

**Impact of Cognitive Therapy Analogue on Startle Reactivity  
During Anticipation of Aversive Stimuli**

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THESIS

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## **LIST OF ABBREVIATIONS**

ANOVA	Analysis of Variance
EMG	Electromyography
GAD	Generalized Anxiety Disorder
GTS	Global Temperament Survey
GAD	Generalized Anxiety Disorder
GG	Greenhouse-Geisser
ICC	Intraclass Correlation Coefficient
IDAS	Inventory of Depression and Anxiety Symptoms
IUS	Intolerance of Uncertainty Scale
NS	No Shock
PANAS	Positive Affect Negative Affect Scale
PS	Predictable Shock
PPS	Predictable Partial Shock
PSWQ	Penn State Worry Questionnaire
PTSD	Posttraumatic Stress Disorder
SD	Standard Deviation
US	Unpredictable Shock

## SUMMARY

Theories of anxiety have long implicated the importance of exposure to unpredictable aversive situations in the etiology of anxiety disorders. Some people are more uncomfortable with unpredictable situations than others. Specifically, individuals who are intolerant of uncertainty are particularly sensitive to uncertain circumstances and exhibit heightened anxiety and excessive worry when they are exposed to uncertain situations relative to those who are more tolerant (Dugas and Robichaud, 2007). Cognitive therapy aimed at improving tolerance for uncertainty has been shown to increase subjective tolerance for uncertain situations and decrease symptoms of anxiety (Dugas et al., 2010; Ladouceur et al., 2000). Little is known, however, about whether improving tolerance for uncertainty can influence in vivo physiological responding to an uncertain aversive stimulus. To investigate this question, we tested whether a cognitive therapy (CT) analogue directed at improving tolerance for uncertainty would reduce aversive responding (in vivo startle eyeblink response and subjective report) relative to a control intervention during an anxiety-inducing task. Using a variant of an established experimental paradigm, we varied predictability of shock and measured participants' aversive responses to both predictable and unpredictable threats of shocks (Grillon et al., 2004, 2008). Results indicated that the cognitive intervention reduced subjective but not psychophysiological responding relative to the control intervention. Our findings supported the hypothesis that teaching cognitive strategies would produce immediate, subjective emotional relief for people facing anxiety-provoking situations; however, the brief cognitive intervention did not appear to impact eyeblink startle response.

# **I. INTRODUCTION**

## **A. Background**

Whereas all aversive stimuli elicit negative responses, research finds that humans and animals display more maladaptive behavior and abnormal physiological response during exposure to unpredictable compared to predictable aversive stimuli (e.g., shock; Grillon et al., 2004; Grillon et al., 2008; Seligman, 1968; Seligman and Maier, 1967; Weiss, 1970). Furthermore, many animal and human models of anxiety propose that the unpredictability of the aversive stimulus is a key parameter that evokes anxious responses (Foa et al., 1992; Grillon et al., 2004; Mineka and Kihlstrom, 1978; Mineka and Zinbarg, 2006). For example, clinical research suggests that unpredictable panic attacks elicit greater subjective anxiety than predictable panic attacks among patients who experience both predictable and unpredictable panic attacks (Craske et al., 1995). Because of the importance of predictability in distinguishing aversive responses, researchers often label the emotions elicited by predictable and unpredictable aversive events differently. Specifically, researchers have used the label “fear” to refer to the phasic response to predictable aversiveness, and the label “anxiety” to refer to the sustained response to unpredictable aversiveness (Barlow, 2000; Davis, 2006; Grillon et al., 1994; Grillon et al., 1998; Grillon et al., 2004).

Measurement of the eyeblink startle reflex (Davis, 2006) provides a useful methodology for investigating aversive responses (Lang et al., 1990). Startle is a fast, muscular twitch evoked by a sudden and intense stimulus; it consists of eyelid closure and contraction of skeletal, facial, and neck muscles in humans and in animals (Lang et al., 1990; Koch, 1999). The startle reflex is mediated by a simple neuronal pathway and is thought to serve a protective function and be related to the fight/flight response (Koch, 1999). The human response to acoustic stimuli with

greater than 80 dB sound pressure level, known as the acoustic startle reflex, is manifested in the contraction of the orbicularis oculi muscles underneath the eyes. Thus, startle response can be assessed by measuring the contraction of the orbicularis oculi muscles.

The acoustic startle reflex has been shown to be sensitive to differences in affective state (Koch, 1999; Lang et al., 2000) and, more specifically, aversive motivation (Fanselow, 1994; Grillon et al., 2004; Lang et al., 2000). For example, startle becomes potentiated, or increased, in the presence of a cue that has previously been paired with an aversive stimulus, such as a shock. This amplified startle reflex is referred to as “fear-potentiated startle” (Davis, 2006; Grillon, 2008). Similarly, threatening features of an experimental context that are not as immediately predictive of an aversive stimulus have been shown to elevate startle above baseline -- a phenomenon sometimes referred to as “anxiety-potentiated startle.” For example, research has indicated that patients’ anxiety-potentiated startle increased when experimenters simply placed shock electrodes on a participant’s arm, but were instructed that shock was not yet possible (Grillon et al., 1998); thus, patients exhibited potentiated startle response to cues indicating implicit experimental threat. In sum, “fear-potentiated startle” refers to the increase in startle response found in response to a cue that signals danger or aversiveness, and “anxiety-potentiated startle” refers to the increase in startle response that occurs in the absence of specific cues when the experimental context suggests impending threat.

Grillon and colleagues have conducted a series of experiments that examined the acoustic startle response during an experimental task that varied the predictability of shock (Grillon et al., 2004, 2006, 2007, 2008; see also Moberg and Curtin, 2009) to explore fear- and anxiety-potentiated startle. For example, Grillon et al. (2004) exposed healthy participants to no shock, predictable shock, and unpredictable shock conditions to investigate the effects of predictable



versus unpredictable threat on startle potentiation. Results indicated that startle was potentiated during predictable threat cues in the predictable shock condition relative to non-threat cues in the unpredictable and no shock conditions; thus, cues signaling predictable shock elicited fear-potentiated startle. Startle was also potentiated during the absence of cues during the unpredictable shock condition relative to the absence of cues during predictable and no shock conditions; thus, the absence of cues when unpredictable shock was possible elicited anxiety-potentiated startle. Given our understanding of fear as a response to predictable aversiveness and anxiety as a response to unpredictable aversiveness, Grillon's findings in this study and others (Grillon et al., 2006, 2007, 2008, 2009) suggested that varying the predictability of shock offered a viable experimental design to investigate fear and anxiety responses. Furthermore, this series of studies indicated that this experimental design reliably evoked fear and anxiety responses among healthy as well as anxiety-disordered individuals (Grillon et al., 2004, 2008, 2009).

Grillon and colleagues have also used their experimental paradigm to compare startle response among groups of anxiety-disordered patients and found differential response patterns based on diagnosis. For example, in a study that compared patients with Posttraumatic Stress Disorder (PTSD) to patients with Generalized Anxiety Disorder (GAD) and healthy controls (Grillon et al., 2009), results indicated patients with PTSD exhibited heightened startle during unpredictable threat relative to patients with GAD and healthy controls. Similarly, research showed that patients with panic disorder exhibited heightened startle during unpredictable threat relative to healthy controls (Grillon et al., 2008). Thus, patients with panic disorder and PTSD appeared to share an abnormal response to unpredictability, whereas patients with GAD appeared to have a normal response (as compared to controls).

## **B. Treatment for Intolerance of Uncertainty**

Coping with unpredictable aversive events may present a particular challenge to those who are intolerant of uncertainty. Intolerance of uncertainty has been conceptualized as a disposition that stems from a set of negative beliefs about the implications of uncertainty (Dugas and Robichaud, 2007). People who are intolerant of uncertainty are likely to endorse beliefs such as “uncertainty is stressful and upsetting ... unexpected events are negative and should be avoided, and ... uncertainty interferes with one’s ability to function” (Dugas and Robichaud, 2007, p.24). Thus, intolerance of uncertainty has emotional, cognitive, and behavioral implications (Dugas and Koerner, 2005).

Furthermore, intolerance of uncertainty may help to explain the uncontrollable worry present among patients with GAD and certain other anxiety disorders (Dugas and Robichaud, 2007). Research finds that higher intolerance of uncertainty is associated with more negative interpretations and worry about ambiguous situations; for example, Dugas et al. (2005) found that participants high in intolerance for uncertainty were more likely than participants low in intolerance for uncertainty to report elevated concern about ambiguous situations. In addition, participants’ threatening interpretations of ambiguous situations were more highly related to self-reported intolerance for uncertainty than to measures of worry, anxiety or depression. When an ambiguous situation is perceived as threatening, individuals with GAD or other forms of disordered anxiety may find themselves with increased negative thoughts about the threat and engaging in worry behaviors.

Given that uncertainty is ubiquitous in everyday life (to varying degrees), finding ways to manage and become more tolerant of uncertainty has adaptive implications. Several efficacious treatments for anxiety address the role that thoughts about uncertainty play in anxiety (Beck et

al., 1985; Borkovec, 2006; Salkovskis, 1996). For example, Dugas and Koerner (2005) developed a cognitive-behavioral treatment for GAD that focuses on teaching patients to be more tolerant of uncertainty, which would thus decrease worry symptoms (Dugas and Koerner, 2005). Unlike other cognitive treatments, the treatment developed by Dugas and colleagues does not emphasize identifying cognitive distortions, such as overgeneralization (i.e., one negative experience suggests that all future experiences will have negative outcomes) and changing all-or-nothing thinking (i.e., a situation can be categorized as completely good or completely bad; Beck, 1976). Instead, treatment for intolerance of uncertainty encourages patients to accept that uncertain events may occur and to acknowledge that worry about uncertainty has limited utility.

In a randomized controlled trial, this psychotherapy reduced GAD patients' intolerance of uncertainty, decreased GAD symptomatology, and improved functioning relative to wait-list controls (Dugas et al., 2003; Ladouceur et al., 2000). Furthermore, treatment for other anxiety disorders, such as Obsessive Compulsive Disorder, suggests that improving tolerance for uncertainty may be key to reducing symptomatology (Grayson, 2010; Overton and Menzies, 2005). In sum, the success of psychotherapy that promotes improved tolerance of uncertainty suggests that it may be useful in helping individuals cope with unpredictable aversive events.

Psychotherapy efficacy research would benefit from improved understanding of the mechanisms of action by which interventions produce symptom relief for patients (Zinbarg et al., 2010). Several theoretical models for clinical anxiety (Barlow, 2000; Beck et al., 1985; Mineka and Zinbarg, 2006) describe anxiety symptoms as cognitive (e.g., thoughts such as "the world is a dangerous place"), behavioral (e.g., behaviors such as worry or avoidance), or psychophysiological (i.e., hyperarousal, such as exaggerated startle response). Indeed, interventions targeting anxiety symptoms may reduce anxiety by impacting thoughts, behaviors,

or psychophysiology, or some combination of these domains. We may surmise as to the ways in which improved tolerance for uncertainty produces symptom relief for anxiety-disordered individuals. Improving tolerance for uncertainty may effect reductions in anxiety by reducing the frequency of worry behaviors (Dugas and Koerner, 2005). It is also possible that improved tolerance for uncertainty would reduce a person's level of physiological arousal. On the other hand, improving tolerance for uncertainty may change the content of or reduce a person's frequency of negative thoughts.

To date, relatively few studies have examined mechanisms by which improving tolerance for uncertainty reduces overall anxious symptomatology (Dugas et al., 2010; Dugas and Koerner, 2005). To improve understanding of the mechanisms by which improving tolerance for uncertainty decreases anxiety, research examining the impact of improving tolerance for uncertainty on various aspects of aversive emotional responding is needed. Studies examining whether improved tolerance for uncertainty impacts physiological, cognitive, and/or behavioral aspects of aversive emotions would help to understand how cognitive-behavioral treatment for anxiety works (Zinbarg et al., 2010). In the present research, we examined the impact of learning strategies to improve tolerance for uncertainty on a psychophysiological measure of anxiety (startle response) and self-reported emotions during an anxiety-provoking task.

### **C. Differentiating Degrees of Threat versus Safety and Aversive Responses**

The safety signal hypothesis provides an explanation for why uncertainty is anxiogenic: in situations involving uncertain threat, there are no reliable safe periods. To demonstrate the impact of reliable safe periods on animal behavior, Seligman (1968) conducted a laboratory study in which two groups of rats learned to press a lever for food and were subsequently exposed to unpredictable or predictable shock. In the unpredictable shock condition, no signal

reliably predicted shock delivery; however, in the predictable shock condition, a conditioned stimulus (CS; either a light or a tone) reliably preceded the onset of shock, and the absence of the CS indicated safety from shock. Then, shocks were removed and both rat groups learned to lever-press again for food. In the second phase of the experiment, all rats were exposed to predictable shock, and were required to continue lever pressing for food. Rats who were in the unpredictable shock condition during the first phase of the experiment stopped pressing for food altogether; these rats failed to learn the contingency between the CS and shock in subsequent learning trials and developed extensive stomach ulceration. By comparison, rats initially in the predictable shock condition continued pressing for food in the absence of the CS, learned contingencies between the CS and shocks in subsequent learning trials, and did not develop stomach ulcers.

Seligman (1968) hypothesized that, in a situation in which shock is possible, animal behavior is controlled the presence of reliable predictors of safety and threat. Furthermore, the safety signal hypothesis suggests that predictable threat is preferred over unpredictable threat because of predictable and reliable safe periods that are indicated by the absence of cues that predict danger (Mineka and Hendersen, 1985). In sum, the safety signal hypothesis suggests that uncertainty and unpredictability are anxiogenic due to the absence of reliable, cued safe periods.

The safety signal hypothesis may also help explain why improving tolerance for uncertainty is effective at reducing anxiety. As described above, when an animal is conditioned that a stimulus (e.g., a red light) signals the possibility of shock, it similarly associates the absence of the conditioned stimulus with safety from shock. Stated another way, when the conditioned stimulus is absent, safety is certain; during these certain safe periods, the animal can reduce vigilance and relax (Seligman, 1968; Seligman and Binik, 1977). The appeal of certainty

relative to uncertainty may be due to the animal's ability to reduce vigilance and relax during less uncertain conditions. On the other hand, the absence of a safety signal, as in unpredictable threat conditions, keeps animals in a state of chronic apprehension or fear (Seligman and Meyer, 1970). Animals with lower ability to tolerate this uncertainty may have even higher apprehension and fear in unpredictable threat conditions compared to those with greater tolerance for uncertainty.

Whereas a safety signal provides an external cue that safety is certain, improved tolerance for uncertainty may offer animals an internal, cognitive strategy to tolerate the uncertainty, reduce vigilance, and relax. Thus, an animal's tolerance for uncertain situations may influence its response to situations involving unpredictable threat. Moreover, improved tolerance for uncertainty may enable animals to cope with unpredictable and uncertain aversive events and reduce reliance on safety signals to provide a sense of well-being.

Imada and Nageishi (1982) provided an alternative explanation for the anxiogenic effects of uncertainty. The authors defined uncertainty as a "class of situations involving elements of irregularity, lack of lawfulness, or unpredictability about environmental events" (Imada and Nageishi, 1982, p. 574). They reviewed a series of animal experimental studies in which uncertainty was present and found that animals preferred and exhibited more adaptive behaviors in response to certainty compared to uncertainty. The authors discussed that preferences for predictable shock could not be explained by the safety signal hypothesis alone, as animal studies that have manipulated predictability of shock duration but controlled for safety signals have continued to demonstrate animal preferences for predictable conditions (D'Amato and Safarjan, 1979). Instead, the authors contended that the information hypothesis (Berlyne, 1960; D'Amato, 1974) better explained animal preferences and greater frequency of adaptive behaviors in

situations involving certainty compared to uncertainty. The information hypothesis explains that in any situation, animals prefer having information compared to not having information. In this view, the problem with uncertainty is the lack of information about environmental variables.

The information hypothesis may also provide clues as to why improving tolerance for uncertainty helps to reduce anxiety. The process of learning to tolerate uncertainty may be seen as a way to receive information about the class of situations that otherwise appears irregular. For instance, when people learn that uncertainty is ubiquitous, they may come to view uncertain situations as more familiar, because one uncertain situation may seem similar to another uncertain situation. For example, people may liken the uncertainty of waiting at a bus stop and not knowing when the bus will arrive to the uncertainty of an experimental medical procedure. Likewise, when people receive information that worry about uncertainty is not a helpful strategy, they may become more capable at recognizing their worry responses. Thus, information about the futility of worry may promote insight about one's own worry behaviors. In sum, information about uncertainty and responses to it may help people to reduce anxiety about uncertain situations.

