Personality Correlates of Startle Habituation:

An Examination in Three Separate Samples

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THESIS

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LIST OF ABBREVIATIONS

ASI   Anxiety Sensitivity Index

AS   Anxiety Sensitivity

DSM   *Diagnostic and Statistical Manual of Mental Disorders*

EMG   Electromyographic

GAD   Generalized Anxiety Disorder

GSR   Galvanic Skin Response

GTS   General Temperament Survey

NE   Negative Emotionality

N   Neuroticism

OCD   Obsessive Compulsive Disorder

PC   Percent Change

PD   Panic Disorder

PTSD   Post Traumatic Stress Disorder

SUMMARY

Personality traits have been shown to longitudinally predict the onset of anxiety disorders (Clark, Watson, & Mineka, 1994; Hayward, Killen, Kraemer, & Taylor, 2000). One process that may be at the core of the personality-anxiety relation is a deficit in habituation, or the decrease in response to repeated aversive stimuli over time (Harris, 1943). Past research suggests that individuals with anxiety disorders show reduced physiological habituation to aversive stimuli, including galvanic skin response (Lader & Wing, 1964; Rothbaum, Kozak, Foa, & Whitaker, 2001) and acoustic startle response (Ludewig et al., 2005). Less is known about the relationship between personality and habituation. However, if individuals with anxiety disorders show patterns of disrupted physiological habituation, and certain personality traits (i.e. AS and/or N) are known to correlate highly with (and often predict) anxiety disorders, it is possible that personality would predict differences in habituation. The present study examined whether AS and/or N was associated with habituation during a 9-blink, 2.5 minute baseline startle period in three separate samples of undergraduates (total N=284). Additionally, because of the widely varying methodological definitions of physiological habituation used in past studies (LaRowe, Patrick, Curtin, & Kline, 2006; Rothbaum et al., 2001), three definitions of startle habituation were examined in hopes of eliciting the most appropriate measure of the construct. Results indicated that higher levels of AS but not N evidenced reduced startle habituation, but the strength of this relationship was dependent on the definition of habituation used. The most robust definition of habituation involved an examination of the individual slopes across each of the nine blinks, which revealed significant linear and quadratic effects. Clinical implications are discussed relating the present findings to an understanding of the pathogenesis of anxiety disorders in high-risk populations.

1. INTRODUCTION

Anxiety disorders constitute some of the most prevalent mental health conditions in the U.S. and are associated with numerous adverse outcomes. Twelve-month prevalence rates of anxiety disorders in individuals ages 18-54 in the U.S. are estimated at 18.1%, which is larger than any other class of mental disorders (Kessler, Chiu, Demler, & Walters, 2005). Additionally, the treatment of anxiety disorders costs approximately 42 billion dollars every year, when taking into consideration the cost of medications, psychotherapy sessions, and effects on school and work functioning and productivity (Greenberg et al., 1999). Consequently, research focusing on the risk factors of anxiety disorders is imperative in order to help identify individuals at risk for these debilitating conditions, and possibly develop preventative interventions.

1.1. **Personality Traits and Anxiety Disorders**

1.1.1 **Anxiety Sensitivity**

Personality traits are particularly good candidates to examine as risk factors as they are thought to be stable over time, (Costa & McRae, 1986; Caspi, Bem, & Elder, 1989) and longitudinally predict the onset of anxiety disorders (Clark et al., 1994). One personality trait that has received a lot of attention in the anxiety disorder literature is Anxiety Sensitivity (AS). AS is an individual's fear of anxiety-related sensations (Stewart, Taylor, & Baker, 1997) involving physical sensations (i.e. rapid heart rate), cognitive sensations (i.e. racing thoughts), as well as fears about social consequences of appearing anxious. AS has been shown to be a valid and stable construct when examined cross-culturally (Zvolensky, McNeil, Porter, & Stewart, 2001; Zvolensky, Kotov, Antipova, & Schmidt, 2005) and has longitudinally predicted the onset of anxiety disorders, even when adjusting for trait anxiety (Hayward, Killen, Kraemer, & Taylor, 2000). Although AS may be associated with onset of several anxiety disorders, evidence suggests that it may be a particular risk factor for the development of panic disorder (Schmidt,

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Zvolensky, & Maner, 2006). For instance, in two studies, AS has been shown to longitudinally predict the onset of spontaneous panic attacks in non-clinical samples, even controlling for trait anxiety (Schmidt, Lerew, & Jackson, 1997; 1999; Schmidt, Zvolensky, & Maner, 2006). Furthermore, when comparing ASI scores across a multitude of anxiety disorders, Taylor and colleagues (1992) found that AS levels were highest in those with panic disorder, even when controlling for trait anxiety. AS may be particularly associated with panic because of its emphasis on the fear of anxiety-related sensations. For example, those who catastrophize physiological arousal such as increased heart rate or sweating have been shown to experience heightened perceived levels of anxiety, which therefore increases the likelihood of them experiencing future panic attacks (Schmidt et al., 2006). More simply stated, anxiety about anxiety increases one's anxiety (and ultimately increases the possibility of panic attacks).

1.1.2 **Neuroticism**

Another personality trait, Neuroticism (N), sometimes referred to as Negative Affectivity (NA) (Clark et al., 1994) or Negative Emotionality (NE), has also been hypothesized as a vulnerability factor for a multitude of anxiety disorders, including post-traumatic stress disorder (PTSD) (Breslau, Davis, Andreski, & Peterson, 1991), obsessive-compulsive disorder (OCD) (Hirshfield & Klerman, 1979), generalized anxiety disorders (GAD), panic disorder (PD), and social and specific phobias (Clark et. al., 1994). For example, in a longitudinal study by Krueger and colleagues (1999), high negative emotionality at age 18 increased the odds of being diagnosed with an anxiety disorder at age 21. Similar findings have been reported by others (Clark, Watson, & Reynolds, 1995; Clark, 2005) suggesting that neuroticism may be a broad underlying risk factor across disorders.

Given the association between these traits and the onset of anxiety disorders, it is plausible that AS and N would relate to patterns of aversive responding in laboratory and/or real

world settings. Norris and colleagues found that people with elevated levels of neuroticism had greater and prolonged skin conductance reactivity when shown aversive pictures than people who were emotionally stable (Norris, Larsen, & Cacioppo, 2007). Similar results have been found for AS. For example, when exposed to a voluntary hyperventilation task, Holloway & McNally (1987) found that college students who scored high on the Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986) reported stronger hyperventilation-type sensations than those who scored low on ASI. Higher levels of AS have also been shown to predict greater subjective pain during the cold pressor pain task (Keogh & Mansoor, 2001). Additionally, some studies have suggested that individuals who are high in AS experience attentional biases toward threatening stimuli (Lees, Mogg, & Bradley, 2003; Keogh, Dillon, Georgiou, & Hunt, 2001). These findings indicate that both AS and N predict responsivity to threatening and aversive stimuli.

1.2 **Single vs. Multiple Events**

The majority of past and current research looking at personality and aversive responding has focused on single aversive events, rather than on a *pattern* of responding over time. In order to understand the etiology/risk factors of anxiety disorders, it is equally important to examine the way individuals respond to multiple aversive events over time, as this may help determine factors that are influential in the maintenance or modification of anxiety-related behaviors. One example of such a study examined the moderating effect of neuroticism on a person's affective response to daily stressors over the course of eight days (Suls, Green, & Hillis, 1998). This study found that highly neurotic individuals reported more problematic events and were more distressed by daily occurrences than those who had low rates of neuroticism. These results suggest that personality may be an important determinant of both immediate reactivity and

responding over time. Studies such as these that examine emotional responsivity over time are often termed "affective chronometry" studies (Davidson, 1998).

1.3   **Habituation**

One way that past researchers have measured repeated events over time is the examination of habituation. Habituation is defined as the decrease in response to a repeated stimulus over time (Harris, 1943) and its description and physiological underpinnings have been examined for decades (Groves & Thompson, 1970; Thompson & Spencer, 1966).   One classic description of habituation purported by Groves and Thompson (1970) argues that habituation is a dual-process theory, comprised of not only the gradual decrease in reactivity to a repeated stimulus over time, but also as a function of sensitization. Sensitization is defined as a temporary *enhancement* in responding to an aversive stimulus after previous presentations of the stimulus (Groves & Thompson, 1970). This phenomenon is believed to be time-limited, and occurs when the successive stimulus is of equal intensity to the first (Groves & Thompson, 1970). Thus, although classic definitions of habituation describe it as a decrease in responding to a repeated stimulus over time, there may be more complex processes underlying and influencing this definition.

1.3.1   **Habituation in Anxiety Disorders**

In addition to understanding the effects of anxiety on emotional responsivity over time (i.e. affective chronometry; Davidson, 1998), it is also important to understand the effects of anxiety on physiological responsivity. Studies comparing anxious and non-anxious individuals on physiological habituation consistently demonstrate that anxious individuals have difficulty habituating to aversive stimuli. An early study conducted by Lader and Wing (1964) indicated that individuals with "anxiety states" had reduced habituation of the psycho-galvanic reflex when compared to normal subjects. A more recent study investigating habituation of electrodermal

responses found deficits in habituation in rape victims with PTSD compared with non-PTSD rape victims (Rothbaum et al., 2001). Additionally, patients with panic disorder have been shown to have deficits in skin conductance habituation when presented with aversive auditory tones (Roth, Ehlers, Taylor, Margraf, & Agras, 1990).

