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# Using the NEO-PI-R Personality Domains to Predict Success of Exposure Therapy for Social Anxiety Disorder

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A Thesis in the Field of Psychology

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## Abstract

Social Anxiety Disorder is a common anxiety disorder that negatively affects individuals' lives. The standard treatment for this anxiety disorder is exposure-based cognitive-behavioral therapy during which an individual's anxiety is reduced by exposure to feared social situations in controlled settings. The aim of exposure is for the experience of social fear, without the feared outcome, to encode an extinction memory that what was once fearful no longer needs to be feared. However, clinicians do not find this approach effective for every case. Therefore, it is important to identify unique characteristics of individuals that may predict outcomes for the treatment in order to improve results. The Neuroticism, Extraversion, Openness to Experience personality inventory revised (NEO-PI-R) assesses individuals in five domains, which include Neuroticism, Extraversion, Openness to Experience, Conscientiousness, and Agreeableness. The current study aimed to investigate if there was a relationship between the NEO-PI-R personality domains and exposure therapy treatment outcomes in individuals with Social Anxiety Disorder. The study included thirty-two subjects with Social Anxiety Disorder, who participated in a 5-week exposure therapy treatment. Anxiety was measured using the Liebowitz Social Anxiety Scale (LSAS). Participants completed the LSAS and NEO-PI-R before treatment. Hypothesis 1 was that individuals high in Extraversion would demonstrate the greatest improvement in LSAS scores. Hypothesis 2 was that individuals high in Neuroticism would demonstrate the least improvement in LSAS scores. The results supported Hypothesis 2 but not Hypothesis 1

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# Chapter I

## Introduction

Social Anxiety Disorder is a common anxiety disorder with a 7%-9% prevalence rate in the United States (American Psychiatric Association, 2013) that often presents with other mental disorders (Ohayon & Schatzberg, 2010; American Psychiatric Association, 2013; Koyuncu et al., 2014). Social Anxiety Disorder may interfere with the individual's personal, professional and academic life (Eng, Coles, Heimberg, & Safren, 2005; Barrera & Norton, 2008; Sung et al., 2012; Jazaieri, Goldin, & Gross, 2016), which makes effective treatment vital to quality of life.

## Social Anxiety Disorder

Social Anxiety Disorder is an excessive and debilitating fear of adverse judgment by others in social situations that is present for 6 months or more. An individual with Social Anxiety Disorder feels extreme anxiety in social situations or avoids them completely, which disrupts everyday life (American Psychiatric Association, 2013). Social Anxiety Disorder symptoms typically start in adolescence, between ages 8 and 15 years old. The average age of onset is 13 years old (American Psychiatric Association, 2013). Females are diagnosed with Social Anxiety Disorder more than males with an odds ratio from 1.5 to 2.2 (American Psychiatric Association, 2013). Further, individuals with Social Anxiety Disorder are at greater risk for and often concurrently experience an additional mental disorder such as Major Depressive Disorder, Alcohol Dependence or

other anxiety disorders (American Psychiatric Association, 2013; Beesdo et al., 2007). For instance, 35% - 70% of individuals with Social Anxiety Disorder also have Major Depressive Disorder, 3% - 21% have Bipolar Disorder (Koyuncu et al., 2014), and 59% have other phobias (Ohayon & Schatzberg, 2010). Koyuncu et al. (2014) found that close to 90% of the 247 subjects with Social Anxiety Disorder included in their study exhibited at least one comorbid condition. Among the 247 subjects, Major Depressive Disorder was the most common with a lifetime comorbidity rate of 74.5%. 15.4% were reported to have Bipolar Disorder, and comorbidity with other anxiety disorders was reported at a lifetime rate of 27.5%. Comorbid anxiety-related disorders included Specific Phobia, Panic Disorder, Generalized Anxiety Disorder, Post-Traumatic Stress Disorder, and Obsessive-Compulsive Disorder. [However, Obsessive-Compulsive Disorder and Post-Traumatic Stress Disorder are no longer considered anxiety disorders in the DSM-5 (American Psychiatric Association, 2013)]. In many cases, Social Anxiety Disorder is present before onset of the other condition (American Psychiatric Association, 2013). For example, a study consisting of 18,980 subjects from the general population in five European countries including the United Kingdom, Germany, Italy, Portugal, and Spain found that, of the individuals with Social Anxiety Disorder, 19.5% had both Social Anxiety Disorder and Major Depressive Disorder. (The study used the DSM-IV diagnostic criteria for the disorders.) Of the subjects with Social Anxiety Disorder and Major Depressive Disorder, 65.5% reported having Social Anxiety Disorder prior to their first Major Depressive episode (Ohayon & Schatzberg, 2010). This demonstrates that individuals with Social Anxiety Disorder are at risk for other mental health disorders such as Major Depressive Disorder and Substance Abuse (Beesdo et al., 2007).

Additionally, mood disorders can exacerbate Social Anxiety Disorder symptoms (Koyuncu et al., 2014). However, Social Anxiety Disorder alone significantly disrupts an individual's life.

Social Anxiety Disorder negatively affects several aspects of individuals' lives. Individuals with Social Anxiety Disorder often have fewer friends and do not marry as frequently as individuals without the diagnosis (American Psychiatric Association, 2013). Further, individuals with Social Anxiety Disorder have higher school dropout rates, lower employment, and are less productive at work than the general population (Aderka et al., 2012). This can contribute to an overall decline in life satisfaction. Jazaieri, Goldin, and Gross (2016) used the Satisfaction with Life Scale to measure quality of life in individuals with Social Anxiety Disorder. The Satisfaction with Life Scale is a 5-item questionnaire. Higher scores indicate a higher satisfaction with life, and lower scores indicate a lower satisfaction with life. Results showed individuals with Social Anxiety Disorder had significantly lower life satisfaction than the healthy control group [$t(163) = -5.14$, $p<.001$]. The mean score for individuals with Social Anxiety Disorder was 14.88 with a standard deviation of 8.38 compared to the healthy control's mean score of 21.83 with a standard deviation of 0.68. This demonstrated how Social Anxiety Disorder substantially impacts the individual's quality of life. Eng, Coles, Heimberg, and Safren (2005) conducted a similar study with 138 subjects with Social Anxiety Disorder. They used the Quality of Life Inventory, which consisted of four subjective areas of life satisfaction including Achievement, Social Functioning, Personal Growth, and Surroundings. Achievement evaluated individuals' feelings about their professional and financial accomplishments. Social Functioning assessed individuals' level of contentment

with their social life and relationships. Personal Growth evaluated satisfaction with goals to achieve personal fulfillment. Surroundings evaluated individuals' feelings about their physical environment (e.g., level of crime, aesthetics of where they live, etc.). Results showed subjects with Social Anxiety Disorder had significantly lower scores for Achievement and Social Functioning compared to the other two areas, Personal Growth and Surroundings. As previously noted, individuals with Social Anxiety Disorder can struggle in professional and social aspects of their life, so it is not surprising that they would score lower in these areas of life satisfaction. The subjects then participated in cognitive-behavioral group therapy to address their Social Anxiety Disorder. After treatment, the subjects completed the Quality of Life Inventory again. The scores for Personal Growth and Surroundings remained relatively stable from pre- to post-treatment. However, Achievement and Social Functioning scores significantly improved. The mean score for Achievement increased by 120%, and the mean for Social Functioning increased 94%. This study demonstrates the potential benefit of treatment for Social Anxiety Disorder.

## Exposure Therapy

Exposure therapy is the gold-standard treatment for many anxiety disorders. The aim of exposure therapy is to decrease fear by learning that what was originally feared need no longer be feared (i.e., therapeutic fear extinction). In a regulated setting, the clinician exposes the individual to her source of fear in order to confront and not avoid the resultant anxiety. Learned tolerance of this anxiety is an important component of therapeutic extinction learning. Exposure can occur in different ways. One method, known as *in vivo* exposure, is for the clinician to physically expose the individual to the

feared stimulus in a naturalistic setting. Another approach is to have the individual imagine what she fears (McNally, 2007). Repeated exposure creates a new association with the stimulus that reduces anxiety (i.e., an extinction memory). The new inhibitory memory competes with but does not completely eliminate the original fear. Part of the original association is retained in the individual's memory, so it is possible for the fear to return. This can happen in different ways including new contextual renewal (e.g., encountering fear in a new environment) or spontaneous recovery, which is when a fear extinction memory returns merely after time passes (Craske et al., 2008). Therefore, long-term success of the treatment depends on the patient's ability to apply these new associations outside the controlled therapy setting, which requires the consolidation and generalization of extinction memory (Pace-Schott, Germain, & Milad, 2015).

In general, exposure therapy is an effective treatment for many anxiety disorders, but it may not be the best treatment option for every person. In fact, some clinicians are hesitant to use exposure therapy. Meyer, Farrell, Kemp, Blakey, and Deacon (2014) aimed to investigate why some clinicians do not use exposure therapy for their clients with anxiety disorders. 182 clinicians were surveyed using the Broken Leg Exception Scale, which is a 25-item questionnaire designed to evaluate why clinicians do not include their patients in exposure therapy. Results showed the primary sources of clinicians' concern included the clients' comorbid disorder, emotional vulnerability, and the clients' potential resistance to the type of treatment. Deacon et al. (2013) found similar results with their Therapist Beliefs about Exposure Scale, which consisted of 21 potential reasons why a clinician would hesitate to use exposure therapy. Each item was ranked on a 5-point Likert scale (0 = disagree strongly to 4 = agree strongly). Higher

scores indicated that the clinician was in agreement with the reason for not using exposure therapy. The results found one of the clinicians' primary concerns about the treatment was how their clients would react to the stress of being exposed to the anxiety-inducing fear. For instance, the items "Most clients have difficulty tolerating the distress of exposure therapy" and "Arousal reduction strategies, such as relaxation or controlled breathing, are often necessary for clients to tolerate the distress exposure therapy evokes" had the highest mean scores (mean = 2.25, SD = 1.21; mean = 2.71; SD = 1.28, respectively). Given practitioners' reluctance to use exposure therapy, it might be useful to identify which clients benefit most. The assessment of personality traits may be one way to investigate this.

## NEO-PI-R Test

The NEO-PI-R (Costa & McCrae, 1992) is a 240-question test used to evaluate individuals in five personality domains and thirty personality facets (six per domain). There is a self-report version, Form S, and an observer version, Form R. The domains include Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness. Individuals high in Neuroticism exhibit a more negative emotional state and are at greater risk for developing phobias or depression than individuals with lower scores in the domain (Costa & McCrae, 1992). However, high Neuroticism does not necessarily mean an individual will have a mental disorder. Conversely, not all individuals with mental disorders rank high in Neuroticism (Costa & McCrae, 1992). Extraverts enjoy the company of people. They also tend to be more confident, positive, and lively. In contrast to extraverts, introverts prefer to spend time alone. They are also quieter than extraverts (Costa & McCrae, 1992). Individuals high in Openness to

Experience are inquisitive, imaginative, and interested in learning about the world around them as well as the inner self. Divergent thinking is another characteristic of Openness to Experience, which is associated with creativity (McCrae & Costa, 1992). Agreeable individuals are compassionate and willing to provide assistance when needed. They are generally well-liked and get along with others. Agreeable individuals generally exhibit fewer mental health problems (Costa & McCrae, 1992). The last domain in the NEO-PI-R is Conscientiousness. Individuals high in Conscientiousness are focused, driven, and follow through on tasks. The domains are believed to be orthogonal. An individual can be high in multiple domains or low in multiple domains (Costa & McCrae, 1992).

The facets under Neuroticism are Anxiety, Angry Hostility, Depression, Self-Consciousness, Impulsiveness, and Vulnerability. The facets under Extraversion are Warmth, Gregariousness, Assertiveness, Activity, Excitement-Seeking, and Positive Emotions. The facets associated with Openness to Experience are Fantasy, Aesthetics, Feelings, Actions, Ideas, and Values. The facets under Agreeableness are Trust, Straightforwardness, Altruism, Compliance, Modesty, and Tender-Mindedness. The facets under Conscientiousness are Competence, Order, Dutiful, Achievement Striving, Self-Discipline, and Deliberation (Costa & McCrae, 1992). The facets were not considered in the current study.

