 1984; Qualls, 1982). Broadly, this process may inform the future deployment of regulatory strategies by forecasting the affective and physiological experiences that will occur during the event. In short, anticipatory processes facilitate future responses to an event by increasing perceived event likelihood, providing contextual information, and generating affective and physiological correlates of this event.

In socially anxious individuals, however, anticipatory processes become maladaptive for managing upcoming social stressors. For example, socially anxious individuals recall past failures, rather than success, when anticipating a social stressor (Clark & Wells, 1995; Hinrichsen & Clark, 2003; Vassilopoulos, 2005; Wong & Moulds, 2011). In turn, the perceived likelihood of negative outcomes increases, which elicits distress (Hinrichsen & Wells, 2003). Additionally, socially anxious individuals anticipate they will appear odd or abnormal to others. As a result, these individuals imagine distressing contextual information such as negative reactions from others (Clark & Wells, 1995). Together, these anticipatory processes generate unpleasant affective and physiological reactions during anticipation, which socially anxious individuals forecast to occur during the event in question (for a review, see: Bogels & Mansell, 2004). For example, maladaptive anticipatory processing activates high standard beliefs (e.g. “I must give a perfect speech”) and conditional beliefs (e.g. “People will judge me if I make a mistake”) that induce anxiety as well as physiological reactivity (i.e. skin conductance;

Wong & Moulds, 2011).Together, maladaptive anticipatory processing such as focusing on past failures and predicting negative outcomes has been shown to produce higher levels of self-reported fear in response to confrontation with a social stressor (Wong & Moulds, 2011).

Anxiety-related differences in anticipation of aversive outcomes are magnified by ambiguity. When outcomes are relatively easy to predict, anxious individuals do not differ from non-anxious individuals in the expectation of a threat (Calvo & Castillo, 2001). However, anxiety-related differences emerge when contextually predictive information is lacking, increasing threat uncertainty (Calvo & Castillo, 2001). These differences may be attributable to the fact that anxious individuals are more likely to demonstrate inaccurate estimates of an outcome when information is lacking. More specifically, anxious individuals, relative to non-anxious individuals, report higher probabilities of an outcome in situations when less information is provided (Bensi & Giusberti, 2007). However, anxious individuals perform similarly to non-anxious individuals when making outcome-related determinations when information is more readily available (Bensi & Giusberti, 2007). In sum, anxious individuals demonstrate biased estimates of aversive outcomes, which are exacerbated under uncertain conditions (Leon & Revelle, 1985).

Avoidance

In addition to maladaptive anticipatory responses, socially anxious individuals reduce elevated distress levels through maladaptive coping strategies involving avoidance. Subtle avoidance or safety behaviors may include avoiding eye contact, approaching another individual more slowly, maintaining greater distances from another

individual during social interactions or avoiding interactions entirely (Rinck, Rortgen, Lange, Dotsch, Wigboldus, & Becker, 2010; Clark & Wells, 1995; Rapee & Heimberg, 1997). In addition to social interactions, socially anxious individuals are also hypothesized to utilize cognitive distraction to avoid distressing internal stimuli such as physiological arousal (e.g. racing heart) and unpleasant emotions such as anxiety (Kashdan, Weeks, & Savostyanova, 2011).

Although such avoidant responses reduce acute distress, these responses also maintain the anticipatory distress associated with a stressor. In social anxiety, avoidance behaviors maintain distorted perceptions of social interactions by preventing opportunities for these distortions to be disconfirmed (Rapee & Heimberg, 1997). Avoiding a feared stimulus prevents learning that this fear response may be excessive or even unnecessary (Lovibond, Mitchell, Minard, Brady, & Menzies, 2009). In contrast, interacting with feared stimuli allows an individual to develop a more accurate perception of the threat associated with a stimulus, producing appropriate modulation of fear responses (Lovibond, Mitchell, Minard, Brady, & Menzies, 2009). Within SAD, avoiding distress evoked during social situations prevents learning that distress levels decline in the absence of avoidance strategies (Rapee & Heimberg, 1997). As such, treatments for SAD target avoidance responses as a means to reduce the distress associated with social situations. Reductions in avoidance behavior have been shown to mediate treatment outcomes in SAD (Aderka, McLean, Huppert, Davidson, & Foa, 2013), providing additional confirmation that avoidance plays an integral role in the disorder.

Relationship between Anticipation and Avoidance

Despite the extensive literature demonstrating that anticipatory processes and avoidance responses play key roles in the etiology and maintenance of SAD, no research to date has examined a potential relationship between these processes. Rather, extant research on SAD has examined anticipatory and avoidance processes in isolation. As outlined above, socially anxious individuals engage in avoidant behaviors to reduce distress associated with a stressor. However, research has suggested that anticipation of a social stressor may be more distressing than the experience of a social stressor. For example, the *anticipation* of giving a speech produces higher levels of state anxiety, heart rate, and negative mood in individuals with SAD compared to affect and physiology experienced *during* a speech (Davidson, Marshall, Tomarken, & Henriques, 2000). In contrast, non-anxious individuals only demonstrated a weak linear increase in state anxiety across these phases, suggesting that anxiety-related differences were maximal during anticipation of a speech (Davidson, Marshall, Tomarken, & Henriques, 2000).

Within SAD, however, there is a large degree of variability in the patterns of anxious arousal experienced during anticipation of a speech. More specifically, socially anxious individuals who reported the highest distress levels prior to a speech task (e.g. the most socially anxious individuals) do not necessarily experience the highest distress levels when giving a speech (Coles & Heimberg, 2000). Rather, socially anxious individuals who demonstrate the most rapid increase in distress during a 4-minute anticipation period ultimately experience the highest levels of distress while giving a speech (Coles & Heimberg, 2000). Given that fear is postulated to drive avoidant responses (Clark & Wells, 1995; Rapee & Heimberg, 1997), these findings may suggest

that fear during anticipation, rather than confrontation, plays the largest role in determining subsequent avoidance.

After receiving CBT, individuals with SAD conjointly demonstrate a reduction in the *rate* of increased distress during a 3 minute anticipation period prior to giving a speech as well as a subsequent decrease in *total* distress while giving the speech (Price & Anderson, 2011). This pattern of results, although only suggestive, may indicate a relationship in which reductions in distress produced during anticipation results in downstream effects on subsequent effectiveness in coping with social stressors. Such findings highlight the importance of examining anticipation as it relates to other processes involved in social anxiety such as avoidance.

Although not studied in SAD, previous research has found evidence for a relationship between anticipation and avoidance in Panic Disorder (PD). Within PD, the anticipation of experiencing a panic attack, rather than the number of experienced panic attacks in a situation, are more predictive of avoidance of this situation (Cox, Swinson, Norton, & Kuch, 1991). Moreover, among a number of predictors including severity, frequency, and occurrence of panic symptoms/attacks, anticipation of panic emerged as the strongest predictor of avoidance behavior (Cox, Endler, & Swinson, 1995). Based on work in PD and the large degree of commonality in mechanisms among anxiety disorders (Brown, Campbell, Lehman, Grisham, & Mancill, 2001), anticipation and avoidance may be linked in SAD as well.

Additional support for a relationship between anticipation and avoidance has also been demonstrated by neuroimaging findings in healthy individuals. For example, activation in the anterior insula during the anticipation of, rather than in response to, an

aversive outcome (e.g. money loss) predicts avoidant learning (Samanez-Larkin, Hollon, Carstensen, & Knutson, 2008). More specifically, greater anterior insula activation during the anticipation of this aversive outcome predicted a greater number of responses geared towards avoiding this outcome. However, activation levels in this region when experiencing the outcome itself was not associated with avoidant responding. Functionally, the insula is directly involved in processing social threat such as angry faces (Straube, Kolassa, Glauer, Mentzel, & Miltner, 2004) as well as interoceptive awareness of physiological arousal (e.g. heart beat detection; Critchley, Wiens, Rotshstein, Ohman, & Dolan, 2004), both of which are hyper-active in SAD. Moreover, the right anterior insula also mediates the relationship between the thalamus, a neural region involved in detecting bodily sensations, and fear of social situations (Teresawa, Shibata, Moriguchi, & Umeda, 2013). As such, the aforementioned relationship between insular activation during anticipation and the number of avoidance responses may be suggestive of a broader link between anticipation and avoidance in SAD.

Together, these findings support the need to investigate anticipation and avoidance conjointly in order to examine their relationship in SAD. Studies on avoidance learning have typically conceptualized avoidant responses as a method for individuals to avoid a feared stimulus (e.g. Delgado, Jou, LeDoux, & Phelps, 2009). By engaging in avoidant strategies, however, socially anxious individuals rarely engage directly with a feared stimulus. Instead, socially anxious individuals only indirectly experience social stressors, if at all, through the anticipation of these stressors (Clark & Wells, 1995; Rapee & Heimberg, 1997). For example, socially anxious individuals reduce reactivity during social stressors through the utilization of safety behaviors (e.g. avoiding eye contact;

Rapee & Heimberg, 1997). In more severe cases, socially anxious individuals will avoid an anticipated social stressor entirely to prevent exposure to said stressor (Rapee & Heimberg, 1997). Given this conceptualization, avoidant responses in SAD may largely be attributable to the anticipation of a social stressor, rather than direct engagement with a social stressor. As such, examining the relationship between anticipation and avoidance may inform a more comprehensive understanding of these mechanisms in SAD.

Fear Conditioning Paradigms in Social Anxiety

Fear conditioning paradigms are commonly used to study anxiety-related differences in fear expression (for a review, see Lissek, et al., 2004). To experimentally elicit learned fear, fear conditioning paradigms utilize principles of classical conditioning. Typically, two neutral stimuli (e.g. two different colored squares) are presented to participants, with each stimulus paired with different contingencies. One stimulus (CS+) is paired with an aversive outcome (e.g. shock), which serves as the unconditioned stimulus (US). In contrast, the other stimulus (CS-) is never paired with the US. Following multiple paired and unpaired presentations with the US, participants learn that the CS+ signals threat whereas the CS- signals safety respectively. As a result, fear conditioning paradigms allow experimental manipulation of fear expression between the CS+ and CS-.

