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## **Committee Approval**

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Michelle Lemay find it satisfactory and recommend that it be accepted.

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# Idaho State UNIVERSITY

Office for Research Integrity

921 South 8th Avenue, Stop 8046 • Pocatello, Idaho 83209-8046

May 26, 2015

Michelle Lemay  
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RE: regarding study number IRB-FY2015-67 : Sleep Quality and Emotion Processing Biases

Dear Ms. Lemay:

I have reviewed your request for expedited approval of the new study listed above. This is to confirm that I have approved your application.

Notify the HSC of any adverse events. Serious, unexpected adverse events must be reported in writing within 10 business days.

Submit progress reports on your project in six months. You should report how many subjects have participated in the project and verify that you are following the methods and procedures outlined in your approved protocol. Then, report to the Human Subjects Committee when your project has been completed. Reporting forms are available on-line.

You may conduct your study as described in your application effective immediately. The study is subject to renewal on or before Fri, 20 May 2016, unless closed before that date.

Please note that any changes to the study as approved must be promptly reported and approved. Some changes may be approved by expedited review; others require full board review. Contact Tom Bailey (208-282-2179; email [humsbj@isu.edu](mailto:humsbj@isu.edu)) if you have any questions or require further information.

Sincerely,



Ralph Baergen, PhD, MPH, CIP  
Human Subjects Chair

UNDERSTANDING THE RELATIONSHIP BETWEEN SLEEP AND AFFECT:  
THE ROLE OF EMOTION PROCESSING BIAS

by

Michelle Lemay

A thesis

Submitted in partial fulfilment

Of the requirements for the degree of

Master of Science in the Department of Clinical Psychology

Idaho State University

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## Abstract

Deficient sleep has been identified as a factor in multiple types of psychopathology. Research has indicated that specific aspects of sleep such as sleep quality and sleep difficulties are related to emotional difficulties such as symptoms of depression and anxiety. Another construct, emotion processing bias, has been shown to be related to emotion regulation difficulties and symptoms of depression and anxiety. These emotion processing biases include attention bias, or how an individual is biased to attend to particularly valenced stimuli, interpretation bias, or how an individual interprets specifically valenced stimuli, and memory bias, or how an individual recalls stimuli of a certain valence. The present study investigated whether these biases mediated the relationship between an individual's self-reported sleep quality and emotion regulation difficulties/affect. Participants performed a dot-probe-task using a series of faces with different emotions, measuring attention bias, then read a series of social situations and respond to them, measuring interpretation bias, and lastly completed a free recall task using emotional and non-emotional words in order to measure memory bias. They also completed self-report questionnaires on sleep quality, emotion regulation, and positive/negative affect. We expected individuals with poorer sleep quality to display increased levels of emotion processing biases towards negatively valenced stimuli, and display increased negative affect, decreased positive affect, and increased emotion regulation difficulties. Data were analyzed by multiple linear regression. We did not find any support of the hypotheses. Study design and time of data collection might have affected these findings.

### Understanding the Relationship between Sleep and Affect: The Role of Emotion Processing Bias

Sleep is a naturally occurring bodily process. Research has shown, however, that many individuals have deficient sleep, or sleep patterns that prevent the feeling of being well rested or receiving an adequate amount of sleep. Sleep deficiency is a broad concept of sleep-related abnormalities such as sleep deprivation, or not receiving an adequate amount of sleep, disruptive sleep, delayed or early sleep-wake cycle, or poor sleep quality. Deficient sleep has been shown to be associated with symptoms of various forms of psychopathology (Harvey, Murray, Chandler, & Soehner, 2011; Benitez & Gunstad, 2012; Dolsen et al., 2014). Sleep deficiency has not only been shown to be related to deficits in mental health, but has been shown to be related to affect as well (Kyle et al., 2014; Carpenter et al., 2015). Deficient sleep can lead to a reduction in energy and activity levels, can impact attentional abilities, and increase emotional reactivity (Fairholme & Manber, 2015). Deficient sleep has been considered to be an etiological and/or maintaining factor in many psychological disorders and overall mental health.