## NEO-PI-R and Mental Disorders

The NEO-PI-R has often been used to investigate how personality characteristics relate to mental disorders. Anxiety sensitivity (Deacon et al., 2003) has been associated with NEO-PI-R domains. Anxiety sensitivity, a “fear of anxiety”, means that individuals feel distress about the potential physical and cognitive symptoms associated with anxiety

(Cox, Borger, Taylor, Fuentes, & Ross, 1999). Anxiety sensitivity has been found to be a predictor of anxiety disorders including Social Anxiety Disorder (Naragon-Gainey, Rutter, & Brown, 2014). Cox, Borger, Taylor, Fuentes, and Ross (1999) sampled 317 college students to investigate the relationship between Anxiety Sensitivity and the NEO-PI-R personality domains. The Anxiety Sensitivity Index was used to measure Anxiety Sensitivity. The researchers conducted a multiple regression analysis with the Anxiety Sensitivity Index total scores and all five NEO-PI-R personality domains. The results showed that Neuroticism had the strongest positive relationship with anxiety sensitivity, and Extraversion had a negative relationship with anxiety sensitivity (multiple regression model R = 0.53). Naragon-Gainey, Rutter, and Brown (2014) looked more closely at the interaction between Extraversion and anxiety sensitivity using the Anxiety Sensitivity Index in relationship to Social Phobia (now known as Social Anxiety Disorder in the DSM-5; American Psychiatric Association, 2013). The Anxiety Sensitivity Index includes a high-level score and a breakdown into three lower-level scores for physical concerns, cognitive concerns, and social concerns. Physical concerns include fearing the physical symptoms of anxiety (e.g., increased heart rate). Cognitive concerns are the individual's fear of losing mental control (e.g., concern about having a mental disorder). Social concerns are a fear of exhibiting anxiety symptoms in a public setting. Results found that the inverse relationship between Extraversion and Social Anxiety Disorder became greater as anxiety sensitivity increased (R = -0.23). The main effect was strongest with the social concern score (R = 0.51). Social Anxiety Disorder has been investigated using the NEO-PI-R in other studies as well. Rector, Bagby, Huta, and Ayearst (2012) examined a relationship between NEO-PI-R personality domains and specific mood and

anxiety disorders diagnosed using the DSM-IV. They included Major Depressive Disorder, Post-Traumatic Stress Disorder, Panic Disorder with and without agoraphobia, Obsessive Compulsive Disorder, and Generalized Social Phobia. Results showed that individuals with Social Anxiety Disorder scored highest in Neuroticism (mean = 70.63; SD = 11.97, $p < .01$), and lowest in Extraversion (mean = 36.47; SD = 12.58, $p < .01$). (The maximum score for each personality domain is 192.) Understanding this relationship is important for prediction of anxiety disorders. However, it is important to take the research a step further and use the NEO-PI-R personality domains to evaluate treatment outcomes for anxiety disorders.

## NEO-PI-R and Treatments for Mental Disorders

There is limited research regarding how NEO-PI-R personality traits affect individual responses to anxiety treatments. Miller (1991) had 101 adult individuals currently participating in psychotherapy complete the NEO-PI to determine how individuals characterized as high and low in each personality domain differed in attitudes toward and responses to treatment. Ninety-one patients were formally diagnosed with a mental disorder using the DSM-III, 7 did not have diagnoses, 3 could not be diagnosed with certainty, and 18 were family members of treatment-seekers. The type of psychotherapy used was different depending on the patient. For instance, Miller stated he first used psychodynamic psychotherapy with individuals high in Extraversion, but then changed to conversational cognitive therapy when the first approach made the patients uncomfortable (p. 424). He found that Neuroticism was associated with the magnitude and duration of negative feelings in an individual. Extraversion was associated with the individual's eagerness to be in treatment. Individuals low in Extraversion had less

excitement for treatment than individuals high in Extraversion. Openness to Experience was associated with an individual's response to the clinician's psychotherapy approach. Agreeableness was associated with how the individual interacted with the clinician. Conscientiousness was associated with the individual's commitment to the tasks required by the psychotherapy.

Miller's work showed how the NEO-PI in clinical settings contributed to a patient's receptivity to psychotherapy. However, his study used various types of psychotherapy and patients with varying or no diagnoses. The current study will narrow the focus to exposure-based interventions for Social Anxiety Disorder and investigate two hypotheses.

## Study Aims and Hypotheses

The research questions included: Is there a relationship between the NEO-PI-R personality domains and exposure therapy outcomes for Social Anxiety Disorder? Do higher scores in a specific domain predict better response to exposure therapy for Social Anxiety Disorder? Do higher scores in a specific domain predict poorer response to exposure therapy for Social Anxiety Disorder? Exposure therapy treatment outcome was measured using the Liebowitz Social Anxiety Scale (LSAS) that has two subscales, fear and avoidance (Liebowitz, 1987). The NEO-PI-R (Costa & McCrae, 1992) was used to evaluate subjects' personality domains.

Hypothesis 1 was that subjects high in Extraversion would have the highest reduction in scores (i.e., percent change) on the LSAS and its subscales from the beginning to end of the treatment.

Hypothesis 2 was that subjects high in Neuroticism would have the lowest reduction (i.e., percent change) in LSAS scores and its subscales.

## Significance of Study

Understanding how scores on the NEO-PI-R personality domains predict response to exposure therapy will help clinicians optimize treatment for their patients (Craske et al., 2008). For example, if an individual high in Neuroticism responds poorly to exposure therapy, the clinician may take a different approach or modify the exposure to improve outcomes. Tailoring treatments to the individual will make it more effective, and hopefully, support long-term success. This is in line with the field of psychiatry's recent focus on "personalized medicine" for patients (Preskorn, 2016).

# Chapter II

## Method

The current study used previously collected data from the Sleep and Anxiety Disorders Laboratory (E. Pace-Schott, Director) in the Department of Psychiatry at Massachusetts General Hospital in Boston, Massachusetts. Dr. Pace-Schott is an Assistant Professor of Psychiatry at Massachusetts General Hospital and Harvard Medical School. The primary aim of the original investigation was to determine if post-exposure naps improved exposure therapy treatment outcomes for Social Anxiety Disorder (Pace-Schott et al., under review). The current study focused on the relationship between NEO-PI-R personality domains and exposure therapy treatment outcomes (i.e., percent change in LSAS scores). However, NEO-PI-R domain scores and sleep variables were added as covariates to the comparison of percent change, from the beginning to end of treatment, in LSAS total, fear, and avoidance scores between the Nap vs. Wake groups. This is further explained in the *Analysis Plan*.

### Participants

Subjects were recruited for the study through advertisements on social media and publicly accessible electronic bulletin boards. The sample consisted of thirty-two subjects between the ages of 18 and 39 years old with Social Anxiety Disorder. Eighteen were female, and fourteen were male. Subjects participated in a thirty-minute screening interview by phone and, those who met inclusion criteria, underwent a psychiatric and

sleep disorders interview using the Structured Clinical Interview for DSM-IV-TR Axis I Disorders–Non-Patient Edition (SCID I/NP) (First, Gibbon, Spitzer, & Williams, 2007) and the Pittsburgh Structured Clinical Interview for Sleep Disorders (unpublished in-house instrument).

Subjects were included in the study if they met the DSM-IV-TR criteria for Social Anxiety Disorder, and scored higher than 60 on total LSAS. They also had to speak English and commit to not drinking alcohol during specific time periods and not taking recreational drugs at any time during the study.

Subjects were excluded from the study if they were presently receiving cognitive behavioral therapy or exposure therapy for their Social Anxiety Disorder. Individuals with a comorbid disorder that might have influenced results were also excluded. Other exclusion criteria included lifetime history of a neurological illness, serious head injury, Bipolar Disorder, Schizophrenia, other psychotic disorder, or Pervasive Developmental Disorder. Additionally, individuals with current Major Depressive Disorder, suicidal thoughts, past hospitalization for suicidal thoughts or actions, or DSM-IV Substance Dependence in the past year were not able to participate. Individuals also were not included in the study if they had abused substances within four weeks prior to the start of the study, had a positive urine toxicology test when the clinical interview occurred, or had used psychiatric medication in the four weeks leading up to the beginning of the study. However, following the NIMH Research Diagnostic Criteria initiative (Morris & Cuthbert, 2012), some less disabling comorbidities were accepted in the study. The current co-morbidities that met the DSM-IV-TR criteria included in the study were two subjects with Specific Phobia, two subjects with Obsessive Compulsive Disorder, two

subjects with Generalized Anxiety Disorder, and two subjects with Dysthymia. Lifetime co-morbidities that met the DSM-IV-TR criteria included in the study were one subject with history of Post-Traumatic Stress Disorder, one subject with history of Obsessive Compulsive Disorder, seven subjects with history of Major Depressive Disorder, two subjects with history of a Major Depressive Episode, three subjects with history of Minor Depressive Disorder, one subject with history of Alcohol Dependence, one subject with history of Alcohol Abuse, four subjects with history of Cannabis Abuse, one subject with history of Attention Deficit Disorder, and one subject with history of Pathological Gambling.

The subjects selected for the study completed the exposure therapy without charge and were also paid to participate in the study. Prior to their clinical interviews, the subjects all completed written informed consent. The Partners Healthcare Institutional Review Board approved the study. The Committee on the Use of Human Subjects at Harvard University approved the study for the thesis. The human subject data was de-identified to protect each subject's privacy.

## Measures

The following measures were used in the current study for the thesis.

### Liebowitz Social Anxiety Scale (LSAS)

The Liebowitz Social Anxiety Scale is a questionnaire that describes 24 social scenarios. The individual being assessed ranks each one from 0 (lowest) to 3 (highest) in level of fear and level of avoidance (Liebowitz, 1987). It is frequently used by clinicians to measure social anxiety due to its strong validity, reliability, and stability (Baker,

Heinrichs, Kim, & Hofmann, 2002; Heimberg et al., 1999). The current study used the clinician-administered version of the LSAS and baseline and post-treatment interviews were completed by telephone.

Neuroticism, Extraversion, Openness to Experience Personality Inventory Revised (NEO-PI-R)

The NEO-PI-R is a 240-item test that assesses individuals in five personality domains (Costa & McCrae, 1992). Each item on the test is a statement such as "I often enjoy playing with theories or abstract ideas" or "I tend to be cynical and skeptical of others' intentions" that the individual answers using a 5-point Likert scale from Strongly Disagree to Strongly Agree. Each point on the scale corresponds to a number from 0 – 4. Domain scores range from 0 – 192 (Costa & McCrae, 1992).

The NEO-PI-R is a commonly used research instrument. Longitudinal studies have demonstrated that individuals' personalities alter during development, but remain relatively consistent after age 30 (McCrae, 1991). Studies with the NEO-PI-R have shown strong test-retest reliability. A 6-year study evaluating Neuroticism, Extraversion, and Openness to Experience resulted in high correlations for both the self-report, Form S, and the observer forms, Form R, of the test. Form R is intended for peers, significant others, and other acquainted third parties to complete about another individual. The test-retest correlations ranged from .75 to .86 (McCrae, 1991). Similar results were found during a 3-year study for Agreeableness and Conscientiousness (McCrae, 1991).

One reason people question the NEO-PI-R as a useful tool is that it relies on self-report. People often have an altered or incorrect view of themselves. This concern was addressed by comparing 403 NEO-PI self-report forms, Form S, to NEO-PI observer

forms, Form R. Results found significant positive correlations between the self-reports and peer/spouse reports for all five personality domains. The correlations ranged from .35 to .63 (McCrae, 1991). The NEO-PI-R's convergent validity has been shown in other studies as well (Trapnell & Wiggins, 1990; Ostendorf, 1990).

Morningness-Eveningness Questionnaire (MEQ)

The Morningness-Eveningness Questionnaire (Horne & Ostberg, 1976) is a 19-item self-report questionnaire that inquires about individuals' subjective preferences for morning or evening as they relate to waking activities and sleep timing. On a continuous scale, greater "Morningness" reflects a preference to conduct waking activities in the morning, whereas, greater "Eveningness" refers to a preference for evenings. Those scoring in the upper range of scores for morningness and eveningness are defined as "Morning" and "Evening" types, respectively, whereas those with intermediate scores are classified as "Neither" type. Those with greater morningness go to bed earlier and wake up earlier with the opposite being the case for greater eveningness. Morningness and eveningness scores have been shown to correlate well with physiological markers of the endogenous circadian rhythm such as the evening rise in plasma melatonin (Adan et al., 2012). The MEQ demonstrates strong validity and reliability. For instance, several studies with populations from 150 to 2,526 subjects showed a reliability coefficient range for the MEQ from 0.77 to 0.86 (Di Milia, Adan, Natale, & Randler, 2013). The MEQ also demonstrates strong agreement with other similar measures. For example, the Composite Scale of Morningness correlation range with the MEQ was 0.87 to 0.95 (Di Milia, Adan, Natale, & Randler, 2013).

### Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index is the gold-standard self-report sleep quality questionnaire and consists of 19-items. The seven sleep quality factors it assesses are subjective sleep quality, sleep onset latency, sleep time, sleep efficiency, sleep disturbances, sleep medication use, and daytime disturbances due to poor sleep (Buysse et al., 1989). The PSQI demonstrates good validity and reliability. Mollayeva et al. (2016) found in an evaluation of several studies that the reliability coefficient range for the PSQI was 0.70 to 0.83. The PSQI also exhibits good test-retest stability (Knutson, Rathouz, Yan, Liu, & Lauderdale, 2006)

### Total sleep time (TST)

Total sleep time was a longitudinal measure of home sleep quality in the study. It is a sleep quality measure that evaluates the total time asleep (Reed & Sacco, 2016). It was measured using wrist actigraphy and sleep diaries on all nights of the study.