Importantly, the experimental manipulation of fear permitted by fear conditioning paradigms may uniquely allow a conjoint examination of anticipation and avoidance. Previous research has predominantly relied on social-interaction based paradigms such as a speech task. However, these paradigms may not be optimal for assessing both anticipation and avoidance or comparing these processes under certain and uncertain

conditions. Speech tasks permit measurement of anticipation, but not behavioral avoidance given that all participants are required to give a speech of identical length. However, modifying this paradigm to allow avoidance of the speech is problematic as it may influence anticipatory processes. Specifically, a speech task may not elicit affective responses if participants know the speech can be avoided. Although this specific problem can be mitigated by not providing this information prior to the speech, it introduces a confound in measuring physiological recovery following an avoidance response. Providing an unexpected option to avoid the speech at the time of exposure would be expected to produce anxiety-related differences in the amount of exposure to a speech, which may influence physiological recovery following the decision to avoid. As such, anxiety-related differences in physiological recovery may be attributable to concomitant differences in speech exposure time across groups. However, fear conditioning paradigms standardize the anticipation, exposure, and post-avoidance periods across participants by experimentally controlling the time, stimuli, and responses permitted in each phase. Experimental control of each phase allows responses to be studied as an integrated process while preventing confounding interactions across phases.

In fear conditioning studies of social anxiety, a shock is typically utilized as the US. Despite the social components of fear that characterize social anxiety, shock is preferable to aversive social outcomes (e.g. negative feedback) in examining fear expression in social anxiety. Given elevations in fear of negative evaluation, socially anxious individuals may perceive negative feedback as more aversive compared to non-anxious individuals (Reichenberger, et al., 2014). In fear conditioning paradigms, however, this selection is problematic as fear learning is directly related to the

aversiveness of the US (Cordero, Merino, & Sandi, 1998). Consistent with this view, socially anxious individuals demonstrate fear conditioning when negative feedback is employed as a US, whereas non-anxious individuals do not demonstrate learned fear (Lissek, et al., 2008). As such, anxiety-related differences in fear expression could be attributable to concomitant differences in subjective US intensity, rather than differences in fear learning. In contrast, shock intensity is individually tailored to each participant to prevent this confound. As a result, more recent animal models have utilized shock in social contexts to successfully examine social fear learning (Toth, Neumann, & Slattery, 2012).

Limitations of Past Research

Anticipatory Processes

Previous research on anticipation in social anxiety has primarily utilized self-report measures such as distress ratings (e.g. Price & Anderson, 2011; Coles & Heimberg, 2000). However, there are several limitations in utilizing such measures in studying anticipation of threat. First, self-report measures cannot be acquired continuously, rather, these measures must be acquired at pre-determined time points within a paradigm (e.g. before/after a threat). Using single assessment points is problematic as threat anticipation is a continuous, rather than discrete, process (Grillon, Ameli, Merikangas, Woods, & Davis, 1993). In contrast, physiological measures such as skin conductance response (SCR) provide an online assessment of anticipatory anxiety as it unfolds in real time. Second, self-report measures may engage processes that are independent of the process under study. For example, asking participants to provide distress ratings while anticipating a social stressor (e.g. speech task) requires participants

to identify and describe their internal state. Engaging in such processes introduces variability that is not related to the process being examined, resulting in potential confounds. For example, self-report measures require an individual to turn attention towards their own internal state (e.g. self-focused attention), which increases negative affect in socially anxious individuals (for a review, see Spurr & Stopa, 2002). Physiological assessments do not require that participants focus attention towards themselves, allowing a less intrusive examination of the processes being studied. Due to the limitations of self-report measures in examining anticipatory anxiety, utilizing physiological measurements may provide a more accurate assessment of threat anticipation.

Physiological responses to threat are primarily associated with activation of the sympathetic, rather than parasympathetic, nervous system (Rau, 1991). As such, an ideal measurement of reactivity to threat would be primarily mediated by the sympathetic nervous system. In contrast to some physiological measures such as heart rate that are dually influenced by both sympathetic and parasympathetic systems (Levy, 1990), skin conductance physiology is almost exclusively activated by the sympathetic system (Shields et al., 1987). Additionally, SCL has been widely used in studies of anticipation and decision-making given that anticipation of outcomes reliably evokes changes in SCL (for a review, see Dawson, Schell, & Courtney, 2011). Moreover, changes in SCL during anticipation of an outcome provide an online measure of outcome expectancy (for a review, see Dawson, Schell, & Courtney, 2011). Given the benefits conferred by SCL in assessing anticipatory processes, skin conductance will serve as our primary

measurement of threat anticipation. However, self-report data will also be collected in order to ensure a comprehensive assessment of anticipation.

Although some studies have examined physiological responses during anticipation in social anxiety and have suggested an interaction between anxiety and threat certainty (e.g. Wong & Moulds, 2011), these studies have only examined anticipation of certain threat. Specifically, anxiety-related differences in SCL have been detected during the anticipation of an imminent speech (Wong & Moulds, 2011), but SCL during anticipation of an uncertain social threat (e.g. an upcoming speech that may or may not occur) has not been examined. Given the aforementioned research suggesting an interaction between anxiety and threat certainty, this study may have failed to identify important interactions between these factors. More importantly, however, this study did not examine avoidance, precluding any detection of a link between anticipatory processes and avoidance behaviors in social anxiety.

Avoidance

Despite the prominent role of avoidance within cognitive frameworks of SAD, previous findings are methodologically limited. More specifically, the extant literature typically assesses avoidance utilizing one measure (e.g. retrospective behavioral avoidance). In order to obtain a multi-method assessment of avoidance, we will examine physiological, behavioral, and self-reported avoidant responses. To assess physiological and behavioral avoidant responses, we conjointly examined physiological (i.e. skin conductance) and behavioral (i.e. reaction time) reactivity during the anticipation and avoidance responses within a novel paradigm. To examine avoidance behaviors outside of the laboratory context, we also collected self-report data on daily avoidant behaviors

(e.g. “I avoid answering the phone”). Similarly, we assessed cognitive avoidance of social stressors (e.g. “I avoid thinking about interpersonal tension”).

Additionally, previous research has demonstrated individual differences in physiological recovery following the anticipation of a stressor (Waugh, Panage, Mendes, & Gotlib, 2010). In these paradigms, physiological recovery is conceptualized as the amount of reduction in physiological activation immediately following anticipation. However, no research to date has examined anxiety-related differences in physiological recovery following anticipation *and* avoidance of a stressor. Accordingly, we will examine differences in physiological recovery following the anticipation and avoidance of threat between socially anxious and non-anxious individuals. In short, we will examine both avoidant responses as well as recovery following these responses. This multi-method approach to studying avoidance as a process rather than an isolated outcome provides a more comprehensive conceptualization of avoidance relative to past social anxiety research.

Current Study

The goal of the present research is to examine anxiety-related differences in anticipation and avoidance in the context of a fear conditioning paradigm in social anxiety, as well as the relationship between these two processes. First, we will assess differences in anticipation between socially anxious and non-anxious individuals in response to varying levels of threat certainty. Second, we will examine differences in task-based avoidance, as well as self-reported avoidance behaviors in social contexts. Third, we will examine anxiety-related differences in physiological recovery following task-based avoidance responses. Finally, by utilizing a paradigm that induces the co-

occurrence of anticipatory anxiety and avoidance, we will examine the relationship between anticipation and both task-based and social avoidance in social anxiety.

Study Aims and Hypotheses

Aim 1: To characterize physiological and subjective differences in threat anticipation between socially anxious and non-anxious individuals.

Hypothesis 1.1. Socially anxious individuals will demonstrate greater SCL reactivity to the CS+ vs. CS- compared to non-anxious individuals during the anticipation of uncertain, but not certain, threat.

Hypothesis 1.2. Socially anxious individuals will demonstrate greater increases in fear and outcome expectancy ratings to the CS+ vs CS- compared to non-anxious individuals for uncertain threats, but not certain threats.

Aim 2: To characterize physiological and behavioral differences in threat avoidance between socially anxious and non-anxious individuals.

Hypothesis 2.1. Socially anxious individuals will demonstrate both faster task-based avoidant behavioral responses (CS+ vs. CS-) as well as greater social avoidance compared to non-anxious individuals.

Hypothesis 2.2. Socially anxious adults will demonstrate slower physiological recovery after avoiding threat compared to non-socially anxious individuals.

Aim 3: To delineate the relationship between threat anticipation and threat avoidance.

Hypothesis 3.1. Greater SCL reactivity during the anticipation of threat will be associated with both faster task-based avoidant responses (CS+ vs CS-) as well as higher levels of self-reported avoidance of social situations in daily life.

Hypothesis 3.2. SCL reactivity during the anticipation of uncertain threat will demonstrate a stronger association with both task-based and self-reported avoidance compared to SCL reactivity during the anticipation of certain threat.

CHAPTER TWO

METHOD

Participants

Sixty-one undergraduate students (19.62 ± 1.66 years, 31 females) were recruited through the University of Miami Department of Psychology subject pool based on scores obtained on the Social Interaction and Anxiety Scale (SIAS), which assesses fear regarding social interactions (Mattick & Clarke, 1998). Utilizing empirically identified cut-off scores, participants were classified as either socially anxious (SIAS ≥ 34, n= 27, 17 females) or non-anxious (SIAS ≤ 19, n= 33, 14 females; Brown et al., 1997; Heimberg et al., 1992). These score cutoffs have been shown to reliably identify clinical cases of Social Anxiety Disorder with 86% sensitivity and 70% specificity (Brown et al., 1997). Several exclusion criteria were used to maximize the quality of the data collected as well as minimize the potential risks of participation. Participants were excluded if they reported uncorrected vision problems, were not fluent English speakers, taking psychotropic medication, or factors contraindicative with receiving electrical stimulation (e.g. pregnancy, chronic medical conditions, neurological conditions, etc.).