Offering further support to the idea that various factors (e.g., safety signals or information) may promote a sense of safety and well-being to animals in situations in which threat is possible, research indicates that various features of situations can come to represent safety to people. Although Seligman's classic experiments typically identified the absence of a conditioned stimulus as a safety signal, additional research has shown that qualitatively and quantitatively different stimuli can function as both safety and danger signals (Lohr et al., 2007). McNally & Reiss (1982) conducted a noteworthy study in which they presented participants with both pleasant (e.g., flower) and unpleasant (e.g., snake) safety signals to test whether the

negative stimulus was contra-prepared for safety-signal conditioning (McNally and Reiss, 1982). Results indicated that snakes and flowers were equivalent in their ability to be conditioned as safety signals. Thus, even fear-relevant stimuli can function as safety signals given adequate conditioning. Clinical research also finds that anxiety-disordered individuals can use a trusted companion as a safety signal that helps to counter agoraphobic avoidance (Sartory et al., 1989). Furthermore, just as disparate stimuli may denote safety, diverse stimuli may designate danger to individuals. Neutral stimuli associated with threat may become conditioned to signal threat independently of an unconditioned aversive stimulus; for example, a neutral alley may signal danger (e.g., conditioned fear) for a person who has been assaulted, regardless of whether an attacker is present. Thus, various safety signals, as well as danger signals, may be conditioned to denote safety to individuals.

Whereas various stimuli can be conditioned to signal safety (and danger), the majority of research identifies safety as a period during which threat is completely absent (i.e., Seligman, 1968; Seligman and Binik, 1977; Seligman and Meyer, 1970). For example, Seligman defined the safe period as a time without threat of shock that was signaled by the absence of a conditioned stimulus. However, it is also possible that periods of reduced threat (e.g., when there is a possibility of receiving a mild shock) may provide a relative safety for individuals, particularly if information about the threat is provided (Imada and Nageishi, 1982). For example, compared to a signal indicating the absence of threat, a signal indicating a less aversive event may be perceived as relatively safe as it provides *some* information about the situation. If periods of relative safety evoke reduced aversive responses compared to those evoked by full threat, this may indicate that safety is a dimensional construct.



Of note, research has also shown the seemingly paradoxical results that lower levels of shock may elicit greater startle potentiation relative to higher levels of shock. For example, Davis and Astrachan (1978) found that variations in the intensity of shock from low to high resulted in rats' startle potentiation that followed an inverted U-shape pattern, reflecting higher startle potentiation when shock was moderate and lower startle potentiation when shock was high. On the other hand, it is possible that there is no such thing as partial threat, and any level of threat (even minimal) will elicit aversive motivation and maladaptive behavioral patterns. Thus, to improve understanding of how safety vs. danger signals influence aversive motivation, research exploring whether individuals can detect and differentiate degrees of threat (and, conversely, degrees of safety) is needed.

#### **D. The Present Study**

We were interested in whether an information session geared toward improving tolerance for uncertainty (Dugas and Robichaud, 2007; Ladouceur et al., 2000) would influence online aversive responding to predictable and unpredictable threat. To test this, we examined whether a very-brief information session, focused on providing information and cognitive strategies for improving tolerance for uncertainty, could impact aversive responding during a specific, anxiety-provoking task. Short-term cognitive-behavioral treatments have received increasing attention in recent years and some research supports its helpfulness in reducing immediate distress (Koss et al., 1986; Knekt et al., 2008), particularly when specific goals are identified (Talley et al., 1992). Moreover, research finds that brief interventions (e.g., fewer than 5 sessions) are often used on university campuses and often provide some benefit to college students (Haggerty et al., 1980; Pinkerton, 1994).

Thus, we investigated whether a very brief information session would influence aversive responding during a specific task among university students. Half of the participants were randomized to receive a brief, Cognitive Strategies information session aimed at improving tolerance of uncertainty (experimental group). The other half (control group) were randomized to receive a brief, Psycho-Education information session about anxiety. We expected that those in the experimental group would exhibit a bigger change in aversive responding compared to baseline than those in the control group.

We examined aversive responding in several ways. Given that the safety-signal hypothesis suggests that predictable safe periods influence aversive responding, two qualitatively different safety signals were employed and compared to conditions of predictable threat (i.e., no safety). Specifically, we manipulated the predictability of the timing and intensity of the aversive stimulation to test whether individuals exhibit reduced aversive responses during periods of “low threat” compared to periods of “high threat.”

## **II. METHOD**

### **A. Overview**

The experimental paradigm was based on a design by Grillon and colleagues (Grillon et al., 2004, 2008) that examined the eyeblink startle reflex under conditions of predictable and unpredictable shock. Our design had one between- and three within-subjects factors. The between-subjects factor was Group (Psycho-education, Cognitive Strategies), and the within-subjects factors were Shape (Circle, Square), Threat (No Shock, Predictable Shock, Predictable Partial Shock, and Unpredictable Shock), and Time (Pre-information, Post-information). Thus, we were able to test whether aversive responses to threat conditions changed over time as a function of group.

## **B. Participants**

Participants were 100 undergraduate psychology students recruited from the psychology subject pool. Inclusion criteria included participation in the psychology subject pool; exclusion criteria included intoxication, inability to read or speak English, and blindness or deafness. Prior to experimentation, participants received a complete description of the study and signed informed consent documents. Upon arrival, participants were randomly assigned to one of two information-session groups: Psycho-education, or Cognitive Strategies. Fifteen participants' data were excluded from the analysis because the participant refused to participate in the shock work-up procedure ( $N = 1$ ), the equipment did not record properly ( $N = 2$ ), or the participant provided fewer than 2 scorable blinks within at least one condition (i.e., it was not possible to calculate an average blink response;  $N = 12$ ). Consistent with the demographics of UIC psychology subject pool, the remaining 85 participants were primarily female (63.5%) and right-handed (88.2%), with an average age of 19.9 years ( $SD = 3.0$  years). Our sample was ethnically diverse, including 29% Caucasian, 19% Hispanic, 11% African American, and 41% other participants. Participants included in the analyses did not differ from those excluded on age [ $t(93) = .46, ns$ ], gender [ $\chi^2(1, N = 100) = .22, ns$ ], or ethnicity [ $\chi^2(4, N = 100) = .24, ns$ ].

## **C. Stimuli and Physiological Responses**

Aversive stimuli were regulated by a commercial system (Contact Precision Instruments, London, UK), and data were recorded with an acquisition software program (Neuroscan 4.4). Startle response was operationalized as the eyeblink response to 103 dB- bursts of white noise presented binaurally through headphones for 50 ms and was recorded using two electrodes placed over the orbicularis oculi muscle underneath the right eye: the first electrode was placed directly below the pupil of the right eye, and the second electrode was placed approximately 1

cm to the right of the first. The two orbicularis oculi electrodes were referenced to each other. Ground and noise cancellation electrodes were placed along the midline of the forehead and back of the neck, respectively.

The aversive stimulus was an electric shock presented for 40ms to the participant's non-dominant wrist. For each participant, shocks were presented at one of two levels depending on the Threat condition (described in detail below). During Predictable Shock, Unpredictable Shock, and Predictable Partial Shock conditions, the participant received shocks that he/she rated as "highly annoying but not painful," up to a maximum shock of 5 mA. It was important to identify this level on an individual basis, as people differ in the degree to which they find shock levels aversive (Rollman and Harris, 1987). During the Predictable Partial Shock condition, participants also received shocks at half the "highly annoying but not painful" level. Therefore, once each participant's shock level was determined, we presented him/her with a shock that was half the "highly annoying but not painful" level to ensure its perceptibility and inform his/her expectations.

#### **D. Measures**

Participants completed a questionnaire battery (see Appendix A) including the Intolerance of Uncertainty Scale (IUS; Buhr and Dugas, 2002), the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990), the Inventory of Depression and Anxiety Symptoms (IDAS; Watson et al., 2007), and the Global Temperament Survey (GTS; Clark and Watson, 1990, unpublished manuscript). The IUS is a 27-item measure that assessed how people react to ambiguous and/or indeterminate occurrences and provided an index of the participants' subjective tolerance of uncertain life events. The IUS has been shown to have good test-retest reliability (Buhr and Dugas, 2002) and in our sample the Cronbach's alpha was excellent ( $\alpha =$

.95). The PSWQ is a 16-item measure that assessed the generality, excessiveness and uncontrollability of worry and provided an index of participants' worry tendencies. The PSWQ has been shown to have good test-retest reliability (Meyer et al., 1990) and in our sample the Cronbach's alpha was acceptable ( $\alpha = .78$ ). The IDAS is a 64-item measure that assessed specific symptom dimensions of depression and anxiety disorders during the previous 2 weeks and provided an index of participants' current depression and anxiety symptoms. The IDAS has been shown to have good test-retest reliability (Watson et al., 2007) and in our sample the Cronbach's alpha values for the IDAS subscales ranged from acceptable to good ( $\alpha$  range = .60 to 0.89). The GTS is a 90-item measure that assessed the tendency to experience positive and negative emotions and provided an index of participants' trait positive (GTS-PE) and negative affect (GTS-NE). The GTS has been shown to have good test-retest reliability (Harlan and Clark, 1999) and in our sample the Cronbach's alpha for GTS-PE was good ( $\alpha = .89$ ) and GTS-NE was excellent ( $\alpha = .93$ ). We selected these questionnaires (see Appendix A) because we wanted to conduct additional exploratory analyses of potential response moderators. We wanted to test whether participants who reported elevated depression or anxiety symptoms, positive or negative emotions, worry, and/or intolerance of uncertainty would exhibit differences relative to those who reported lower levels of these variables (data not reported here).

#### **D. Procedure**

After signing informed consent documents, participants completed the questionnaire battery. Next, electrodes were placed on participants and they were seated in a sound-attenuated booth approximately 1 meter from a computer screen. First, participants underwent a 3-minute baseline exposure period during which they received 11 startle stimuli and no shocks. This habituated participants to the startle probe and reduced initial startle reactivity (data not

analyzed). Then, the participants were exposed to a shock work-up procedure, during which the participants indicated the level of electric shock they found “highly annoying but not painful.” Then, participants received explicit instructions regarding the conditions under which they would receive shocks.

The experimental task was modeled after the task designed by Grillon and colleagues (Grillon et al., 2004, 2006, 2007, 2008) and was presented in two recording blocks (see Figure 1). Whereas the paradigm designed by Grillon and colleagues consisted of 3 types of trials (No Shock, Predictable Shock, and Unpredictable Shock), our experimental task consisted of 4 types of trials (No Shock, Predictable Shock, Predictable Partial Shock and Unpredictable Shock). We added a fourth type of trial in our experiment to test the impact of predictable low threat on aversive responding (Predictable Partial Shock).

During each of our 4 trials, squares and circles alternated on the computer monitor, each lasting between 6 and 10 seconds and having a mean duration of 8 seconds. The meaning of squares and circles varied across the 4 types of trials. During the No Shock (NS) trials, participants were informed they would not receive any shocks, so both squares and circles indicated safety from any shock. During Predictable Shock (PS) trials, the squares indicated the possibility of receiving a shock that was “highly annoying but not painful,” and the circles indicated safety from any shock. During Predictable Partial Shock (PPS) trials, the squares indicated the possibility of receiving a shock that was “highly annoying but not painful,” and the circles indicated the possibility of receiving low shock that was half the level of the “highly annoying but not painful” shock. Thus, squares were cues designating possibility of threat and circles were cues designating complete safety or partial safety in both PS and PPS trials. During

Unpredictable Shock (US) trials, participants received a “highly annoying but not painful” shock during circles or squares (neither circles nor squares denoted safety).

The four types of trials were presented in one of two orders that were counterbalanced across participants: PS, NS, PPS, US, PS, NS, PPS, US or US, PPS, NS, PS, US, PPS, NS, PS. Given research suggesting that the color red influences both behavioral and psychophysiological measures of avoidance motivation (Elliot et al., 2007; Elliot et al., 2009), we counterbalanced the significance of color for participants. For half of the participants, the color of the shapes was reversed (i.e., red circles and blue squares) to ensure that both blue and red could be conditioned to mean threat or safety for participants. For the sake of clarity, “red square” refers to red square/blue circle and “blue square” refers to blue square/red circle in the present document.

In each experimental block (before and after the information session), participants received 48 startle probes (3 during squares and 3 during circles within each trial) and 10 shocks. Among the shocks, 2 had low intensity (presented during circles of PPS trials) and 8 had strong intensity (2 during squares in PS trials, 2 during squares in PPS trials, 2 during squares in US trials, and 2 during circles in US trials). The shocks were delivered between 3 and 9 seconds following shape onset.

Of note, in the present study “predictable” in the PS and PPS conditions referred to rules designating the type of shock (high vs. low shock) possible during each trial. Predictability did not indicate that shock was reliably delivered every time the PS and PPS trials were shown to participants; indeed, strong shocks were not delivered every time the square was on the screen in the PS or PPS safety trials, nor were mild shocks delivered every time the circle was on the screen in the PPS safety trial. If the timing of shocks had been fully predictable, many more shocks would have had to be presented, and participants’ responses toward the aversive stimulus

would likely have diminished due to habituation. Instead, circles and squares in PS and PPS trials represented “predictable” shock because shock delivery was more likely or predictable during these trials relative to US trials, in which shock delivery was not signaled.

#### **E. Treatment-Analog groups**

Our between-subjects manipulation involved randomly assigning participants to one of two treatment-analog groups: Psycho-education or Cognitive Strategies. Participants in the Psycho-education group received a 15-minute psycho-education session providing information about the cognitive, behavioral, and physiological aspects of anxiety. This psycho-education session represented a common component of anxiety treatment and described beliefs that are common in anxiety (i.e., danger is imminent) and physiological manifestations of anxiety (i.e., body tension). In this condition, the experimenter did not discuss uncertainty, intolerance to uncertainty, or unpredictability, etc.

In contrast, the Cognitive Strategies group received a 15-minute cognitive information session focusing on reducing intolerance of uncertainty. This information was based on a CBT treatment designed for patients with GAD (Dugas and Robichaud, 2007) that has been shown in several randomized controlled trials to reduce GAD symptomatology and improve functioning among patients (Dugas and Ladouceur, 2000; Ladouceur et al., 2000). The information emphasized that one’s perception of uncertainty was an important source of worry and anxiety. As with the Psycho-education group, the experimenter began with a brief discussion about the cognitive, behavioral, and physiological aspects of anxiety, but went on to discuss how response to uncertainty could influence anxiety. For example, the experimenter explained that because uncertainty was pervasive in everyday life for all individuals, people could not try to eliminate uncertainty but rather should accept the uncertainty that potentially negative events may occur



and develop coping strategies to deal with uncertain situations and potentially negative outcomes. Then, the experimenter discussed the futility of worry when confronting uncertainty. The experimenter stressed that correcting erroneous beliefs about worry (i.e., that worrying was helpful) helped to promote tolerance of uncertainty. That is, one needed to learn to deal with the uncertainty of future (negative) events rather than try to control them by using worry.

Given that the participants were not clients seeking therapy (nor did they necessarily have elevated anxiety), the experimenter did not work with participants to identify, restructure, or challenge their own beliefs about uncertainty or anxiety in either treatment-analog condition. Rather, in both conditions, the material was presented as informational. Both Psycho-education and Cognitive Strategies information was presented by the same doctoral-level psychology graduate student (E.J.R.A) in the same experimental chamber, thereby controlling for non-specific treatment factors such as experimenter and location. A script was developed and followed for the Psycho-Education and Cognitive Strategies information sessions to promote within-group similarity and maintain between-group differences (see Appendix B).

To ensure equivalence of nonspecific intervention factors across the two groups and specificity of information content in each information session, a subset of information sessions (Psycho-Education = 12, Cognitive Strategies = 12) were recorded and rated by two independent raters who were blind to study hypotheses. Raters listened to recorded information sessions and provided ratings of the experimenter's warmth, enthusiasm, and genuineness, as well as the bond between the experimenter and participant and participant enthusiasm; ratings were given on a Likert scale ranging from 0 ("not at all") to 7 ("extremely"). With regard to information content, raters coded statements for their presence in the information session (i.e., "yes" for present). For the psycho-education information session, it was important that the experimenter provided

information about behavioral, cognitive, and physiological symptoms of anxiety but did not provide information about accepting uncertainty, worry, or coping strategies. For the Cognitive Strategies information session, the information provided by the experimenter was not restricted. It was important that the experimenter provided information about accepting uncertainty, recognizing the futility of worry, and using cognitive coping strategies to face uncertainty. The experimenter also provided information about behavioral, cognitive, and physiological symptoms of anxiety. We sought to ensure that information in the psycho-education information session was restricted to basic information about anxiety, but there were no restrictions for the Cognitive Strategies information sessions.