### Sleep onset latency (SOL)

Sleep onset latency was a longitudinal measure of home sleep quality in the study. It is a sleep quality measure that evaluates the amount of time it takes to fall asleep (Reed & Sacco, 2016). It was measured using wrist actigraphy and sleep diaries on all nights of the study.

### Sleep efficiency (SE)

Sleep efficiency was a longitudinal measure of home sleep quality in the study. It is a sleep quality measure that evaluates the ratio of total sleep time to time spent in bed

(Reed & Sacco, 2016). It was measured using wrist actigraphy and sleep diaries on all nights of the study.

### Sleep midpoint (SM)

Sleep midpoint was a longitudinal measure of home sleep quality in the study. It is a sleep quality measure that evaluates the approximate halfway mark between the time an individual falls asleep and when she wakes up (Sato-Mito et al., 2011) and which shows good correlation with the time of evening melatonin rise (Burgess et al., 2003; Martin & Eastman, 2002; Terman, Terman, Lo, & Cooper, 2001). It was measured by wrist actigraphy and sleep diaries on all nights of the study and expressed as minutes past midnight.

### Wrist actigraphy

Wrist actigraphy was a tool used to obtain longitudinal objective measures of home sleep quality in the study. The Actiwatch 2 (Philips Respironics, Bend, OR) is a bracelet, similar to a watch, that tracks arm movements in one-minute periods (Sadeh, 2011). Subjects wore it on the wrist of their non-dominant hand the entire day. Data was recorded during sleep and wake. Subjects indicated on the watch when they were going to bed and when they woke up in the morning. Data was sent from an Actiwatch-2 Communication Dock System to a PC computer. Each minute was then scored as asleep or awake with the default algorithm of the Actiware 5.61 software and TST, SOL, SE and SM were computed from this data and averaged, for each participant, across the entire study.

### Sleep diary

The sleep diary was a tool used to obtain longitudinal subjective measures of home sleep quality in the study. The sleep diary used was the Evening/Morning Sleep Questionnaire (EMSQ) (Pace-Schott et al., 1994). In the evening, subjects documented what they did during the day and the time they went to bed. In the morning, subjects documented the time they woke up, how long it took to fall asleep (i.e., subjective SOL), how long they were asleep (i.e., subjective TST), and how many times they woke up during the night. SE and SM were computed from this data and averaged, for each participant, across the entire study. Subjects were also requested to indicate the quality and depth of their sleep and how awake and rested they felt in the morning using visual analog scales.

## Procedure

The treatment consisted of a 5-week group exposure therapy design (Hofmann et al., 2006; Smits et al., 2014). During the 5-week treatment, subjects met in groups of 3-4 once a week for 1.5 hours for therapy sessions with two Ph.D. clinical psychologists. During Session 1, subjects were taught how avoiding fear-inducing stimuli (i.e., social settings) reinforced the fear, which resulted in it persisting. Subjects continued the lesson in Session 2. The subjects were then required to give a presentation to the group about what they learned and how the exposure therapy would help. In Sessions 3 and 4, the subjects gave a speech to the group about a topic of their choosing with guidance from the therapists. Speeches were video-taped and reviewed with the group. Session 5 focused on how to avoid relapse, and subjects discussed what they learned over the five weeks. The exposure elements of the treatment were the required presentations the

subjects gave during sessions 2 – 4. Giving the presentation elicited the fear of negative evaluation from others in a social setting, which is a necessary component of exposure therapy treatment. Experiencing this fear in the absence of adverse consequences allows a therapeutic extinction memory to be encoded. The participants' session-2 speech also reinforced their learning of the objectives of the exposure during treatment. The subjects were also required to write down, on a Daily Record of Fearful Situations (DRFS), their anxiety levels and avoidance behaviors during fear-inducing situations between sessions. Each subject's DRFS was reviewed at the following session.

The subjects completed the LSAS by phone with an experienced evaluator, who was blind to a subject's assigned group (see below), before the treatment started, after the third session, and at the completion of the treatment. They completed the NEO-PI-R, MEQ, and the PSQI before and after treatment.

There were 9 therapy groups in total run over a period of about 1.5 years. Five groups consisted of four subjects and four of 3 subjects. The primary experimental intervention in the study utilized sleep because sleep aids memory consolidation (Rasch & Born, 2013) and, therefore, may promote consolidation of the therapeutic fear extinction learned during exposure therapy (Pace-Schott, Germain, & Milad, 2015). Subjects were randomly divided into two groups, Nap and Wake, before Session 3. They were split evenly between Nap and Wake. In groups that had three subjects, two subjects were assigned to Nap in three groups, and two subjects were assigned to Wake in one group.

After Sessions 3 and 4, all of the subjects went to the Massachusetts General Hospital Sleep Laboratory. The subjects in the Nap group were given a two-hour sleep

opportunity with polysomnographic monitoring. The subjects in the Wake group were fitted with electrodes, similar to what was needed for polysomnographic monitoring but electrodes were plugged into a sham recorder that did not record any data. Wake participants stayed awake during the two hours and watched episodes of a nature documentary, *Planet Earth*.

The sleep quality measures including TST, SOL, SE, and SM were assessed throughout the seven-weeks using wrist actigraphy and sleep diaries. The subjects started their diaries and began wearing the wrist actigraphy one week prior to treatment and stopped one week after treatment ended.

## Analysis Plan

Hypothesis 1 was that subjects high in Extraversion would have the greatest reduction in scores on the LSAS from the beginning to end of the treatment. Hypothesis 2 was that subjects high in Neuroticism would have the least reduction in LSAS scores.

First, to directly test Hypotheses 1 and 2, simple regression was used to determine if there were relationships between the NEO-PI-R personality domain scores and the primary clinical outcome measures--percentage change across treatment = 100 x [(pre-treatment score) – (post-treatment score)/ pre-treatment score] in LSAS total, fear, and avoidance scores. Additional simple regressions determined whether there were relationships between sleep variables and percent change in LSAS total, fear, and avoidance scores.

The primary clinical outcome measures--percent change in LSAS total, fear, and avoidance scores—were compared between Group (Nap and Wake) using unpaired t-tests. Then, those NEO-PI-R domain scores and sleep quality measures that were

significantly related to the primary clinical outcome measures were used to explore whether such relationships might have influenced the comparison of outcome measures between the 2 groups. Specifically, those NEO-PI-R domain scores or sleep measures that were correlated with one of the outcome measures (i.e., percent change in LSAS total, fear and avoidance scores) at least at a trend level ($p < 0.10$) served as covariates in Analyses of Covariance (ANCOVA), comparing that outcome measure between the two groups. Specifically, ANCOVAs were first run with each covariate individually. If the covariate x Group interaction was not significant, it was removed from the ANCOVA model and the Nap vs. Wake comparison was re-examined with the added covariate. The ANCOVA model was then run with each pair of such covariates to examine if, in combination, they might have influenced the Nap vs. Wake comparison. However, if the covariate x Group interaction was significant for a particular covariate, then simple regressions were run for the Nap and Wake groups separately to examine how the two groups differed with regard to the relationship of that covariate to the outcome measure.

# Chapter III

## Results

The final sample consisted of thirty-two subjects. The demographic details are outlined in Table 1.

Table 1. Demographic Analysis.

| Variables | Nap group | Wake group | Both groups |
|---|---|---|---|
| Sample size | 17 | 15 | 32 |
| Age: Mean (SD) | 26 (6.49) | 26 (6.39) | 26 (6.26) |
| Gender: Female (%) | 9 (52.9%) | 9 (60%) | 18 (56.3%) |

### Comparison of Percent Change in LSAS between Nap and Wake groups

Before testing the hypotheses, unpaired t-tests compared percent change in LSAS scores between the Nap and Wake Groups. There was no significant difference of percent change in LSAS total scores between the Nap (Mean = 25.84, SD = 20.89) and Wake (Mean= 35.33, SD = 16.50) Groups [$t(29) = -1.38$, $p = 0.178$]. The boxplot in Figure 1 demonstrates these results. There was also no significant difference in percent change of LSAS fear scores between the Nap (Mean = 21.83, SD = 25.46) and Wake (Mean= 32.11, SD = 23.16) Groups [$t(29) = -1.16$, $p = .254$]. The boxplot in Figure 2 demonstrates these results. There was additionally no significant difference in percent change of LSAS avoidance scores between the Nap (Mean = 28.54, SD = 27.10) and

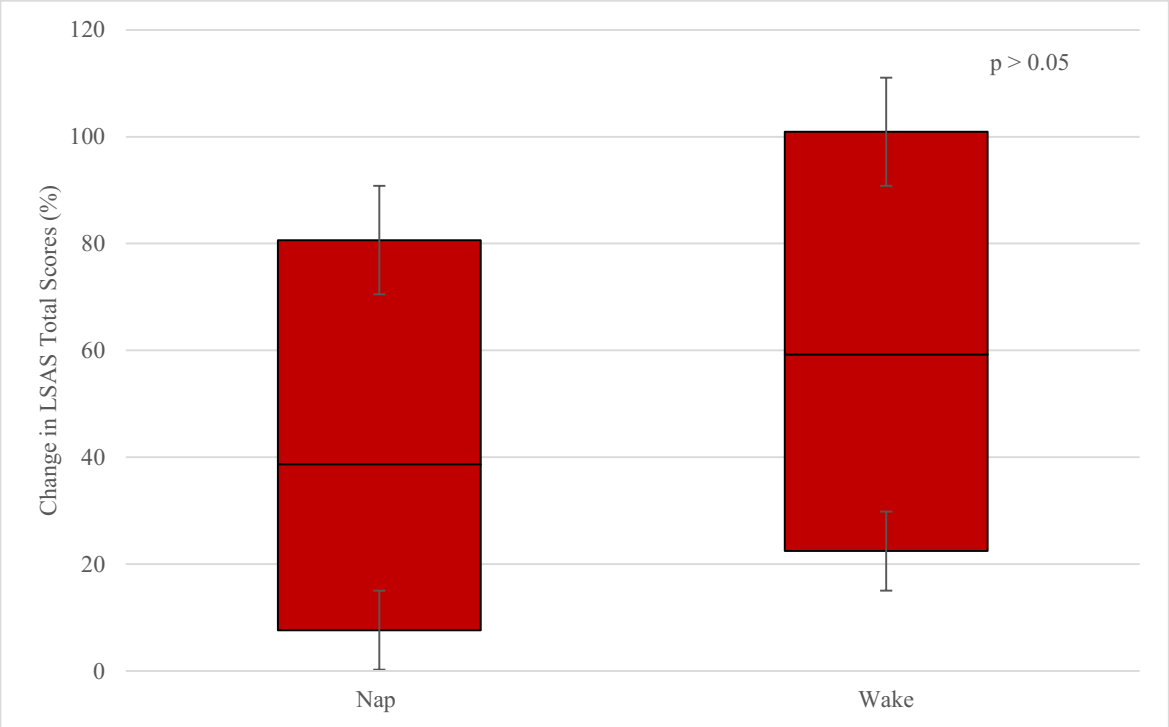



*Figure 1. Percent change in LSAS total scores for Nap and Wake groups from pre-to post treatment. Error bars represent standard error of the mean.*

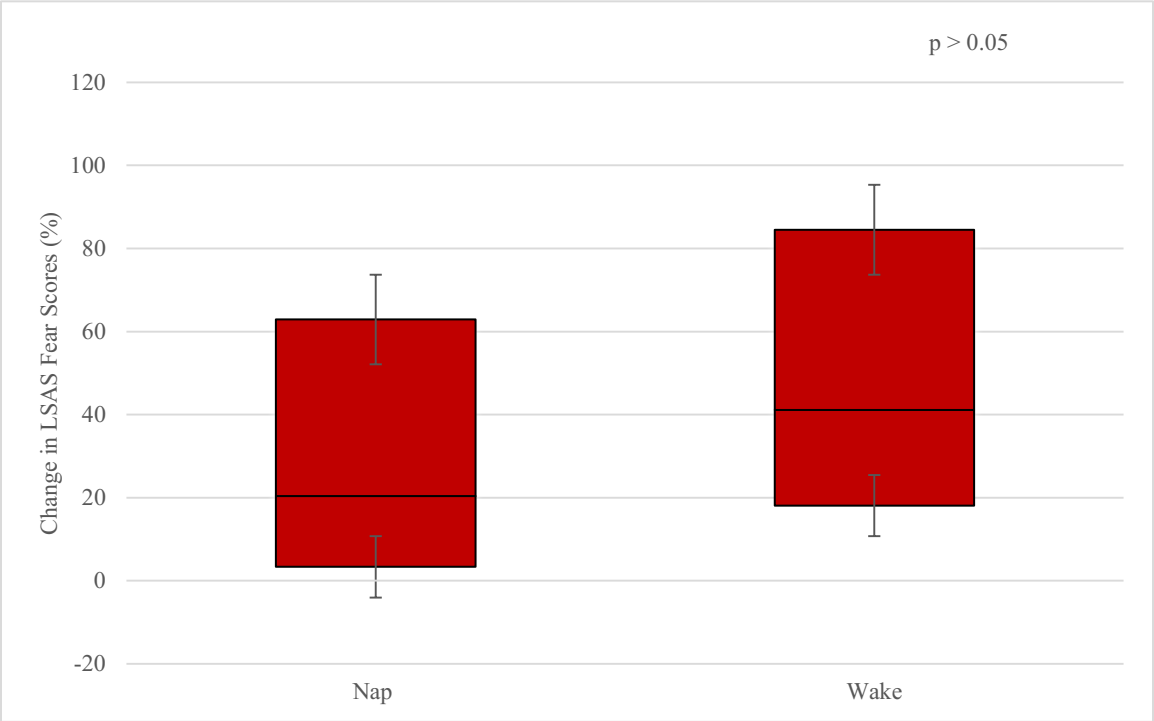



*Figure 2. Percent change in LSAS fear scores for Nap and Wake groups from pre-to post treatment. Error bars represent standard error of the mean.*