Procedure Overview

For a schematic overview of the study procedure, see Figure 1.

After obtaining informed consent, participants completed self-report questionnaires (see Appendix) assessing various features of social anxiety as well as depression. After completing questionnaires, recording electrodes were attached to participants to measure physiological signals (e.g. skin-conductance) and baseline

physiology measures were collected. Next, participants completed a stimulus habituation procedure, a shock-work up procedure, and a behavioral task assessing anticipation and avoidance of threat. Following this task, participants provided subjective ratings of the stimuli used. Finally, participants were debriefed by an experimenter and compensated with research credits or payment.

Questionnaires

The Social Interaction and Anxiety Scale (SIAS; Mattick & Clarke, 1989). The SIAS assesses how characteristic it is for an individual to experience anxiety related to social interactions. The SIAS includes twenty items rated on Likert scale ranging from 0 (*Never*) to 4 (*Extremely)*, yielding a possible range of scores between 0-80. Research has found that the SIAS demonstrates excellent internal consistency (Cronbach's $\alpha = .94$) as well as excellent test-retest reliability across 12 weeks ($r = 0.93$; Mattick & Clarke, 1997). The SIAS has also been demonstrated to discriminate with high levels of sensitivity between individuals diagnosed with SAD and non-anxious individuals using the score criteria previously described (Brown, Turovsky, Heimberg, Juster, Brown, & Barlow, 1997).

The Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987). To measure avoidance of social situations, the LSAS was administered. The LSAS measures the level of fear and avoidance an individual experiences in response to several types of social interactions (e.g. using a telephone in public). The LSAS is a 24 item scale that yields a total fear score (0 = Never; 3 = Usually) ranging between 0 and 72, a total avoidance score (0 = None; 3 = Severe) between 0 and 72, as well as a total composite social

anxiety score between 0 and 144. As a measure, the LSAS demonstrates excellent internal consistency (Cronbach's a = 0.96), with both fear and avoidance sub-scales demonstrating similarly high internal consistency (Cronbach's $a > 0.83$; Heimberg, Hornier, Juster, Safren, Brown, Schneier, & Liebowitz, 1999). Additionally, the LSAS demonstrates good test-retest reliability (r = .83) across a 12 week period (Baker, Heinrichs, Kim, & Hofmann, 2002). The LSAS can be administered as part of a clinical interview or as a self-report measure. Psychometric studies suggest that there are no differences in the reliability or validity between these forms of administration (Rytwinksy, et al., 2009; Baker, Heinrichs, Kim & Hofmann, 2002; Fresco et al., 2001). As a result, we utilized the self-report version for feasibility purposes.

The Depression, Anxiety, and Stress Scale (DASS-21; S. H. Lovibond & P. F. Lovibond, 1995). To measure depression severity, the depression sub-scale of the DASS-21 was administered. The depression sub-scale measures the level of core depressive symptoms experienced during the previous week. The depression sub-scale is a 7 item scale that yields a total depression score (0 = Never; 4 = Almost Always) ranging between 0 and 28. As a measure, the depression sub-scale demonstrates excellent internal consistency (Cronbach's a = 0.94; Antony et al., 1998). Additionally, the depression sub-scale demonstrates excellent convergence with other measures of depression such as the Beck Depression Inventory (S. H. Lovibond & P. F. Lovibond, 1995).

Pre-task Procedures

After completing self-report questionnaires, participants completed several pre-task ratings regarding the stimuli used in the behavioral task (e.g. "how afraid does this

woman make you feel?", "how pleasant/unpleasant is this woman?"). Participants were then seated in front a 23" computer monitor in a sound attenuated room. Once seated, physiological sensors were then attached to the participant. Next, baseline measures of physiology (e.g. skin conductance level) were obtained while participants sat quietly for five minutes while a white screen was presented on the monitor.

After completing the baseline physiology assessment, participants completed a habituation task in which they were exposed to several presentations of the stimuli used in the behavioral task. Habituation procedures are commonly employed to reduce physiological reactivity associated with stimulus novelty that may skew results (e.g. Lissek et al., 2008). After completing the habituation procedure, an appropriate shock intensity level was determined individually with each participant. Research has demonstrated large individual differences in the perceived aversiveness of shocks, which may result in dissimilar conditioning between participants (Rollman & Harris, 1987). To account for these individual differences, each participant completed a brief procedure to determine a shock intensity level that was aversive, but not painful (e.g. Grillon et. al, 2004). The shock electrode was applied to participants' left forearm, and using a Grass Instruments stimulator (Model SD-9, West Warwick, RI), increasing shock intensities were be delivered until the appropriate level was reached. Shock intensity levels never exceeded 5 microvolts, regardless of subjective intensity ratings.

Behavioral Task

Participants completed a modified version of a fear conditioning paradigm designed to study physiological reactivity during the anticipation of various outcomes

(Low, Lang, Smith, & Bradley, 2008). We modified the structure of this paradigm to examine physiological reactivity both during the anticipation and subsequent avoidance of a cue signaling threat (i.e., shock). Given our interest in perturbations within social anxiety, we selected images of faces as conditioned stimuli within this paradigm to examine anticipation and avoidance of learned threat associated with social stimuli. As noted previously, we selected a more controlled unconditioned stimulus (US; i.e. shock as opposed to feedback) to standardize US aversiveness across participants. Further details of the behavioral task are described below.

In this task, a series of random images on a black background were presented to participants using E-Prime software (Sharpsburg, PA). Amongst a stream of colored neutral images from the IAPS data set (Lang, Bradley, & Cuthbert, 2008), two different grayscale images of females with neutral facial expressions from the NIMSTIM collection (Tottenham et al., 2009) appeared randomly (see Fig. 2). Through instructed fear conditioning, these two women became associated with threat and safety. One face (CS+) was paired with the possibility of receiving an aversive shock, which signaled threat. The other face (CS-) was never be paired with a shock, which signaled safety. Prior to the task, participants were explicitly informed which of the two faces would be paired with a shock. The assignment of faces to the CS+ and CS- was randomized and counterbalanced across participants. The faces were readily distinguishable from the neutral images in content (i.e. faces vs. non-human objects) and color (grayscale vs full color; see Fig. 2).

The neutral IAPS images served two purposes. First, the neutral images increase the ecological validity of the task. For instance, presenting threatening cues within a

larger stream of information may be more representative of threat processing outside the laboratory. Additionally, these images facilitated task interest over time by reducing expectancy effects and maintaining participants' attention between trials.

Behavioral Task *Anticipation*. To produce anticipation of threat, the faces increased in size to simulate approach towards the participant. As shown in Figure 2, a face enlarged six times in equal intervals (Full Approach Sequence). At the conclusion of this approach process, a shock was randomly administered (CS+). At times, however, the face only enlarged three times and terminated its approach prematurely (Half Approach Sequence).

The inclusion of the half approach sequence established two different probabilities of aversive outcome (uncertain and certain). When images size 1-3 appeared, an outcome remained uncertain because on 50% of trials the face's approach terminated at image 3 and no longer advanced to the second approach stage. However, on the remaining 50% of trials, the face continued to advance indicating the aversive stimulus (CS+) may follow image 6.

Behavioral Task *Avoidance.* As depicted in Figure 3, at the conclusion of a full approach trial, participants were provided with an opportunity to avoid the aversive outcome. The background color surrounding the face changed from black to white (response cue), signaling an opportunity for avoidance. For CS+ trials, participants were instructed that pressing the spacebar fast enough upon presentation of the response cue would allow the participant to avoid an incoming shock. However, pressing the spacebar too slowly would result in receiving a shock. The response cue was presented for 500ms.

Unbeknownst to participants, a shock was randomly delivered on 20% of the response cues regardless of performance to ensure an equal number of received shocks are administered across participants. After a response was made, but prior to the administration of a 5ms shock, the response cue (white background) was removed (see Fig. 3). Removing the response cue prior to shock delivery prevents conditioning participants to fear the response cue (i.e., white background), as opposed to the CS+ itself. Following the termination of the shock, feedback was presented for 2 seconds. In shock trials, participants received feedback stating "You failed to avoid the shock". For all other CS+ trials, participants received feedback stating "You avoided the shock".

For CS- trials, which were not paired with shock, participants were exclusively administered feedback regarding their response speed. Participants either received "You were fast enough" on 80% of CS- trials or "You were too Slow" on 20% of trials. This feedback matched purported performance on CS+ trials and was included to incentivize participants to maintain attention and performance levels on CS- trials.

Behavioral Task *Physiological Recovery*. Both full and half approach trials were followed by an intertrial interval (ITI; see Fig. 4). The ITI was a presentation of a blank screen for an average of 12s (10-14s). The ITI following each trial type served two primary purposes. First, the absence of stimuli allowed for a measurement of decreases in physiological activation (physiological recovery) following avoidance. Second, the absence of stimuli allowed physiological reactivity to return to baseline levels prior to the onset of the next trial to prevent influence on subsequent trials.

Behavioral Task *Structure*. The experiment consisted of 4 runs. Within each run, 10 full approach and 10 half approach trials were randomly presented among a stream of 100 neutral IAPS images. Equal numbers of CS+ and CS- trials were presented. For both CS+/- and neutral stimuli, each image was presented for 1500ms with a 500ms interstimulus interval. Before the behavioral task, participants completed a brief practice version of the task in which no shocks were administered.

Rating Task

Subjective ratings of the stimuli were collected after completion of the behavioral task. Participants provided ratings for each CS+ and CS- image size (i.e. incremental size 1-6) as well as response cue for both CS+ and CS-. Each CS+/- image size was randomly presented and participants rated their current fear level of each image as well as the probability that a shock followed each image during the behavioral task using a dynamic 6 point visual analogue scale (0 = *None*; 6 = *Extremely*). Next, participants rated the perceived aversiveness of the shocks they received, their mood and attention levels during the task, as well as any discomfort experienced during the study. Participants were then debriefed regarding the study procedures by the experimenter.