#### **G. Subjective Emotions Ratings**

After completion of the first (before receiving the information session) and second (end of the experiment) trials, participants retrospectively rated their levels of nervousness and worry during circles and squares in each type of threat trial. Nervousness was assessed to explore participants' self-reported negative affect. Worry was assessed to explore associations between worry and aversive responses, as well as whether worry changed as a function of treatment group. Participants also rated how intense, unpleasant, and anxiety-provoking both levels of shocks were. Emotion, worry and shock ratings were completed using a Likert scale ranging from 0 ("not at all") to 7 ("extremely"). Participants also rated the degree to which they would avoid experiencing the two levels of shocks again on a Likert scale ranging from 0 ("would definitely avoid") to 7 ("would definitely not avoid").

Finally, participants completed scales indicating their positive and negative affect (PANAS) at four times during the experiment: prior to the first experimental trial, at the end of

the first experimental trial (before the information session), after the information session (before the second experimental trial), and at the completion of the second experimental trial.

## **H. Data Analysis**

Eyeblink startle data were scored according to guidelines provided by Blumenthal et al. (2005). Startle EMG was rectified and then baseline corrected using the 50 ms immediately preceding stimulus onset. Next, EMG data was smoothed using an FIR filter (low pass cutoff of 40 Hz, 24 dB/oct roll-off). Peak amplitude of the blink reflex was determined in the 20-150 ms time frame following the startle probe onset.

Each blink was assessed for its conformity to established guidelines (Blumenthal et al., 2005). Blinks were counted as “non-responses” if they were not differentiated from general orbicularis oculi activity during the epoch, and blinks were counted as “missing” if a) the blink onset occurred before it could reasonably be considered a response to the probe, b) an earlier blink interfered with the response blink, or c) excessive noise occurred within the EMG signal for that epoch. Participants were counted as non-responders and were excluded from all analyses if fewer than 2 of 8 blinks within a condition could be analyzed. Two indices of average blink size were computed: amplitude, and magnitude (Blumenthal et al., 2005), the latter of which included non-responses.

### **1. Group Impact on Aversive Responding**

For statistical analyses, we conducted a one-way ANOVA with Group (Psycho-education, Cognitive Strategies) as a between-subjects factor and pre-intervention startle response as the dependent measure to determine whether our groups differ on initial startle reactivity. Next, we conducted an omnibus ANOVA with Group (Psycho-education, Cognitive

Strategies) as a between-subjects factor, and Threat Condition (NS, PS, PPS, US), Shape (Circle, Square), and Time (Pre-information, Post-information) as within-subjects factors.

Next, we conducted specific follow-up comparisons to investigate types of aversive responding as per the data analytic strategy of the developers of the paradigm (Grillon et al., 2004, 2006, 2007, 2008). Specifically, we distinguished between anxious and fearful responses by obtaining anxiety-potentiated and fear-potentiated dependent measures. Similar to previous studies (Grillon et al., 2004, 2008, 2009), we operationalized anxiety-potentiated responses as average startle eyeblink response and subjective ratings during periods of safety/relative safety (i.e., during circles). To analyze anxiety-potentiated responses, average blink size and subjective ratings during circles were subjected to a 3-way analysis of variance (ANOVA) with Group (Psycho-education, Cognitive Strategies) as a between-subjects factors and Threat (NS, PS, PPS, US) and Time (Pre-information, Post-information) as repeated factors. By comparing the startle and subjective response during circles across different threat conditions, we planned to examine the participants' anxious response elicited by the stressful experimental situation/context and by different types of safety and threat signals. We also planned to observe changes in anxious responses from Time 1 to Time 2 as a function of group.

Also following Grillon's paradigm (Grillon et al., 2004; 2008; 2009), we operationalized fear-potentiated responses as the difference in average startle eyeblink response and subjective emotions ratings during times of relative threat vs. times of relative safety (i.e., square minus circle). To analyze fear-potentiated responses, these difference scores were subjected to a 3-way analysis of variance (ANOVA) with Group (Psycho-education, Cognitive Strategies) as a between-subjects factor, and Threat (NS, PS, PPS, US) and Time (Pre-information, Post-information) as repeated factors. By comparing the difference in startle and subjective response

from circles to squares across different threat conditions, we planned to examine participants' amplification in response due to the presence of the more threatening shape. Comparing the difference scores would provide information about the effectiveness of safety signals for shock timing and intensity. We also planned to observe changes in fearful responses from Time 1 to Time 2 as a function of group.

## **2. Detecting Degrees of Threat versus Safety**

Finally, to explore our safety signal manipulation and test whether participants could detect degrees of threat (high versus low) and differentiate them from safety, we compared startle response and subjective nervousness ratings during contrasting safety/threat conditions. Given the exploratory nature of our comparison, we selected shape and threat combinations that reflected the range of safety/threat conditions: PS-circle, when no shock was possible (i.e., traditional safety signal and a circle to control for the type of stimulus presented); PPS-circle, when low shock was possible (i.e., experimental, partial safety signal); PS-square, when high shock was possible (i.e., absence of safety signal); and PPS-square, when high shock was possible (i.e., absence of safety signal). Since we did not know whether participants would interpret PPS-circle as a safety or threat condition, it was necessary to include both threat and safety conditions for comparison. To analyze responses to threat and safety signals, we subjected startle and nervousness ratings to a 3-way ANOVA with Group (Psycho-education, Cognitive Strategies) as a between-subjects factor, and Threat (PS, PPS) and Time (Pre-information, Post-information) as repeated factors. We sought to determine whether lower versus higher levels of threat and safety impacted participants' physiological reactivity and subjective nervousness.

## **I. Hypotheses**

### **1. Anxiety Hypotheses**

Based on prior research suggesting that the threat of unpredictable shock elicits higher anxiety-potentiated startle (Grillon et al., 2004), we predicted a main effect of threat condition on anxiety-potentiated startle and ratings. Specifically, we expected greater startle and subjective nervousness and worry during Unpredictable Shock compared to No Shock, Predictable Shock and Predictable Partial Shock conditions. Given the effectiveness of cognitive-behavioral treatment in reducing intolerance of uncertainty (Dugas et al., 2010), we predicted an interaction of Group X Time X Threat on anxiety-related startle/ratings reflecting reduction in anxiety-related startle/nervousness and worry following Cognitive Strategies information compared to Psycho-education for the Unpredictable Shock condition.

### **2. Fear Hypotheses**

Based on prior research suggesting that specific, predictable aversive stimuli elicit fear-potentiated startle (Grillon et al., 1998, 2004, 2006, 2007, 2008), we expected to find a main effect of Threat on fear-potentiated startle/ratings. In contrast to anxiety responses, we expected to find greater fear-potentiated startle/nervousness & worry ratings during Predictable Shock and Predictable Partial Shock trials compared to No Shock and Unpredictable Shock trials. Given that fear is operationalized as the response to predictable and not unpredictable threat, we did not expect that learning cognitive strategies to improve tolerance for uncertainty would reduce fear responses; thus, we did not expect to find an interaction of Group X Time X Threat on fear-potentiated startle or subjective ratings.

### **3. Detecting Degrees of Threat versus Safety**

Due to the exploratory nature of our safety signal manipulation, we did not have specific hypotheses as to whether aversive responses would differ for Predictable Shock and Predictable Partial Shock conditions trials. Similar aversive responding across PPS-circle, PS-square, and PPS-square threat conditions would suggest that low levels of threat were not distinguished from high levels of threat for participants; furthermore, this would indicate that partial threat did not signal safety. On the other hand, lower startle and nervousness ratings during PPS-circle relative to PS-square and PPS-square threat conditions would suggest that lower threat was preferable to higher threat and participants' aversive response mechanisms were sensitive to safety and threat levels.

## **III. RESULTS**

### **A. Intervention Ratings**

Two independent raters who were blind to study hypotheses and the subjects' experimental conditions provided ratings for a subset of recorded information sessions (Psycho-Education = 12, Cognitive Strategies = 12) to ensure equivalence of nonspecific intervention factors (e.g., therapist warmth) and fidelity to study protocol. To assess inter-rater agreement on nonspecific information-session factors, we calculated intraclass correlation coefficients (ICC) for each rating using a two-way mixed model and an absolute agreement definition (Shrout and Fleiss, 1979). Next, to test whether ratings of nonspecific information-session factors across raters differed as a function of group, we conducted repeated-measures ANOVAs with group as a between-subjects factor and the two raters' ratings on each item as repeated factors. Results indicated strong inter-rater agreement on ratings of bond between experimenter and participant ( $M = 4.93$ ,  $SD = 1.34$ ,  $ICC = .66$ ,  $p < .01$ ), experimenter genuineness ( $M = 5.98$ ,  $SD = .71$ ,  $ICC =$

.41,  $p < .05$ ), experimenter enthusiasm ( $M = 5.78$ ,  $SD = .66$ ,  $ICC = .37$ ,  $p < .05$ ), participant enthusiasm ( $M = 4.91$ ,  $SD = 1.47$ ,  $ICC = .70$ ,  $p < .01$ ), and number of times participants spoke during the ( $ICC = .70$ ,  $p < .01$ ). Most importantly, the two groups did not differ on these variables (minimum  $p = .14$ ). In contrast, raters reported a trend for greater experimenter warmth during the Cognitive Strategies information ( $M = 5.96$ ,  $SD = .63$ ) relative to the Psycho-Education information ( $M = 5.93$ ,  $SD = .64$ ),  $F(1, 22) = 3.06$ ,  $p = .09$ , although this variable had low inter-rater agreement ( $ICC = .13$ , *ns*).

To further assess fidelity to study protocol, we analyzed ratings about the presence of pre-determined allowable utterances for each information session. These analyses determined whether the two information sessions remained distinct, or whether the Psycho-education information contained information intended for the active, Cognitive Strategies information only (e.g., “Cognitive signs of anxiety involve a person’s thoughts” was an allowed statement for both Psycho-education and Cognitive Strategies groups, but “To cope with uncertainty, you can try to accept that there is some uncertainty all around us” was an allowed statement for the Cognitive Strategies group only). We calculated intraclass correlation coefficients (ICC) for all ratings using a two-way mixed model and a consistency definition. Results indicated high inter-rater agreement on allowable utterances ( $ICC = .54$ ,  $p < .01$ ). Furthermore, there were not any unallowed utterances in the Psycho-education information session, indicating the experimenter used only allowable utterances during the Psycho-Education information session. In sum, analyses of intervention ratings indicated similarity of nonspecific intervention factors across groups and experimenter fidelity to the group protocols.

Information sessions were approximately 14.7 minutes long on average; however, length of the information session differed significantly between the Cognitive Strategies ( $M = 14.07$ ,  $SD$



= 2.01) and Psycho-Education groups, [ $M = 15.26$ ,  $SD = .1.17$ ;  $F(1, 84) = 11.4$ ,  $p < .01$ ]. Thus, the Cognitive Strategies was somewhat longer than the Psycho-Education information session.

## **B. Manipulation Checks of Threat Responses**

First, we tested whether our manipulations were effective by examining the impact of Threat and Shape on startle response at Time 1 (i.e., prior to randomization). We conducted a repeated-measures ANOVA on startle magnitude with Threat and Shape as repeated factors. Greenhouse-Geisser corrections (GG- $\epsilon$ ) were used for main effects and interactions involving factors with more than two levels. As expected, results indicated main effects of Threat,  $F(3, 252) = 47.87$ ,  $p < .01$ ,  $\eta_p^2 = .36$ , GG- $\epsilon = .74$ ; and Shape,  $F(1, 84) = 17.69$ ,  $p < .01$ ,  $\eta_p^2 = .17$ . Pairwise comparisons of startle magnitude averaged across square and circle cues during each threat condition indicated that startle magnitude was lower during NS compared to all other threat conditions; lower during US relative to PS and PPS; and lower during PS relative to PPS (NS < US < PS < PPS; all  $ps < .05$ ). Main effects were qualified by an interaction effect of Threat X Shape,  $F(3, 252) = 7.17$ ,  $p < .01$ ,  $\eta_p^2 = .08$ , GG- $\epsilon = .91$ . We followed up our significant interaction by examining the effect of shape during each threat condition and found significant effects of shape during PS [ $F(1, 84) = 30.65$ ,  $p < .01$ ] and PPS [ $F(1, 84) = 6.35$ ,  $p < .05$ ] threat conditions, but not during NS or US threat conditions [ $ps > .40$ ]. In both PS and PPS threat conditions, participants' time 1 startle magnitude was greater during squares compared to circles, which was consistent with the greater threat level signaled by the squares. Together, time 1 analyses indicated that our threat manipulation was effective in modulating startle responses in the predicted directions.

Next, we tested whether participant groups (Cognitive Strategies vs. Psycho-education) differed on initial startle reactivity by conducting a repeated-measures ANOVA on Time 1 startle

magnitude with Group as the between-groups factor and Shape and Threat as repeated factors. No main or interaction effects with Group were present, suggesting that randomization was effective and groups did not differ on pre-intervention startle magnitude (all  $p$ 's > .5).

We also tested whether participants randomized to the red square condition differed from those randomized to the blue square condition by conducting independent t-tests of these two populations on all measures of startle magnitude. Results indicated only one trend-level difference, with participants in the red square condition showing higher startle magnitude at time 2 during the red square cue of the US threat relative to those viewing the blue square cue,  $t(83) = 1.81$ ,  $p = .07$ . Remaining t-tests were nonsignificant. Thus, results suggested that differences in the color of the higher threat cue was not related to startle response.<sup>1</sup>

Analyses of Time 1 subjective ratings indicated that participants found the shocks moderately intense ( $M = 4.68$ ,  $SD = 1.15$ ) and anxiety-provoking ( $M = 4.76$ ,  $SD = 1.56$ ) and highly annoying ( $M = 5.46$ ,  $SD = 1.44$ ). They also reported they would prefer to avoid receiving the shocks again ( $M = 4.88$ ,  $SD = 1.64$ ). Together, these ratings indicate that the shocks had the intended aversive effect. We tested whether participant groups (Cognitive Strategies vs. Psycho-education) differed on Time 1 shock ratings by conducting a repeated-measures ANOVA on Time 1 startle magnitude with Group as the between-groups factor and Shape and Threat as repeated factors. No main or interaction effects with Group were present, suggesting that randomization was effective and groups did not differ on pre-intervention shock ratings ( $ps > .5$ ).

### **C. Tests of Aversive Startle Responses**

Next, we conducted an omnibus, repeated-measures ANOVA on startle magnitude with Group as the between-groups factor and Threat, Shape and Time as repeated factors. As expected, results indicated significant main effects of Shape,  $F(1, 83) = 20.57$ ,  $p < .01$ ,  $\eta_p^2 = .20$ ,

with lower overall startle during circle relative to square shapes; Time,  $F(1, 83) = 61.41, p < .01$ ,  $\eta_p^2 = .43$ , with lower overall startle across shape and threat conditions at time 2 relative to time 1; and Threat,  $F(3, 249) = 66.33, p < .01$ ,  $\eta_p^2 = .44$ , GG- $\epsilon = .72$ . Pairwise comparisons of startle magnitude averaged across square and circle cues during each threat condition indicated that startle magnitude was lower during NS compared to all other threat conditions; lower during US relative to PS and PPS; and lower during PS relative to PPS (NS < US < PS < PPS; all  $ps < .05$ ). These main effects were qualified by significant two-way interactions of Shape X Time,  $F(1, 83) = 3.95, p < .05$ ,  $\eta_p^2 = .05$ ; Shape X Threat,  $F(3, 249) = 8.29, p < .01$ ,  $\eta_p^2 = .09$ , GG- $\epsilon = .92$ ; and Time X Threat,  $F(3, 249) = 6.06, p < .01$ ,  $\eta_p^2 = .07$ , GG- $\epsilon = .71$ . In addition, the three-way interaction of Shape X Time X Threat achieved a trend,  $F(3, 249) = 2.30, p = .08$ ,  $\eta_p^2 = .03$ , GG- $\epsilon = .92$ . The predicted interaction of Group X Shape X Time X Threat was nonsignificant,  $F(3, 249) = .36, ns$ . None of the remaining interactions achieved significance (all  $ps > .1$ ).

Even though the 3-way Shape X Time X Threat interaction was at trend-level, we followed it up by examining the Shape X Threat interaction at each time point. The 2-way Shape X Threat interaction was significant at both Time 1 [ $F(3, 252) = 6.49, p < .01$ , GG- $\epsilon = .91$ ] and Time 2 [ $F(3, 252) = 3.76, p < .05$ , GG- $\epsilon = .94$ ]. We followed-up the Shape X Threat interactions by examining the effect of Shape on startle response during each level of threat at both Time 1 and 2. As reported above, Time 1 analyses indicated simple effects of shape during PS [ $F(1, 84) = 33.92, p < .01$ ] and PPS [ $F(1, 84) = 7.03, p < .01$ ] threat conditions, but not during NS or US threat conditions [ $ps > .40$ ]. Time 2 analyses indicated a simple effect of shape during the PS [ $F(1, 84) = 12.33, p < .01$ ] threat condition, but not during NS, US, or PPS threat conditions [ $ps > .20$ ]; participants exhibited greater startle during square relative to circle shapes during the PS

condition at Time 2. Together, these results suggested that participants responded to the threat manipulations and habituated to threat of shock over time.