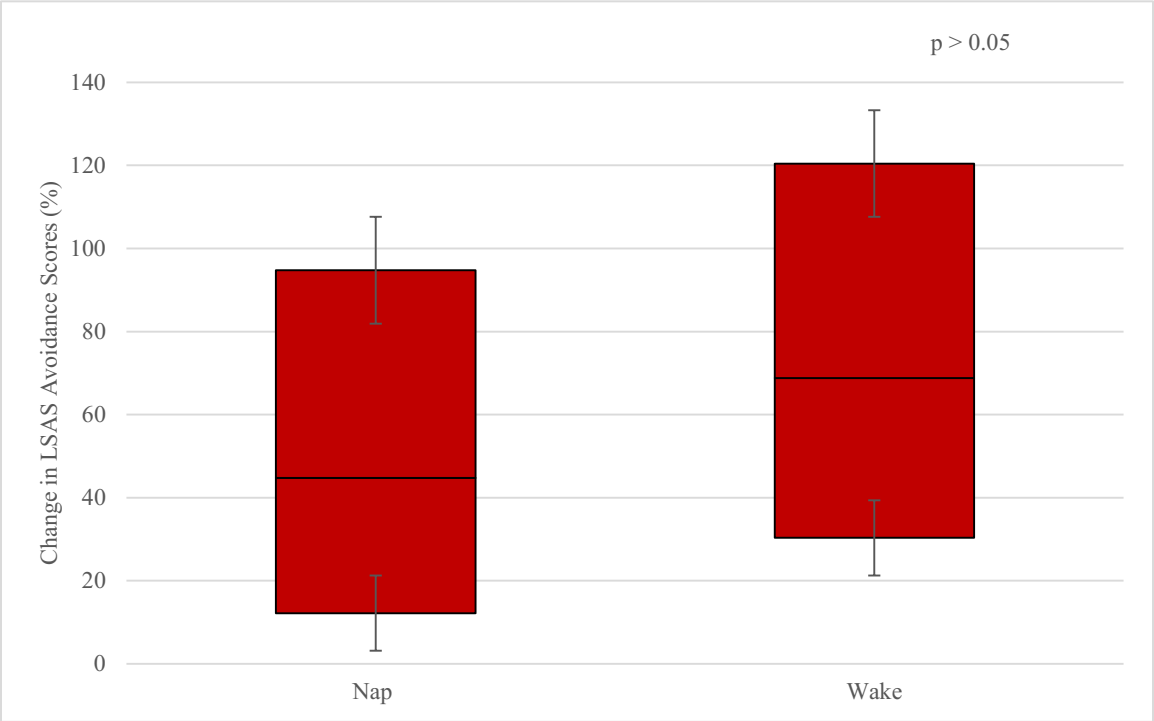



*Figure 3. Percent change in LSAS avoidance scores for Nap and Wake groups from pre- to post treatment. Error bars represent standard error of the mean.*

Wake (Mean = 39.02, SD = 17.18) Groups [t(29) = -1.25, p = .221]. The boxplot in Figure 3 displays these results.

### Relationships of Percent Change in LSAS with NEO-PI-R and Sleep Variables

The above results indicated the sleep intervention did not have a significant effect on the percent change in LSAS total, fear, or avoidance scores from the beginning to end of treatment. Therefore, the Nap and Wake groups could be analyzed together to investigate the main 2 hypotheses of the thesis. Simple regression was used to determine if NEO-PI-R personality domains or sleep quality measures significantly predicted change in LSAS total, fear, or avoidance scores. The summary of results are outlined in Tables 2, 3, and 4.

There were no significant relationships found between NEO-PI-R Extraversion and percent change in LSAS total ($R = 0.088$, $p = 0.643$), fear ($R = 0.107$, $p = 0.573$), or avoidance scores ($R = 0.032$, $p = 0.866$). There was also no significant relationship between NEO-PI-R Neuroticism and percent change in LSAS avoidance scores ($R = 0.236$, $p = 0.210$). There were, however, significant relationships found between NEO-PI-R Neuroticism and percent change in LSAS total ($R = 0.374$, $p = 0.042$) and fear scores ($R = 0.390$, $p = 0.033$). Figure 4 is the scatterplot that shows the relationship between percent change in LSAS total scores and Neuroticism. Figure 8 is the scatterplot that shows the relationship between percent change in LSAS fear scores and Neuroticism.

In addition to the significant relationships with Neuroticism and percent change in LSAS total and fear scores, scatterplots were also created for all significant ($p < .05$) and trend ($p < 1.0$) correlations between covariates and percent change in LSAS scores in the simple linear regression analysis (Figures 4 – 13).

Table 2. Summary of simple regression analyses for percent change in LSAS total scores as the dependent variable.

| Measure | *p* | R |
|---|---|---|
| NEO-PI-R Neuroticism | **0.042** | 0.374 |
| NEO-PI-R Extraversion | 0.643 | 0.088 |
| NEO-PI-R Openness to Experience | 0.612 | 0.097 |
| NEO-PI-R Agreeableness | 0.952 | 0.011 |
| NEO-PI-R Conscientiousness | *0.067* | 0.338 |
| MEQ | 0.144 | 0.269 |
| PSQI | 0.101 | 0.097 |
| Total sleep time (TST) actiwatch | 0.271 | 0.204 |
| Sleep efficiency (SE) actiwatch | 0.146 | 0.163 |
| Sleep onset latency (SOL) actiwatch | 0.195 | 0.239 |
| Sleep midpoint (SM) actiwatch | 0.404 | 0.155 |
| Total sleep time (TST) diary | 0.146 | 0.267 |
| Sleep efficiency (SE) diary | **0.009** | 0.460 |
| Sleep onset latency (SOL) diary | **0.046** | 0.360 |
| Sleep midpoint (SM) diary | 0.398 | 0.157 |

Bold = significant ($p < .05$); Italics = trend ($p < 1.0$)

Table 3. Summary of simple regression analysis for percent change in LSAS fear scores as the dependent variable.

| Measure | *p* | R |
|---|---|---|
| NEO-PI-R Neuroticism | **0.033** | 0.390 |
| NEO-PI-R Extraversion | 0.573 | 0.107 |
| NEO-PI-R Openness to Experience | 0.176 | 0.254 |
| NEO-PI-R Agreeableness | 0.476 | 0.135 |
| NEO-PI-R Conscientiousness | 0.177 | 0.253 |
| Morningness-Eveningness Questionnaire (MEQ) | 0.361 | 0.170 |
| Pittsburgh Sleep Quality Index (PSQI) | *0.076* | 0.112 |
| Total sleep time (TST) actiwatch | 0.574 | 0.105 |
| Sleep efficiency (SE) actiwatch | 0.239 | 0.218 |
| Sleep onset latency (SOL) actiwatch | 0.223 | 0.225 |
| Sleep midpoint (SM) actiwatch | 0.326 | 0.183 |
| Total sleep time (TST) diary | 0.983 | 0.004 |
| Sleep efficiency (SE) diary | **0.024** | 0.405 |
| Sleep onset latency (SOL) diary | **0.013** | 0.441 |
| Sleep midpoint (SM) diary | 0.313 | 0.187 |

Bold = significant ($p < .05$); Italics = trend ($p < 1.0$)

Table 4. Summary of simple regression analysis for percent change in LSAS avoidance scores as the dependent variable.

| Measure | *p* | R |
|---|---|---|
| NEO-PI-R Neuroticism | 0.210 | 0.236 |
| NEO-PI-R Extraversion | 0.866 | 0.032 |
| NEO-PI-R Openness to Experience | 0.761 | 0.058 |
| NEO-PI-R Agreeableness | 0.654 | 0.085 |
| NEO-PI-R Conscientiousness | 0.127 | 0.285 |
| Morningness-Eveningness Questionnaire (MEQ) | 0.121 | 0.285 |
| Pittsburgh Sleep Quality Index (PSQI) | 0.256 | 0.218 |
| Total sleep time (TST) actiwatch | 0.278 | 0.201 |
| Sleep efficiency (SE) actiwatch | 0.808 | 0.046 |
| Sleep onset latency (SOL) actiwatch | 0.333 | 0.180 |
| Sleep midpoint (SM) actiwatch | 0.593 | 0.100 |
| Total sleep time (TST) diary | **0.021** | 0.412 |
| Sleep efficiency (SE) diary | **0.039** | 0.372 |
| Sleep onset latency (SOL) diary | 0.318 | 0.186 |
| Sleep midpoint (SM) diary | 0.609 | 0.096 |

Bold = significant ($p < .05$); Italics = trend ($p < 1.0$)

## Influence of Personality and Sleep Variables on Comparison of LSAS between Nap and Wake Groups (Analyses of Covariance)

Analyses of Covariance (ANCOVA) were conducted to further examine potential differences between the Nap and Wake groups in percent change of LSAS total, fear, and avoidance scores across treatment while controlling for the variables (covariates) found to correlate significantly ($p < .05$) or at a trend level ($p < 0.10$) with an LSAS measure. Neuroticism, SE diary and SOL diary were found to significantly correlate with LSAS total scores with a trend-level correlation for Conscientiousness. Neuroticism, SE diary and SOL diary were found to significantly correlate with LSAS fear scores with a trend-level correlation for PSQI. TST diary and SE diary were significantly correlated with LSAS avoidance scores. ANCOVAs were first run with each covariate individually.

If the Group x covariate interaction was significant, follow up simple regressions were conducted for the Nap and Wake groups individually. A significant interaction in an ANCOVA means the slopes of the regression lines are significantly different between the two groups, and thus the two groups were analyzed and interpreted independently of each other. If the Group x covariate interaction was not significant, the interaction was removed and the Group difference was re-evaluated without its influence.

### LSAS total

For total LSAS, after adding Neuroticism as a covariate to the ANCOVA model comparing Nap and Wake groups, there was a significant Group x covariate interaction [$F(1,26) = 7.940$, $p = 0.009$]. Therefore, the relationship between percent change in total LSAS and Neuroticism was examined separately in the Nap and Wake groups. In the Nap

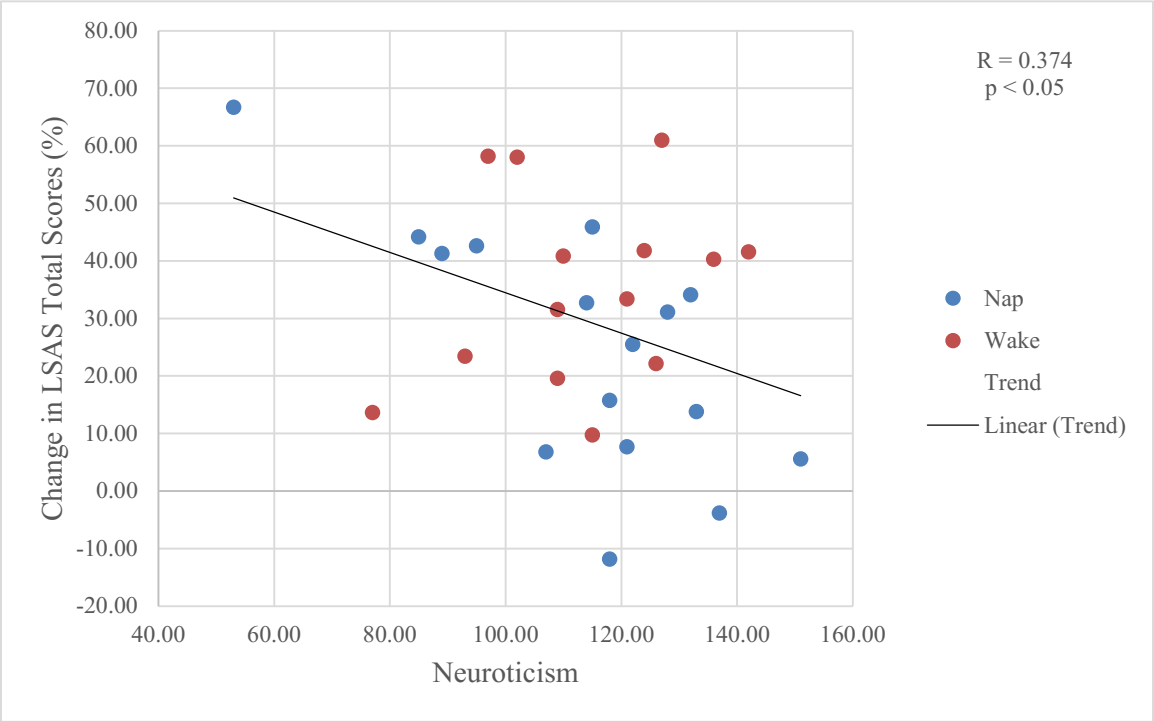



*Figure 4. Scatterplot of relationship between Neuroticism and percent change in LSAS total scores*