1.3.2 **Habituation and Personality**

Consequently, if individuals with anxiety disorders evidence patterns of disrupted physiological habituation, and certain personality traits (such as AS or Neuroticism) are known to correlate highly with (and often predict) anxiety disorders, it is possible that personality would predict differences in habituation. This hypothesis is also consistent with Hans Eysenck's classic theory of personality (Eysenck, 1967). According to Eysenck (1967), personality traits are primarily classified according to two orthogonal factors: Extroversion/Introversion, and Neuroticism. Eysenck proposed that two partially independent physiological processes are linked to each of these two factors, namely, that differences in Extroversion reflect differences in reticular arousal, which relates to the processing of external stimuli, whereas Neuroticism is linked to differences in the threshold for limbic activation, which are related to emotional processing. In his theory, Eysenck proposed that high levels of Neuroticism, present in those with "anxiety states" (as referenced above), but not Extroversion, would be associated with disrupted habituation. Eysenck also reviews various studies linking personality with certain physiological variables, including those showing reduced galvanic skin response (GSR) activity in psychopathic individuals when compared to controls (Eysenck, 1956). Additionally, Coles, Gale and Kline (1971) conducted a direct test of Eysenck's hypotheses, examining the electrodermal activity of individuals varying on levels of Extroversion and Neuroticism. Using habituation of electrodermal activity as a dependent measure, Coles et al. (1971) found that High Neurotics habituated at a slower rate than Low Neurotics.

Recent research has also examined the relationship between personality and the habituation of physiological responses. A recent study in infants found a negative correlation between behavioral inhibition (a related construct to Neuroticism) and habituation of cardiovascular responses (Moehler et al., 2006) to aversive auditory stimuli. Similarly, in a study examining physiological responses during a public speaking task, those who had lower levels of social anxiety had gradually decreased physiological responses (skin conductance and heart rate) and self-reported nervousness over time (i.e. habituation) during an the task, whereas high socially anxious individuals did not (Eckman & Schean, 1997). Lastly, individuals high in Neuroticism have also demonstrated greater and prolonged skin conductance reactivity (i.e. reduced habituation) to emotionally-valenced pictures than those low in Neuroticism, especially when the images were aversive (Norris et al., 2007). Together, these studies indicate that personality measures are highly related to physiological manifestations of anxiety over time.

1.3.3 **Startle Habituation**

One widely used method to measure emotional responding to aversive events over time is the startle response. This response seems to function as a cross-species protective mechanism from threat/danger, preparing them for possible injury (Koch, 1999). Research has shown that, when a person is startled by a sudden, aversive event, one of the first physical movements that occur in the startle response is the eyeblink response (Lang, Bradley, & Cuthbert, 1990). In studies of humans, startle eyeblink response is typically using electromyographic (EMG) electrodes placed directly on orbicularis oculi muscle (the muscle which closes the eyelid). To elicit a startle eyeblink response, participants are presented with an aversive, unexpected stimulus, and the associated EMG eyeblink response been shown to be a sensitive, non-invasive, and stable indicator of the startle response (Blumenthal, Cuthbert, Filion, Hackley, Lipp, & Van Boxtel, 2005).

While some studies have examined habituation in various psychopathologies using other physiological measures (e.g., skin conductance), far fewer studies have examined habituation of the startle response. Additionally, prior investigations that have examined startle habituation have yielded inconsistent results. For instance, some studies have found deficits in acoustic startle response habituation in patients with schizophrenia when compared to control subjects (Geyer & Braff, 1982; Ludewig et al., 2003), whereas other studies did not show these results (Braff et al., 2001; Cadenhead, Swerdlow, Shafer, Diaz, & Braff, 2000). Further, Ludewig and colleagues (2005) found deficits in the habituation of startle responses in panic disorder patients when compared to controls (Ludewig et al., 2005) while Orr and colleagues (1997) did not find any significant differences in the habituation of PTSD patients versus controls, although PTSD patients did show nonsignificantly lower rates of habituation. However, even with these inconsistent results, compared to measures such as skin conductance, startle may be a better measure to use to examine habituation of aversive responding as the former increases to both positive and negative emotional states while the latter only increases to negative states (Lang et al., 1990; Lang, 1995; Winton, Putnam, & Krauss, 1984).

1.3.4 **Operationalizing Habituation**

Contradictory findings on the relation between habituation and psychopathology or personality may not be a question of whether those relationships exist, but rather a result of widely varying operationalizations of *habituation.* One method is to use the difference (or change) in responding from the first and last aversive stimulus (Ellwanger, Geyer, & Braff, 2003). A second method is to define habituation as a proportion change from the first blink, which has been used by previous researchers to measure change over time (see Nelson, Shankman, Olino, & Klein, 2011). The advantage of the proportion over the raw habituation

index is that it accounts for any individual differences in initial startle response. A third method

has been to examine the 'slope' or trajectory of the response (LaRowe et al., 2006).

When investigating habituation, there are other factors to consider besides differences in

overall levels of habituation, such as *when* people habituate, the non-linear pattern in habituation,

and whether certain groups exhibit sensitization. Figure 1 represents a hypothetical pattern of

startle response over time in three groups. All three groups have the same amount and proportion

of habituation (i.e. the overall difference in blink amplitude between the first and last responses

compared to the first response). However, Group C habituates at a much faster rate than Group A

or B, and Group B shows a distinct pattern of sensitization between the first and second stimulus.

Thus, it may be useful to use multiple measures of habituation in order to detect these important

differences.

1.4.   **Aims and Hypotheses**

As such, the present study will examine whether the personality construct of AS

moderates the habituation of a repeated acoustic startle response in three, independent, non-

clinical samples. We will also examine the role of N, to determine whether any differences we

find in startle habituation are due to this broad, general factor, or if they are specific to AS.

Further, given the limitations of previous definitions of habituation, the current study will utilize

multiple indices of startle habituation: 1) raw habituation, defined as the raw difference in

eyeblink startle amplitude from the initial startle probe to the last; 2) percent change from first

blink (PC), defined as the amount of raw habituation compared to the initial blink amplitude; and

3) the slope of habituation over time, incorporating each individual blink. The inclusion of

multiple conceptualizations of habituation will allow us to explore important differences between

these methodologies and provide evidence as to which method may be the most robust definition

of the construct. Moreover, if personality traits that are associated with anxiety disorders predict

deficits in habituation, it is possible that deficits in habituation may underlie the well-replicated findings between personality and disorder onset.

The study has the following primary hypotheses. First, we predict that higher levels of AS will be associated with slower rates of habituation. We will also examine the role of Neuroticism, and whether or not any differences in startle habituation are specific to anxiety (i.e. AS) or a broader construct of Negative Affectivity. Additionally, this question will be examined using three independent samples. This will not only add to research in this area by essentially contributing results from three separate studies, but will also increase the robustness of our findings because each of the samples have slightly different methodologies in terms of either recruitment or EMG recording parameters. Lastly, we will also examine the relationship between our personality measures and blink latency, in light of a small subset of research latencies in individuals with anxiety disorders yielding mixed results (Britt & Blumenthal, 1993; Blumenthal, Chapman, & Muse, 1995).

2. METHODS

2.1 <u>Participants</u>

Participants were selected as part of three separate projects investigating acoustic startle response to emotionally-valenced stimuli. All three samples were recruited at three separate times from Introductory to Psychology Subject Pools between 2007-2010. All participants gave informed consent, and were given course credit for their participation.

In order to be included in the analyses, each subject needed to have at least six of the nine possible baseline blinks present, with neither blink 1 nor blink 9 classified as *missing*, as well as blink 1 not scored as a *non-response.* A blink scored as *missing* indicated that significant EMG activity was present immediately prior to the acoustic startle probe, which would result in signal interference and measurement not truly due to the probe. A blink scored as a *non-response*

indicated that there was not enough EMG activity to detect a blink in the 75 seconds following the acoustic startle probe in order to be considered a blink.   These definitions are in accordance with Blumenthal's guidelines (Blumenthal et al., 2005). Consequently, if a participant's first blink was unusable for any reason (i.e. missing or no response), we were unable to calculate a habituation score due to its definition being reliant on a raw difference or proportion compared to the first blink. However, we did allow the last blink to be classified as a non-response (but not a missing), as we felt this was consistent with the definition of habituation. Because there were only 9 total blinks possible during this baseline period, we decided that an usable subject needed to have at least 2/3, or 6 of the 9 total blinks, in order to reflect an accurate representation of that person's pattern of responding.

The three samples contained 108, 69, and 167 participants, respectively. In Sample 1, 7 were excluded because of mechanical error, 1 was excluded due to fewer than 6 of 9 usable blinks, 5 were excluded because of an unusable first blink, and 6 were excluded because of a missing 9th blink, resulting in a total of 89 usable subjects. In Sample 2, 3 were excluded because of mechanical error, 5 were excluded due to fewer than 6 of 9 usable blinks, 5 were excluded because of an unusable first blink, and 3 were excluded because of a missing 9th blink, resulting in a total of 53 usable subjects. Lastly, in Sample 3, 2 were excluded because of mechanical error, 9 were excluded due to fewer than 6 of 9 usable blinks, 3 were excluded because of an unusable first blink, and 10 were excluded because of a missing 9th blink, resulting in a total of 143 usable subjects. In all three samples, those included vs. excluded from analysis did not differ on age, gender, ethnicity, ASI, or NE (all p's < .10).

2.2   **Questionnaires**

Participants completed two self-report questionnaires, the Anxiety Sensitivity Index (ASI; Reiss et al. 1986; Taylor et al. 2007) and the General Temperament Survey (GTS) (Clark & Watson, 1990), at the end of the experimental session.