Data Acquisition

Throughout the behavioral task, skin conductance data was continuously recorded at 1,000 Hz. Psychophysiological measures were collected using a BioNex 2 Slot Mainframe with BioLab Acquisition Software (Model 50-3711-02; Version 3.0.13, Mindware Technologies LTD., Columbus, OH). After applying a conductive 1.00% NaCl paste, two disposable 7mm Ag-AgCl electrodes were attached to the palmar surface of

the medial phalanges of the second and third fingers of the participant's non-dominant hand. A constant voltage of 0.05 Volts was applied between the electrodes to measure skin conductance level (SCL). Using E-Prime Software (Sharpsburg, PA), reaction time data was acquired through button presses made on a computer mouse using participants' dominant hand.

Data Reduction

Data analysis was exclusively performed on Full Approach Sequences. Full approach trials contained image sizes 1-6, while half approach trials included image sizes 1-3. Analyzing both half and full approach trials would create an unequal number of trials between the uncertain and certain threat anticipation phases, increasing the likelihood of bias in results.

Skin conductance. Skin conductance data was analyzed offline using Mindware Technologies software (Version 3.0.21, Mindware Technologies LTD., Columbus, OH). First, SCL data was smoothed with a 20ms moving window average across the experiment. Next, SCL was time-locked and averaged at each image, referenced against a 500ms pre-stimulus baseline to control for individual differences in overall SCL. Finally, SCL scores were square-root transformed to reduce skew and kurtosis (e.g. Boucsein et al., 2012). Participants who failed to demonstrate deviations of .001 microsiemens across 70% of trials were classified as non-responders so that analyses could be conducted both with and without these individuals.

Reaction time. First, trials in which no response was made were categorized as errors and excluded from subsequent analyses. Next, trials with reaction time that

exceeded two standard deviations above and below each subject's mean reaction time were excluded from analysis. Finally, participants who demonstrated non-responses on 50% or more trials were excluded from all subsequent analyses (Non-anxious = 3; Socially anxious = 1).

Following data reduction procedures, all subsequent analyses were conducted on a final sample of 57 participants (Non-anxious n = 30; Socially anxious n = 27).

Data Analysis Strategy

All statistical analyses were conducted using SPSS (Version 22) analysis software. In the absence of significant omnibus effects, interactions at the subsequent level were examined. For example, in the absence of a 4-way omnibus effect, 3-way interactions were examined if significant. Statistical significance was determined using $p = 0.05$. When assumptions of sphericity were violated, Greenhouse-Geisser corrections were utilized accordingly.

To examine the influence individual differences on results, gender was entered as a fixed factor in all analyses described below. Given the lack of interactions observed with gender across all results (all $p > 0.10$), however, gender was removed from all models. Additionally, results were compared when SCL non-responders were included or excluded from analyses. No substantial differences in obtained results or interpretation were observed. As a result, non-responders were included in all analyses.

To address specific aim 1 (hypotheses 1.1 and 1.2), SCL data and subjective responses (Fear and Shock ratings) were investigated using a 2 (Group: High and Low

anxious) × 2 (CS: CS+, CS-) × 2 (Certainty: Uncertain, Certain) × 3 (Image: Sizes 1 – 3) omnibus ANOVA.

To address specific aim 2 (hypothesis 2.1), task-based avoidance was investigated using a 2 (Group: High and Low anxious) × 2 (CS: CS+, CS-) ANOVA. Daily avoidance behaviors were compared between the two groups using independent samples t-tests. To address hypothesis 2.2, physiological recovery was investigated using a 2 (Group: High and Low anxious) × 2 (CS: CS+, CS-) × 2 (Certainty: Uncertain, Certain) 3-way ANOVA.

To address specific aim 3, the relationship between anticipation and avoidance was investigated using separate Generalized Linear Mixed Models (GLMM) to predict task-related avoidance and daily avoidance behaviors. A GLMM framework provides the ability to test interactions among Between-Group and Within-Group factors when predictor variables are highly intercorrelated. Additionally, we examined the relationship between exposure and avoidance in a similar manner. This relationship was examined to determine whether our findings were specific to anticipatory processes, rather than related to social anxiety more broadly.

Across all models, continuous variables (i.e. SCL) were mean-centered and between-subjects fixed factors (e.g. group) were dummy coded. GLMMs were conducted separately for anticipatory and exposure SCL. For anticipatory models, task-related and daily avoidance were separately predicted with a 2 (Group: High and Low anxious) × 2 (CS: CS+, CS-) × 2 (Certainty: Uncertain, Certain) × SCL (continuous covariate). Each anticipation model contained 4 anticipatory SCL variables corresponding to Uncertain

CS-, Uncertain CS+, Certain CS-, and Certain CS+. To measure anticipation, the rates of change in SCL reactivity were computed across each CS type (CS+, CS-) within each anticipatory phase (Uncertain, Certain). For the uncertain phase, SCL during the third image was subtracted from the first image (i.e. image 3 – image 1), generating an index of skin conductance increase over this period. For the certain phase, SCL during the sixth image was indexed against the fourth image (i.e. image 6 – image 4). Using these contrasts, positive scores indicate an increase in SCL across a threat phase whereas negative scores indicate a decrease in SCL across a threat phase.

For exposure models, task-related and daily avoidance were separately predicted with a 2 (Group: High and Low anxious) × 2 (CS: CS+, CS-) × SCL (continuous covariate) GLM. To measure exposure, SCL was measured during the presentation of the response cue for CS- and CS+ trials. Given that exposure exclusively occurred following the certain phase, this model only had two regressors for anticipation.

CHAPTER THREE

RESULTS

Questionnaires

To validate our group selection criteria, we compared social anxiety (SIAS), avoidance behaviors (LSAS Avoid), and depression symptoms (DASS-Depression) between the socially anxious and non-anxious groups using independent samples t-tests. Consistent with our hypotheses, significant between-group differences were observed on all measures (all $p < .001$) such that the socially anxious group demonstrated higher levels of social anxiety, avoidance behaviors, and depression compared to the non-anxious group. Using independent samples t-tests, the socially anxious group (M = 18.89, SD = 0.92) was younger on average compared to the non-anxious group (M = 19.48, SD = 1.56; $t(54) = 3.22$, $p = 0.002$). Using a chi-square test, no differences emerged in the distribution of gender between the socially anxious and non-anxious groups (X^2 (2, N = 57) = 1.21, p = 0.19). Finally, we compared pre-task ratings of the CS+ and CS- between groups to ensure the groups did not differ in their perception of the stimuli prior to fear conditioning. As expected, no anxiety-related differences were observed on any pre-task ratings (all $p > .05$).

Anticipation

For SCL, a 2 (CS) × 2 (Certainty) × 3 (Image) emerged across the sample ($F_{2, 53}$ = 5.87; p = .004; See Fig. 4.1). SCL increased more in response to the CS+ and CS- during the Certain phase ($F_{2, 53}$ = 9.29; p = .001) compared to the Uncertain phase ($F_{2, 53}$ = 3.34; p = .07); however, no anxiety-related interactions were observed (all $p > 0.05$).

For Fear ratings, a significant omnibus effect emerged, which was consistent with our hypothesis ($F_{2, 53} = 4.18$; $p = .04$; See Fig. 4.2). This effect was driven by an anxiety-related interaction in the Certain phase ($F_{2, 53} = 3.84$; $p = .03$), which was absent within the Uncertain phase ($F_{2, 53} = 2.60$; $p = .76$). Within the Certain phase, fear ratings increased more across the CS+ images compared to the CS- images in the socially anxious ($F_{2, 24} = 8.14$; $p = .002$), but not the non-anxious group ($F_{2, 28} = 0.56$; $p = .55$). Confirmatory analyses were conducted using the linear increase (e.g. Image 3 – Image 1) in Fear ratings across both phases using a 2 (Group) x 2 (CS) x 2 (Certainty) ANOVA. This analysis produced a similar pattern of results, confirming our interpretation that the omnibus effect emerged due to differences in the *rate* of fear increase, rather than differences in fear *expression* more generally.

For Shock Expectancy ratings, a 2 (CS) × 2 (Certainty) × 3 (Image) interaction emerged across the sample ($F_{2, 53} = 13.58$; $p < .001$; See Fig. 4.3), such that such that shock ratings increased more in response to the CS+ compared to the CS- in both Certain ($F_{2, 54} = 37.35$; $p < .001$) and Uncertain ($F_{2, 54} = 9.42$; $p < .001$) phases. Similar to SCL findings, this effect was stronger during the Certain compared to Uncertain phase ($F_{2, 53} = 13.58$; $p < .001$). No anxiety-related interactions were observed (all $p > 0.05$).

Avoidance

For task-based avoidance, reaction times were faster following CS+ trials compared to CS- trials across the sample ($F_{1, 54} = 16.90$; $p < .001$; See Fig. 5). No interaction with anxiety group emerged ($F_{1, 54} = 0.13$; $p = .72$). As noted previously, however, independent sample t-tests revealed that socially anxious group (M = 23.96, SD

= 11.30) demonstrated significantly higher levels of avoidance behaviors in daily life compared to the non-anxious group (M = 8.47, SD = 6.07; $t(54) = -6.51$, $p < .001$).

For physiological recovery, a significant 2 (Group) × 2 (Certainty) interaction was detected ($F_{1, 54} = 4.03$; $p = 0.05$; See Fig. 6) demonstrating that the socially anxious group recovered slower after avoiding both Certainty phases compared to the non-anxious group, regardless of CS type. Additional, follow-up analyses revealed that a Certainty interaction emerged in the socially anxious group ($F_{1, 25} = 9.39$; $p = 0.005$), but not in the non-anxious group ($F_{1, 29} = 0.18$; $p = 0.68$) across CS types. Exclusively within the socially anxious group, SCL recovery was slower following Certain trials relative to Uncertain trials.