### 1. Anxiety-Potentiated Startle

Given our a priori hypotheses regarding anxiety-potentiated startle, we next tested whether startle magnitude during circles (which represented no threat in NS and PS, unpredictable threat in US, and low threat in PPS conditions) varied as a function of Threat and Group over time. We conducted a repeated-measures ANOVA on startle magnitude when participants viewed the circle with Group as a between-groups factor and Threat and Time as repeated factors and obtained F-statistics using the omnibus error terms for each variable as divisors. Results indicated that anxiety-potentiated startle was impacted by a main effect of Threat,  $F(3, 249) = 23.17, p < .01, \text{GG-}\epsilon = .86, \eta_p^2 = .37$ . Contrary to hypotheses, pairwise comparisons indicated higher anxiety-potentiated startle during PPS relative to all other threat conditions; also, anxiety-potentiated startle during PS and US, which did not differ, was higher compared to NS ( $\text{NS} < \text{PS} = \text{US} < \text{PPS}$ ). Results also showed a main effect of Time,  $F(1, 83) = 25.89, p < .01, \eta_p^2 = .44$ , reflecting higher overall startle across all circles at time 1 compared to time 2. Contradicting expectations, there was no interaction of Threat X Time X Group,  $F(3, 249) = .68, ns$ ; remaining interactions were nonsignificant. Figure 2 depicts the main effects of Threat and Time on anxiety-potentiated startle.

### 2. Fear-Potentiated Startle

Despite the lack of significance of the Group X Time X Threat X Shape interaction in our omnibus analyses, we next conducted specific planned analyses to test our a priori hypotheses regarding the impact of Threat and Group on fear-potentiated startle response over time. We defined fear-potentiated startle as the increase in startle response from circle to

square shapes and calculated fear-potentiated startle values by subtracting startle during circles from startle during squares for each threat condition. We subjected this within-subjects difference in startle magnitude between response to circle and square cues to a repeated-measures ANOVA with Group as the between-groups factor and Time and Threat as repeated factors and calculated F-statistics using each variable's omnibus error term. As expected, results revealed a significant main effect of Threat,  $F(3, 249) = 4.68, p < .01, \text{GG-}\epsilon = .92, \eta_p^2 = .09$ . Pairwise comparisons of fear-potentiated startle across threat conditions indicated that fear-potentiated startle was significantly greater during the PS condition relative to the NS, US, and PPS conditions, which did not differ from each other ( $\text{NS} = \text{US} = \text{PPS} < \text{PS}$ ). As predicted, Group had no main or interaction effects on fear-potentiated startle (all  $p$ s for main and interaction effects involving Group  $> .15$ ), suggesting that the type of information participants received (Cognitive Strategies vs. Psycho-Education) did not influence fear-potential in the various Threat conditions. Figure 3 depicts the main effect of Threat on fear-potentiated startle. Of note, larger numbers represent a bigger difference between square and circle cues, such that people exhibited a larger startle in response to the square (which represented higher threat in the PS and PPS condition) relative to circle.

### **3. Moderating Effect of Gender**

When the moderating effects of gender were tested in the omnibus startle model, results showed only trend-level interactions of Time X Gender,  $F(1, 81) = 3.25, p = .08, \eta_p^2 = .04$ ; and Time X Threat X Gender,  $F(3, 243) = 2.77, p = .06, \eta_p^2 = .03$ . Based on the nonsignificant impact of gender on our omnibus results, we did not include it as a between-subjects variable in further analyses.

## **D. Tests of Subjective Aversive Responses**

### **1. Nervousness Ratings**

To examine the impact of our variables on reported nervousness, we conducted an omnibus repeated-measures ANOVA on nervousness ratings with Group as the between-subjects factor and Threat, Shape and Time as repeated factors. Results indicated the expected 4-way interaction of Time X Shape X Threat X Group,  $F(3, 246) = 13.23, p < .01, \eta_p^2 = .14, GG-\epsilon = .75$ . We followed up these results with anxiety and fear analyses as follows.

Anxiety-related nervousness ratings were analyzed in a repeated-measures ANOVA on nervousness ratings during circle cues with Group as the between-subjects factor and Threat and Time as repeated factors; omnibus error terms were used in calculating F-statistics. Results indicated a main effect of Time,  $F(1, 82) = 22.47, p < .01, \eta_p^2 = .38$ , such that participants reported higher nervousness at Time 1 compared to Time 2, and a main effect of Threat,  $F(3, 246) = 63.93, p < .01, \eta_p^2 = .58$ . Pairwise comparisons indicated that participants reported similarly low levels of nervousness during NS and PS circles relative to during PPS circle, which was also lower than during US circle (NS = PS < PPS < US). Main effects were qualified by a significant 3-way interaction of Time X Threat X Group,  $F(3, 246) = 7.12, p < .01, \eta_p^2 = .13$ .

Next, we examined the 2-way interaction of Time X Threat during circle cues for each group. Among participants in the Cognitive Strategies group, the 2-way Threat X Time interaction was significant,  $F(3, 126) = 18.74, p < .01, \eta_p^2 = .40, GG-\epsilon = .80$ ; but not for those in the Psycho-Education group,  $F(3, 120) = .86, ns$ . Consistent with our hypotheses, this suggested that the impact of threat condition on nervousness ratings across time differed for the two groups.

We followed-up the Threat X Time interaction in the Cognitive Strategies group by examining the effect of time on nervousness ratings during circles at each level of threat for

participants in the Cognitive Strategies group. These results indicated simple effects of Time during PPS [ $F(1, 42) = 10.35, p < .01$ ] and US [ $F(1, 42) = 35.08, p < .01$ ] circle, but no impact of Time on reported nervousness during the NS and PS circle ( $ps > .10$ ). In both PPS and US threat conditions, participants in the Cognitive Strategies group reported lower nervousness at Time 2 compared to Time 1. This suggests that participants who learned cognitive strategies to cope with uncertainty experienced lower subjective nervousness when faced with the possibility of uncued shock relative to those who did not learn strategies. The Time X Threat X Group interaction on anxiety-related nervousness ratings is depicted in Figure 4.

The fear-related increase in nervousness ratings from lower to higher threat was examined using a repeated-measures ANOVA on the difference in nervousness ratings from squares to circles with Group as the between-subjects factor and Threat and Time as repeated factors. Results showed main effects of Threat,  $F(3, 246) = 38.88, p < .01, \eta_p^2 = .60$ ; and Time,  $F(1, 82) = 9.85, p < .01, \eta_p^2 = .36$ ; that were qualified by a significant 3-way interaction of Threat X Time X Group,  $F(3, 246) = 9.88, p < .01, \eta_p^2 = .14$ . To follow-up this 3-way interaction, next, we examined the 2-way interaction of Time X Threat for each group. Among participants in the Cognitive Strategies group, the Time X Threat interaction was significant,  $F(3, 126) = 22.83, p < .01, \eta_p^2 = .41$ ; but not for those in the Psycho-Education group,  $F(3, 126) = .52, ns$ . Next, we examined the effect of time on fear-related nervousness at each level of threat for participants in the Cognitive Strategies group and found a simple effect of time during PS [ $F(1, 42) = 23.53, p < .01$ ], but no impact of time during NS, PPS or US ( $ps > .10$ ). In the PS threat condition, participants in the Cognitive Strategies group reported lower fear-related nervousness at Time 2 compared to Time 1. This suggests that participants felt less nervous in

the face of heightened threat after learning strategies to cope with uncertainty relative to before learning strategies.

## 2. Worry Ratings

Analyses of anxiety-related worry ratings during circle cues revealed a nearly identical pattern of results to results for nervousness ratings. Results for worry also showed a main effect of Threat,  $F(3, 249) = 57.33, p < .01, \eta_p^2 = .55, GG-\varepsilon = .63$ ; however, unlike the nervousness ratings, for worry ratings, pairwise comparisons indicated that worry during circle cues differed significantly across all threat conditions ( $NS < PS < PPS < US$ ). Remaining interactions were similar to those for nervousness ratings, suggesting that participants who learned cognitive strategies to cope with uncertainty experienced lower subjective worry when faced with possibility of uncued shock relative to those who did not learn cognitive strategies. The Time X Threat X Group interaction on anxiety-related worry ratings is depicted in Figure 5.

Analyses of fear-related worry ratings revealed nearly identical results for subjective worry as for subjective nervousness. However, when we examined the effect of time on fear-related worry ratings at each level of threat for participants in the Cognitive Strategies group, we found simple effects of time in both PPS [ $F(1, 42) = 4.55, p < .05$ ] and PS [ $F(1, 42) = 19.17, p < .01$ ], but no impact of time during NS and US ( $ps > .10$ ). In both PPS and PS threat conditions, participants in the Cognitive Strategies group reported lower fear-related worry at Time 2 compared to Time 1. This suggests that participants worried less in the face of heightened threat when they learned strategies to deal with uncertainty.

## 3. Positive/Negative Emotions Ratings

To examine the impact of Group and Time on self-reported positive and negative emotions across time (before and after the first block of the experiment, after the information



session, and after the second block of the experiment), we first conducted an omnibus repeated-measures ANOVA on positive emotions ratings with Group as the between-groups factor and Time as a repeated factor. As anticipated, results indicated a significant 2-way interaction of Time X Group on positive emotions ratings,  $F(3, 246) = 3.56, p < .02, \eta_p^2 = .04, GG-\epsilon = .83$ .

We followed up our 2-way interaction by examining the effect of Time on positive emotions ratings for each Group. Among participants in the Psycho-Education group, results indicated a main effect of Time,  $F(3, 123) = 11.17, p < .01$ . Pairwise comparisons of positive emotions at each time among participants in the Psycho-Education group indicated that Time 3 positive emotions (immediately after the information session) showed a trend for being higher compared to Time 1, and were significantly higher compared to Time 2 and Time 4; Time 1 positive emotions showed a trend for being higher compared to Time 2 and were significantly higher than Time 4; and Time 2 positive emotions were significantly higher compared to Time 4 ( $T4 < T2 < T1 < T3$ ). Among participants in the Cognitive Strategies group, results indicated a trend-level effect of Time,  $F(3, 123) = 2.60, p = .06$ . Even though it was only a trend, we followed up our effect by examining pairwise and found that positive emotions were higher at Time 1 compared to Time 2, but did not differ from Time 3 or Time 4; furthermore, Time 2, Time 3, and Time 4 positive emotions showed no differences from each other ( $T2 < T1; T1 = T3 = T4; T2 = T3 = T4$ ). In sum, both groups reported a decline in positive emotions over the first experimental block; however, whereas participants in the Psycho-Education group continued to report declines in positive emotions over the second experimental block, participants in the Cognitive Strategies group reported no further declines in positive emotions.

Next, we conducted an omnibus repeated-measures ANOVA on negative emotions ratings with Group as the between-groups factor and Time as a repeated factor. Results indicated

a trend-level 2-way interaction of Time X Group on negative emotions ratings,  $F(3, 249) = 2.63$ ,  $p = .06$ ,  $\eta_p^2 = .03$ , GG- $\varepsilon = .85$ .

Even though the interaction only showed a trend, we followed it up by examining the effect of Time on negative emotions ratings for each Group. Among participants in the Psycho-Education group, results indicated a main effect of Time on negative emotions,  $F(3, 123) = 6.58$ ,  $p < .01$ . Pairwise comparisons of negative emotions at each time among participants in the Psycho-Education group indicated that Time 3 negative emotions (immediately after the information session) were significantly lower compared to Time 1 and Time 2, and showed a trend for being lower compared to Time 4; Time 2 negative emotions were higher compared to Time 3 and Time 4; and Time 4 negative emotions did not differ from Time 1 ( $T1 = T2$ ;  $T1 = T4$ ;  $T2 < T4$ ;  $T3 < T1, T2, T4$ ). Among participants in the Cognitive Strategies group, results also indicated a main effect of time on negative emotions,  $F(3, 123) = 12.02$ ,  $p < .01$ .

Pairwise comparisons of negative emotions at each time among participants in the Cognitive Strategies group indicated that Time 3 negative emotions were lower compared to Time 1 and Time 2, which did not differ from each other, and Time 4 negative emotions were lower compared to Time 1, Time 2, and Time 3. ( $T4 < T3 < T2 = T1$ ). In sum, both groups reported lower negative emotions following the information session; however, participants in the Cognitive Strategies group reported further declines in negative emotions over the second experimental block, whereas participants in the Psycho-Education group reported increased negative emotions over the second experimental block.

## E. Tests of Aversive Responding to Degrees of Threat and Safety

### 1. Startle Response

To understand whether participants viewed cues signaling low threat as a relative safety signal or threat signal, we next tested whether participants' startle response differed during anticipation of no threat, low threat, and high threat. We conducted a repeated-measures ANOVA on startle magnitude during PS circle (i.e., no shock possible), PS square (i.e., high shock possible), PPS circle (i.e., low-shock possible) and PPS square (i.e., high-shock possible) with Group as the between-groups factor and Threat and Time as repeated factors. As expected, results indicated a main effect of Threat,  $F(3, 249) = 11.61, p < .01, \eta_p^2 = .12, GG-\epsilon = .89$ . Pairwise comparisons of startle magnitude during each threat condition indicated lower threat during PS-circle compared to PPS-circle, PS-square, and PPS-square, which did not differ from each other (PS-circle < PPS-circle = PS-square = PPS-square). Results also indicated a main effect of Time,  $F(1, 83) = 61.56, p < .01, \eta_p^2 = .43$ , with lower overall startle across shape and threat conditions at time 2 relative to time 1. Results also indicated a significant 2-way interaction of Threat X Time,  $F(3, 249) = 3.08, p < .05, \eta_p^2 = .04, GG-\epsilon = .70$ . There was no interaction of Threat X Time X Group,  $F(3, 249) = 1.56, ns$ , suggesting that group assignment had no impact on response to threat versus safety over time. No remaining effects were significant.

We followed up the 2-way Time X Threat interaction by examining the simple effects of Threat at each Time and used the Threat error from the previous analysis to calculate F-statistics. Results indicated simple effects of Threat at Time 1,  $F(3, 252) = 13.46, p < .01$ ; and at Time 2,  $F(3, 252) = 2.74, p < .05$ . In each case, startle was lower during PS-circle relative to PPS-circle, PS-square, and PPS-square, which did not differ from each other (PS-circle < PPS-circle = PS-

square = PPS-square). Together, these results suggested that participants exhibited differential startle response to threat versus no threat conditions, but did not exhibit differences between predictable low versus predictable high threat conditions. Furthermore, the differential startle response to threat versus no threat conditions (but not to low versus high threat) showed no changes over time. The Threat X Time interaction on startle response to degrees of threat is depicted in Figure 6.

## 2. Nervousness Ratings

Next, we examined the impact of low versus high threat on subjective nervousness and conducted a repeated-measures ANOVA on nervousness ratings during PS-circle (i.e., no shock possible), PS square (i.e., high shock possible), PPS circle (i.e., low-shock possible), and PPS-square (i.e., high shock possible) with Group as the between-groups factor and Threat and Time as repeated factors. Results indicated significant main effects of Time,  $F(1, 83) = 88.52, p < .01, \eta_p^2 = .52$ , with lower overall nervousness across shape and threat conditions at time 2 relative to time 1; Group,  $F(1, 83) = 9.93, p < .01, \eta_p^2 = .11$ , with the Cognitive Strategies group reporting lower nervousness across time and threat conditions relative to the Psycho-education group; and Threat,  $F(1, 249) = 125.36, p < .01, \eta_p^2 = .60$ . Pairwise comparisons of nervousness ratings across Threat conditions indicated lower nervousness ratings in PS-circle relative to PS-square, PPS-circle, and PPS-square; lower nervousness ratings in PPS-circle relative to PS-square and PPS-square; and lower nervousness ratings in PPS-square relative to PS-square (PS-circle < PPS-circle < PPS-square < PS-square). Results also indicated significant 2-way interactions of Time X Group,  $F(1, 83) = 39.77, p < .01, \eta_p^2 = .32$ ; Threat X Group,  $F(3, 249) = 4.98, p < .01, \eta_p^2 = .06$ ; and Threat X Time,  $F(3, 249) = 18.51, p < .01, \eta_p^2 = .18$ . Results were qualified by a 3-

way interaction of Time X Threat X Group,  $F(3, 249) = 10.24, p < .01, \eta_p^2 = .11$ .