2.2.1 **The Anxiety Sensitivity Index (ASI)**

The ASI assesses an individual's degree of fear of anxiety-related sensations, stemming from catastrophic beliefs about those sensations (i.e. fear of death, heart attack, psychosis). Items are rated on a five-item scale, ranging from "Very Little" to "Very Much." Since the original publication of the 16-item ASI (Reiss et al., 1986), there have been two revisions/updates of the ASI - the 36 item ASI-R (Taylor & Cox, 1998), and the 18-item ASI-3 (which consists of a subset of ASI-R items; Taylor et al., 2007). In order to be able to examine all three versions of ASI, participants in all three samples completed a total of 42 questions, which included the 36 ASI-R items, plus the 6 items from the original ASI, which were cut in subsequent revisions. Because the ASI-3 has been shown to have the best psychometric properties, we chose to use this as our primary predictor for subsequent analyses.[1]

2.2.2 **The General Temperament Survey (GTS)**

The GTS (Clark & Watson, 1990) is a 90-item collection of true-or-false statements developed to assess general aspects of temperament and personality, such as Negative Emotionality (NE) and Positive Emotionality (PE). PE items include statements such as "I am able to approach tasks in such a way that they become interesting or fun," with a true answer indicating more PE. NE items include statements such as "My anger frequently gets the better of me," with a true answer indicating more NE. NE has been shown to correlate highly with Neuroticism.

Cronbach's Alpha revealed that both the ASI (all *a's* > .94) and GTS_NE (all *a's* > .77) were reliable measures in all three samples.

2.3   **Stimuli and Physiological Responses**

For all three studies, startle tones were presented by Contact Precision Instruments (London, UK) and physiological data was recorded using a PC-based acquisition system (Neuroscan 4.3). Startle response was operationalized as the eyeblink response to nine 40 ms, 103db bursts of white noise presented binaurally through headphones for Study 1 and Study 3. Study 2 used 95db bursts of white noise. Thus, the aversive stimuli for Study 2 were slightly less intense than those used in Study 1 and 3 (although still within the range of recommended decibel level by Blumenthal et al., 2005). The startle eyeblink in all three samples was recorded using two electrodes placed over the orbicularis oculi muscle underneath the right eye and collected with a bandpass filter of 10-200 Hz at a sampling-rate of 1000 Hz.

2.4   **Procedure**

Following electrode placement, all participants were seated in a sound-attenuated booth approximately one meter from a computer screen. During a 2.5-minute baseline period, participants were told to relax and focus on a fixation cross present on the monitor in front of them while nine acoustic startle probes were played through headphones. Interstimulus intervals (ISIs) between startle probes ranged between 15 and 20 seconds (mean = 17.22 seconds).

2.5   **Data Analysis**

Startle EMG was rectified and then smoothed using an FIR filter (low pass cutoff of 40 Hz). We added a hipass filter of 28 Hz following initial data collection in order to smooth the data, based on recommendations by Van Boxtel, Boelhouwer, and Bos (1998). Peak blink response was measured during the 20 to 100-ms window following presentation of the startle probe onset relative to baseline. Each blink was scored as per established guidelines (Blumenthal et al. 2005). Blinks were scored as non-responses if there was no distinguishable blink activity when compared to baseline during the initial window following the startle probe. Missing blinks

were classified as those following a period of clear EMG activity immediately prior to or during the startle probe, indicating that the participant blinked prior to hearing the auditory stimulus. Each individual blink was square root transformed to adjust for skewness and kurtosis, and as such, dependent variables were computed based upon our square root transformed blinks. For all analyses, gender was coded as 0 (males) and 1 (females), and continuous predictors (e.g., AS) were mean centered.

2.5.1 **Definitions of Habituation**

We examined startle habituation using three definitions. The first, termed *raw habituation*, was the raw difference score of initial blink minus the last (i.e., ninth) blink. Our second definition, defining habituation as the percentage change from the first blink (PC)*, was equal to the difference from the first blink to the 9th blink, divided by the first blink. This represented the proportion of the first blink that changed over the course of the habituation phase.

Our third definition of habituation, looking at individual slopes, used Random Coefficients Modeling (Hedeker & Gibbons, 2006) using SAS 9.2 (SAS Institute Inc., 2008). This type of analytic strategy tests not only for the presence of sample-wide effects (i.e. fixed effects), but also subject-level effects (i.e. random effects). This also allows for a more complete examination of the relationship between personality and startle response than our previously described regression analyses, primarily due the ability to: 1) incorporate data from the entire series of blinks (as opposed to just the first and last blink); and 2) account for the influence an individual subject may have on their own future repeated observations (Hedeker & Gibbons, 2006). These models also allow for the presence of missing data. Thus, we could have included a larger number of participants for these analyses compared to the raw and proportion change analyses (i.e., include people who had fewer than 6 of 9 blinks). However, we kept the N the

same for the definitions of habituation in order to be able to best compare the results. Random coefficients models also allowed us to test for the presence of linear or quadratic effects.

Blink number represented our variable of time and was coded from 0-8. Additionally, all random coefficients analyses were initially completed using both startle amplitude (i.e. missing blinks and non-responses are kept as missing values) and startle magnitude (i.e. blinks scored as non-responses kept as a value of 0). We did not find any differences when comparing results based on amplitude or magnitude, and thus we will only present results from the analyses involving amplitude.

Using a multiple regression model, levels of AS and NE were regressed onto our dependent variable of interest (i.e., startle habituation) to test our primary hypothesis. We also examined the roles of gender and age, in light of literature suggesting that certain personality measures vary as a function of gender and/or age (Stewart et al., 1997), as well as the well-documented relationship between age and the startle eyeblink response (Ford, Roth, Isaacks, White, Hood, & Pfefferbaum, 1995; Ludewig et al. 2003). Because of the differential breakdown in gender between the three samples, we did include this as a covariate in all analyses. However, age did not differ between the samples and did not affect our analyses, and was therefore omitted from our models.

For the random coefficients models, we first searched for the most appropriate model based on the variance and covariance structure of each independent sample (as described in Hedeker & Gibbons, 2006) using tests of -2 log likelihood differences to determine model fitness with each respective sample. Once a model that best suited the variance/covariance structure of each dataset was identified, we used that model in all subsequent analyses to test our hypotheses.

3. RESULTS

3.1   **Sample Characteristics**

Chi square and ANOVA analyses indicated that the three samples did not differ on age, gender, ethnicity, GTS-NE, or ASI (all p values > .234). Bivariate correlations also revealed that ASI was uncorrelated with mean blink in Samples 1 and 3 (both p's > .261) and was correlated at a trend level in Sample 2 (p = .09). See Table 1 for each sample's demographic and personality characteristics. Figure 2 represents the mean startle response for each of the nine blinks in the three samples. Generally, participants in all three samples appear to habituate across the course of the nine blinks.

3.2 **Relationship Between ASI and Startle Habituation**

First, we examined the relationship between AS and *raw habituation* in each of the three samples using multiple linear regression analyses. In Sample 1, AS was found to be associated with raw startle habituation (β = -.234 t = -2.218, p = .029), such that individuals with higher levels of AS had lower rates of habituation. Similarly, in Sample 2, higher scores on the AS were also associated with lower rates of raw habituation (β = -.328, t = 2.467, p = .017). In Sample 3, we did not find a significant relationship between AS and raw habituation, (β = -.080, t = -.931, p = .354).

Next, we examined whether AS was associated with PC habituation in each of our three samples. In Sample 1, AS was associated with PC habituation (Sample 1: β = -.248, t = -2.358, p = .021). However, in Samples 2 and 3, the relationship between AS and PC habituation was not significant (Sample 2: β = -.203, t =-1.463, p = .150; Sample 3: β = -.074, t =-.861, p = .391).

3.2.1 **Gender X ASI Interaction in Sample 3**

Although we did not find the expected relationship between AS and either habituation measure in Sample 3, post-hoc analyses revealed a significant Gender by AS interaction with raw habituation (β = -.399, t = -2.534, p = .012) and a trend-level interaction with PC habituation

(β = -.293, t = -1.463, p = .067). To follow-up this significant interaction, we examined the relationship between AS and habituation in males versus females, using guidelines to examine interactions between continuous and categorical variables (Aiken & West, 1991; Holmbeck, 2002). Results revealed that, among females in Sample 3, AS was not significantly associated with raw habituation (β = .262, t = 1.643, p = .103). However, among males in Sample 3, those with higher levels of AS evidenced significantly lower levels of startle habituation (β = -.215, t = -2.149, p = .033). Similarly, when following up the trend-level AS by PC habituation interaction using an identical analysis as outlined above, results revealed a stronger negative relationship between AS and PC habituation in males (β = -.171, t = -1.698, p = .092) than in females (β = .179, t = 1.113, p = .268). Thus, males who reported higher AS displayed less startle habituation in Sample 3 according to our first two definitions.

3.3 **Slope Analyses using Random Coefficients Modeling**

In all three samples, random coefficients analyses revealed significant linear and quadratic effects for time (b = -.606, t = -6.70, p < .0001 for linear effect; b = .029, t = 2.68, p = .009 for quadratic effect). Thus, on average, subjects had decreasing blink amplitudes over time, but the rate of this decrease also decelerated with time. In addition, there was a significant AS by time interaction in all three samples, indicating that subjects' blink amplitudes decreased over time as a function of their AS score. However, in Sample 3, this effect was qualified by a three-way AS by gender by time interaction. We did not find any significant AS by quadratic time effect, indicating that the quadratic effect did not differ as a function of AS.

To follow up each significant AS by time interaction, we examined patterns of habituation between subjects with high and low AS scores using simple slopes analysis (Aiken & West, 1991; Holmbeck, 2002), recoding our independent variable (ASI) into two separate variables representing high and low levels of ASI (1 SD above and below the mean,

respectively). Random coefficients models were then run incorporating time, the independent variable of interest (i.e. high or low AS), and the interaction between the two. In both of these samples, AS was negatively associated with startle habituation (i.e. significant AS by time interaction), but subjects with lower AS showed steeper reductions in blink amplitude over the startle baseline period than those with high AS (see Figures 3 and 4).