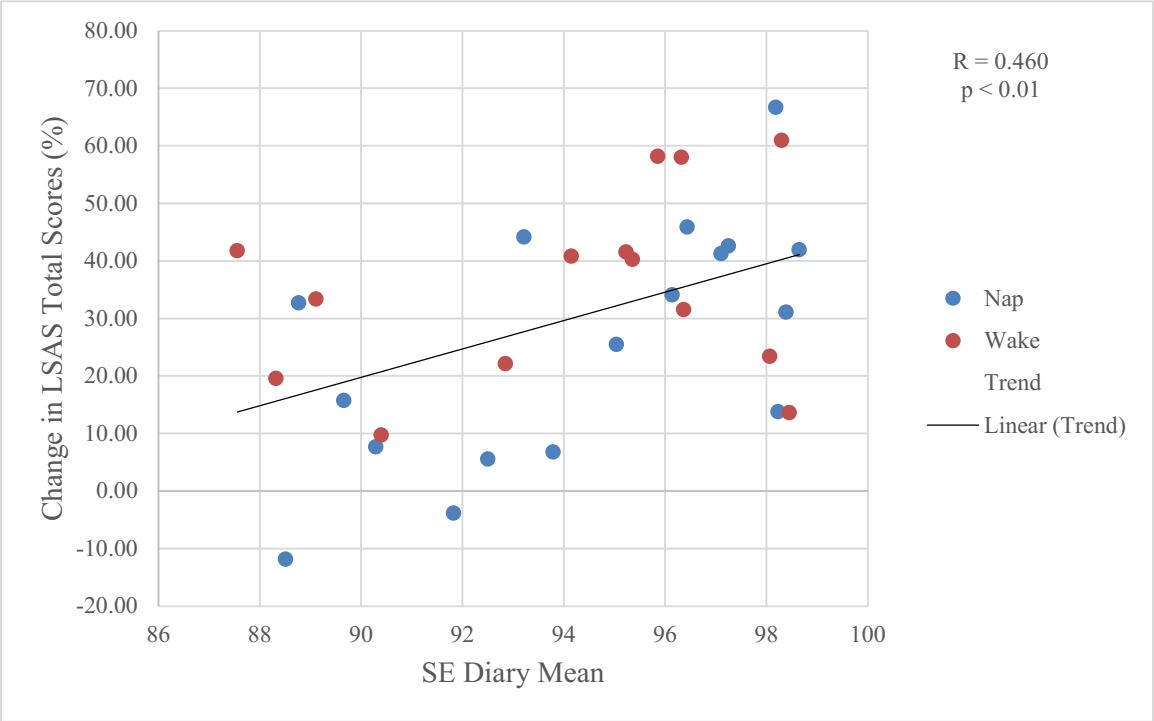



*Figure 5. Scatterplot of relationship between sleep efficiency (SE) diary mean and percent change in LSAS total scores*

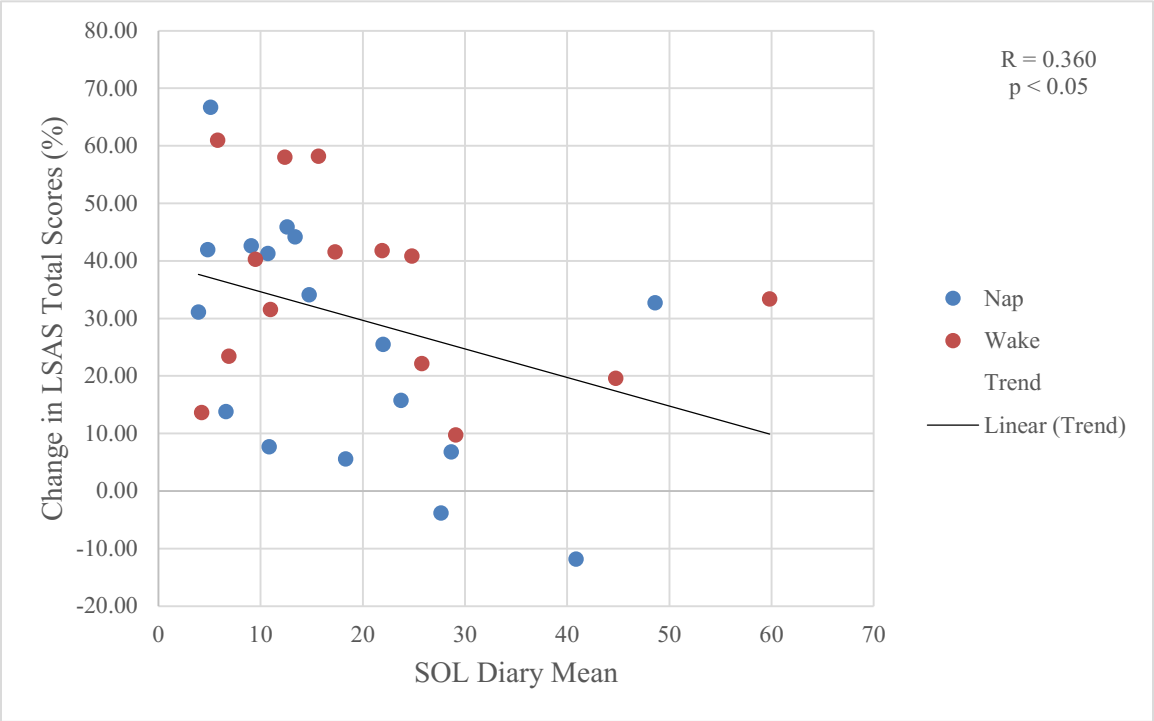



*Figure 6. Scatterplot of relationship between sleep onset latency (SOL) diary mean and percent change in LSAS total scores*

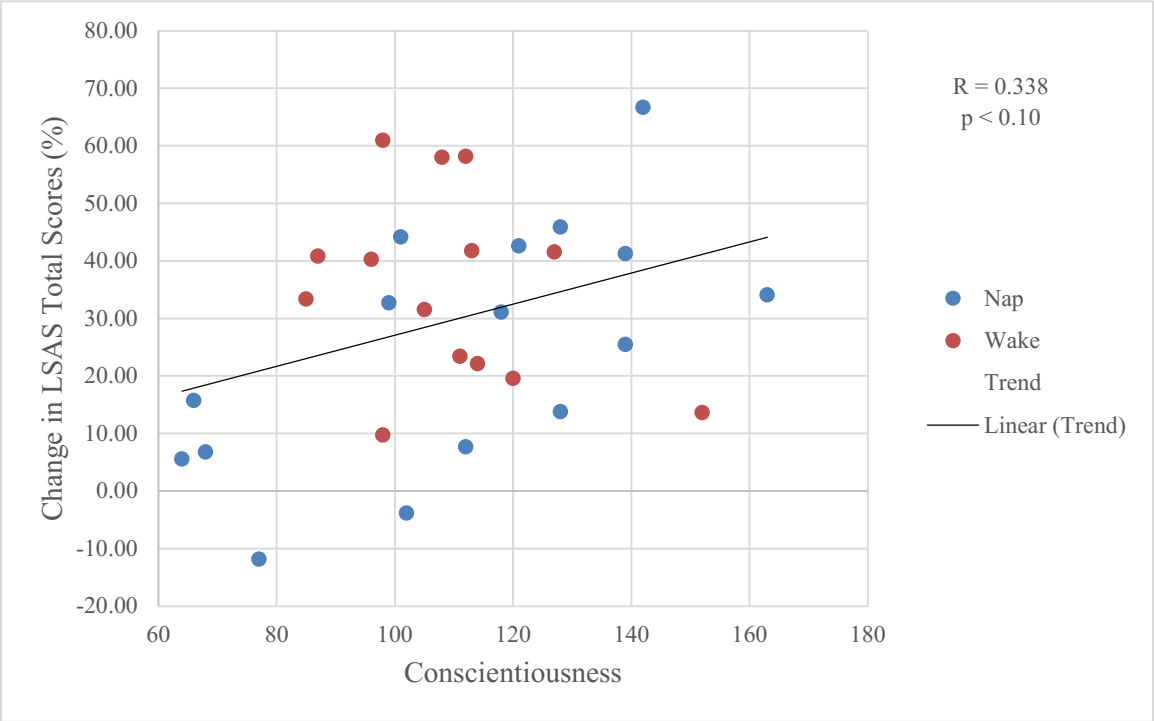



*Figure 7. Scatterplot of relationship between Conscientiousness and percent change in LSAS total scores*

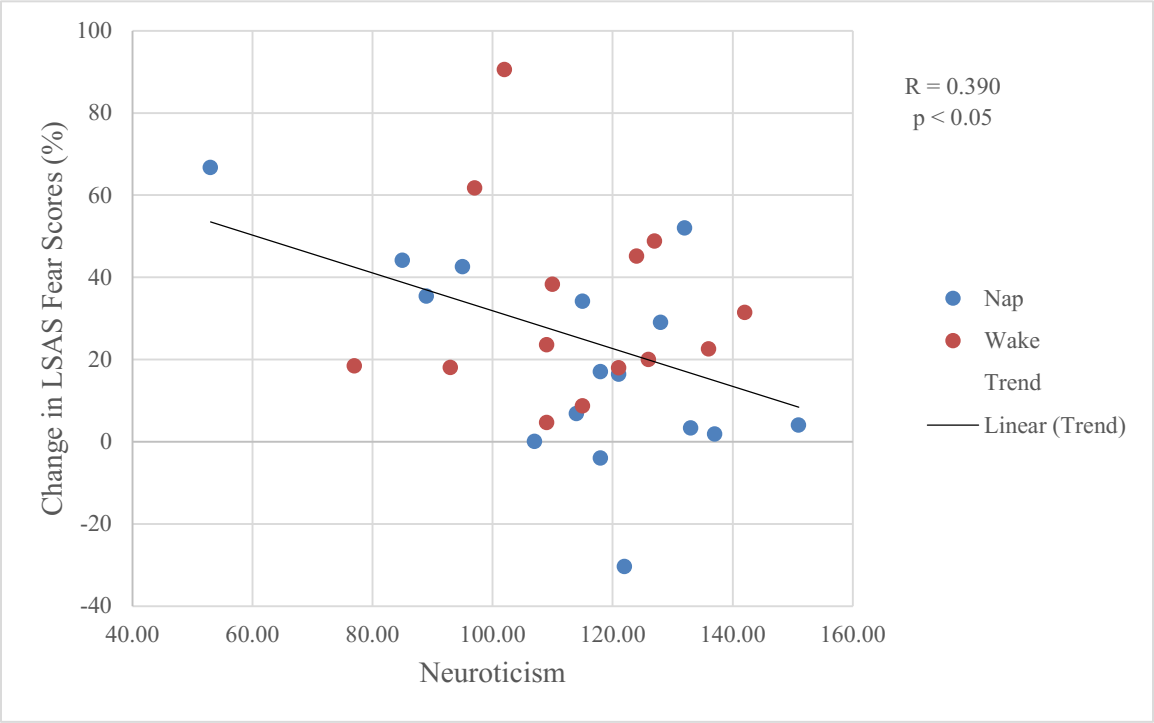



*Figure 8. Scatterplot of relationship between Neuroticism and percent change in LSAS fear scores*