Next, we examined the 2-way interaction of Time X Threat on nervousness ratings for each group. The Time X Threat interaction was significant for participants in the Cognitive Strategies group,  $F(1, 123) = 27.82, p < .01$ ; but not for those in the Psycho-education group,  $F(3, 123) = 1.60, ns$ . Among participants in the Cognitive Strategies group, the simple effect of Threat was significant at Time 1,  $F(3, 126) = 39.37, p < .01$ ; pairwise comparisons of Threat conditions at Time 1 indicated lower nervousness ratings during PS-circle relative to PPS-circle, PPS-square, and PS-square; lower nervousness ratings during PPS-circle relative to PPS-square and PS-square; and lower nervousness ratings during PPS-square relative to PS-square (PS-circle < PPS-circle < PPS-square < PS-square). Among participants in the Cognitive Strategies group the simple effect of Threat was also significant at Time 2,  $F(3, 126) = 3.21, p < .05$ . Nervousness ratings were lower during PS-circle compared to PPS-circle, which were both lower compared to PPS-square and PS-square, which did not differ from each other (PS-circle < PPS-circle < PPSsquare = PS-square). Results suggested that participants reported lower levels of nervousness during low threat compared to high threat, suggesting that low shock presented partial safety relative to high shock in terms of nervousness ratings and that nervousness ratings were sensitive to threat levels. The interaction of Time X Threat X Group on nervousness ratings to degrees of threat is depicted in Figure 7.

#### IV. DISCUSSION

Low tolerance for uncertainty has been posited as a central component of pathological anxiety (Boelen and Reijntjes, 2009; Dugas and Koerner, 2005; Grayson, 2010; Holaway et al., 2006; Lee, Orsillo, Roemer, & Allen, 2010), and improving tolerance for uncertainty has been associated with reduction in anxious symptomatology in numerous empirical trials (Dugas et al.,

2010; Ladouceur et al., 2000; Overton and Menzies, 2005). To better understand the mechanisms by which improving tolerance for uncertainty reduces anxiety symptoms, we investigated whether strategies to improve people's tolerance for uncertainty would decrease their immediate subjective and physiological anxiety responses relative to a control intervention during an anxiety-provoking situation. We hypothesized that providing people with these strategies would reduce their psychophysiological and subjective aversive responses specifically during threat conditions where shock was possible but not cued. The results of our study can be summarized as follows:

1. Subjective emotions ratings differed in the experimental group compared to the control group. Participants in the Cognitive Strategies group reported lower subjective negative emotions (i.e., worry, nervousness, and negative emotions ratings), and maintained subjective positive emotions (i.e., positive emotions ratings), relative to Psycho-education. Thus, learning strategies to improve tolerance for uncertainty contributed to participants reporting more adaptive emotions.
2. A psychophysiological indicator of aversive states (startle response) was not impacted by improved tolerance for uncertainty. Participants in the Cognitive Strategies group showed no differences in startle response from participants in the Psycho-education group. Thus, learning strategies to improve tolerance for uncertainty had no impact on startle potentiation in a situation in which shock was threatened.
3. The same startle response was elicited by mild- and high-threat conditions, both of which were elevated relative to a no-threat condition. Thus, startle response showed no differentiation between mild and high threat, suggesting that psychophysiological aversive responses show categorical differences between threat and no-threat conditions.

On the other hand, participants reported lower nervousness during no-threat relative to mild-threat conditions, and lower nervousness during mild-threat relative to high-threat conditions. Thus, subjective emotions ratings differentiated between levels of threat, suggesting that emotions ratings show dimensional differences among threat conditions.

#### **A. Self-Reported Aversive Emotions**

Our study found that a brief information session providing strategies on coping with uncertainty and improving tolerance for uncertainty was capable of reducing subjective aversive emotions relative to neutral information about anxiety (a plausible placebo condition) during an anxiety-provoking task. After receiving only 15 minutes of cognitive strategies emphasizing accepting uncertainty, participants retrospectively reported lower nervousness, worry, and negative emotions, as well as consistent levels of positive emotions, when they were exposed to the threat of unpredictable shock. This effect suggests that even very brief interventions may be effective at helping people cope with stressful situations (Siegel and Weinberger, 2009) and report more adaptive emotions (Searle et al., 2011).

Subjective emotions showed similar patterns across multiple indices of self-reported emotions, suggesting that group effects on emotions ratings were reliable (Sloan and Kring, 2007). Our choice of self-report emotions measures enabled us to examine different aspects of aversive emotions during the experiment: whereas nervousness and worry ratings enabled us to compare specific negative emotions during each threat condition, PANAS ratings enabled us to compare global emotions at various times during the experiment. Furthermore, our emotions ratings measures tapped participant emotions at different points in the experiment. Nervousness and worry ratings reflected retrospective emotions, but PANAS ratings reflected current

emotions. Thus, collecting two indices of self-reported emotions strengthened our findings that groups differed in subjective emotions.

For nervousness and worry ratings, comparison of self-reported nervousness and worry across time for each threat condition indicated the effect of the information session on self-reported emotions. Nervousness and worry declined over time during PPS and US conditions for the Cognitive Strategies group, but not for the Psycho-Education group, suggesting that improved tolerance for uncertainty helped to reduce subjective nervousness and worry.

For analyses with PANAS ratings, comparison of Time 2 and Time 3 ratings indicated the effect of the information session, whereas comparison of Time 3 and Time 4 indicated the effect of the second block of the experiment on positive and negative emotions. PANAS positive emotions remained the same across Time 2, 3 and 4 for the Cognitive Strategies group, but increased from Time 2 to 3 and decreased from Time 3 to 4 for the Psycho-Education group. PANAS negative emotions decreased from Time 2 to 3 and again from Time 3 to 4 for the Cognitive Strategies group, but decreased from Time 2 to 3 and increased from Time 3 to 4 for the Psycho-Education group. Thus, nervousness, worry, and PANAS positive and negative emotions ratings analyses indicated more adaptive emotions among participants in the Cognitive Strategies relative to the Psycho-Education group.

Our use of a plausible control condition enabled us to control for both passage of time and nonspecific therapeutic effects and made it possible to attribute the emotions ratings results to the information content provided to participants (Kendall et al., 2004; Parloff, 1986). Moreover, our use of an active control group engenders greater confidence that differences in emotions ratings were due to the specific information and strategies provided to the experimental group than if we used a placebo-attention control (Horvath, 1986; Kazdin, 1986). The findings



presented here suggested that cognitive strategies to improve tolerance for uncertainty were efficacious and specific (Chambless and Hollon, 1998) in promoting adaptive emotions among participants. In addition, using an active control condition may suggest greater generalizability of our findings and effectiveness of our experimental strategies in real-world settings (Clarke, 1995), as psycho-education offers a real-world, realistic alternative to cognitive therapy. In sum, our choice of control group strengthens our claim that cognitive strategies to improve tolerance for uncertainty positively impacted subjective emotions.

#### **B. Anxiety-Potentiated Startle Response**

We defined anxiety-potentiated startle as startle response during periods of lower threat signaled by circles; startle response during these non-threat or low-threat cues was thought to reflect anxiety potentiation to threatening features of the experimental situation and not to immediate threat of shock (Grillon et al., 2004). We expected to find a 3-way interaction of Threat X Time X Group on anxiety-potentiated startle indicating that the Cognitive Strategies group showed reduced psychophysiological aversive responding during unpredictable shock threat condition at time 2 relative to time 1. Our finding that increased tolerance for uncertainty had no impact on anxiety-potentiated startle contradicted expectations.

It is possible that anxiety-potentiated startle did not respond to our cognitive-therapy analogue because the information session was simply too brief. Longer-duration psychotherapy may be needed for people to exhibit changes in psychophysiological responding. Some research suggests that longer-duration cognitive-behavioral interventions may produce physiological changes among patients. For example, a recent study of the impact of cognitive-behavioral therapy on heart rate variability showed that female rape victims showed a decrease in heart rate variability following successful treatment for PTSD (Nishith et al., 2003), which consisted of a

complete Prolonged-Exposure or Cognitive-Processing Therapy treatment protocol (i.e., usually 10-12 hour-long weekly sessions). Similarly, a recent study found that a 10-week cognitive-behavioral stress management intervention was able to produce adaptive physiological changes, including lower cortisol, among women undergoing treatment for breast cancer (Antoni et al., 2009). Perhaps using an active intervention with longer duration would elicit changes in anxiety-potentiated startle response.

The adaptive impact of our cognitive-based intervention on subjective ratings may suggest a reason to be hopeful that the cognitive strategies would produce adaptive change in other aspects of emotional responding (Sloan and Kring, 2007), including physiological aversiveness, given additional time. Moreover, startle response is certainly not the only index of anxiety-related physiological reactivity. To ascertain whether improved tolerance for uncertainty impacts physiological aspects of anxiety, future studies may wish to include additional measures psychophysiological dependent variables, such as skin conductance, heart rate, EEG, and fMRI.

However, it is also possible that we did not find significant group effects on anxiety-potentiated startle because startle is not an action mechanism impacted by our cognitive behavioral approach (Zinbarg et al., 2010). Research suggests that aversive motivation consists of multiple response systems (Lang et al., 1998; Mineka & Zinbarg, 2006), including physiological, cognitive and behavioral responses. Whereas some have suggested that emotions systems are functionally related (Ekman, 1992; Levenson, 1994) and present a coherent set of responses (Dolan, 2002), others argue that emotions systems may not cohere (Mauss et al., 2005; Mauss and Robinson, 2009). Changes in emotions may be reflected in some methodologies and not others, making it worthwhile to include more than one dependent variable (Sloan and Kring, 2007). Thus, it is possible that participants' improved tolerance for uncertainty was evidenced by

their subjective emotions report, but not their startle response, because cognitive strategies did not affect impact their psychophysiological responding during our task. However, contradicting this idea, some studies have found changes in psychophysiological arousal measures as a result of cognitive therapy (Galovski et al., 2003; Lundgren et al., 2006).

Our discrepant results for psychophysiological and subjective aversive responses suggests that psychophysiological and experiential domains of aversive emotions compose distinct response systems that do not necessarily follow similar patterns of excitation or reduction. Numerous studies have reported a discrepancy between self-report and psychophysiological indices of anxiety (Grillon et al., 2007, 2008, 2009; Harmer et al., 2003). Thus, it is not unusual to find discrepancies between these two response modalities.

Anxiety-potentiated startle response may have been impacted in the present study if our treatment had included a behavioral element that is often used in treating anxiety related to specific stressors. Substantial research supports the effectiveness of behavioral techniques, such as exposure and response prevention, at treating disordered anxiety (Barlow et al., 1989; Foa et al., 2005; Siev and Chambless, 2007). Exposure and response prevention has two components: exposure, which involves deliberately approaching feared situations, places, objects or people that had previously been avoided; and prevention, which involves stopping or preventing safety or avoidance behaviors. It is thought that exposure is effective because the technique activates patients' idiosyncratic, pathological fear structures (Foa and Kozak, 1986) and, during exposure exercises, patients learn that they can handle their anxiety, and they incorporate changes into their fear structures (Foa and Rauch, 2004; Hembree et al., 2003; Rauch and Foa, 2006).

In the present experiment, cognitive strategies focused on accepting uncertainty, but did not address avoidance, activate fear structures or facilitate participants' incorporating new

learning into their fear structures. Furthermore, it would not have been possible to include a behavioral exposure technique in our experiment, as our participants were not seeking treatment and, therefore, we were not able to identify idiographic, feared situations to use during exposure exercises. If the absence of group effects on psychophysiological indices of anxiety was due to the absence of behavioral techniques in our intervention, this would support the hypothesis that separate response mechanisms are involved in anxiety reduction: whereas subjective anxiety may be reduced cognitively, physiological anxiety may be reduced behaviorally.

### **C. Fear-Potentiated Startle Response**

Our finding of a significant Threat X Shape interaction on startle response at Time 1 was consistent with previous research finding fear-potentiated startle during predictable shock conditions (Grillon et al., 2004, 2006, 2007, 2008, 2009). Participants exhibited higher startle during squares compared to circles during PS and PPS threat conditions because the possibility of higher threat signaled by the squares elicited a fear response. NS and US threat conditions failed to elicit an amplification in startle response during square compared to circles because no difference in threat level was signaled by the shapes in these two conditions.

### **D. Differentiating Degrees of Threat versus Safety**

A secondary aim of our study was to determine whether people would exhibit differential aversive responses to lower versus higher levels of threat. In particular, we wondered whether participants would view the low threat designated by PPS-circle as a relative safety signal compared to the high threat of the PS-square or PPS-square threat conditions. If participants exhibited lower startle and negative emotion ratings during PPS-circle relative to PS-square and PPS-square, this would suggest that low threat represented partial safety and that there was a continuum of participants' aversive responses. On the other hand, if participants exhibited

similar startle and negative emotion ratings during PPS-circle cue, PS-square, and PPS-square conditions, this would suggest that threat was categorical and participants responded similarly to high and low levels of threat.

Similar to the analyses for group effects, analyses of threat-level responses revealed differences across subjective and psychophysiological data. Participants' nervousness ratings during PPS-circle were in-between no threat (PS-circle) and high threat conditions (PPS-square and PS-square), suggesting a continuum of subjective aversive responses that was differentiated by degrees of threat and safety. On the other hand, participants exhibited similar startle response during PPS-circle as during PS-square and PPS-square conditions, suggesting that threat, regardless of degree, potentiated startle.

Participants' lower nervousness ratings when low shock was possible compared to when high shock was possible suggested that they felt safer during these periods. Furthermore, these results suggested that people differentiated levels of threat versus safety in their subjective emotion report, and found lower threat relatively safe compared to higher threat. Thus, participants did not require absence of threat to report more adaptive emotions compared to higher threat.

It is worth noting that our emotions ratings were retrospective and, as such, may have been influenced by the participants' understanding of the experimenter's expectations; generalized beliefs about the situation; or memorable aspects of the experiment, such as the information session (Kahneman, 1999; Robinson and Clore, 2002; Whitehouse et al., 2002). Whereas it is possible that participants' emotions ratings reflected demand characteristics or inaccurate memories of their emotions, participants still identified and differentiated levels of

threat in their self-report. Thus, self-reported emotion was sensitive to degrees of threat and reflected threat as a dimensional construct.

On the other hand, physiological aversive responses suggested no differences between levels of threat. Participants responded to low threat with the same physiological aversive responding as they did to high threat, suggesting that any level of threat elevated physiological aversiveness, even if the threat amount was low.

The safety signal and information hypotheses may offer some insight into our findings. The safety signal hypothesis suggests that animals prefer predictable to unpredictable threat conditions due to signaled safe periods when shock is not possible (e.g., not because of the reduced aversiveness of the predictable shock). During these safe periods, the animal can reduce vigilance and relax (Seligman, 1968; Seligman and Meyer, 1970). During unpredictable shock conditions, the animal remains in chronic fear because there are no known safe periods. Our finding of reduced aversive subjective emotions during periods of lower threat suggested that participants perceived the reduced threat as relatively safe, which enabled them to reduce negative affect. On the other hand, the safety signal hypothesis may also explain why startle response remained elevated under threat of low shock in the PPS condition: even threat of low shock presented some danger. In this view, startle responses during PPS were similar to startle responses during US because shock was possible, and safety was not absolute.

By contrast, the information hypothesis (Berlyne, 1960; D'Amato, 1974; Imada and Nageishi, 1982) focuses on the animal's preference for information about the possibility of aversiveness. Our finding that participants reported lower subjective nervousness during low shock conditions supported the information hypothesis, because it appeared that participants' information about the degree of threat influenced their subjective emotions. On the other hand,

the information hypothesis was not supported by the finding that participants exhibited similar startle across low and high threat conditions; startle response was not impacted by information about the shock, which may have been thought to reduce startle reactivity.

In our anxiety-potentiated startle analyses, participants' higher startle response during the PPS-circle compared to US-circle condition suggested higher physiological aversive responding when low shock was possible compared to when high shock was possible. On the surface, these results seem paradoxical, as threat was lower during the PPS circle compared to the US circle. However, it is possible that participants responded not only to the possibility of low shock during the circle cue of the PPS condition, but also to the proximity of possible high shock during the square cue of the PPS condition. Given the sequence of cues and conditions in our experimental design, when participants viewed a circle in the PPS condition, they knew they would see a square (which indicated a high shock) in just a few seconds. Thus, it is possible that heightened startle during the circle cue of PPS relative to US represented *cumulative* aversive responding from possible low shock and impending possibility of high shock. These results are supported by the observation that startle was higher during PS relative to NS circle cues, even though no shock was possible during either cue. Our findings may suggest that physiological aversive responding during threat conditions is additive and represents an accumulation of aversive motivation due to the number and sequence of anxiety-provoking events. However, the present results should be replicated before conclusions are generalized.

Whereas numerous studies have found increased startle during anticipation of impending threat (Grillon et al., 2004; Naliboff et al., 2008), research is limited on the impact of additive threat on startle reactivity. As an analogue to studying the impact of multiple aversive events, the study of multiple traumas on psychopathology indicates that the experience of multiple traumatic

events is associated with higher rates of depression and PTSD, but not anxiety (Suliman et al., 2009). Although not directly related, our results appear to contradict these findings in that physiological anxiety was heightened among our participants when two aversive events close together in time were possible.