To follow up the significant AS by time by gender interaction detected in Sample 3, we first tested for an AS by time interaction in each gender separately. Results revealed that this interaction was significant in males (b = -.012, t = -3.16, p = .002), but not in females (b = .002, t = 1.00, p = .317). Similar to the strategy we used to follow up significant interactions with our first two definitions of habituation, we followed up this significant AS by time interaction by looking at the effect of time in males one standard deviation above and below the mean of ASI (Aiken & West 1999; Holmbeck, 2002), running separate models for males and females. While the rate of habituation in females with varying levels of AS was consistent (as shown in Figure 5) (i.e. no difference in linear or quadratic slope between high and low ASI females), in males, high ASI scores were associated with a greater linear decrease in blink amplitudes over time (b = -.782, t = -5.60, p < .0001), than low ASI scores (b = -.461, t = -3.55, p < .001) (see Figure 6.)

3.4.   **Effects of Broad NE**

As AS was highly correlated with NE in all three samples (all Pearson r's > .50), we examined the relationship between NE and habituation in all three samples. Results from multiple regression analyses as well as random coefficients analyses indicated that NE was not predictive of startle habituation in any of the three samples (all p's > .238). Moreover, adding NE to our models with AS did not change the significant effect of AS in predicting startle habituation. As such, it appears that abnormal startle habituation is specifically related to the construct of AS, and not simply associated with the larger factor of NE.

4. DISCUSSION

The current study set out to examine the relationship between Anxiety Sensitivity, Neuroticism, and startle habituation. Extant literature has demonstrated an association between these personality characteristics and the onset of many anxiety disorders (Hayward et al. 2000; McNally et al. 2002; Clark et al. 1995). Additionally, individuals with anxiety disorders have been found to exhibit abnormal startle reactivity (Grillon, 2002) as well as deficits in startle habituation (Ludewig et al., 2005). However, few studies have integrated these two literatures and examined the relationship between startle habituation and trait vulnerabilities for anxiety disorders.

Results from this study indicated that levels of anxiety sensitivity are associated with startle habituation over time. More specifically, individuals who were highly sensitive to anxiety-related sensations (i.e. high in ASI scores) were not as able to adapt to a repeated, aversive stimulus compared to those with lower levels of AS. Additionally, this finding was replicated in three independent samples (although the finding was only found in males in Sample 3). Neuroticism was not significantly associated with habituation in any of our analyses, suggesting that the failure to habituate is specific to anxiety and not general negative affectivity. This is particularly important given the assertion that AS's association with panic may be accounted for by the shared variance between AS and traits like neuroticism (Lilienfeld, Turner, & Jacob, 1993). Additionally, we did not find any association between our personality measures and blink onset.

This finding has key implications for our understanding of the development and maintenance of anxiety disorders. The way individuals respond to repeated stressful and aversive events is, essentially, at the heart of the etiology of most anxiety disorders. For example, an episode of panic would largely be considered a strongly aversive, stressful life event. While as

many as 22.7% of people experience a panic attack at some point during their lives (Kessler,

Chiu, Jin, Ruscio, Shear, & Walters, 2006), only a small subset (approximately 4.7% [NIMH]) of

those people go on to develop Panic Disorder during their lifetimes. What may separate those

who develop PD from those who do not could be an ability to habituate to panic symptoms (or

anxiety in general), as individuals who meet criteria for PD develop an intense, distressing fear

of panic-related symptoms. Consequently, examining more basic processes illustrating this

phenomenon, such as startle habituation, may provide crucial information related to those who

may be more at risk for developing anxiety disorders.

Relatedly, the relationship between certain personality traits (i.e. AS and NE) and the

development of future anxiety disorders has been well-documented (Clark et al., 1994; Schmidt

et al., 2006). However, identifying the underlying processes and mechanisms behind this

relationship allows us to gain a deeper understanding of *why* certain traits function as risk factors

for anxiety. The present findings provide evidence that one possible mechanism present in those

most at risk for the development of anxiety disorders (i.e. those high in AS) is a deficit in

habituation to aversive stimuli.

Our findings highlight the need to determine the best definition for the construct of

habituation, a core distinction that is crucial for research in this area to move forward. Previous

studies have used widely varying definitions of habituation (LaRowe et al. 2006; Roth et al.

2001), but no studies to our knowledge have examined multiple definitions of habituation in

order to determine which is the most valid and reliable. The current study attempted to explore

these differences in methodology by examining the association between anxiety sensitivity and

three different definitions of startle habituation: raw habituation, percent change from first blink

(PC), and individual slopes and patterns of responding using random coefficients modeling. In

sum, results from our analysis of slopes were more consistent with the findings using our raw habituation change score than with our analyses using PC as our dependent variable.

Notably, results from this study also revealed that the strength of the relationship between AS and startle habituation was somewhat dependent on the definition of habituation. When habituation was defined as a change score (i.e. the difference in blink amplitude between the first and last blinks in the baseline period), our results were robust, showing significant relationships between habituation and ASI-3 scores in Samples 1 and 2. Percent of first blink habituation (PC) was significantly associated with levels of anxiety sensitivity only in Sample 1. Although future research is needed to confirm the most appropriate conceptual, methodological, and statistical way to examine habituation, our findings suggest that rather than rely solely on the first and last response in a given period, the best way to operationalize habituation may be one that incorporates an analysis of all of an individual's startle response in order to map the trajectory of startle response over time.

Results from our random coefficients modeling also revealed a significant quadratic effect, suggesting that habituation does not only occur in a linear direction, but rather significantly decelerates over time. Evaluating patterns of responding could shed light on the rates that people adapt to aversive stimuli, as well as if certain individuals show heightened responses. For instance, previous animal literature describes the process of sensitization, or a sharp increase in physiological responding following the initial administration of an aversive stimulus (Groves and Thompson, 1970). Based on previous findings from a multitude of animal and human studies (Szabo and Kolta, 1967; Groves and Thompson, 1970; Ornitz and Guthrie, 1989), Groves and Thompson (1970) theorize that, when exposed to a novel stimulus, individuals respond with patterns of habituation as well as sensitization. Additionally, these authors propose that sensitization occurs because of changes in the how aroused the subject is,

which is a dependent on the intensity and/or aversiveness of the stimulus. As the stimulus is repeatedly presented, the process of sensitization wanes, and the subject most often proceeds to habituate to the stimulus (Groves and Thompson, 1970). Habituation, in this context, appears to be entirely dependent on the process of sensitization, and as such should not be assumed only occurs in linear patterns. Evaluating the process and influence of sensitization along with habituation, as well as personality correlates of deficits in sensitization, may be useful in our future understanding of the way humans process aversive stimuli.

In our third sample, gender differences arose between startle habituation and anxiety sensitivity. In all three of our definitions of habituation, we found that habituation did not vary as a function of anxiety sensitivity in females, but in males. Specifically, males with higher AS levels had less startle habituation. There are several potential explanations for this finding. First of all, men and women differed on ASI in Sample 3, but not Samples 1 and 2 (Samples 1 and 2: p's $> .254$; Sample 3: $p = .024$, $t = -2.29$). Additionally, Sample 3 had statistically greater variance in ASI compared to Sample 1 and Sample 2, which could also account for the significant gender interaction. Future research is needed to determine more concretely whether there are gender differences in the relationship between ASI and startle habituation.

The current study has many strengths, including replication in three separate samples, the comparison of multiple definitions of habituation, and utilizing longitudinal statistical techniques to detect important differences in patterns of blink reactivity. However, it also has several limitations. First, while we did evaluate the relationship between startle habituation and personality in three separate samples, participants across studies were somewhat homogenous as they were all college students. Thus, the generalizability of our findings is limited. Second, we did not screen for the presence of psychiatric disorders and it is unknown whether psychopathology played a significant role in the current findings. Third, our baseline startle

period consisted of only 9 startle probes over the course of two and a half minutes, which may not be the most optimal, accurate way to measure habituation. Future studies would benefit from measuring startle response, perhaps, over the course of multiple days. Fourth, lab-based stressors, such as an acoustic startle probe, may not be ecologically valid and thus, future research is needed to determine whether there are differences in the relation between personality and habituation across more 'real life' aversive stimuli.

In conclusion, the present study was the first of our knowledge to examine the relationship between anxiety-related personality constructs and startle habituation, using multiple definitions of habituation. The current study adds to the literature in four important ways: 1) it is one of the few that has examined the relationship between personality predictors of anxious disorders (i.e. Anxiety Sensitivity and Neuroticism) and startle habituation during a baseline startle period; 2) we aimed to replicate these findings in three separate samples; 3) multiple definitions of habituation were used to explore important differences between operational methodologies; and 4) we employed sophisticated longitudinal analyses to detect changes in the pattern of responding over time, with the ability to detect linear or quadratic trends. Overall, our results indicate that anxiety sensitivity is associated with deficits in startle habituation and suggests that these deficits may underlie the relationship between personality traits and the onset of anxiety disorders. Future research utilizing a prospective design is needed to determine the temporal order of personality, deficits in habituation, and anxiety disorder onset. Furthermore, it is imperative that, in the future, researchers do not limit their conceptualizations of startle habituation to a linear construct, as it appears to be a more complex phenomenon than a simple difference in responding from one stressful event to another.