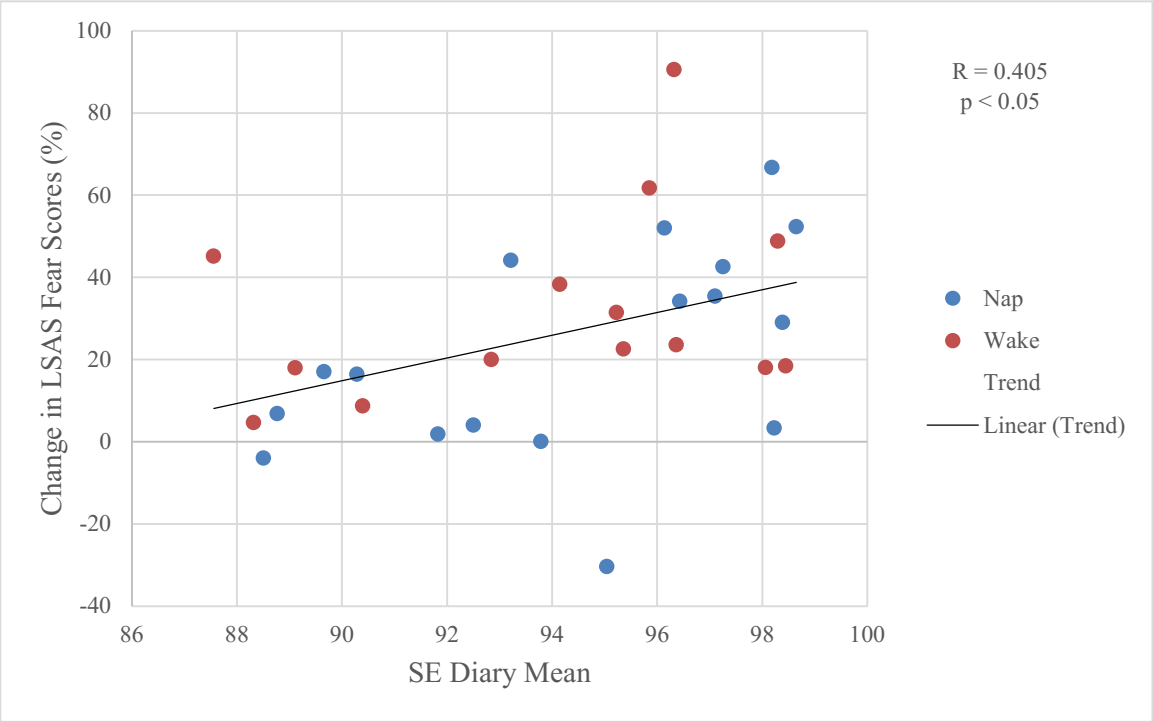



*Figure 9. Scatterplot of relationship between sleep efficiency (SE) diary mean and percent change in LSAS fear scores*

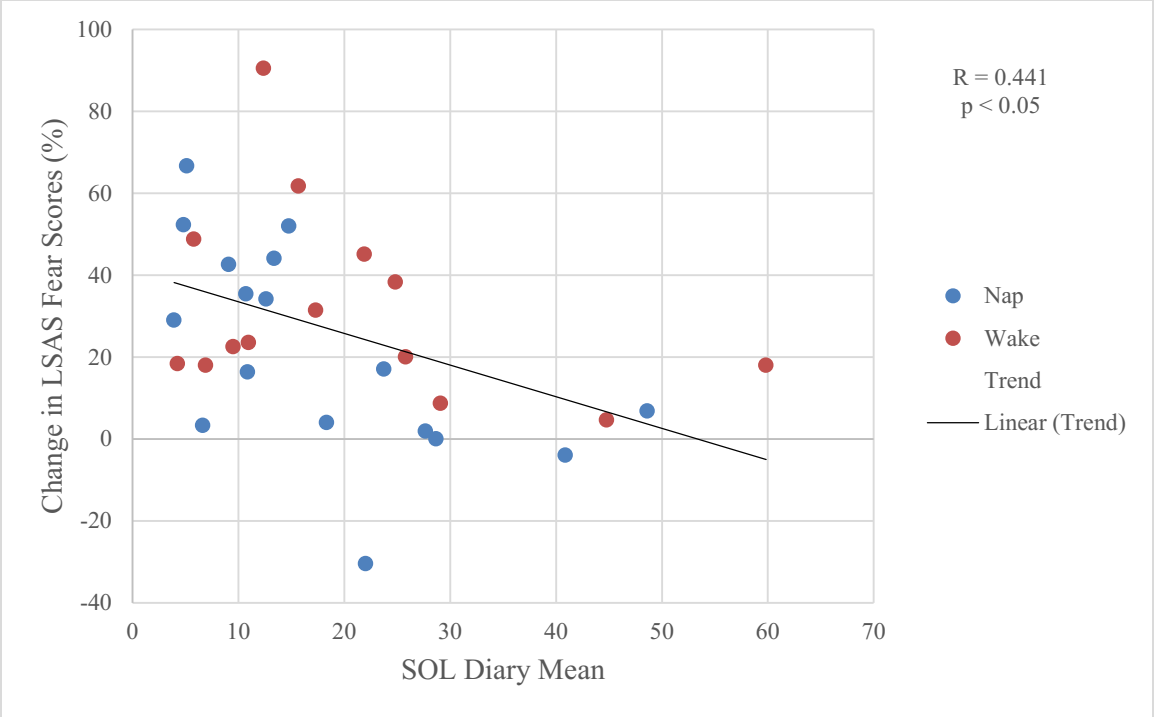



*Figure 10. Scatterplot of relationship between sleep onset latency (SOL) diary mean and percent change in LSAS fear scores*

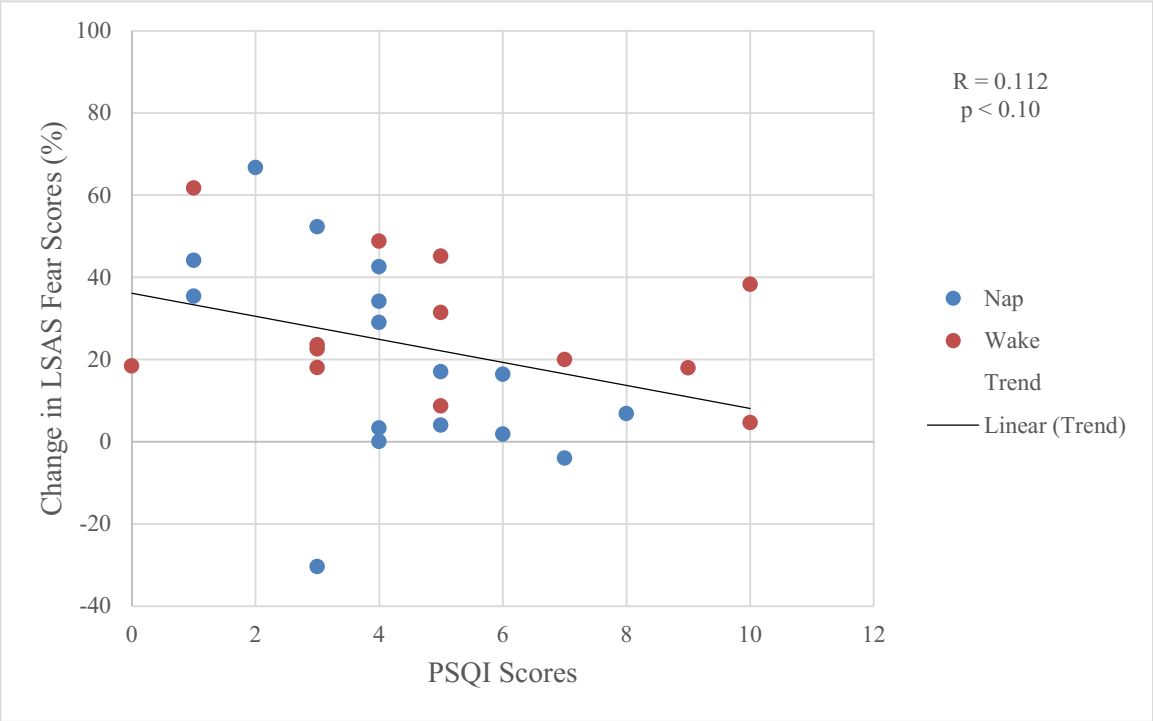



*Figure 11. Scatterplot of relationship between Pittsburgh Sleep Quality Index (PSQI) and percent change in LSAS fear scores*

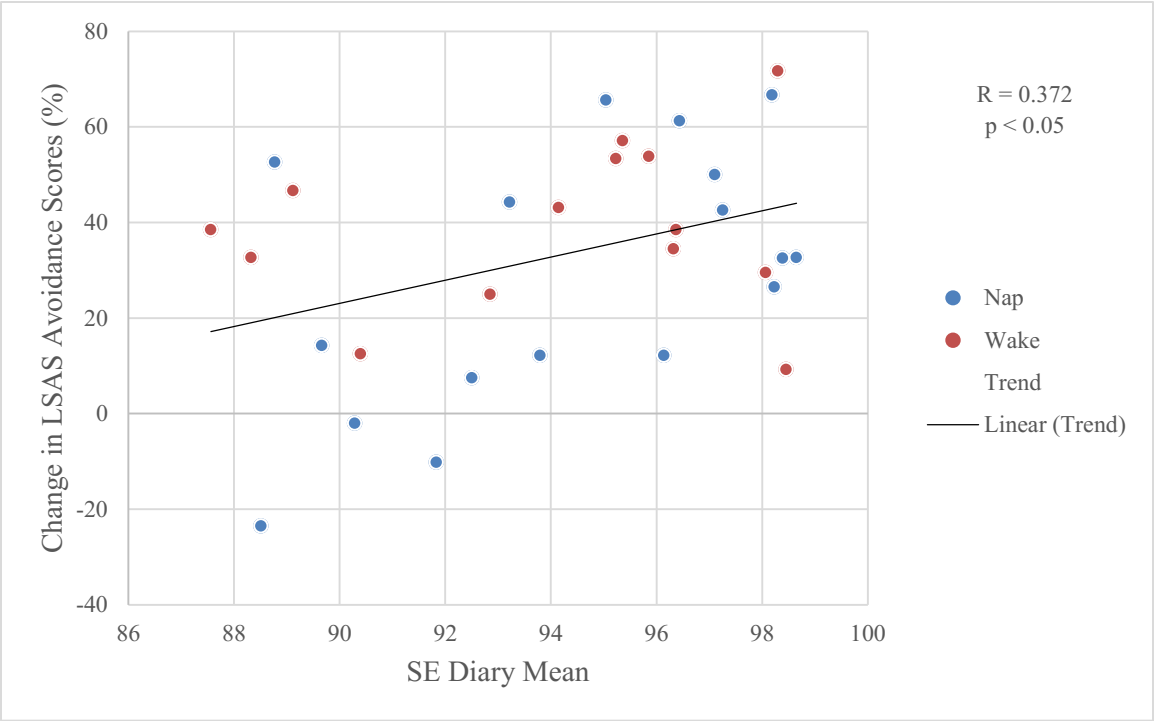



*Figure 12. Scatterplot of relationship between sleep efficiency (SE) diary mean and percent change in LSAS avoidance scores*

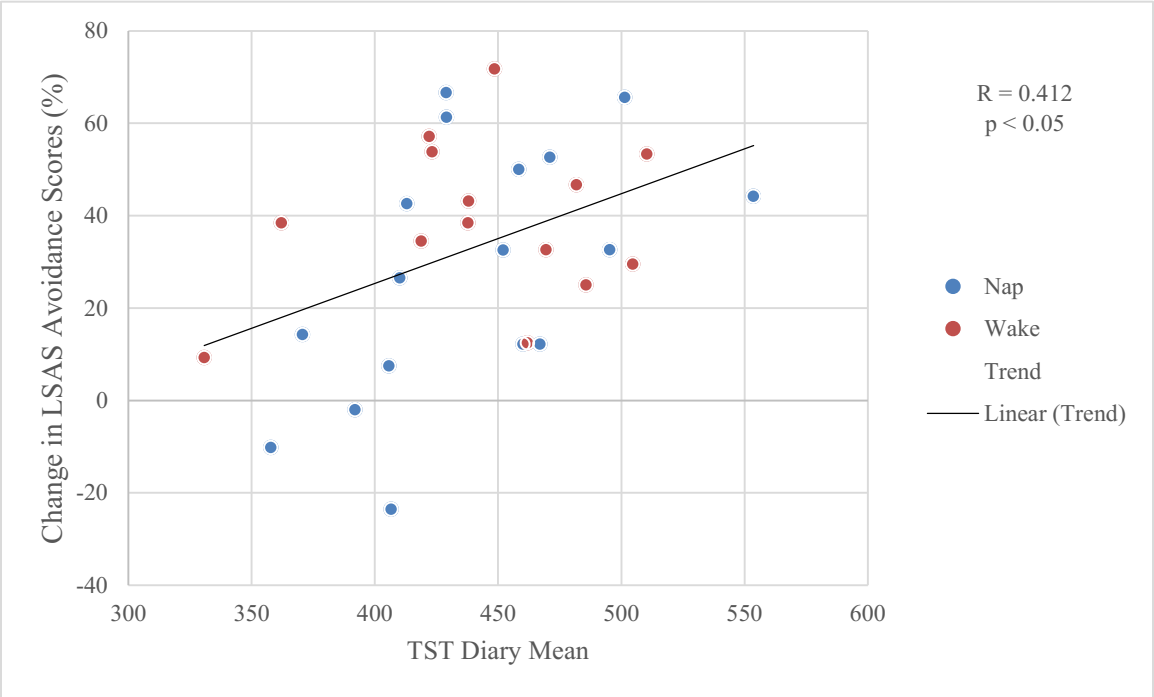



*Figure 13. Scatterplot of relationship between total sleep time (TST) diary mean and percent change in LSAS avoidance scores*

group, there was a significant negative relationship between percent change in LSAS total scores and Neuroticism (R=0.706, p=0.002). The scatterplot in Figure 14 demonstrates these results. In the Wake group, there was no significant relationship between percent change in LSAS total scores and Neuroticism, (R=0.252, p=0.385). The scatterplot in Figure 15 demonstrates these results.