#### **E. Strengths and Weaknesses of the Present Study**

The present study had several strengths. First, the sample ( $N=85$ ) was sufficiently large to afford us statistical power to examine the independent and interactive effects of Group and Threat. Second, we used a plausible placebo condition for our control condition, making our findings for differences in self-reported emotions ratings between experimental and control groups more convincing (Kendall et al., 2004). Third, we counterbalanced shape color during higher threat conditions, so we could rule out the possibility that participants' aversive responses were influenced by color. Fourth, therapist fidelity to each group's information-session protocol was assessed and found to be satisfactory. Thus, we were able to ensure that our nonspecific intervention factors were similar across groups and that interventions contained distinct content.

The study had several limitations as well. First, we obtained subjective emotions ratings for each experimental condition at the end of each experimental block rather than during the experiment. Thus, these results may have been susceptible to retrospective biases (Robinson and Clore, 2002). However, even emotion ratings obtained 'online' during the experiment may have been subject to demand effects. Second, participant ratings may have been influenced by their interpretations of the experimenter's expectations for their reduced anxiety and more adaptive emotions. Whereas we attempted to make nonspecific intervention factors, such as therapist enthusiasm, equivalent across groups, it is still possible that the experimenter inadvertently gave participants cues about appropriate emotions ratings. To address this concern, experimenters may



wish to obfuscate their objectives in future studies by lengthening the amount of time between the information session and the questionnaire, or by limiting the shared language (i.e., “worry”) between the questionnaires and the information session (Zizzo, 2010). Third, since the person delivering the information session was familiar with the experiment’s hypotheses, it is possible that experimenter bias influenced the results because the experimenter inadvertently manipulated the experiment in favor of hypotheses. However, the experiment was highly scripted and the text for each information session was written out and followed; thus, it is unlikely that the experimenter inadvertently changed aspects of the experiment in favor of hypotheses. Fourth, two facets of the present experiment may limit generalizability to the population at large: our sample was restricted to college-aged students, and the information sessions were all provided by only one person (E.J.R.A.). Future studies with a broader age and demographic range of participants and additional providers are needed.

We neglected to control for three factors during our information sessions that may have impacted results. First, we did not obtain a measure of expectancy from participants; thus, we are unable to rule out the possibility that results were due to participants’ greater expectations for the helpfulness of the Cognitive Strategies compared to Psycho-education. However, the participants were not seeking therapy and the information session was not focused on their own problems or concerns; thus, their expectations for the helpfulness of the information was not as relevant as it would be for a clinical intervention. Second, we did not include a suggestion for something that may be helpful to participants in both groups. Whereas the Cognitive Strategies group received a suggestion for something that may help them to reduce anxiety, the Psycho-education group received no suggestion at all. Thus, merely receiving a suggestion may have influenced the results. Of note, our psycho-education information session was a control condition, but it was not

necessarily a placebo condition, as our participants were not seeking therapy and our experimental information session was not intended as an intervention. Nevertheless, to control for the impact of receiving a suggestion, future studies that include a suggestion to both groups (i.e., “you may find this information helpful”) would be useful. Third, the Cognitive Strategies information was approximately one minute longer on average than the Psycho-Education information. Thus, it is possible that the additional time in the Cognitive Strategies information session contributed to group differences in emotions ratings. To rule out this possibility, future studies should make the duration of each information session approximately equivalent.

#### **F. Clinical Implications**

The strength of our brief, strategic information session in reducing subjective nervousness and worry suggests that brief interventions focused on improving tolerance for uncertainty may be valuable in clinical settings. In particular, such an intervention may be helpful for patients on clinic waitlists who present with symptoms of anxiety. Despite clinicians’ best efforts to provide patients with rapid access to mental health care, many clinics find themselves with more people seeking treatment than available treatment providers. Providing patients with brief cognitive interventions focused on improving tolerance for uncertainty may ease patients’ anxiety symptoms while they are waiting for an available clinician. Moreover, patients who are told that they must wait for treatment may feel more cared for if their intake clinician provides them with strategies to help them cope with their difficulties with anxiety.

#### **G. Future Directions for Research**

In the future, we plan to examine whether there were differences in response to our Cognitive Strategies information session among groups of participants who reported high versus low levels of worry, anxiety, and intolerance for uncertainty. We are interested in finding

whether participants with higher subjective worry, anxiety symptoms, and/or intolerance for uncertainty show a different pattern of anxiety-potentiated startle and emotions ratings results compared to participants with lower subjective worry, anxiety symptoms, and intolerance for uncertainty. For example, if participants in the Cognitive Strategies group who reported elevated intolerance for uncertainty exhibited lower Time 2 anxiety-potentiated startle relative to those with lower intolerance for uncertainty, this may indicate that Cognitive Strategies are more helpful for those with greater intolerance for uncertainty. Furthermore, we may find different levels of coherence between subjective and psychophysiological response among those with higher versus lower subjective symptoms of anxiety, worry, or intolerance for uncertainty. To investigate these questions, we will conduct moderator analyses based on participants' responses to the IDAS, PSWQ, IUS, and GTS questionnaires

## **H. Summary**

In summary, we found that cognitive strategies to improve tolerance for uncertainty had no immediate effect on psychophysiological anxious responding during threat of predictable, unpredictable, or predictable partial shock; however, cognitive strategies were effective at reducing subjective nervousness and worry during threat of predictable, unpredictable and predictable partial shock. Moreover, participants reported immediate relief from aversive emotions when they received cognitive strategies to improve tolerance for uncertainty. The present results suggest that even a brief presentation of cognitive strategies to improve tolerance for uncertainty could benefit people with elevated anxiety by promoting more adaptive emotions. It is possible that longer duration psychotherapy using exposure techniques and opportunities to incorporate new information into existing fear structures may be necessary to promote additional changes in psychophysiological indices of anxiety. Future studies examining the impact of

longer duration cognitive-behavioral psychotherapy with exposure techniques on various measures of psychophysiological arousal are necessary to clarify the mechanisms by which CBT techniques reduce anxiety.

## ENDNOTE

<sup>1</sup>Due to equipment malfunction, a substantial minority of participants ( $N = 31$ ) received up to 7 more shocks (and 7 fewer startle probes) during the US condition per recording block than originally written into the experiment design (of note: the shocks never violated the rules of the conditions – i.e., never a shock during the NS condition, etc.). To test whether these participants exhibited early habituation to threat of shock and/or differential response to the task, we conducted independent t-tests comparing participants receiving 10 shocks per block (as planned) to those receiving 17 shocks per block on all measures of startle magnitude. Results indicated no group differences (all  $ps > .13$ ), suggesting that receiving more shocks did not lead to premature habituation or differential response to the task. Additionally, a one-way ANOVA of Time 1 number of shocks on 4 separate shock ratings (including how intense, how anxiety-provoking, and how annoying were the shocks, and to what degree would you avoid experiencing the shock again) did not yield any differences ( $ps > .30$ ), suggesting that groups did not differ in their perception of the shocks.


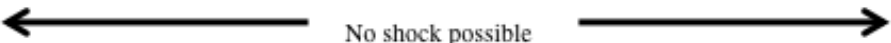
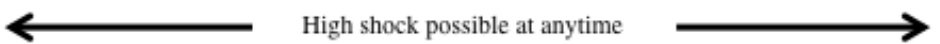
								
NS	●	■	●	■	●	■	●	■
								
PS	●	■	●	■	●	■	●	■
	No Shock	High Shock Possible	No Shock	High Shock Possible	No Shock	High Shock Possible	No Shock	High Shock Possible
US	●	■	●	■	●	■	●	■
								
PPS	●	■	●	■	●	■	●	■
	Low Shock Possible	High Shock Possible	Low Shock Possible	High Shock Possible	Low Shock Possible	High Shock Possible	Low Shock Possible	High Shock Possible

Figure 1. Meanings of circle and square cues in each type of threat condition: Predictable safety (PS), Total safety (TS), Predictable partial safety (PPS), and No safety (NS).

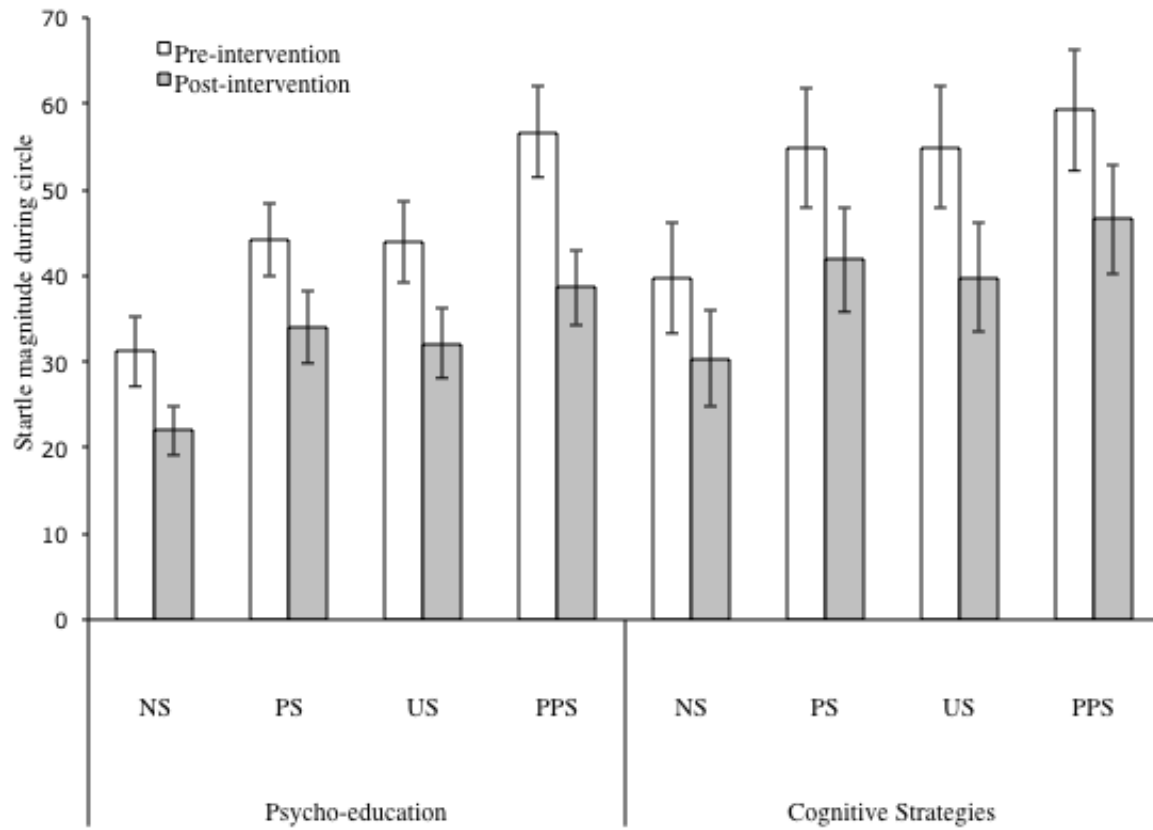


Figure 2. Anxiety-potentiated startle magnitude as a function of threat condition, time, and group (startle during Circle cues;  $N = 85$ ).

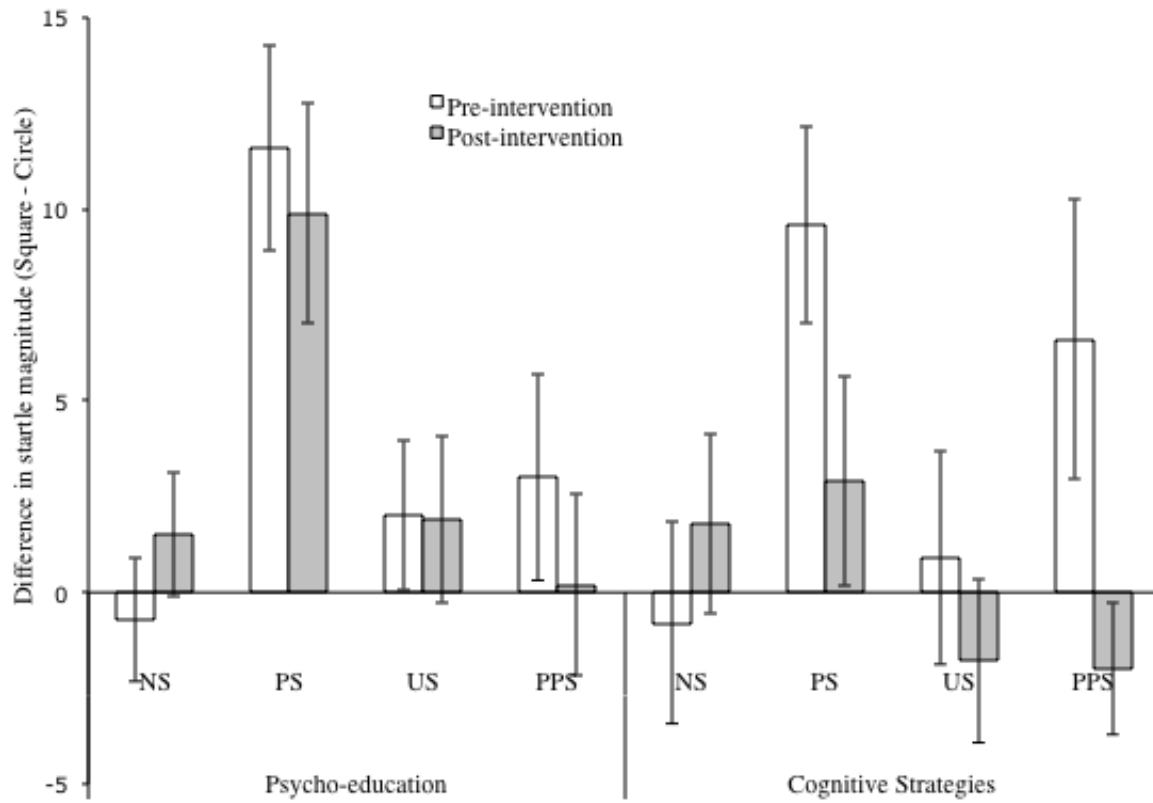


Figure 3. Fear-potentiated startle magnitude as a function of threat condition, time, and group (difference in startle during Square – Circle cues;  $N = 85$ ).



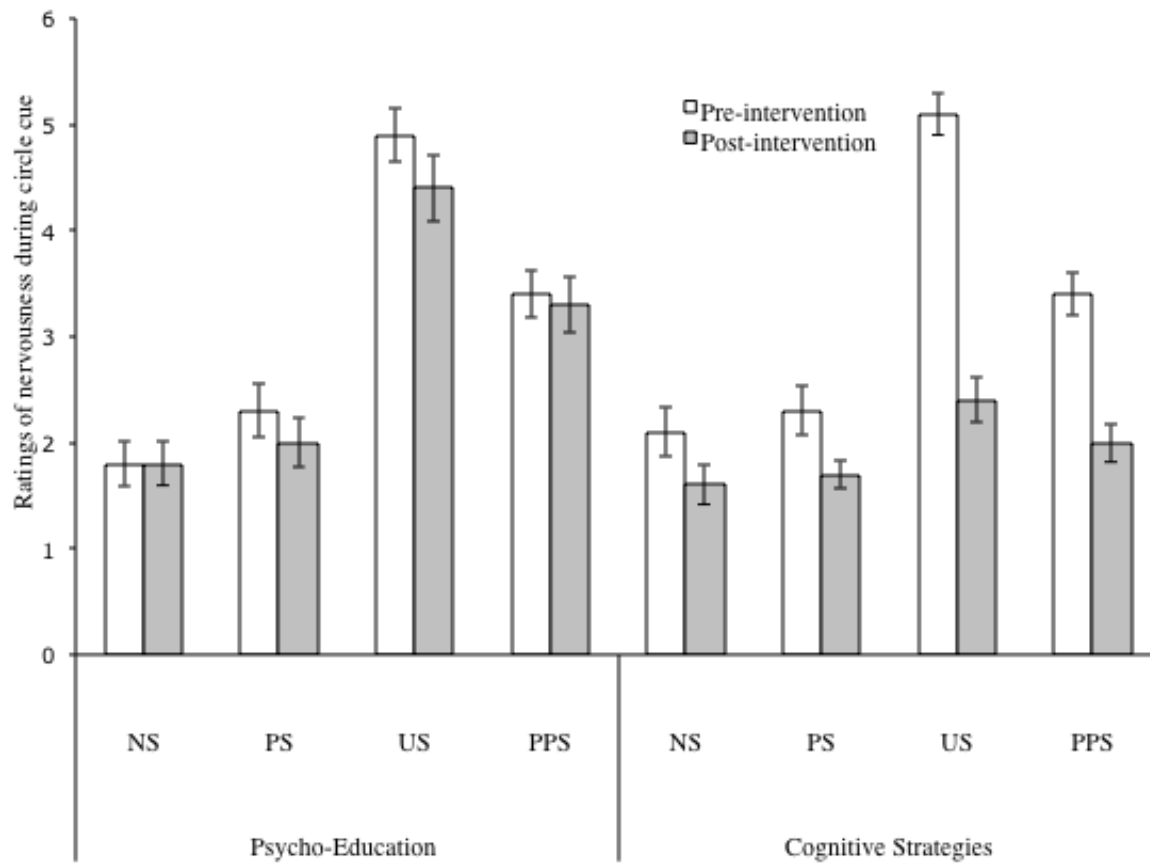


Figure 4. Anxiety-related subjective nervousness ratings as a function of threat condition, time, and group (nervousness ratings during circle cues;  $N = 85$ ).