Footnotes

[1] We ran analyses examining for relationships between habituation and all three existing ASI measures: the original version of the ASI (Reiss et al., 1986), the ASI-R (Taylor & Cox, 1998), and the ASI-3 (Taylor et al. 2007). Our results were most consistent and robust using the most recent version of the ASI, the ASI-3. We had similar (but not as strong) results when using the ASI-R. Of note, none of our analyses were significant using the ASI-O.

[2] We also examined the relationship between each of our personality variables and startle onset latency across each of the 9 blinks, using an analyses strategy identical to what was used when startle amplitude was our dependent variable. However, none of these analyses yielded significant findings.
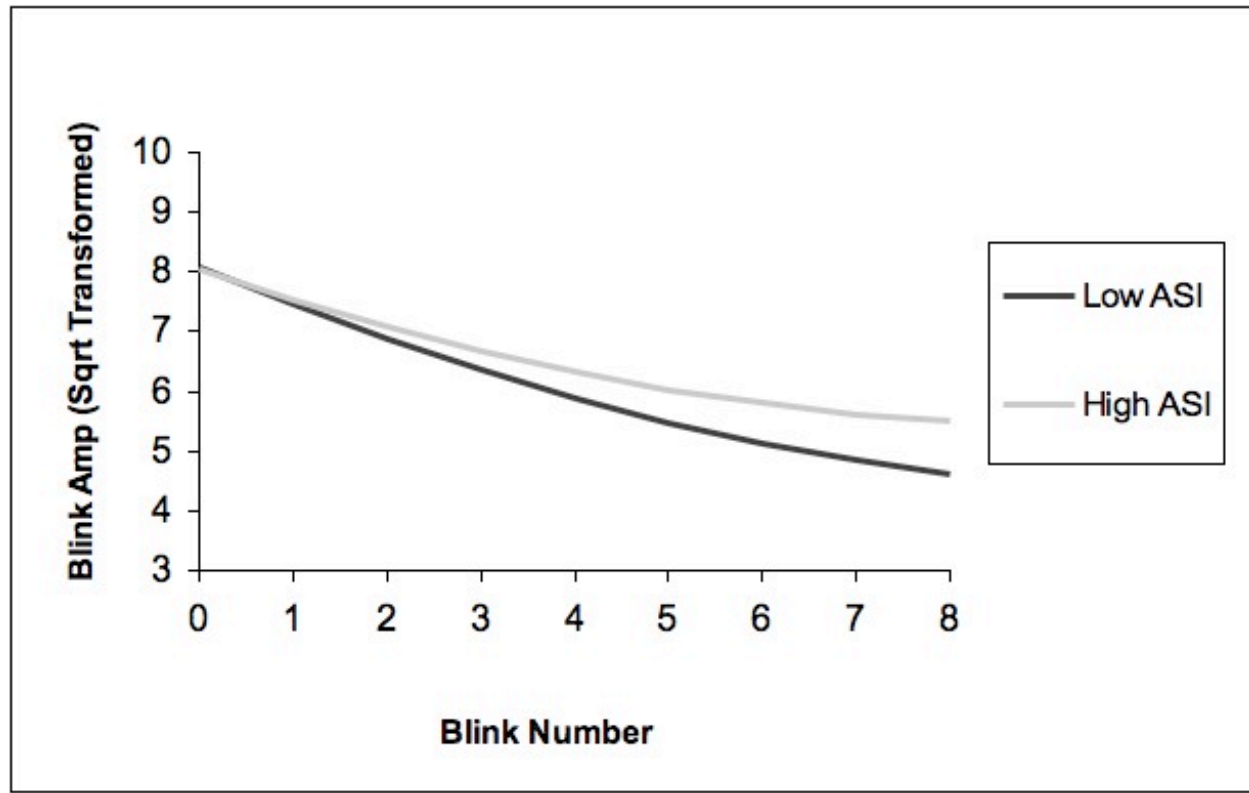
Figure 1. Hypothetical patterns of habituation.
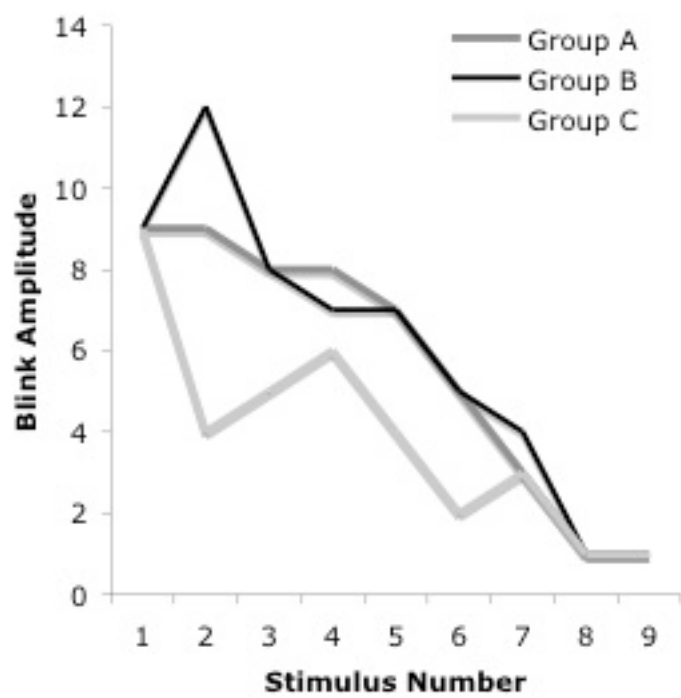
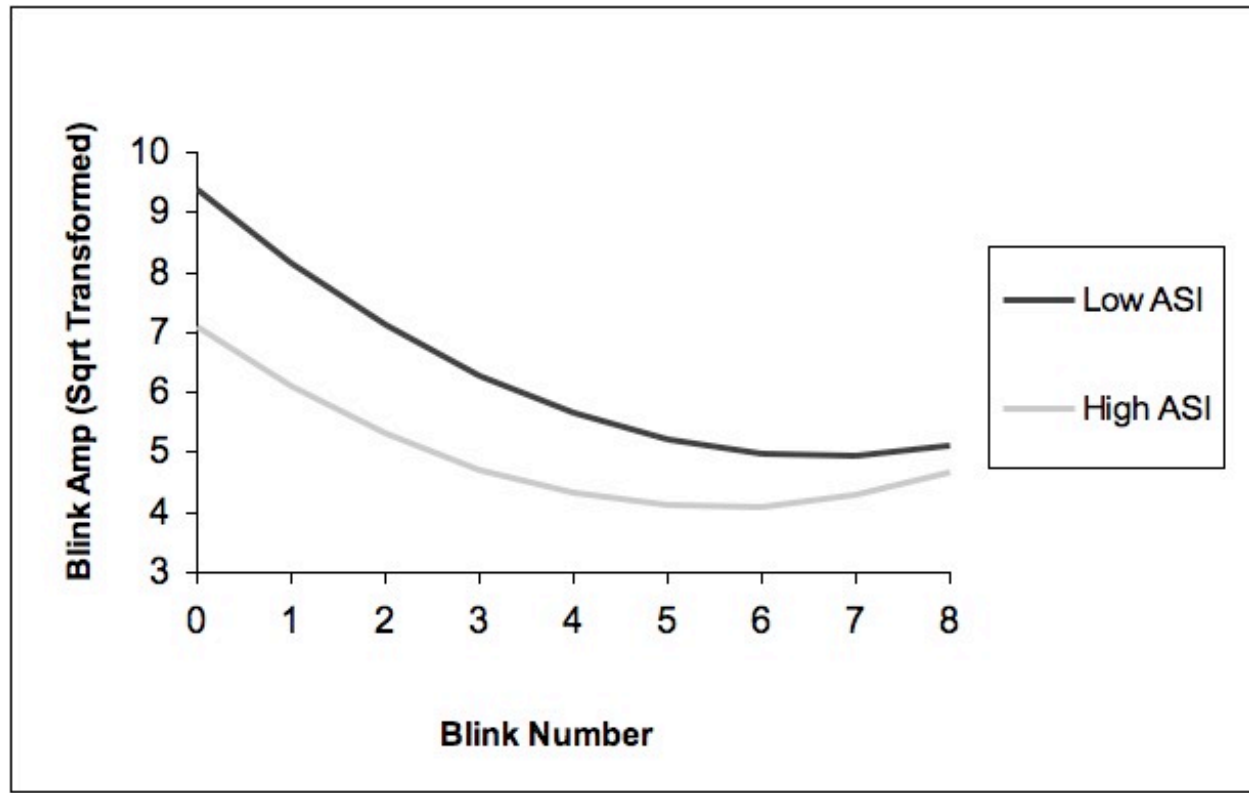**Figure 2.** Mean EMG amplitude for all three samples.
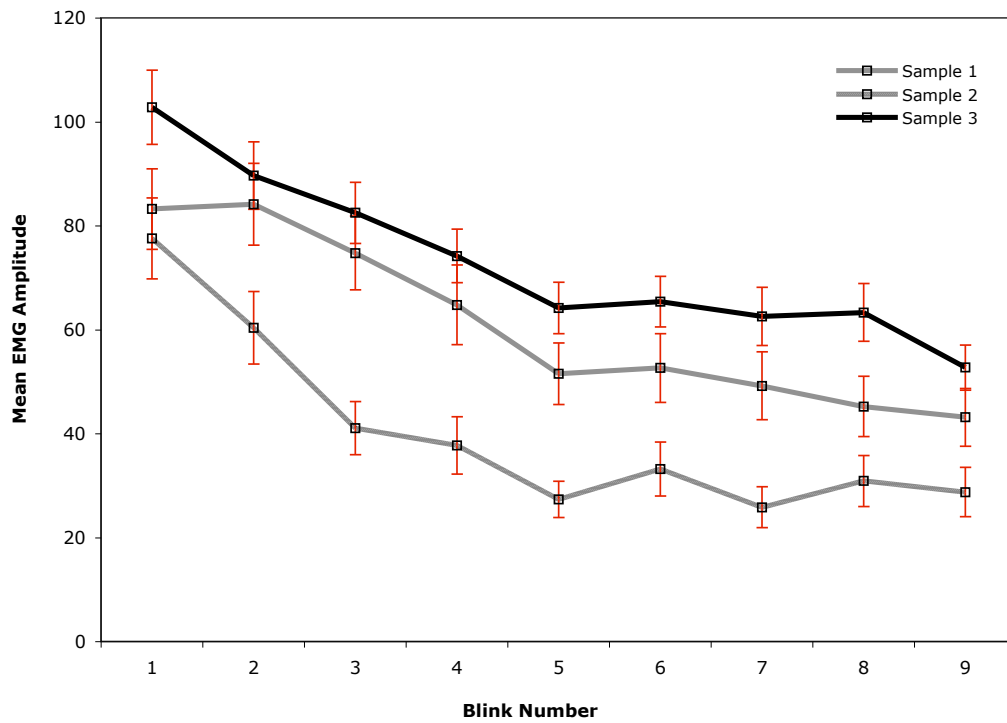
Figure 3. Sample 1: ASI by linear time interaction.