Similarly, for total LSAS, after adding Conscientiousness as a covariate to the ANCOVA model comparing Nap and Wake groups, there was a significant Group x covariate interaction [F(1,26) = 5.755, p = .024]. Therefore, the relationship between percent change in total LSAS and Conscientiousness was examined separately in the Nap and Wake groups. In the Nap group, there was a significant positive relationship between Conscientiousness and percent change in total LSAS (R=0.642, p=0.01) (Figure 16), whereas, for the Wake group there was no significant relationship between Conscientiousness and percent change in total LSAS (R=0.308, p=0.284) (Figure 17).

For percent change in total LSAS, after adding diary-based SE as a covariate to the ANCOVA model comparing Nap and Wake groups, there was no Group x covariate interaction [F(1,27) = 2.098, p = 0.159]. Therefore, the interaction was removed from the model. When this was done, there remained a strong main effect of SE diary [F(1,28) = 8.719, p = 0.006] and the difference between the Nap and Wake groups approached trend level [F(1,28) = 2.849, p = 0.103] with the Wake group showing greater improvement.

For percent change in total LSAS, after adding diary-based SOL as a covariate to the ANCOVA model comparing Nap and Wake groups, there was no Group x covariate interaction [F(1,27) = 1.516 , p = 0.229]. Therefore, the interaction was removed from the model. When this was done, there remained a strong main effect of SOL diary [F(1,28) =

5.357, p = 0.028] and the difference between the Nap and Wake groups was a trend [F(1,28) = 2.932, p = 0.098] with the Wake group showing greater improvement.

LSAS fear

For percent change in fear LSAS, after adding Neuroticism as a covariate to the ANCOVA model comparing Nap and Wake groups, there was no Group x covariate interaction [F(1,26) = 1.556, p = 0.223]. Therefore, the interaction was removed from the model. When this was done, there remained a significant main effect of Neuroticism [F(1,27) = 5.203, p = 0.031] but the difference between the Nap and Wake groups remained absent [F(1,27) = 2.148, p = 0.154].

Similarly, for fear LSAS, after adding PSQI as a covariate to the ANCOVA model comparing Nap and Wake groups, there was no significant Group x covariate interaction [F(1,25) = 2.489, p = 0.127]. Therefore, the interaction was removed from the model. When this was done, there remained a strong main effect of PSQI [F(1,26) = 4.232, p = 0.050] but the difference between the Nap and Wake groups remained absent [F(1,26) = 1.733, p = 0.199].

For percent change in fear LSAS, after adding diary-based SE as a covariate to the ANCOVA model comparing Nap and Wake groups, there was no Group x covariate interaction [F(1,27) = 0.602, p = 0.445]. Therefore, the interaction was removed from the model. When this was done, there remained a strong main effect of SE diary [F(1,28) = 6.149, p = 0.019] but the difference between the Nap and Wake groups remained absent [F(1,28) = 1.896, p = 0.179].

For percent change in fear LSAS, after adding diary-based SOL as a covariate to the ANCOVA model comparing Nap and Wake groups, there was no Group x covariate

interaction [F(1,27) = 1.308 , p = 0.263]. Therefore, the interaction was removed from the model. When this was done, there remained a strong main effect of SOL diary [F(1,28) = 8.209, p = 0.008] and the difference between the Nap and Wake groups approached trend level [F(1,28) = 2.533, p = 0.123] with the Wake group showing greater improvement.

LSAS avoidance

For percent change in avoidance LSAS, after adding diary-based SE as a covariate to the ANCOVA model comparing Nap and Wake groups, there was no Group x covariate interaction [F(1,27) = 2.321, p = 0.139]. Therefore, the interaction was removed from the model. When this was done, there remained a strong main effect of SE diary [F(1,28) = 5.129, p = 0.031] but the difference between the Nap and Wake groups remained absent [F(1,28) = 2.078, p = 0.161].

Similarly, for percent change in avoidance LSAS, after adding diary-based TST diary as a covariate to the ANCOVA model comparing Nap and Wake groups, there was no Group x covariate interaction [F(1,27) = 1.963, p = 0.173]. Therefore, the interaction was removed from the model. When this was done, there remained a strong main effect of TST diary [F(1,28) = 5.873, p = 0.022] but the difference between the Nap and Wake groups remained absent [F(1,28) = 1.638, p = 0.211].

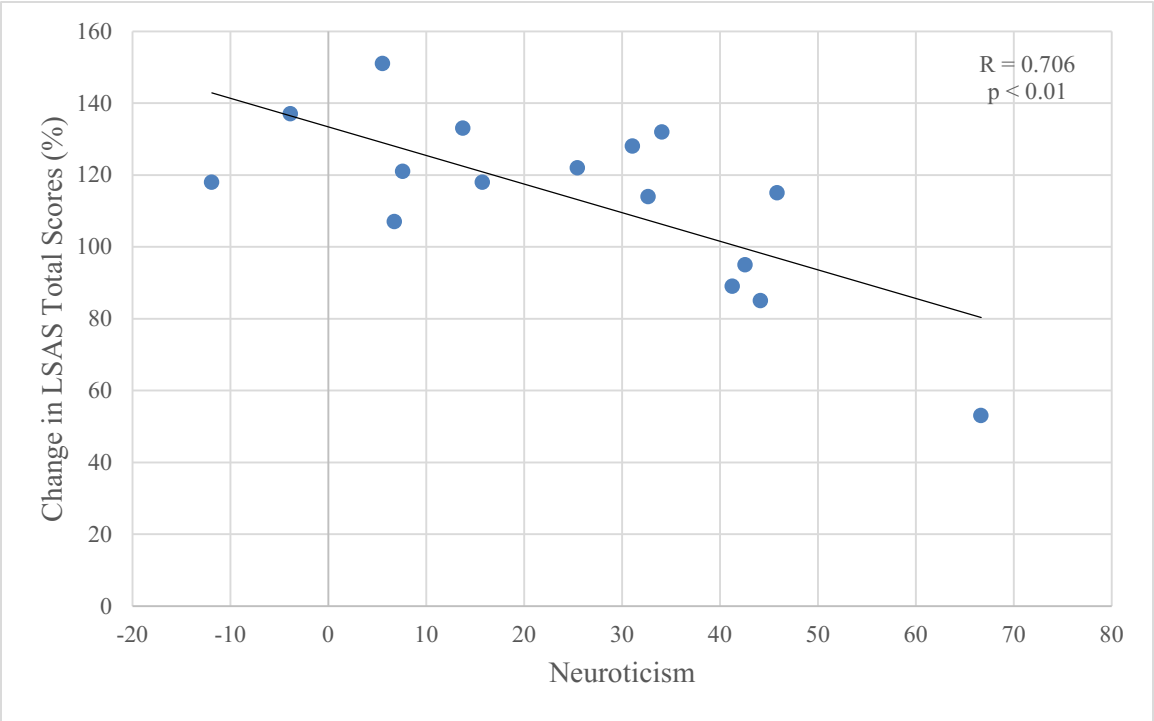



*Figure 14. Scatterplot of relationship between Neuroticism and percent change in LSAS total scores for Nap group only*

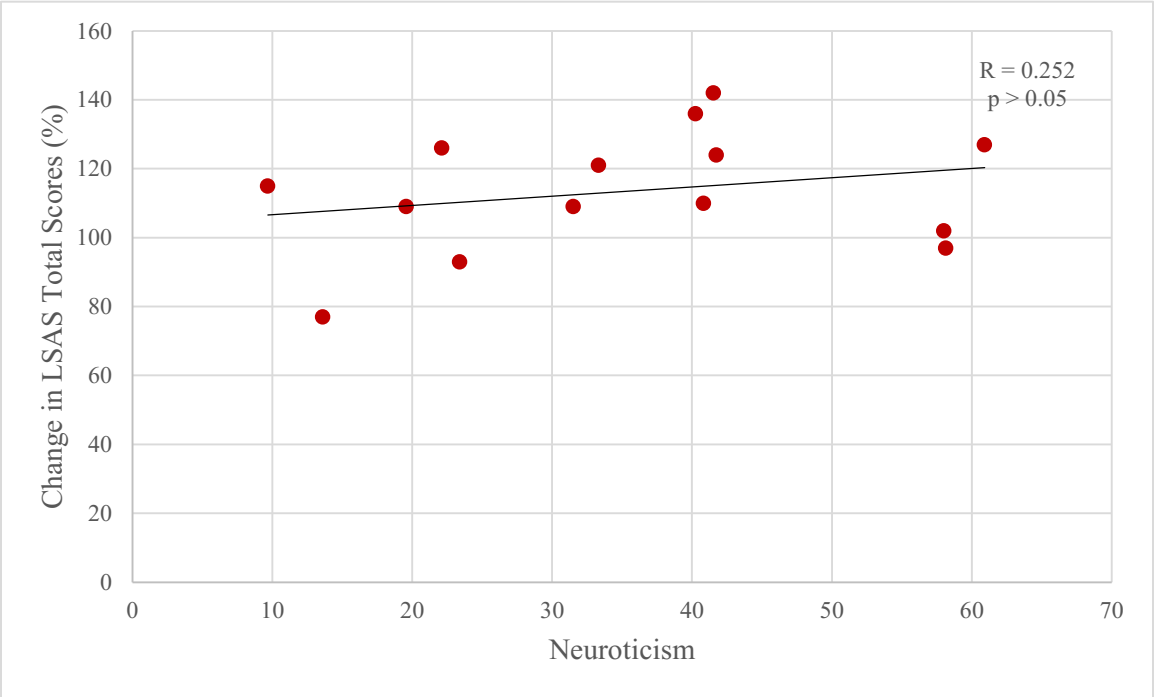



*Figure 15. Scatterplot of relationship between Neuroticism and percent change in LSAS total scores for Wake group only*

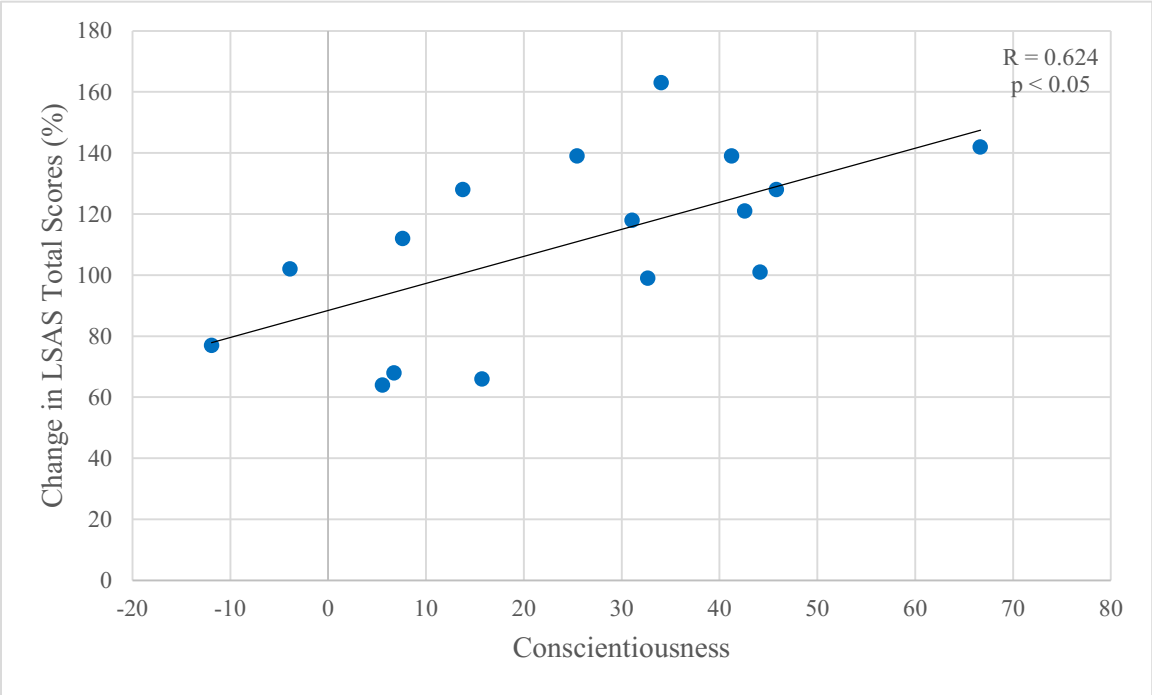



*Figure 16. Scatterplot of relationship between Conscientiousness and percent change in LSAS total scores for Nap group only*