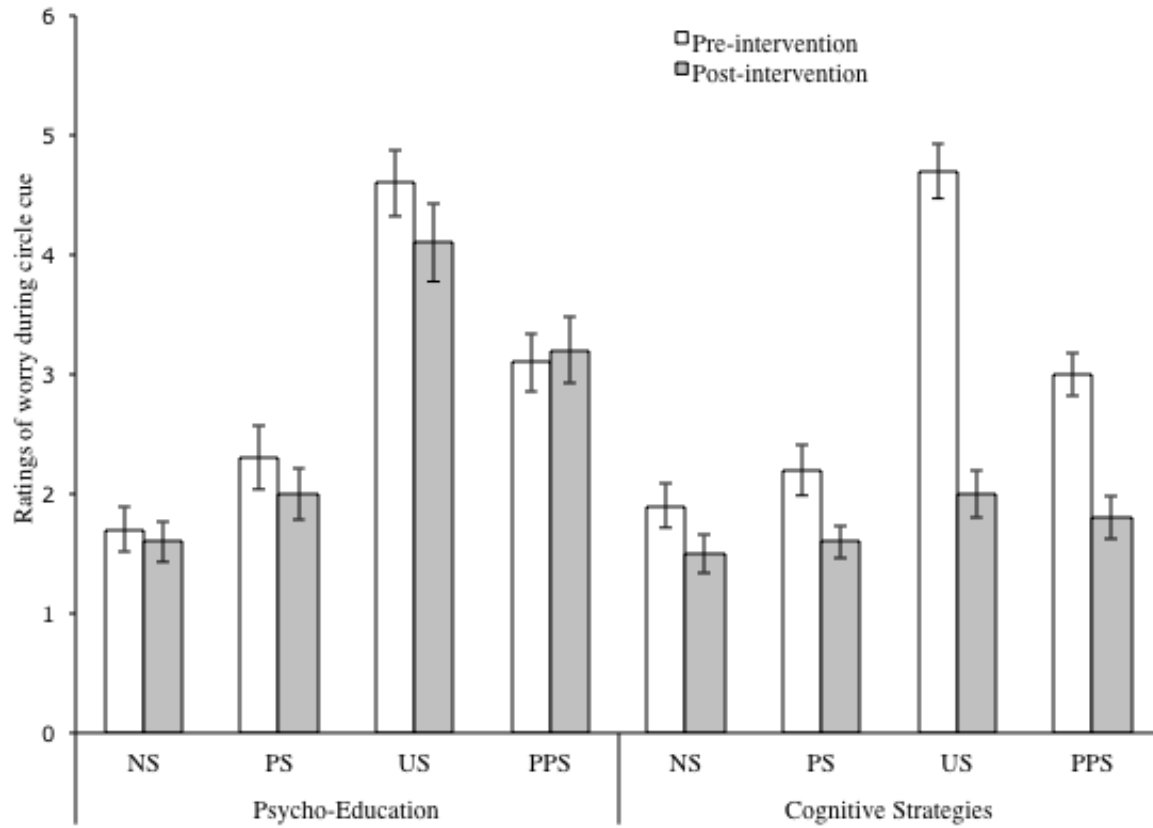


Figure 5. Anxiety-related subjective worry ratings as a function of threat condition, time, and group (worry ratings during circle cues;  $N = 85$ ).

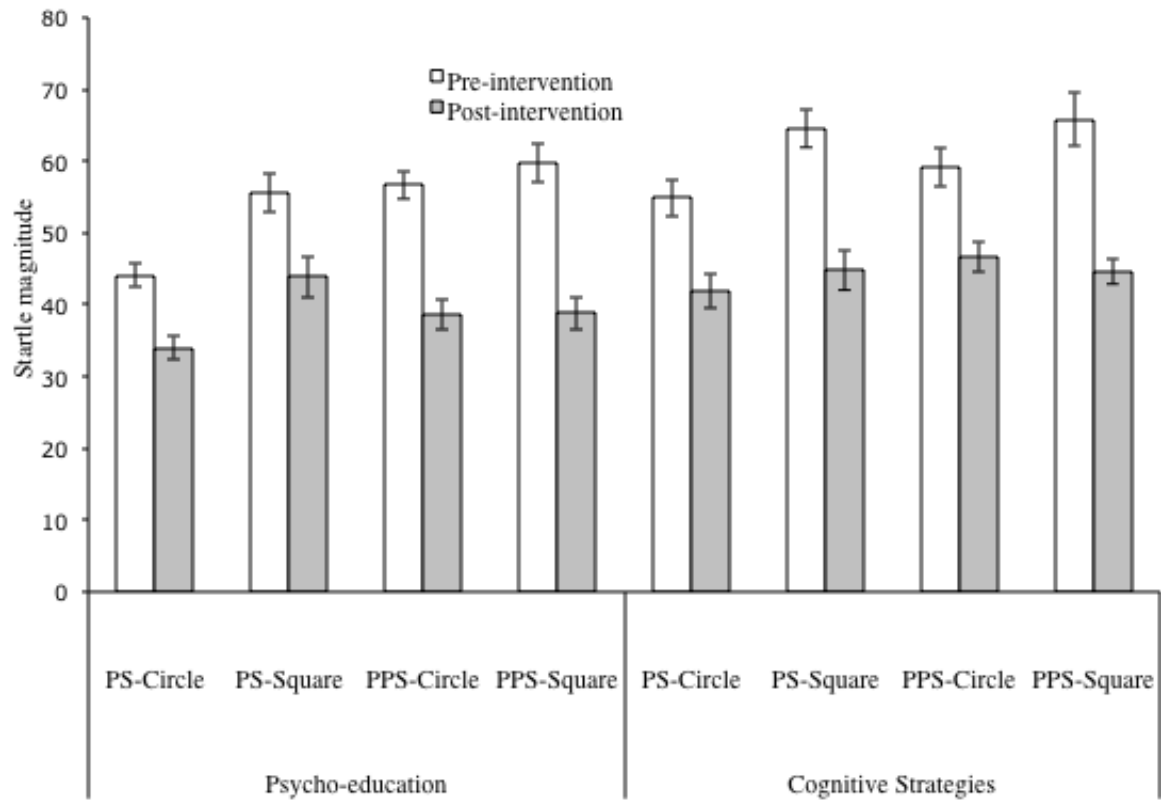


Figure 6. Startle magnitude response to degrees of threat as a function of threat, time, and group ( $N = 85$ ).

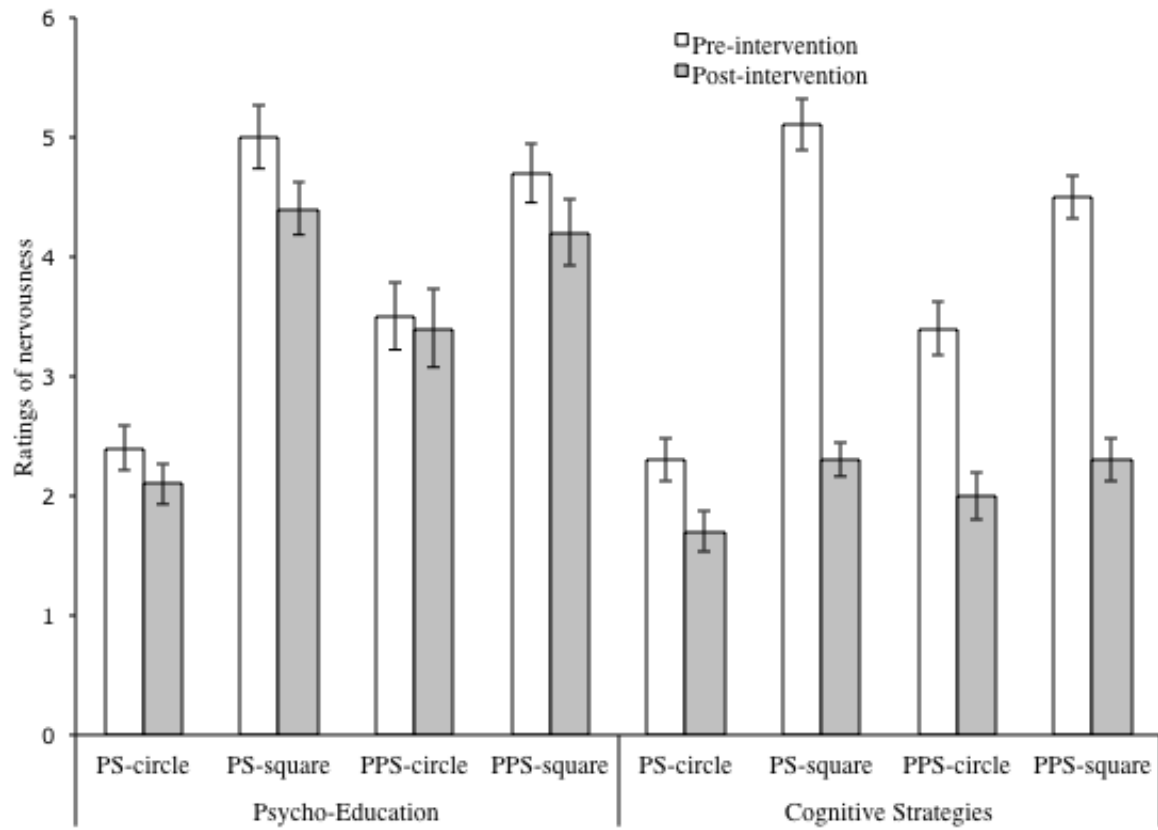


Figure 7. Nervousness ratings to degrees of threat as a function of threat, time, and group ( $N = 85$ ).

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## APPENDIX A

### A. Participant Questionnaires

#### Inventory of Depression and Anxiety Symptoms (IDAS)

Below is a list of feelings, sensations, problems, and experiences that people sometimes have. Read each item to determine how well it describes your recent feelings and experiences. Then select the option that best describes **how much** you have felt or experienced things this way **during the past two weeks, including today**. Use this scale when answering:

1 Not at all	2 A little bit	3 Moderately	4 Quite a bit	5 Extremely
_____ 1. I was proud of myself			_____ 21. I felt optimistic	
_____ 2. I felt exhausted			_____ 22. I ate more than usual	
_____ 3. I felt depressed			_____ 23. I felt that I had accomplished a lot	
_____ 4. I felt inadequate			_____ 24. I looked forward to things with enjoyment	
_____ 5. I slept less than usual			_____ 25. I was furious	
_____ 6. I felt fidgety, restless			_____ 26. I felt hopeful about the future	
_____ 7. I had thoughts of suicide			_____ 27. I felt that I had a lot to look forward to	
_____ 8. I slept more than usual			_____ 28. I felt like breaking things	
_____ 9. I hurt myself purposely			_____ 29. I had disturbing thoughts of something bad that happened to me	
_____ 10. I slept very poorly			_____ 30. Little things made me mad	
_____ 11. I blamed myself for things			_____ 31. I felt enraged	
_____ 12. I had trouble falling asleep			_____ 32. I had nightmares that reminded me of something bad that happened	
_____ 13. I felt discouraged about things			_____ 33. I lost my temper and yelled at people	
_____ 14. I thought about my own death			_____ 34. I felt like I had a lot of interesting things to do	
_____ 15. I thought about hurting myself			_____ 35. I felt like I had a lot of energy	
_____ 16. I did not have much of an appetite			_____ 36. I had memories of something scary that happened	
_____ 17. I felt like eating less than usual			_____ 37. I felt self-conscious knowing that others were watching me	
_____ 18. I thought a lot about food				
_____ 19. I did not feel much like eating				
_____ 20. I ate when I wasn't hungry				

## APPENDIX A (continued)

## IDAS – 2

1 Not at all	2 A little bit	3 Moderately	4 Quite a bit	5 Extremely
_____ 38. I felt a pain in my chest				_____ 51. I found myself worrying all the time
_____ 39. I was worried about embarrassing myself socially				_____ 52. I woke up frequently during the night
_____ 40. I felt dizzy or light headed				_____ 53. It took a lot of effort for me to get going
_____ 41. I cut or burned myself on purpose				_____ 54. I woke up much earlier than usual
_____ 42. I had little interest in my usual hobbies or activities				_____ 55. I was trembling or shaking
_____ 43. I thought that the world would be better off without me				_____ 56. I became anxious in a crowded public setting
_____ 44. I felt much worse in the morning than later in the day				_____ 57. I felt faint
_____ 45. I felt drowsy, sleepy				_____ 58. I found it difficult to make eye contact with people
_____ 46. I woke up early and could not get back to sleep				_____ 59. My heart was racing or pounding
_____ 47. I had trouble concentrating				_____ 60. I got upset thinking about something bad that happened
_____ 48. I had trouble making up my mind				_____ 61. I found it difficult to talk with people I did not know well
_____ 49. I talked more slowly than usual				_____ 62. I had a very dry mouth
_____ 50. I had trouble waking up in the morning				_____ 63. I was short of breath
				_____ 64. I felt like I was choking

## APPENDIX A (continued)

ID # \_\_\_\_\_

**General Temperament Survey**

Listed below are a series of statements a person might use to describe his/her attitudes, feelings, interests, and other characteristics. Read each statement and decide how well it describes you. If the statement is TRUE or MOSTLY TRUE, fill in the circle in the first column (under the T) in front of that item. If it is FALSE or MOSTLY FALSE, fill in the circle in the second column (under the F). There are no right or wrong answers, and no trick questions.

Please answer every statement, even if you are not completely sure of your answer. Read each statement carefully, but don't spend too much time deciding on the answer.

T   F

- ☐ ☐ 1. I am able to approach tasks in such a way that they become interesting or fun.
- ☐ ☐ 2. I sometimes rush from one activity to another without stopping to rest.
- ☐ ☐ 3. I don't keep particularly close track of where my money goes.
- ☐ ☐ 4. I often have strong feelings such as anxiety or anger without really knowing why.
- ☐ ☐ 5. I lead an active life.
- ☐ ☐ 6. I will make almost any excuse to goof off instead of work.
- ☐ ☐ 7. I sometimes gets too upset by minor setbacks.
- ☐ ☐ 8. My good mood sometimes changes (for example, from happy to sad, or vice versa) without good reason.
- ☐ ☐ 9. I often stop in the middle of one activity to start another one.
- ☐ ☐ 10. Sometimes I feel "on edge" all day.
- ☐ ☐ 11. I lead a very interesting life.
- ☐ ☐ 12. I frequently find myself worrying about things.
- ☐ ☐ 13. If I had to choose, I would prefer having to sit through a long concert of music I dislike to being in a bank during an armed robbery.
- ☐ ☐ 14. My anger frequently gets the better of me.
- ☐ ☐ 15. I get excited when I think about the future.
- ☐ ☐ 16. Before making a decision I carefully considers all sides of the issue.
- ☐ ☐ 17. People would describe me as a pretty enthusiastic person.

## APPENDIX A (continued)

T F

- O O 18. I can easily find ways to liven up a dull day.
- O O 19. I believe in playing strictly by the rules.
- O O 20. Small annoyances often irritate me.
- O O 21. Sometimes I suddenly feel scared for no good reason.
- O O 22. I work just hard enough to get by.
- O O 23. In my life, interesting and exciting things happen every day.
- O O 24. I sometimes get all worked up as he/she thinks about things that happened during the day.
- O O 25. I rarely, if ever, do anything reckless.
- O O 26. Other people sometimes have trouble keeping up with the pace I set.
- O O 27. The way I behave often gets me into trouble on the job, at home, or at school.
- O O 28. I get a kick out of really scaring people.
- O O 29. I can get very upset when little things don't go my way.
- O O 30. I live a very full life.
- O O 31. If I had to choose, I would prefer being in a flood to unloading a ton of newspapers from a truck.
- O O 32. I am often nervous for no reason.
- O O 33. I often take my anger out on those around me.
- O O 34. I greatly dislike it when someone breaks accepted rules of good behavior.
- O O 35. I am usually alert and attentive.
- O O 36. I would describe myself as a tense person.
- O O 37. I usually use careful reasoning when making up my mind.
- O O 38. I put a lot of energy into everything I do.
- O O 39. I often worry about things I have done or said.
- O O 40. I would much rather party than work.
- O O 41. I can make a game out of some things that others consider work.
- O O 42. It takes a lot to get me excited.
- O O 43. I like to take chances on something that isn't sure, such as gambling.
- O O 44. Sometimes life seems pretty confusing to me.