Note. Linear time effect for low ASI: $b = -.664$, $t = -6.96$, $p < .0001$; linear time effect for high ASI: $b = -.548$, $t = -5.76$, $p < .0001$.
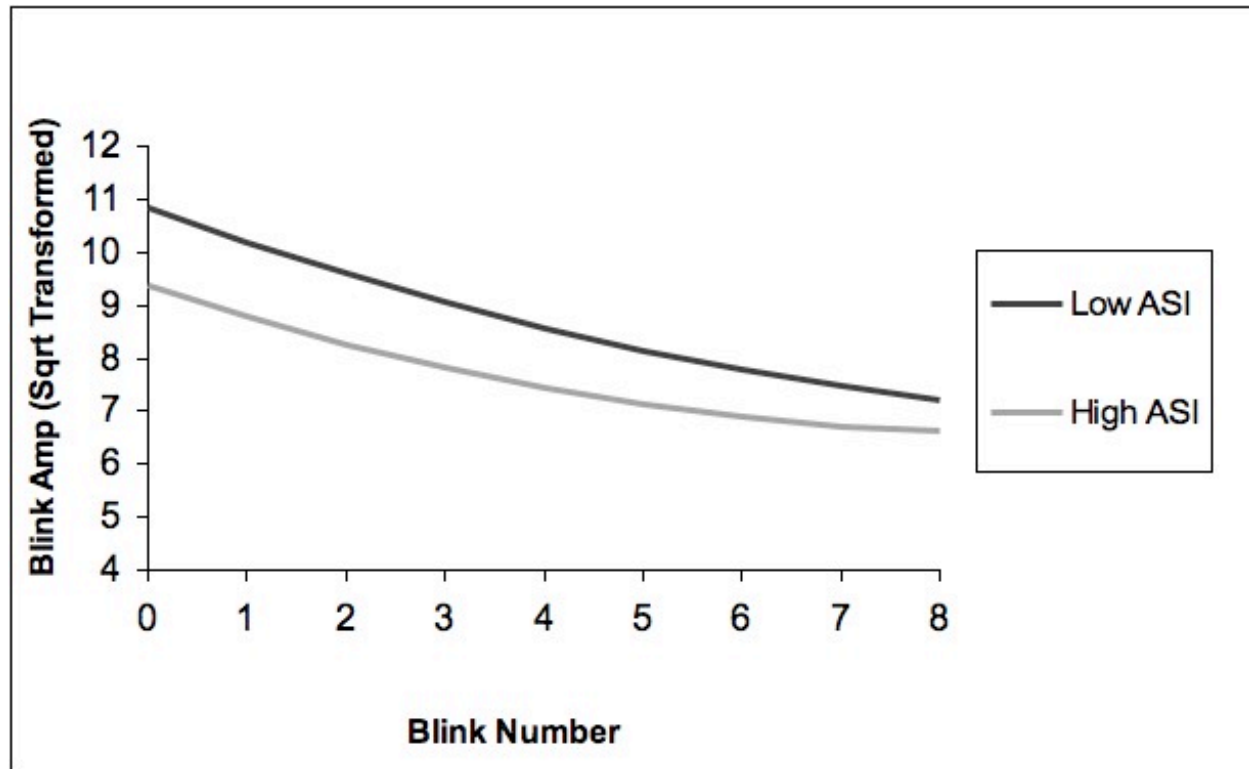
Figure 4. Sample 2: ASI by linear time interaction.

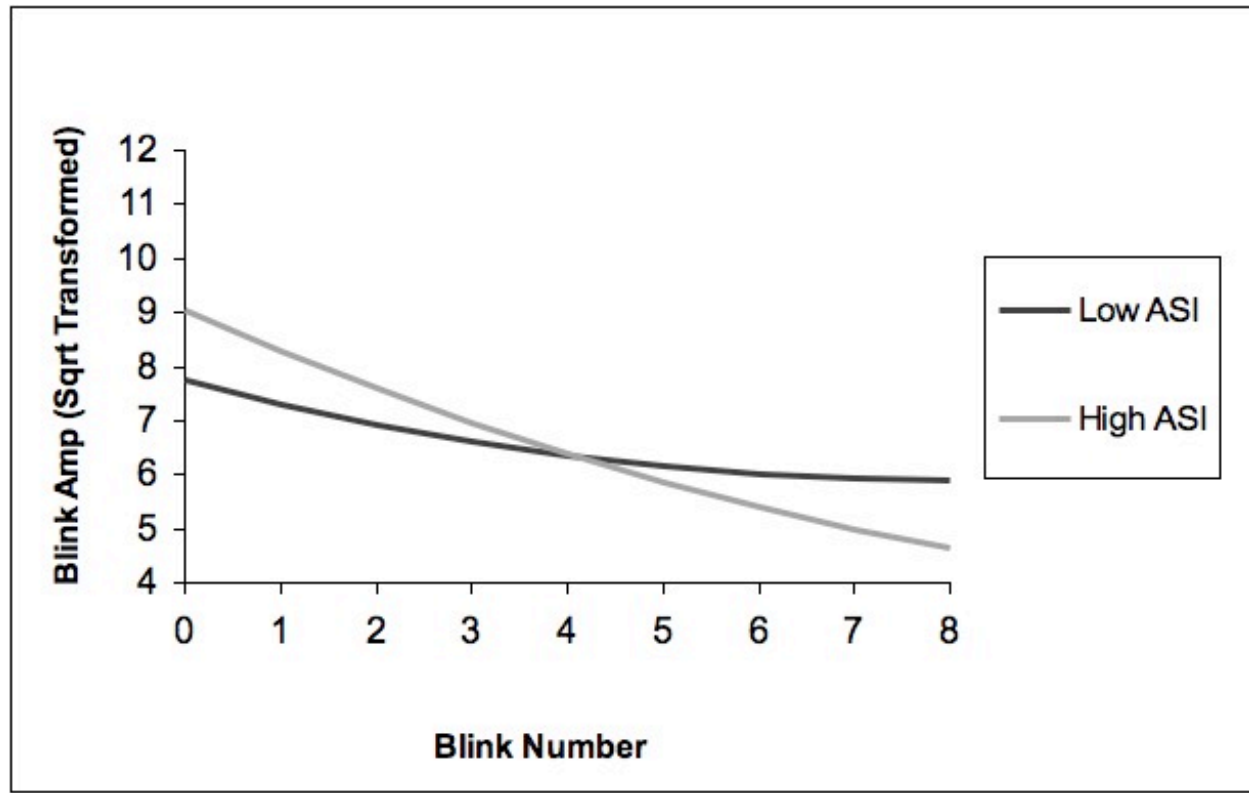*Note.* Linear time effect for low ASI: $b = -1.32$, $t = -11.12$, $p < .0001$; linear time effect for high ASI: $b = -1.09$, $t = -9.20$, $p < .0001$.

Figure 5. Sample 3: Non-significant ASI x linear time interaction in females.

Note. Linear time effect for low ASI females: $b = -.684$, $t = -5.78$, $p < .0001$; linear time effect for high ASI females: $b = -.615$, $t = -5.33$, $p < .0001$.

Figure 6. Sample 3: Significant ASI x linear time interaction in males.

Note. Linear time effect for low ASI males: b = -.461, t = -3.55, p < .001; linear time effect for high ASI males: b = -.782, t = -5.60, p < .0001.

Table 1. Demographics and personality characteristics within each sample.

	Sample 1	**Sample 2**	**Sample 3**
% Female	59.6[1]	73.6[2]	63.4[1]
Age	19.46 (2.23)	19.89 (2.80)	19.57 (1.81)
ASI	18.69 (11.93)[a]	21.19 (9.50)[a]	18.85 (13.87)[b]
NE	12.69 (7.66)	14.30 (7.42)	13.25 (8.21)
Mean Blink Magnitude	60.54[a] (55.73)[1]	40.24b (30.26) [2]	72.19a (54.56)[1]
Blink 1	83.21[1] (72.94)[a]	77.57[1] (56.64)[a]	102.80[2] (85.50)[b]
Blink 9	43.14[1] (52.34)[a]	28.75[1] (34.72)[b]	52.70[3] (52.17)[c]
Ethnicity (%)			
African American	6.9	11.6	9.5
Caucasian	34.5	40.6	37.3
Asian	21.8	26.1	27.8
Hispanic/Latino	29.9	14.5	18.3
'Other'	6.9	7.2	7.1

Note. Data are presented as % of the current sample or mean (*SD*), when appropriate; numerical superscripts indicate significant differences in means from the other two samples; alphabetical superscripts indicate significant different variances from the other two samples.