Relationship between Anticipation and Avoidance

For task-related avoidance, no omnibus effect emerged for the anticipatory GLMM ($F(1, 207.22) = 0.22$, $p = 0.83$). Additionally, no significant interactions or main effects emerged (all $p > 0.35$). Similarly, no omnibus effect emerged for the exposure GLMM ($F(1, 72.75) = 0.08$, $p = 0.78$). No other significant interactions or main effects emerged in either the anticipatory or the exposure GLMM (all $p > 0.10$).

For daily avoidance, a significant Group × Certainty × SCL interaction emerged ($F(1, 151.53) = 6.06$, $p = .02$). Follow-up analyses revealed a Certainty × SCL interaction within the socially anxious group ($F(1, 47.88) = 4.18$, $p < 0.05$), but not non-anxious group ($F(1, 50.98) = 0.79$, $p = 0.38$). Within the socially anxious group, anticipatory SCL demonstrated opposite relationships with daily avoidance between the Uncertain and Certain phases (See Fig. 7). Within the Uncertain phase, anticipatory SCL

was *positively* associated with avoidance behaviors ($F(1, 50) = 2.33$, $p = 0.13$) such that greater increases in SCL were associated with more daily avoidance behaviors. In contrast, anticipatory SCL in the Certain phase was *negatively* associated with avoidance behaviors ($F(1, 50) = 3.95$, $p = 0.052$) such that greater increases in SCL were associated with less daily avoidance behaviors. In the exposure GLMM, no omnibus effect emerged ($F(1, 74.11) = 2.43$, $p = 0.12$). Additionally, no additional significant interactions or main effects emerged (all $p > .09$). As a result, this model was not examined further.

Post-Hoc Power Analyses

Given our small sample size, it is possible that non-significant findings were attributable to a lack of power to detect significant between-group differences. To examine this possibility, post-hoc power analyses were conducted using obtained effect sizes for non-significant interaction terms. Effect sizes ranged from 0.002 to 0.03, which would require approximately a minimum of 28,000 participants to reach appropriate statistical power (i.e. Power = 0.80) to detect significant effects. As a result, it is unlikely that recruitment of additional participants would significantly alter our obtained patterns of results.

CHAPTER FOUR

DISCUSSION

To summarize, we first validated our group selection criteria by observing significant between-group differences in impairment, including: social anxiety symptoms, daily avoidance behaviors, and depression. Next, we confirmed the ability of our behavioral task to elicit anticipatory effects by observing significant task effects in anticipatory processing as indicated by both physiology (SCL) and subjective ratings (fear and shock expectancy). Across all measures, our sample demonstrated heightened reactivity during the anticipation of the CS+ relative to the CS-, with reactivity increasing as a threat certainty increased. Similarly, we confirmed the ability of our behavioral task to elicit avoidance effects by observing significant task effects in both physiology (SCL recovery) and behavioral responses (RT). For physiology, SCL recovered more slowly following the CS+ relative to the CS-, which was most evident following certain threat. For behavioral responses, participants were faster to avoid on CS+ relative to CS- trials. Taken together, these findings provide support for both our group selection criteria and task procedures.

Second, anxiety-related differences were observed in varying degrees across anticipation, avoidance, and their relationship. For anticipation, the socially anxious group demonstrated greater increases in fear during the anticipation of certain threat compared to the non-anxious group. For avoidance, the socially anxious group demonstrated impairments in SCL recovery following both uncertain and certain trials compared to the non-anxious group. For the relationship between anticipation and avoidance, increases in anticipatory SCL were differentially associated with daily

avoidance behaviors exclusively in the socially anxious group. Specifically, anticipatory SCL during the uncertain phase was associated with *greater* avoidance behaviors, whereas anticipatory SCL during the certain phase was associated with *less* avoidance behaviors. The implications of these findings are discussed separately below.

Anticipation

For anticipation, anxiety-related differences were exclusively observed in fear ratings during the certain phase. The socially anxious group demonstrated greater anticipatory fear (CS + vs. CS-) compared to the non-anxious group within the certain, but not uncertain, phase. Socially anxious individuals may only demonstrate heightened fear appraisal within the certain phase due to perceiving the threat as no longer avoidable, necessitating confrontation. In contrast, uncertain threat may fail to elicit anxiety-related differences given that stimulus distance may facilitate the perception that the negative outcome is avoidable. For example, threats that are distal engage the generation of avoidance strategies, whereas threats that are imminent engage confrontation strategies (for a review, see Lang & Davis, 2006). Within the uncertain phase, socially anxious individuals may engage in increased planning of avoidance strategies which suppresses fear responses. As a result, individuals with social anxiety may only experience significant increases in fear when anticipating a social situation that cannot be avoided. Given that certain threats engage confrontation strategies, however, it is unclear if heightened fear during the anticipation of an imminent threat is necessarily maladaptive. Exploring the relationship between anticipation and avoidance provided additional insight into this issue and will be discussed later.

Contrary to our hypotheses, no anxiety-related differences were detected in either physiology or shock expectancy ratings. Discrepancies between physiology and subjective responses are not uncommon (e.g. Lang et al., 1993). In the context of the current findings, a lack of anxiety-related differences in SCL may suggest that *perturbations* in anticipatory processes do not emerge until top-down processing is engaged. Consistent with this view, some research demonstrates that socially anxious individuals demonstrate greater *perceived* physiological activation (e.g. sweaty palms, blushing, etc.), but no differences in physiological activation relative to controls (e.g. Edelmann & Baker, 2002; Mulkens, De Jong, Dobbelaar, & Bogels, 1999). Similarly, Wong and Moulds (2011) only observed anxiety-related differences in physiology during the anticipation of a speech when participants also engaged in maladaptive cognitive processing. However, when these top-down processes were blocked, no anxiety-related differences in physiology were observed (Wong & Moulds, 2011).

Second, fear and shock expectancy ratings measure separate anticipatory processes. Research suggests that fear appraisal and threat expectancy represent distinct cognitive processes involved in anxiety disorders (Britton, et al., 2013; Valentiner, Telch, Ilai, & Hehmsith, 1993). Whereas fear appraisal gauges affective responses to a perceived threat, threat expectancy measures estimates of probability that are largely independent of emotion (Valentiner, Telch, Ilai, & Hehmsith, 1993). Our findings of anxiety-related differences in fear ratings, but not shock expectancy ratings, may suggest that affective reactivity is uniquely altered in social anxiety. Initially, this interpretation appears at odds with the large body of evidence demonstrating elevated expectations of negative outcomes in social anxiety (e.g. Hinrichsen & Wells, 2003). However,

exaggerated threat expectancy in social anxiety may only emerge when coupled with affective components. For example, anticipatory procedures used in past studies (e.g. Hinrichsen and Wells, 2003; Wong & Moulds, 2011) elicit affective perceptions of negative outcomes (e.g. "Think of a past social situation in which you *felt uncomfortable*", "Think about your *feelings* about the upcoming speech", etc.). As such, exaggerated expectations of these types of outcomes may actually represent an interaction between fear appraisal and threat expectancy, rather than threat expectancy in isolation.

Avoidance

For avoidance, anxiety-related differences were observed for daily avoidance behaviors, but not task-based avoidance. Task-based avoidance may assess a separate process that is not perturbed in social anxiety. As noted previously, the socially anxious group did not demonstrate elevated levels of shock expectancy, which may have failed to elicit anxiety-related differences in task-based avoidance. Alternatively, task-based avoidance measured the *speed* of avoidance (i.e. reaction time), but not the *decision* to avoid. All participants were ostensibly provided the opportunity to each shock, which precludes measurement of decision-making processes. In this paradigm, anxiety-related differences in avoidance may only emerge when participants are provided with the choice to avoid particular trials.

For physiological recovery, the socially anxious group demonstrated slower decreases in SCL following both uncertain and certain trials. Interestingly, this effect was observed across both CS+ and CS-trials. Impairments in physiological recovery

following both threat and non-threat trials may suggest similar impairments in threat-safety discrimination once a social situation has been avoided. Consistent with this view, socially anxious individuals report greater perceived danger compared to controls for both objectively "safe" and "dangerous" social situation passages (Gangemi, Mancini, & van den Hout, 2012). In the current study, anxiety-related differences in physiological recovery were greater following the certain phase relative to the uncertain phase. Greater sustainment of sympathetic activation following the certain phase may suggest that avoidance particularly impairs physiological recovery following more certain perceived threats. This interpretation is in line with research demonstrating that avoidance increases perceived threat of social outcomes, but only for socially anxious individuals (Gangemi, Mancini, & van den Hout, 2012). Moreover, perceived threat was highest when avoidance strategies were used following outcomes that were certain (e.g. "after telling a joke, people look at you disapprovingly"), compared to more uncertain (e.g. "after telling a joke, people laugh and seem interested in you"). Taken together, our physiological recovery findings are in line with past research demonstrating impaired threat-safety discrimination as well as the influence of avoidance behaviors on perceived threat in social anxiety. Importantly, our results extend the time-course of these findings into the period immediately following avoidance.

Relationship between Anticipation and Avoidance

Anxiety-related differences emerged in the relationship between anticipatory SCL and *daily avoidance*, but not *task-based avoidance*. Anticipatory SCL was associated with daily avoidance exclusively in the socially anxious group, with opposite patterns emerging between the Uncertain and Certain phases. Specifically, anticipatory SCL in the

Uncertain phase was associated with *greater* levels of daily avoidance, whereas anticipatory SCL in the Certain phase was associated with *lower* levels of daily avoidance. These findings suggest that although anticipation is associated with avoidance in social anxiety, this relationship differs based on the period of anticipation. Moreover, no anxiety-related differences emerged in the relationship between exposure SCL and either type of avoidance, which suggests that our findings were specific to anticipation. The opposing relationship between anticipation and avoidance offers several important implications for understanding contributing factors to avoidance behaviors in social anxiety.