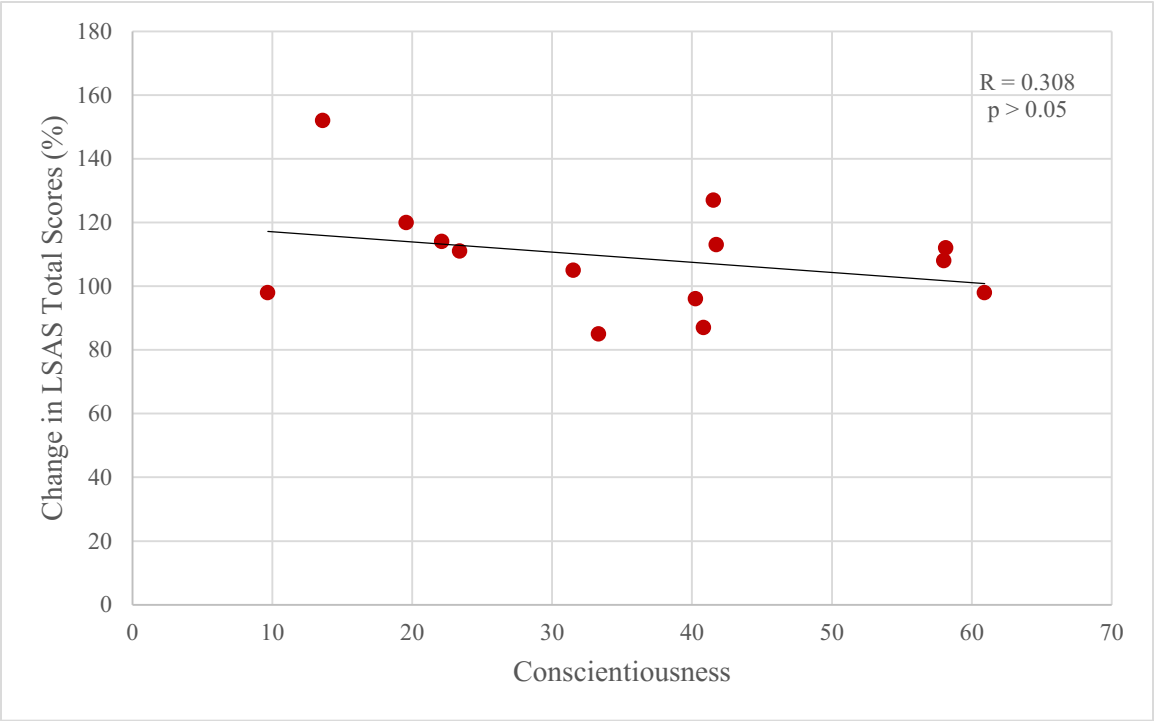



*Figure 17. Scatterplot of relationship between Conscientiousness and percent change in LSAS total scores for Wake group only*

# Chapter IV

## Discussion

The aim of the study was to investigate if there was a relationship between the NEO-PI-R personality domains and outcome measures for exposure therapy in individuals with Social Anxiety Disorder. The outcome measure in the study was the percent change in LSAS total scores and its subscales from the beginning to the end of the treatment. Hypothesis 1 was that subjects high in Extraversion would have the highest reduction in scores (i.e., percent change), and Hypothesis 2 was that subjects high in Neuroticism would have the lowest reduction (i.e., percent change) in LSAS scores and its subscales.

The results did not support Hypothesis 1. There was not a significant correlation between Extraversion and improvement in LSAS scores from beginning to the end of treatment. It was initially thought that individuals high in Extraversion would demonstrate greater improvement on the LSAS because Extraversion is associated with enjoying the company of others (Costa & McCrae, 1992). However, previous research has shown that individuals with Social Anxiety Disorder rank low in Extraversion (Kaplan, Levinson, Rodenbaugh, Menatti, & Weeks, 2015; Kotov, Gamez, Schmidt, & Watson, 2010). Therefore, individuals significantly high in Extraversion may not have been included in the study. The mean Extraversion score in the standardization sample for the NEO-PI-R was 109.4 with a standard deviation of 18.4 (Costa & McCrae, 1992). In comparison, the average Extraversion score in the study was 86, which is more than

one standard deviation below the mean. The mean Neuroticism score in the standardization sample for the NEO-PI-R was 79.1 with a standard deviation of 21.2 (Costa & McCrae, 1992). The average Neuroticism score among the thirty-two subjects in the study was 113, so it was more than one standard deviation above the population mean. The mean Openness to Experience score in the standardization sample for the NEO-PI-R was 110.6 with a standard deviation of 17.3 (Costa & McCrae, 1992). The average Openness to Experience score in the study was 120, so it was close to the standardization sample for the NEO-PI-R. The mean Agreeableness score in the standardization sample for the NEO-PI-R was 124.3 with a standard deviation of 15.8 (Costa & McCrae, 1992). The average Agreeableness score in the study was 118, so it was close to the population norm. The mean Conscientiousness score in the standardization sample for the NEO-PI-R was 123.1 with a standard deviation of 17.6 (Costa & McCrae, 1992). The average Conscientiousness score in the study was 111, so it was also close to the population norm. Thus, Extraversion was the domain in this socially anxious sample that had the lowest representation relative to population norms.

Hypothesis 2 was supported by the results. There was a significant negative correlation found between Neuroticism scores and percent change in LSAS total scores. This means that individuals, who scored higher in Neuroticism, exhibited less improvement in their social anxiety from beginning to end of treatment. Follow up analyses were conducted to determine the influence of Neuroticism on the results.

In the follow up ANCOVA, Neuroticism showed a significant interaction with the main outcome variable--percent change in LSAS total scores. When the Nap and Wake groups were analyzed separately, it was found that Neuroticism had a significant negative

correlation with LSAS in the Nap but not the Wake group. This may have been the case for several reasons.

Research suggests that individuals with anxiety disorders have a propensity to focus on negative thoughts and memories instead of positive ones (Groch et al., 2017). The sleep intervention was included in the original study to enhance consolidation of the fear extinction memory from the exposure therapy (Pace-Schott, Verga, Bennett, & Spencer, 2012). However, the subjects high in Neuroticism may not have consolidated the desired memory when they napped. It is possible that the subjects high in Neuroticism were consolidating the negative feeling of fear associated with the exposure experience instead of the new, positive association required for long-term success of exposure therapy, thus resulting in the negative correlation between Neuroticism and percent improvement in the Nap group.

Another NEO-PI-R personality domain not explored in the hypotheses but which was found to have a positive trend relationship ($p < 0.10$) with change in LSAS total scores across treatment was Conscientiousness. Similar to Neuroticism, in the follow up ANCOVA, Conscientiousness significantly interacted with Group for the outcome variable, percent change in LSAS total score. Therefore, the Nap and Wake groups were analyzed separately, and, in these analyses, Conscientiousness had a statistically significant impact on the treatment outcome for the Nap but not the Wake group. This further supports the notion that post-exposure sleep may provide an opportunity for an individual's personality traits to influence the way in which memory is consolidated—in this case possibly promoting the consolidation of the positive, fear-extinction memory.

The relationships found in the study between treatment efficacy and Neuroticism and Conscientiousness are consistent with literature (Kotov, Gamez, Schmidt, & Watson, 2010; Malouff, Thorsteinsson, & Schutte, 2005). Neuroticism is associated with a more negative emotional state (Kotov, Gamez, Schmidt, & Watson, 2010), which is potentially why those high in Neuroticism had the least reduction in social anxiety in the study. Additionally, it is thought that individuals high in Conscientiousness have better emotional coping skills, and therefore, exhibit fewer mental disorders such as Social Anxiety Disorder (Kotov, Gamez, Schmidt, & Watson, 2010). Therefore, high Conscientiousness in some of these subjects, although socially anxious, might make individuals more emotionally resilient, which may contribute to their greater improvement in LSAS scores.

There may also be a relationship between the personality domains and memory that contributed to the results. Studies indicate individuals high in Neuroticism recall negative memories more often than positive ones (Mayo, 1989; Mayo, 1983), which indicates that high Neuroticism may have a negative bias on what is encoded and consolidated. Dima, Friston, Stephan, & Frangou (2015) conducted a study to investigate the relationship between the NEO-PI-R personality domains and working memory. Results found that individuals high in Neuroticism performed poorly on the working memory task, whereas, individuals high in Conscientiousness performed better on this task. This not only supports there being effects of personality domains on memory, but that Neuroticism and Conscientiousness have an influence on the specific types of memories, which is consistent with the above hypotheses. Limited research exists regarding personality and memory, so further research will need to be completed in order

to better understand the relationship between the NEO-PI-R personality domains and sleep-dependent memory consolidation.

Other noteworthy results included the significant relationships between LSAS scores and sleep quality measures. Diary-based SE had a significant positive relationship with percent change in LSAS total, fear, and avoidance scores. Diary-based SOL had a significant negative relationship with percent change in LSAS total and fear scores. Diary-based TST had a positive relationship with percent change in LSAS avoidance scores. None significantly interacted with Group when added to the models comparing percent change in LSAS for the 2 groups suggesting that subjective sleep quality influenced treatment outcome similarly in the two groups. The significant linear regressions with these variables suggest that better sleep quality may help reduce anxiety in Social Anxiety Disorder patients participating in an exposure therapy treatment. Literature suggests that sleep supports emotion regulation (Pace-Schott, Germain, & Milad, 2015; Goldstein & Walker, 2014), which may be one reason for these results. Another potential reason is better quality sleep might also support better extinction memory consolidation (Pace-Schott, Germain, & Milad, 2015; Pace-Schott et al., under review). The individuals in the Nap group were given two hours to nap during the study, but all subjects were allowed to sleep normally each night. This means each subject had the same opportunity for sleep-dependent consolidation of memory from the exposure therapy during the nights following treatment. Therefore, the subjects that demonstrated better sleep quality during their normal nocturnal sleep may have consolidated the memories better outside the study setting.

For ANCOVA models comparing those with and without post-exposure naps, addition of covariates did not change the basic finding that there was not a significant difference in clinical outcome between intervention groups. However, addition of such covariates did slightly strengthen a non-significant tendency for LSAS outcomes to be better in the Wake group. Nonetheless, the Nap group showed significantly greater improvement over treatment in physiological measures of reactivity to a social stressor (Pace-Schott et al., under review).

## Limitations and Future Directions

The original investigation used the data collections as part of an investigation on how post-exposure naps might improve treatment outcomes for Social Anxiety Disorder. In order to more definitively determine the relationship between NEO-PI-R personality domains and exposure therapy treatment outcome for Social Anxiety Disorder, a larger sample with homogenous treatment would be preferable (i.e., with the Nap/ Wake intervention excluded).

The study used the DSM-IV as one of its diagnostic tools for including subjects in the study. However, the DSM-5 is the most recent version. Some of the criteria for Social Anxiety Disorder varied from the DSM-IV to the DSM-5 (Heimberg et al., 2014). The primary measure of Social Anxiety Disorder in the study, the LSAS, remained the same, but subjects would need to be assessed with the DSM-5 to see if they still meet the criteria for Social Anxiety Disorder in future studies.

Two additional limiting elements of the study were the small sample size and the short duration of the treatment. Effects may have been stronger if subjects were able to continue treatment for a longer period of time. Further, the current study looked at short-

term success of the treatment (i.e., LSAS scores immediately following treatment). There were no follow up evaluations completed to see if the results were sustained. This would be an interesting aspect to consider in future research to determine if a relationship exists between the personality domains and long-term success of exposure treatment for Social Anxiety Disorder.

Another important limitation in the study is the short duration of the sleep intervention. Subjects in the Nap group were given two hours to nap. In that time, only 7 of the 17 subjects achieved REM (Pace-Schott et al., under review), which is thought to be an especially important sleep stage for the consolidation of emotional memory (Pace-Schott, Germain, & Milad, 2015; Goldstein & Walker, 2014). Normal nocturnal sleep would have allowed more subjects to complete several full sleep stage cycles, and therefore, provide more opportunity to consolidate the memory.

The final limitation is that the study involved a treatment for one specific anxiety disorder, Social Anxiety Disorder, and one type of treatment, exposure therapy. However, several other types of mental disorders and treatments exist. Therefore, further research is needed to determine if results can be generalized to other mental disorders and their corresponding treatments.

In conclusion, the study found individuals high in NEO-PI-R Neuroticism did not respond as well to exposure therapy treatment for Social Anxiety Disorder as those with lower scores in this domain. This means clinicians may want to explore alternative or combined treatments options for patients high in Neuroticism. In contrast, individuals high in Conscientiousness responded best to exposure therapy, which means clinicians might expect such individuals to benefit more from exposure. Further research is required

to validate results, however based on the results of this study, it may be beneficial for clinicians to have their patients with Social Anxiety Disorder complete the NEO-PI-R to help inform the best treatment option for them.

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