Table 2. Results from linear regression analyses and random coefficients analyses in all three samples.

	Sample 1	Sample 2	Sample 3
Regression - Raw			
Gender	$\beta = -.097$	$\beta = .103$	$\beta = -.043$
ASI	$\beta = -.234*$	$\beta = -.328*$	$\beta = .262$
Regression - PC			
Gender	$\beta = -.068$	$\beta = .046$	$\beta = -.096$
ASI	$\beta = -.248*$	$\beta = -.203$	$\beta = .268$
Random Coefficients			
Linear	$b = -.606**$	$b = -1.21**$	$b = -.663**$
Quadratic	$b = .029*$	$b = .099**$	$b = .034*$
Gender	$b = .990$	$b = -.566$	$b = 1.64*$
ASI	$b = -.001$	$b = -.119*$	$b = .046$
ASI*Time	$b = .005*$	$b = .012**$	$b = -.011*$

Note. $*p < .05$; $**p < .01$.

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Taylor, S.: Anxiety Sensitivity: Theory, Research and Treatment of the Fear of Anxiety. Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc, 1999.

Taylor, S., and Cox, B.J.: An expanded anxiety sensitivity index: Evidence for a hierarchic structure in a clinical sample. J. Anxiety Disord. 12: 463-484, 1998.

Taylor, S., Zvolensky, M.J., Cox, B.J., Deacon, B., Heimberg, R.G., Ledley, D.R., Abramowitz, J.S., … Bouvard, M.: Robust dimensions of anxiety sensitivity: development and initial validation of the Anxiety Sensitivity Index—3. Psychol. Assessment 19: 176-188, 2007.

Thompson, R.F., and Spencer, W.A.: Habituation: A model phenomenon for the study of neuronal substrates of behavior. Psychol. Rev. 73: 16-43, 1966.

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Zvolensky, M.J., McNeil, D.W., Porter, C.A., and Stewart, S.H.: Assessment of anxiety sensitivity in young American Indians and Alaska Natives. Behav. Res. Ther. 39: 477–93, 2001.

Zvolensky, M.J., Kotov, R., Antipova, A.V., and Schmidt, N.B.: Diathesis-stress model for panic-related distress: a test in a Russian epidemiological sample. Behav. Res. Ther. 43: 521–32, 2005.

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
Chicago, Illinois 60612-7227

Approval Notice
Continuing Review

July 13, 2011

Stewart Shankman, Ph.D.
Psychology
912 S. Wood Street, 4th Floor
M/C 285
Chicago, IL 60612
Phone: (312) 355-3812 / Fax: (312) 413-4122

RE: Protocol # 2005-0626
        "Emotional Processing and Physiology"

Dear Dr. Shankman:

Your Continuing Review was reviewed and approved by the Expedited review process on July 7, 2011. You may now continue your research.

Please note the following information about your approved research protocol:

Protocol Approval Period: July 7, 2011 - July 5, 2012
Approved Subject Enrollment #:   655
Additional Determinations for Research Involving Minors: The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. Therefore, in accordance with 45CFR46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed
Performance Site: UIC
Sponsor: NARSAD (Nat'l Alliance for Research on Schizophrenia and Depression), Office of Social Science Research (OSSR), NIMH - National Institute of Mental Health, Department of Psychology
PAF#:   _   2008-00188, Not available, Not available,2008-05183
Grant/Contract No: Not available, Not available, Not available,1R21MH080689-01A2
Grant/Contract Title: Neurobehavioral processes that are common and/or specific to major depression and anxiety: an fMRI study, Not available, Not available, Anticipating reward & threat: A test of biobehavioral processes in MDD vs anxiety
Research Protocol:
   a) "Emotional Processing and Physiology", Version #6, 09/06/2010

Recruitment Materials:

a) Recontact letter - Emotional Processing and Physiology-Recontact.G, Version 1, 10/16/2009

b) Recontact script - Emotional Processing and Physiology-Recontact.G, Version 1, 10/16/2009

c) Flyer with contact tags, Emotion and Brain (how your're feeling), Version #4, 09/06/2010

d) Flyer with contact tags, Emotion and Brain (panic attacks), Version #4, 09/06/2010

e) Flyer - no tags, Emotion and Brain (depression), Version #4, 09/06/2010

f) Flyer - no tags, Emotion and Brain (panic attacks), Version #4, 09/06/2010

g) Flyer - no tags, Emotion and Brain (how you're feeling), Version #4, 09/06/2010

h) Flyer with contact tags, Emotion and Brain (depression), Version #4, 09/06/2010

i) Re-contact information sheet - version #1 - 5/6/2009

Informed Consents:

a) Emotional Processing, Informant, August 2009, Version #3, 08/04/2009

b) Emotional Processing-fMRI, August 2009, Version #4, 08/04/2009

c) Emotional Processing-Group PSY100.G, August 2009, Version #4, 08/04/2009

d) Emotional processing-Group PSY100.NG, August 2009, Version #3, 08/04/2009

e) Emotional processing-recontact.G, November 2009, Version 2, 11/23/2009

f) Emotional processing-Retest, Version 3, 09/06/2010

g) Emotional processing-Group C, Version #6, 09/06/2010

h) Emotional processing-Group NC, Version #6, 09/06/2010

i) Waiver of Signed Consent Document granted under 45 CFR 46.117 for telephone screening

j) Waiver of Informed Consent granted under 45 CFR 46.116(d) only for recontacting previously enrolled subjects.

Parental Permission:

a) A waiver of parental permission has been granted under 45 CFR 46.116(d) and 45 CFR 46.408(c); however, as per UIC Psychology Subject Pool policy, as least one parent must sign the Blanket Parental Permission document prior to the minor subject's participation in the UIC Psychology Subject Pool.

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
06/29/2011	Continuing Review	Expedited	07/07/2011	Approved

Please remember to:

→ Use your **research protocol number** (2005-0626) on any documents or correspondence with the IRB concerning your research protocol.
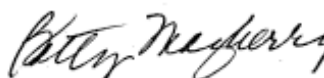
→ Review and comply with all requirements on the enclosure,
 "UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the right 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) 355-2764. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Betty Mayberry, B.S.
IRB Coordinator, IRB # 3
Office for the Protection of Research Subjects

Enclosures:
1. **UIC Investigator Responsibilities, Protection of Human Research Subjects**
2. **Data Security Enclosure**
3. **Informed Consent Documents:**
    a) Emotional Processing, Informant, August 2009, Version #3, 08/04/2009
    b) Emotional Processing-fMRI, August 2009, Version #4, 08/04/2009

    c) Emotional Processing-Group PSY100.G, August 2009, Version #4, 08/04/2009

    d) Emotional processing-Group PSY100.NG, August 2009, Version #3, 08/04/2009

    e) Emotional processing-recontact.G, November 2009, Version 2, 11/23/2009

    f) Emotional processing-Retest, Version 3, 09/06/2010

    g) Emotional processing-Group C, Version #6, 09/06/2010

    h) Emotional processing-Group NC, Version #6, 09/06/2010

4. **Recruiting Materials:**

    a) Recontact letter - Emotional Processing and Physiology-Recontact.G, Version 1, 10/16/2009

    b) Recontact script - Emotional Processing and Physiology-Recontact.G, Version 1, 10/16/2009

    c) Flyer with contact tags, Emotion and Brain (how your're feeling), Version #4, 09/06/2010

    d) Flyer with contact tags, Emotion and Brain (panic attacks), Version #4, 09/06/2010

    e) Flyer - no tags, Emotion and Brain (depression), Version #4, 09/06/2010

    f) Flyer - no tags, Emotion and Brain (panic attacks), Version #4, 09/06/2010

    g) Flyer - no tags, Emotion and Brain (how you're feeling), Version #4, 09/06/2010

    h) Flyer with contact tags, Emotion and Brain (depression), Version #4, 09/06/2010

    i) Re-contact information sheet - version #1 - 5/6/2009

cc: Gary E. Raney, Psychology, M/C 285
            OVCR Administration, M/C 672

MIRANDA L. (NELSON) CAMPBELL
CURRICULUM VITAE

EDUCATION

2012-2014	Doctor of Philosophy, Clinical Psychology University of Illinois at Chicago, Chicago, IL Advisor: Dr. Stewart Shankman
2009-2012	Master of Arts, Clinical Psychology University of Illinois at Chicago, Chicago IL Advisor: Dr. Stewart Shankman
2002-2006	Bachelor of Arts, Psychology Bachelor of Music – Vocal Music Emphasis Augsburg College, Minneapolis, MN Advisor: Dr. Nancy Steblay

Master's Thesis: Personality Correlates of Startle Habituation: An Examination in Three Separate Samples. Master of Arts in Clinical Psychology, The University of Illinois at Chicago, Chicago, IL, 2012. Committee: Dr. Stewart Shankman (Chair), Dr. Ellen Herbener, Dr. Jon Kassel.