First, heightened physiological activation during anticipation may not necessarily be maladaptive in social anxiety. Physiological activation when a social engagement remains uncertain may reflect a mobilization of resources that facilitate avoidance behaviors. In contrast, physiological activation when a social engagement is perceived as imminent may reflect a mobilization of resources that facilitate confrontation. Despite the negative association with actively avoiding a social situation, it is possible that these resources are mobilized for avoidance strategies that are exclusively utilized during confrontation such as safety behaviors. However, a confirmatory GLMM revealed no anxiety-related relationships with safety behaviors (all $p > 0.28$), providing additional evidence that these anticipatory resources facilitate social engagement rather than alternative avoidance strategies.

Second, the differential relationships with avoidance behaviors observed between certainty phases may offer insights into improving extant treatments for social anxiety. Contemporary models of exposure therapy for anxiety disorders such as SAD suggest

that fear activation, habituation, and prevention of avoidance are necessary for symptom reduction (Foa & Kozak, 1986). Based on this framework, exposure therapies for social anxiety almost exclusively target these processes during confrontation of a feared social situation (e.g. while giving a speech). Although effective for some individuals, approximately 50% of individuals with social anxiety do not respond to such treatments (Heimberg et al., 1998). By definition, however, the decision to avoid exposure to a social situation is made *prior* to exposure, rather than *during* exposure. As such, fear reductions during exposure may only indirectly target avoidance decision-making processes. Extant exposure therapies may benefit from widening the exposure target to include anticipation of the feared social situation (e.g. 10 minutes prior to a speech exposure). In particular, individuals with social anxiety may benefit from exposure to anticipation of an uncertain social situation (e.g. a speech that may or may not occur). Based on our findings, targeting fear activation and subsequent habituation during this uncertain anticipatory period may produce more direct reductions in avoidance behaviors compared to exposure in isolation. However, future research will be necessary to determine the feasibility of translating these findings into practice.

The lack of relationship between anticipatory processes and task-based avoidance may provide additional evidence that task-based avoidance measured the *speed* of avoidance responses, rather than the *decision* to avoid. As discussed previously, no anxiety-related differences emerged in task-based avoidance. Instead, anxiety-related differences were only observed in daily avoidance behaviors. Taken together, these findings may suggest that anticipatory processes influence the decision to avoid a social situation, but not the type of reflexive avoidance response our task assessed. In a social

context, this reflexive avoidance response may be more analogous to relatively automatic avoidance strategies such as avoiding eye contact. Consistent with this interpretation, no relationships were observed between anticipation and safety behaviors such as avoiding eye contact or hiding one's hands when in social situations. However, future work with other types of paradigms will be necessary to confirm the specificity of the relationship between anticipation and the decision to avoid.

Limitations

Although these findings offer important implications for our understanding of anticipation and avoidance in social anxiety, several limitations merit discussion. First, our sample was composed entirely of undergraduate students, which limits the generalizability of these findings. A different pattern of results may emerge for a community sample that demonstrates greater impairment, longer symptom chronicity, and more heterogeneous demographics. Future work will be necessary to extend these findings into clinical samples. Second, skin conductance only provides one index of physiological processes. As noted previously, different measures of implicit anticipatory processing such as electromyography and heart rate may have demonstrated a different pattern of results. Finally, SCL and subjective ratings were collected at separate time points, which may account for differences in anticipation across these measures. Whereas SCL was collected online during anticipatory processing, subjective ratings were collected after the behavioral task was completed. As such, SCL may reflect real-time anticipation, whereas subjective ratings reflect the influence of processes that were engaged after completing the task (e.g. memory retrieval). Online ratings of fear and shock-expectancy would provide greater confidence that differences in anticipation

across measures are solely attributable to differences between physiological and subjective processes.

Conclusion

In conclusion, the present study aimed to extend our understanding of anticipation and avoidance in social anxiety by examining these factors multi-modally as well as their relationship. In addition to extending our understanding of anticipation and avoidance processes, we identified a physiological link between anticipation and avoidance behaviors of social situation in daily life. The identification of this link offers important implications for improving the treatment of social anxiety given the central role of avoidance in the maintenance of symptoms. For example, exposure therapy for social anxiety may be augmented by expanding the scope of exposures into periods of anticipation. Specifically, exposure to anticipation of social stressors such as public speaking that may or may not occur (i.e. Uncertain Threat) may be particularly beneficial. Similarly, cognitive reappraisal skills commonly utilized in CBT may be focused towards physiological sensations (e.g. sweaty palms) experienced during periods of uncertain anticipation to reduce avoidance behaviors. In contrast, acceptance-based treatments such as Acceptance and Commitment Therapy (ACT) may target acceptance of physiological sensations (e.g. sweaty palms) that occur immediately prior to an imminent social stressor (i.e. Certain Threat) to increase approach behaviors. Future research will be necessary to examine the clinical utility and feasibility of translating the present findings into treatment protocols.

Table 1. ***Group demographics***

Variable	Low Socially Anxious (n = 30)	High Socially Anxious (n = 26)
Age*	19.48 (1.56) Range: 18.58 – 25.50	18.89 (0.92) Range: 18.25 – 21.58
Gender	17 Males; 13 Females	10 Males; 16 Females
SIAS*	10.86 (4.95) Range: 1.00 – 19.00	45.96 (8.30) Range: 34.00 – 65.00
LSAS Avoid*	8.47 (6.07) Range: 0.00 – 27.00	23.96 (11.30) Range: 1.00 – 41.00
DASS-Depression*	1.21 (1.57) Range: 0.00 – 7.00	3.38 (3.74) Range: 0.00 – 14.00

Note. Data are presented as Mean (*SD*).

* indicates between-group differences; $p < .05$.

Figure 1. ***Overview of study procedures***

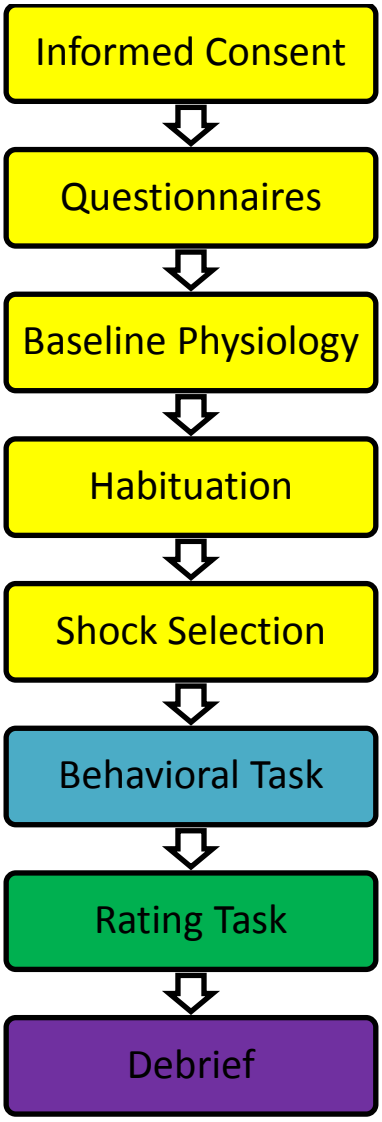


Figure 2. ***CS+ and CS- trials embedded within stream of neutral images***

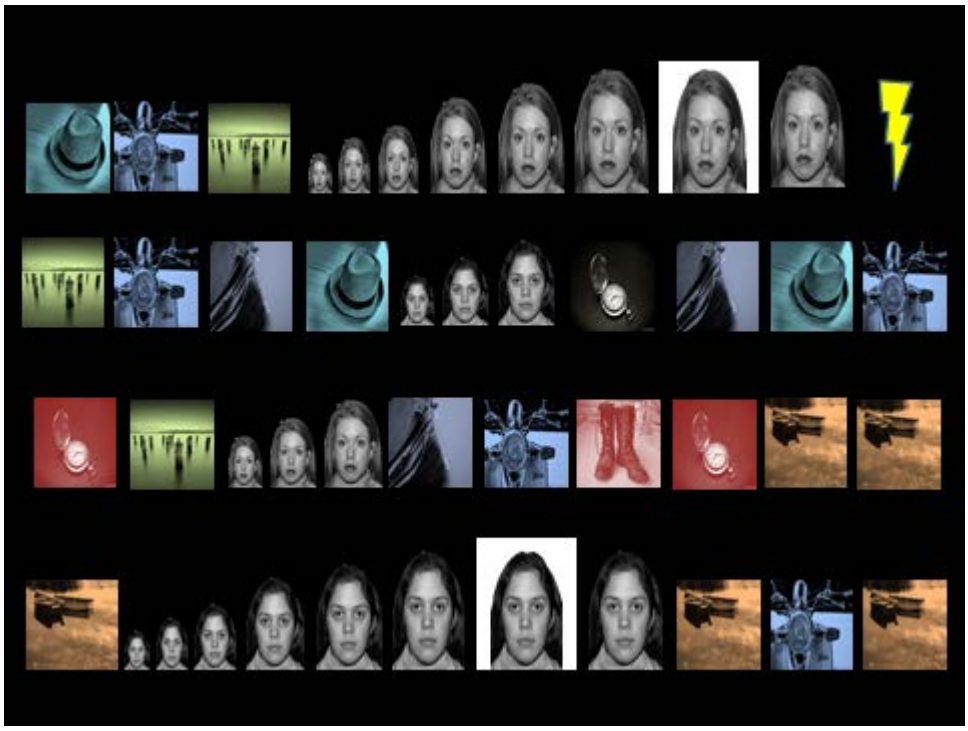


Figure 3. ***Task Flow and Outcomes associated with Half and Full Approach Sequences for CS+ and CS- trials***