## APPENDIX A (continued)

## T E

- O O 45. I can work hard, and for a long time, without feeling tired.
- O O 46. When I resent having to do something, I sometimes make mistakes on purpose.
- O O 47. I am sometimes troubled by thoughts or ideas that I can't get out of my mind.
- O O 48. My pace is usually quick and lively.
- O O 49. I always try to be fully prepared before I begin working on anything.
- O O 50. I would not use others' weaknesses to my own advantage.
- O O 51. I often have trouble sleeping because of my worries.
- O O 52. I really enjoy beating the system.
- O O 53. Most days I have a lot of "pep" or vigor.
- O O 54. I don't get very upset when things go wrong.
- O O 55. I have been told that I work too hard.
- O O 56. People would describe me as a pretty energetic person.
- O O 57. I often feel nervous and "stressed."
- O O 58. He/She is not an "impulse buyer."
- O O 59. He/She has days that he/she is very irritable.
- O O 60. In my life, I would rather try to do too much than too little.
- O O 61. I am a serious-minded person.
- O O 62. I get pretty excited when I am starting a new project.
- O O 63. Little things upset me too much.
- O O 64. I like to show-off.
- O O 65. I am often troubled by guilt feelings.
- O O 66. I seem to be able to remain calm in almost any situation.
- O O 67. Lying comes easily to me.
- O O 68. I worry about terrible things that might happen.
- O O 69. I like to stir up some excitement when things are getting dull.
- O O 70. When I am having a good time, I don't worry about the consequences.
- O O 71. I am often playful around other people.
- O O 72. I worry too much about things that don't really matter.

## APPENDIX A (continued)

## T E

- O O 73. I am a cautious person.
- O O 74. I am sometimes "on the go" so much that I wear myself out.
- O O 75. I have done a lot of things for which I could have been (or was) arrested.
- O O 76. Often life feels like a big struggle for me.
- O O 77. I spend a good deal of my time just having fun.
- O O 78. When I decide things, I always refer to basic rules of right and wrong.
- O O 79. I have more energy than most of the people I know.
- O O 80. Taking care of details is not my strong point.
- O O 81. Things seem to bother me less than most other people.
- O O 82. I often get out of doing things by making up good excuses.
- O O 83. I sometimes feel angry for no good reason.
- O O 84. I get most fun out of things that others think are immoral or illegal.
- O O 85. I would never hurt other people just to get what I want.
- O O 86. I often feel lively and cheerful for no good reason.
- O O 87. I don't ever like to stay in one place for long.
- O O 88. People sometimes tell me to slow down and "take it easy."
- O O 89. I have stolen things from time to time.
- O O 90. I am usually enthusiastic about the things that I do.

## APPENDIX A (continued)

**Penn State Worry Questionnaire (PSWQ)**

Enter the number that best describes how typical or characteristic each item is of you, putting the number next to the item.

- |  | 1                     | 2 | 3                   | 4 | 5               |
|--|-----------------------|---|---------------------|---|-----------------|
|  | Not at all<br>typical |   | Somewhat<br>typical |   | Very<br>typical |
| ___ 1. If I don't have enough time to do everything, I don't worry about it.                 |                       |   |                     |   |                 |
| ___ 2. My worries overwhelm me.  |                       |   |                     |   |                 |
| ___ 3. I do not tend to worry about things.  |                       |   |                     |   |                 |
| ___ 4. Many situations make me worry.  |                       |   |                     |   |                 |
| ___ 5. I know I shouldn't worry about things, but I just cannot help it.                     |                       |   |                     |   |                 |
| ___ 6. When I am under pressure I worry a lot.   |                       |   |                     |   |                 |
| ___ 7. I am always worrying about something.   |                       |   |                     |   |                 |
| ___ 8. I find it easy to dismiss worrisome thoughts.   |                       |   |                     |   |                 |
| ___ 9. As soon as I finish one task, I start to worry about everything else I have to do.    |                       |   |                     |   |                 |
| ___ 10. I never worry about anything.  |                       |   |                     |   |                 |
| ___ 11. When there is nothing more I can do about a concern, I don't worry about it anymore. |                       |   |                     |   |                 |
| ___ 12. I've been a worrier all my life.   |                       |   |                     |   |                 |
| ___ 13. I notice that I have been worrying about things.                                     |                       |   |                     |   |                 |
| ___ 14. Once I start worrying, I can't stop.   |                       |   |                     |   |                 |
| ___ 15. I worry all the time.  |                       |   |                     |   |                 |
| ___ 16. I worry about projects until they are done.  |                       |   |                     |   |                 |

## APPENDIX A (continued)

## IUS

You will find below a series of statements which describe how people may react to the uncertainties of life. Please use the scale below to describe to what extent each item is characteristic of you (please write the number that describes you best in the space before each item).

- [illegible]

## APPENDIX B

**A. Information Session Scripts****1. Psycho-Education**

As you probably gathered from the questionnaire you just filled out, the present study is about anxiety. Research on anxiety is an important part of psychological research. I would like to provide you with some information about anxiety. Anxiety is a common emotional experience. It is normal to experience some anxiety in response to a variety of life circumstances, such as taking a test or being interviewed for a job. When you hear anxiety, what do you think of? [BRIEFLY DISCUSS]. Anxiety may also have physical, mental, and behavioral symptoms.

Physical signs of anxiety involve a person's body. For example, muscle tension and increased heart rate are examples of physical signs of anxiety. Just as it is normal to experience some anxiety, it is normal to have some physical response to anxiety-provoking situations. For example, you may find your heart rate increasing when you have to take a test. Typically, this does not pose a problem for people unless their heart rate increases too much, or their heart rate continues to be elevated long after they finish the test. In fact, some physical signs of anxiety may help people to perform better in a situation like a test because increased heart rate may make them more alert. Greater alertness may help them to devote more energy to solving problems on the test. What do you think of that?

Mental signs of anxiety involve a person's thoughts. For example, thoughts such as "What if I fail?" or "I don't know whether I can handle this" are thoughts that may occur in anxiety. As with physical signs of anxiety, it is normal to have some mental response to anxiety-provoking situations. For example, when you are taking a test, you may find yourself thinking, "I'll never get it!" or "If I fail this test, my future is over!" Typically, as with the physical signs, occasional thoughts such as these worries do not pose a problem for people unless their thoughts interfere with their performance or continue long after the task at hand. In fact, some mental signs of anxiety may help people to perform better in a situation like a test because the thoughts may help them to develop strategies for studying for the test. How do you think physical and mental signs of anxiety go together?

Behavioral signs of anxiety may involve behaviors or things that people do. These are actions (or inactions). For example, avoiding situations, pacing around, and procrastinating are behavioral signs of anxiety. As with physical and mental signs of anxiety, some behavioral signs of anxiety are normal in anxiety-provoking situations. For example, when you are preparing for a test, you may find yourself avoiding studying by going out with friends, surfing the internet, or putting off studying until the last minute. An extreme example of avoidance might involve not showing up for a test due to anxiety over how you would do on the test. Typically, some behavioral signs of anxiety do not pose a problem for people unless their avoidance becomes excessive or interferes with their performance. In fact, some behavioral signs of anxiety may help people to focus on the material when they do study for a test, spurring them to work harder and stay alert. Can you think of someone who shows behavioral signs of anxiety, in real life or TV?

## APPENDIX B (continued)

In summary, there are physical, mental, and behavioral signs of anxiety. Like anxiety itself, physical, mental, and behavioral signs of anxiety are normal and can be helpful in situations in which people need to be alert.

Now, could you describe to me the main take home point of what we just talked about?

### 2. Cognitive Strategies

How are you doing right about now? As you probably gathered, this study is designed to raise your level of anxiety by presenting you with shocks. Anxiety is a common emotional experience. However, there are ways that you can reduce your level of anxiety in everyday situations, as well as during an experiment such as this one. I would like to provide you with some information about anxiety, and then give you some suggestions for how to reduce anxiety.

It is normal to experience some anxiety in response to a variety of life circumstances, such as taking a test or being interviewed for a job. When you hear anxiety, what do you think of? [BRIEFLY DISCUSS]. Anxiety may also have physical, mental, and behavioral signs. Physical signs of anxiety involve a person's body. For example, muscle tension and increased heart rate are examples of physical signs of anxiety. Behavioral signs of anxiety involve actions or things that people do. For example, avoiding situations, pacing around and procrastinating are behavioral signs of anxiety. Mental signs of anxiety involve a person's thoughts. For example, thoughts such as "What if I fail?" or "I don't know whether I can handle this" are worries that may occur in anxiety. It is normal to have some physical, behavioral, and mental responses to a variety of situations. Can you think of a situation that may lead to physical, behavioral, and mental signs of anxiety?

Another mental sign of anxiety that may present some difficulty for people is a concept called 'intolerance of uncertainty.' To describe this, let's take an example from today's experiment. In some trials, you know that you will receive shocks, but you don't know when they will come. So, there is some uncertainty. People who are intolerant of uncertainty think about and focus on the fact that they don't know when the shock will occur.

As you know, uncertainty can never be completely eliminated because things that happen in the future cannot be fully predicted. For people with intolerance of uncertainty, it's like they have a psychological allergy to uncertainty about the future. People with an allergy, to pollen for example, will have a very strong reaction to even a minute quantity of the substance. That is, they might start sneezing, coughing, and their eyes might redden when exposed to a very small amount of pollen. In the same way, intolerance of uncertainty means that a person is "allergic" to uncertainty. Even when there is only a small amount of uncertainty, they will have a strong reaction; in this case, excessive worry or anxiety. How do you think a person who is intolerant of uncertainty will react to (SITUATION MENTIONED EARLIER)?

## APPENDIX B (continued)

What can a person do to deal with “uncertain” situations? To deal with the uncertainty, there are two options: increase certainty, or increase tolerance. Let’s use the example of today’s experiment. To increase your certainty, you can try to predict what will happen based on what has happened in the past. For example, if you have managed to get through receiving electric shocks in the past, you will probably manage to get through receiving electric shocks in the future. However, you can never fully eliminate uncertainty, because in some trials you do not know for sure when the shocks will come.

Another option is to increase tolerance for uncertainty. To increase tolerance, you can accept that there is some uncertainty all around us. For example, when we do the second part of the experiment, you can accept that you have a general idea how experiments like these go, even though you aren’t certain when the shocks will exactly occur. Because it is uncertain, you can focus on the present, rather than the uncertain future. In the present, you can use coping strategies. For example, since you have received shocks in the past, you have information about them. You know the level of the shocks. You know that they will come when the shapes and the text on the screen tell you shock is possible, and not when the shapes and text tell you shock is not possible. You also know that you can handle them because you have gotten through them in the last part of the experiment. Also, you can think about the shocks in a different way – really, they are just mild electric current. So, you can think about how it’s just mild electric current that you are receiving on your wrist during the experiment.

Another thing you can do to accept uncertainty is to recognize that excessive worrying about the mild electric current is not particularly useful. One problem with excessive worry is that it will not stop the mild electric current from happening. Also, excessive worry does not increase certainty. So, excessive worry is not an effective strategy.

To summarize, to cope with uncertainty, you can try to accept uncertainty. How can you accept uncertainty? (BRIEFLY DISCUSS) Yes, and in this experiment, you can remember that you know the level of the mild electric current and approximately when it will come. You also know that you have experienced them before and been fine. If you find yourself worrying excessively, recognize that excessive worry is not particularly helpful. You may also find that accepting uncertainty in your everyday life will help you to reduce anxiety

How can you accept uncertainty in the present experiment? How might you accept uncertainty in other parts of life, such as school or work?

UNIVERSITY OF ILLINOIS  
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)  
Office of the Vice Chancellor for Research (MC 672)  
203 Administrative Office Building  
1737 West Polk Street  
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**Approval Notice**  
**Initial Review (Response To Modifications)**

August 18, 2009

Elizabeth Jenna Robison, Ph.d.  
Psychology  
1007 W Harrison  
M/C 285  
Chicago, IL 60612  
Phone: (312) 413-2681 / Fax: (312) 413-4122

RE: **Protocol # 2009-0678**  
**“Emotional Response to Predictability”**

Dear Ms. Robison:

Your Initial Review application (Response To Modifications) was reviewed and approved by the Expedited review process on August 17, 2009. You may now begin your research.

Please note the following information about your approved research protocol:

**Protocol Approval Period:** August 17, 2009 - August 16, 2010

**Approved Subject Enrollment #:** 100

**Additional Determinations for Research Involving Minors:** These determinations have not been made for this study since it has not been approved for enrollment of minors.

**Performance Site:** UIC

**Sponsor:** None

**Research Protocol:**

- a) Research Protocol for Emotional Processing and Predictability; Version 2; 08/13/2009

**Recruitment Material:**

- a) UIC Psychology Student Subject Pool procedures will be followed

**Informed Consents:**

- a) Emotional Response to Predictability; Version 2; 08/13/2009



- b) Scripts for Two Conditions of Emotional Response to Predictability, Emotional Response to Predictability; Version 2; 08/13/2009

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

(4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.)

Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual,

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

**Please note the Review History of this submission:**

Receipt Date	Submission Type	Review Process	Review Date	Review Action
07/29/2009	Initial Review	Expedited	07/30/2009	Modifications Required
08/13/2009	Response To Modifications	Expedited	08/17/2009	Approved

Please remember to:

→ Use your **research protocol number** (2009-0678) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,  
**"UIC Investigator Responsibilities, Protection of Human Research Subjects"**

**Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.**

**Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.**

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-2014. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Sandra Costello  
Assistant Director, IRB # 2  
Office for the Protection of Research

Subjects

Enclosures:

- 1. UIC Investigator Responsibilities, Protection of Human Research Subjects**
- 2. Informed Consent Documents:**
  - a) Emotional Response to Predictability; Version 2; 08/13/2009
  - b) Scripts for Two Conditions of Emotional Response to Predictability, Emotional Response to Predictability; Version 2; 08/13/2009

cc: Gary E. Raney, Psychology, M/C 285  
Stewart Shankman, Psychology, M/C 285

## VITA

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PUBLICATIONS: Shankman, S.A., Robison-Andrew, E.J., Nelson, B.D., Altman, S.E., and Campbell, M.L.: Effects of predictability of shock timing and intensity on fearful and anxious responses. *International Journal of Psychophysiology*, 80:112-118, 2011.

Robison, E.J., Shankman, S.A., and McFarland, B.R.: Independent associations between personality traits and clinical characteristics of depression. *Journal of Nervous and Mental Disease*, 197:476-483, 2009.

Robison, E.J. and Shankman, S.A.: The role of emotion and personality in gender differences in depression. *Major Depression in Women*. Bancroft, P.R. and Ardley, L.B. (eds.), pp. 1-9, Hauppauge, NY, Nova Science Publishers, Inc., 2008.

### CONFERENCE

PRESENTATIONS: Robison-Andrew, E.J., Shankman, S.A., and McGowan, S.K.: Impact of cognitive therapy analogue on startle reactivity and subjective response during anticipation of aversive stimuli. Poster presented at the Association for Psychological Science Annual Convention, Washington, D.C., 2011.

Nelson, B.D., Shankman, S.A., Sarapas, C., Nelson, M., Altman, S.E., and Robison-Andrew, E.J.: Are distinctive symptoms of anxiety and depression related to emotional responding while anticipating predictable vs. unpredictable threat? Poster presented at the 24th Annual Society for Research in Psychopathology, Seattle, WA, 2010.

Nelson, M.L., Shankman, S.A., Nelson, B.D., Robison-Andrew, E.J., Altman, S.E., and Sarapas, C.: Personality correlates of startle habituation: An examination in three separate samples. Poster presented at the 24<sup>th</sup> Annual Society for Research in Psychopathology, Seattle, WA, 2010.

Robison-Andrew, E. J., McFarland, B. R., & Shankman, S. A.: Positive and negative personality traits and depression: A comparison of individuals during episode and after recovery. Presented at the annual meeting of the Chicago Graduate Student Research Symposium, Chicago, IL, 2010.

Robison, E.J., Nelson, B.D., Altman, S.E., & Shankman, S.A.: Effects of predictability of shock timing and intensity on aversive responses. Poster presented at annual meeting of the Society for Psychophysiological Research, Berlin, Germany, 2009.

Robison, E.J., Shankman, S.A., McFarland, B.R. & Klein, D.N.: Independent effects of age of onset and chronicity of depression on self-report measures of personality. Poster presented at the annual meeting of the Society for Research in Psychopathology, Iowa City, IA, 2006.

Robison, E.J., Persky, I. & Trickett, E.: Employment and life satisfaction associations among immigrants from the former Soviet Union. Poster presented at the annual meeting of the Midwestern Psychological Association, Chicago, IL, 2004.

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