PUBLICATIONS

2008	White, T., **Nelson, M.L**., Lim, K.O. Diffusion Tensor Imaging in Psychiatric Disorders. (2008). *Topics in Magnetic Resonance Imaging*, *19*, 97-109.
2009	Wozniak, J.R., Muetzel, R.L., Mueller, B.A., McGee, C.L., Freerks, M.A., Ward, E.E., **Nelson, M.L**., Chang, P., Lim, K.O. (2009) Microstructural Corpus Callosum Anomalies in Children with Prenatal Alcohol Exposure: An Extension of Previous Diffusion Tensor Imaging (DTI) Findings.
2010	Wozniak, J.R., Mueller, B.A., Muetzel, R.L., Bell, C.J., Hoecker, H.L., **Nelson, M.L.,** Chang, P., Lim, K.O. (2010). Inter-hemispheric functional connectivity disruption in children with prenatal alcohol exposure. Alcoholism: Clinical and Experimental Research, 33, 1825-1835.
2011	Shankman, S.A, Robison-Andrew, E.J., Nelson, B.D., Altman, S.E., & **Campbell, M.L.** (2011). Effects of predictability of shock timing and intensity on fearful and anxious responses. International Journal of Psychophysiology, 80, 112-118.
2011	Gorka, S., Nelson, B.D., Porges, S.W., Sarapas, C., **Campbell, M.L.,** Lewis, G.F., Shankman, S.A. (submitted). Resting heart rate variability as a predictor of startle responses to predictable and unpredictable threat.

2012   Nelson, B.D., Sarapas, C., Robison-Andrew, E.J., Altman, S.E., **Campbell, M.L**., & Shankman, S.A. (2012). Frontal brain asymmetry in depression with comorbid anxiety: A neuropsychological investigation. *Journal of Abnormal Psychology, XX, XXXX.*

2012   Shankman, S.A., **Campbell, M.L.,** Klein, D.N., Leon, A.C., Keller, M.B., Markowitz, J.C., Rothbaum, B.O., Thase, M.E., & Koscis, J.H. (submitted). Dysfunctional attitudes as a moderator of pharmacotherapy and psychotherapy in chronic depression.

2012   Gorka, S., McGowan, S.K., **Campbell, M.L**., Nelson, B.D., Sarapas, C., Bishop, J.R., & Shankman, S.A. (submitted). Resting sinus arrhythmia as a predictor of startle habituation in two independent samples.

2012   **Campbell, M.L.,** Nelson, B.D., Sarapas, C., McGowan, S.K., Gorka, S., Altman, S.E., Robison-Andrew, E.J., Shankman, S.A. (in preparation). Personality correlates of startle habituation: An examination in three separate samples.

HONORS AND AWARDS

2006   Graduated Cum Laude, Augsburg College

2006   Received Departmental Honors in Psychology
Augsburg College

2005   Inducted as a member of Psi Chi, The National Honor Society in Psychology

POSTERS/PRESENTATIONS

2005   **Nelson, M.L**., Steblay, N.S. Evaluating the Fairness of Police Lineups in Hennepin County, Minnesota. (April, 2005). Presented at Minnesota's Private Colleges Day at the Capitol, St. Paul, Minnesota.

2008   Wozniak, J.R., Freerks, M.A., Mueller, B.A., Muetzel, R.L., Chang, P. -N., Ward, E., **Nelson, M.L.**, Lim, K.O. (April, 2008). Executive Functioning Correlates of Frontal White Matter Deficits in Children with Fetal Alcohol Spectrum Disorders. Presented at the International Neuropsychological Society meeting, Waikoloa, Hawaii.

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

2010   Altman, S.E., **Nelson, M.L.,** Faust, J., Shankman, S.A. (October, 2010). Understanding the comorbidity of bulimia nervosa and obsessive compulsive disorder: A startle study of aversiveness sensitivity. Poster presented at the 16th annual Eating Disorders Research Society meeting, Cambridge, MA.

2011   Katz, A.C., Nelson, B.D., Robison-Andrew, E.J., Altman, S.E., **Campbell, M.L**., Sarapas, C., Gorka, S. & Shankman, S.A. (2011). *The moderating effect of trait positive emotionality on EEG asymmetry recorded during a reward processing task*. Poster presented at the 25th annual meeting of the Society for Research in Psychopathology, Boston, MA.

2011   Sarapas, C., Bishop, J.R, Nelson, B.D., **Campbell, M.L**., Robison-Andrew, E.J., Altman, S.E., Katz, A.C., Gorka, S.M., McGowan, S.K., & Shankman, S.A. (September, 2011). *Indirect genetic effects on internalizing symptoms through frontal EEG asymmetry*. Poster presented at 25th annual meeting of the Society for Research in Psychopathology, Boston, MA.

2011   Gorka, S.M., Nelson, B.D., Sarapas, C., **Campbell, M.L**., Robison-Andrew, E.J., Altman, S.E., & Shankman, S.A. (September, 2011). *Resting heartrate variability as a predictor of startle responses to predictable and unpredictable threat*. Poster presented at the 25th Annual Society for Research in Psychopathology, Boston, MA.

2011   **Campbell, M.L.**, Nelson, B.D., McGowan, S.K., Robison-Andrew, E.J., Sarapas, C., Altman, S.E., Gorka, S., Katz, A.C., Shankman, S.A. (September, 2011). *Startle Habituation in Individuals With Depression and/or Panic Disorder*. Poster presented at 25th annual meeting of the Society for Research in Psychopathology, Boston, MA.

2011   Nelson, B.D., Sarapas, C., **Campbell, M.L**., Robison-Andrew, E.J., Altman, S.E., Katz, A.C., Gorka, S., McGowan, S.K., & Shankman, S.A. (September, 2011). *Comparing sensitivity to unpredictable threat versus DSM defined panic disorder on how they predict family history of panic disorder*. Poster presented at the 25th Annual Society for Research in Psychopathology, Boston, MA.

RESEARCH EXPERIENCE

2009-present   Graduate Research Assistant, University of Illinois at Chicago, Chicago, Illinois

- Conducted experiments as part of Dr. Stewart Shankman's

Affective Science and Physiological Research lab

- Used methods such as electroencephalography (EEG), electromyography (EMG), heart rate variability, and magnetic resonance imaging.
- Conducted diagnostic interviews (SCID's) with study participants, including individuals from both clinical and non-clinical populations.
- Administered neuropsychological testing procedures to participants.
- Processed and analyzed psychophysiological data
- Assisted in the preparation of research posters and publications.

2007-2010   Senior Research Assistant, University of Minnesota Medical
             School, Department of Psychiatry, Minneapolis, Minnesota

- Independently ran MRI scans on a variety of clinical populations for research purposes.
- Processed data using software such as FreeSurfer and FSL, checked the quality of the data, and conducted analyses of the data using SPSS and TBSS.
- Attended weekly lab meetings, and assisted in the preparation of manuscripts and posters.

Supervisor: Dr. Kelvin Lim

2005   Intern, The Bureau of Criminal Apprehension, Predatory Offenders
             Unit (POR), St. Paul, Minnesota

- General office work, mass mailings, organizing training materials for state-wide training sessions regarding 2005 legislative changes for sex offenders

- Updated offender information in the POR database by processing change of information forms

- Assisted the BCA Crime Scene Team

- Attended POR training at various sites including MCF-Lino Lakes and the Hennepin County Home School.

Supervisor: Ann Marie O'Neill

2005   Research Assistant, Augsburg College Department of Psychology,
             Academic Fellows Summer Research Program, Minneapolis,
             Minnesota
             Project Title: Evaluating the Fairness of Police Lineups in
             Hennepin County, MN

- Worked with Dr. Nancy Steblay on a study involving eyewitness testimony and police lineup procedures, in conjunction with the Hennepin County Attorney's Office and the National Institute of Justice.

- Acquired this position after applying for the Augsburg College Academic Fellows Summer Research Program.
- Constructed a literature review, recruited study participants, collected and analyzed data, wrote a research paper, and presented results at various poster sessions across Minnesota.

Supervisor: Dr. Nancy Steblay

CLINICAL EXPERIENCE

2009-present   **Office of Applied Psychological Services (UIC Department of Psychology)**
University of Illinois-Chicago, *Chicago, IL*

- Provided psychological assessments, intake interviews, and individual psychotherapy services.
  <u>Supervisors</u>: Gloria Balague, Ph.D., Nancy T. Dassoff, Ph.D., Audrey J. Ruderman, Ph.D.

2011-2012   **University of Illinois-Chicago Medical Center Department of Psychiatry,** *Chicago, IL*

- Provided group and individual psychotherapy services to psychiatric inpatients.
  <u>Supervisor:</u> Stewart Shankman, Ph.D.

2007-2008   **St. David's Child Development and Family Services,** *Minnetonka, MN*

- Provided skills training services to a child with Pervasive Developmental Disorder, ADHD, and other emotional problems.
- Assisted the child in improving her quality of life by decreasing aggressive behavior, increasing her understanding of emotions and the ability to communicate those emotions in a healthy manner, an increased ability to be independent in personal hygiene.

2006-2007   **The Lovaas Institute for Early Intervention**, *Minneapolis, MN*

- Provided early intervention services to young children with autism, using principles of Applied Behavioral Analysis.
- Used positive reinforcement to aid in the development of social skills, language, independent play, hand-eye coordination, and self-control measures.
- Took data on responses, and summarized progress after each session.
- Additionally, participated in weekly team meetings, and assisted in teaching family members the techniques of Applied Behavioral Analysis.

SKILLS/QUALIFICATIONS

* Experience participating in all stages of the research process, including study design and preparation, collecting and analyzing data, writing research papers, and presenting results and methodologies

* Knowledgeable of various computer programs, including Microsoft Office, Adobe, SPSS, SAS, and PowerPoint

* Experience and training in conducting longitudinal data analyses (*i.e.* multi-level modeling, hierarchical linear modeling)

* Experience working under Linux, Windows, and Macintosh operating systems

* Knowledgeable of various software packages used in data analysis of fMRI, MRI, and DTI brain imaging data, including FSL and Freesurfer

* Extensive clinical experience working with adults and children with a wide variety of mental conditions