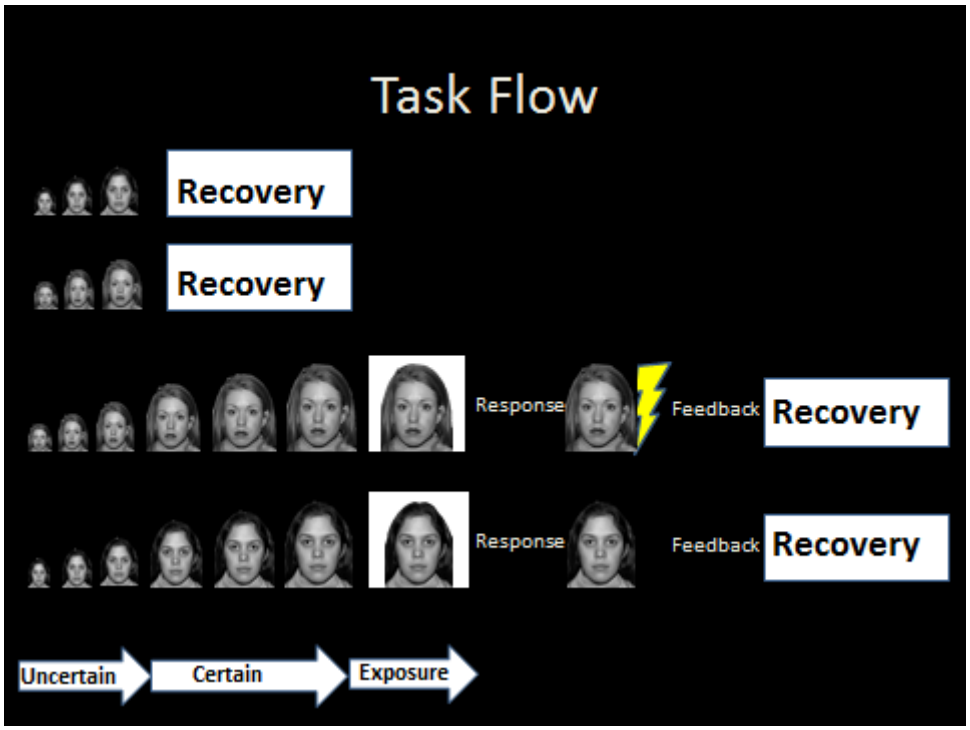


Figure 4.1 ***No anxiety-related differences in the anticipation of either uncertain or certain threat (Skin Conductance Level)***

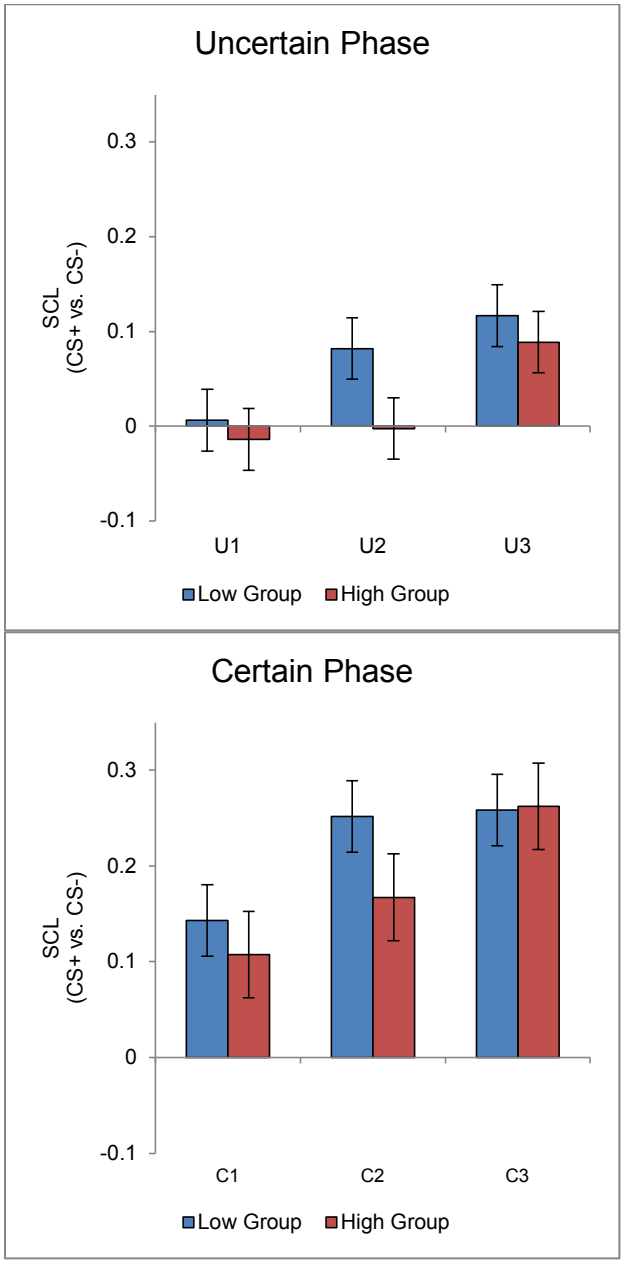


Figure 4.2 ***Anxiety-related differences in the anticipation increase during certain threat only (Fear Ratings)***

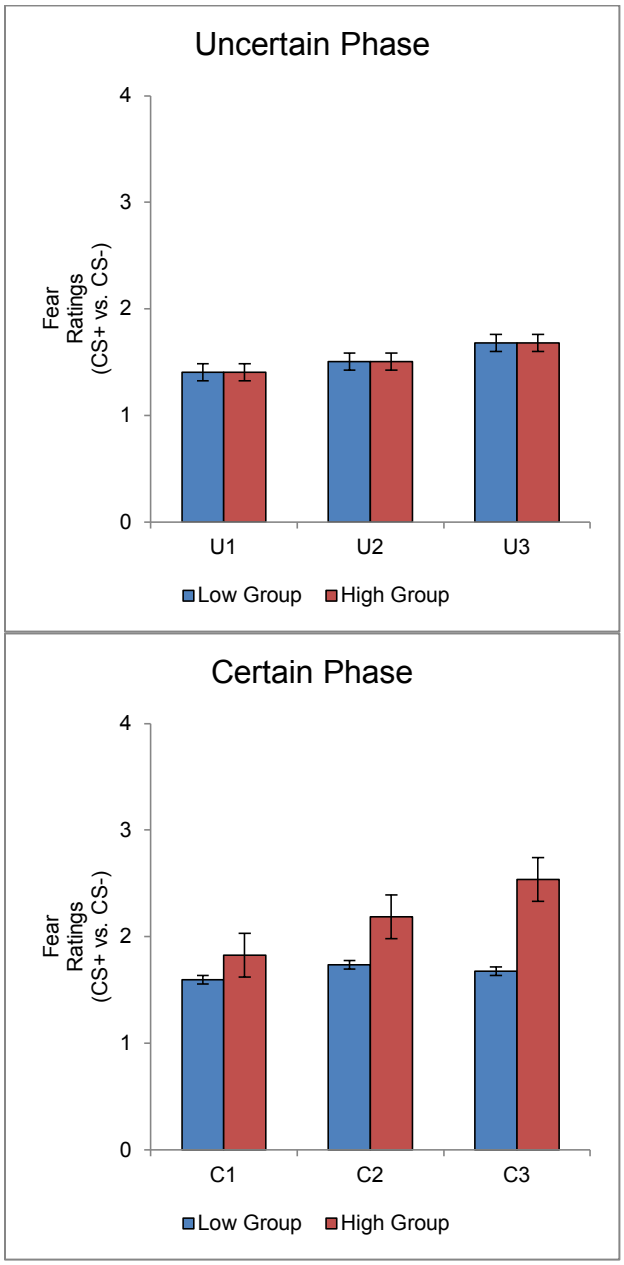


Figure 4.3 ***No anxiety-related differences in the anticipation of uncertain and certain threat (Shock Ratings)***

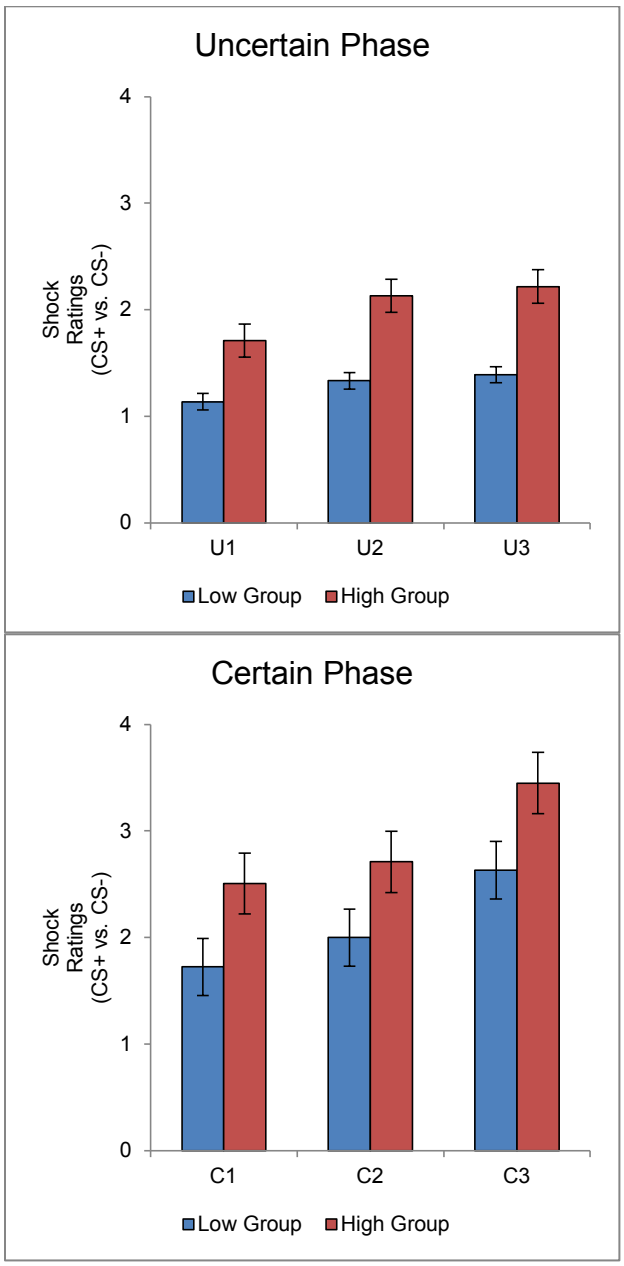


Figure 5. ***No anxiety-related differences in task-based avoidance***

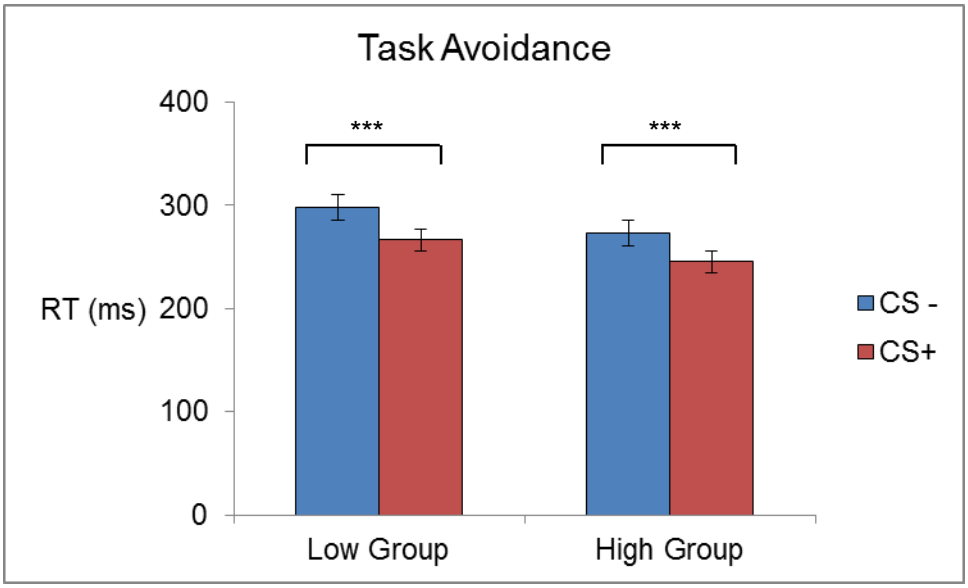
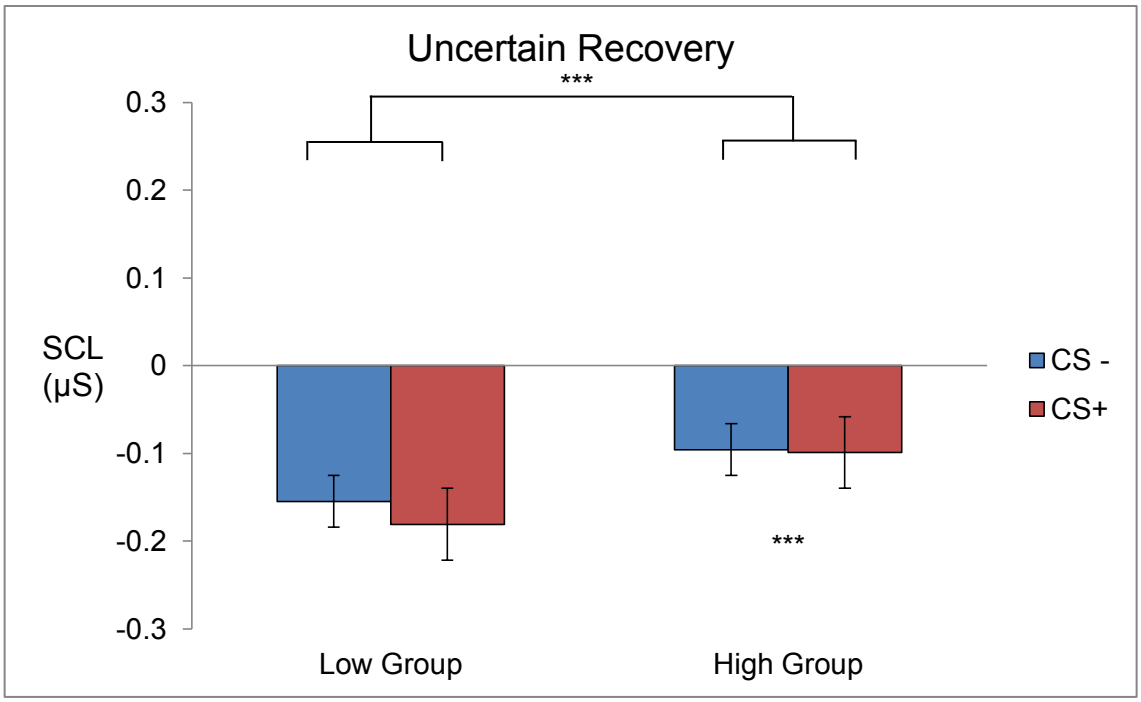


Figure 6. ***Anxiety-related differences in physiological recovery***



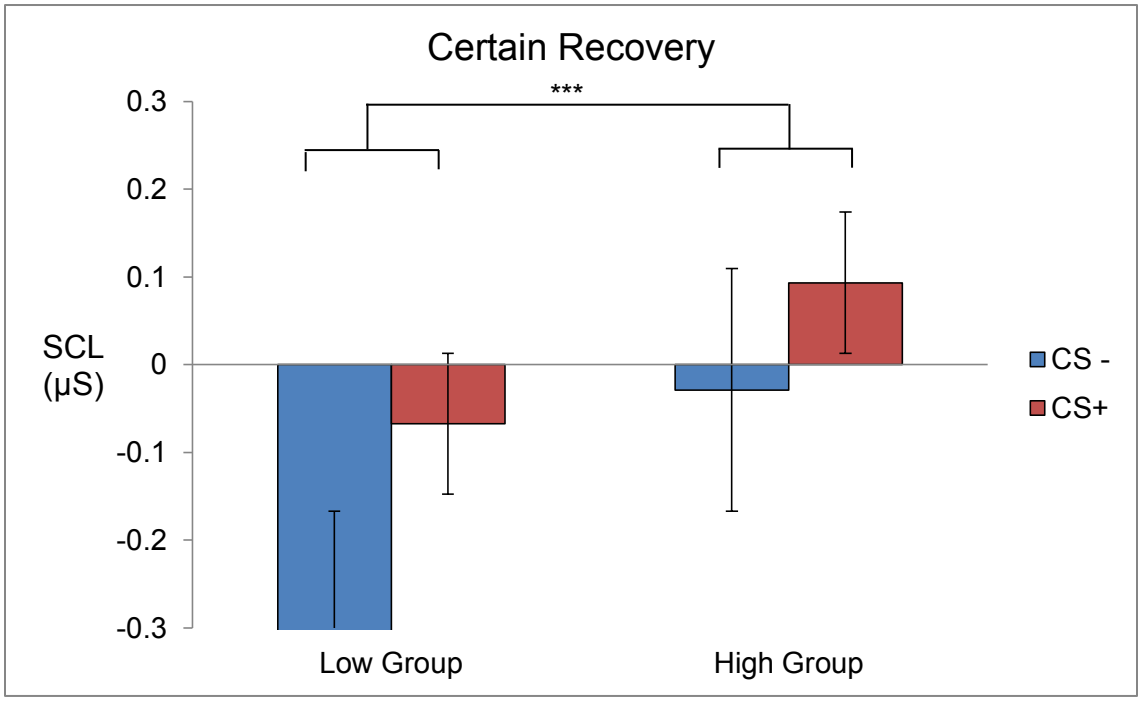
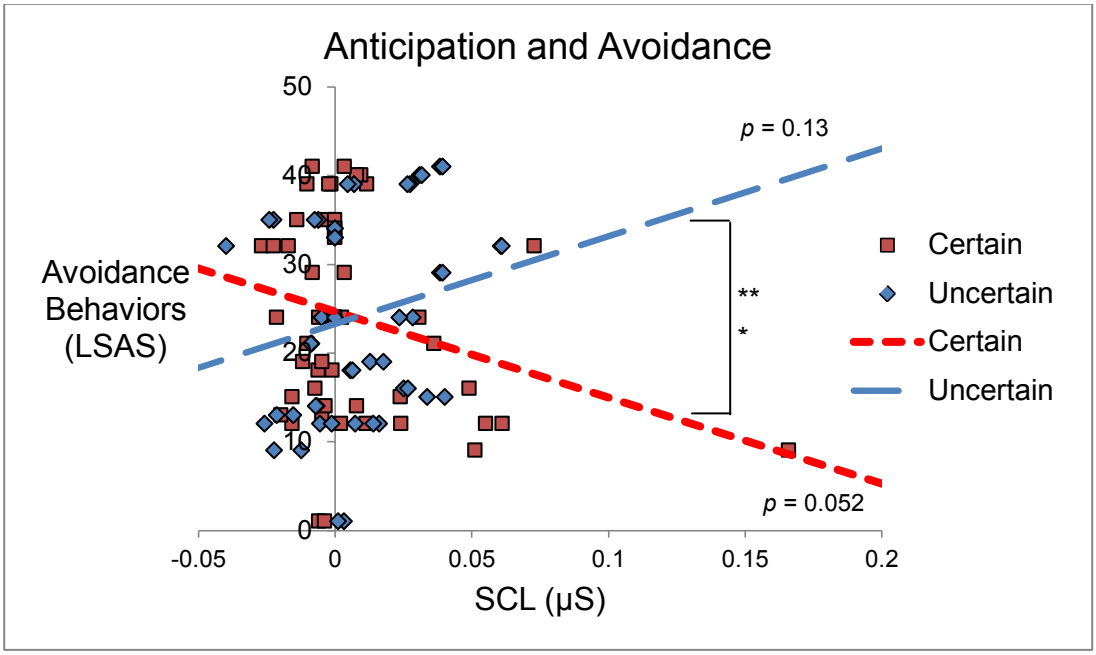


Figure 7. ***Relationship between anticipation and avoidance of threat in the socially anxious group***



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