Recent theoretical models argue that sleep deficiency increases negative affect, reduces positive affect, and impairs emotion regulation. This in turn lowers one's threshold for identifying stressors or potentially threatening stimuli, and simultaneously impairs an individual's ability to cope with stressors and threats (Fairholme & Manber, 2015). Emotion regulation impairment caused by deficient sleep is a factor in affective states such as depressed or anxious moods. In a seminal study examining the relationship between sleep deficiency and affect among medical residents, reduced total sleep time (due to reduced sleep opportunity) was found to promote greater levels of negative affect following goal-disruptive events (Zohar, Tzischinsky, Epstein, & Lavie, 2005).



Research and theory have shown that there is a well-established link between sleep deficiency and affect. Looking more specifically at the aspects to sleep deficiency, including internally or externally restricted sleep, as well as subjectively or objectively rated sleep, we can investigate ways in which affect is related to sleep. All four of these aspects of sleep deficiency have been described as contributing factors to psychological and emotional difficulties. Sleep deficiency can occur when an individual receives a limited amount of sleep, either due to internal factors (e.g. hyperarousal), or external factors (e.g. experimental manipulation), when an individual is limited in the amount of time they are provided to remain in bed (an external factor), when frequency of waking is elevated based off of polysomnography measurement (objective measurement), or when sleep quality is self-rated as poor (subjective measurement). These aspects of sleep deficiency have been researched in depth to better understand the sleep-affect relationship.

The effect of externally limited sleep, or sleep deprivation, has been shown to be related to increased levels of depression, decreased positive affect, and increased levels of anxiety (Scott et al., 2006; Talbot et al., 2010). The effect of reduced sleep due to internally based cues, as often seen in individuals with insomnia, has been shown to be related to many different emotional factors, including increased levels of depression, anxiety, and “emotional blunting,” or perceiving emotional expressions as less emotionally intense (Taylor et al., 2005; Kyle et al., 2014). Similarly, both objective and subjective measures of sleep deficiency have been shown to be related to emotional difficulties (Chorney et al., 2008; Mayers et al., 2009), displaying that there are varying aspects of sleep deficiency that affect one’s affective state.

Although there are multiple aspects to sleep deficiency to investigate, this study chose to investigate how sleep quality influences emotion processing biases based on the previous research suggesting a link between sleep quality and affect. For example, Bower et al. (2010), asked participants who either met criteria for major depressive disorder, displayed mild levels of depressive symptoms, or displayed no depressive symptoms to complete a series of self-report measures investigating affect and sleep quality. An examination of the relationship between their measures of affect and sleep-quality found that subjective sleep quality was closely related to both decreased positive and increased negative affect. By looking more specifically at sleep quality, we were better able to determine if this specific aspect of sleep deficiency was related to a decrease in positive and increase in negative affect, along with impaired emotion regulation.

Researchers have studied the relationship between subjective sleep quality and psychological factors such as anxiety, depression, and affect regulation for years. For example, a cross-sectional study consisting of 4,181 nonclinical individuals from a community setting was conducted in which participants completed a series of measures, including a self-report measure of sleep quality and a clinician-administered diagnostic measure of panic disorder, agoraphobia, social phobia, generalized anxiety disorder, obsessive compulsive disorder, and specific phobia. Ramsawh et al. (2009) were interested in the relationship between anxiety-related disorders and sleep quality, and found a statistically significant relationship between anxiety symptomology and poor sleep quality, with generalized anxiety disorder and social phobia exhibiting the strongest relationship to sleep quality. Similar research has displayed a relationship between self-reported sleep quality and higher levels of anxiety or anxiety-like symptoms (Saletu et

al., 1997; Belanger, Morin, Langlois, & Ladouceur, 2004). These findings establish a direct relationship between sleep quality and symptoms of anxiety.

The relationship between sleep quality and depressive symptoms was investigated by Pilcher et al. (1997), in which 87 college students were asked to complete a 7-day sleep log during the second or third week of the semester, and then complete a series of self-report questionnaires of sleep and affective state following the 7-day sleep log. They found that poor sleep quality, measured prospectively on the daily sleep log and the Pittsburgh Sleep Quality Inventory (PSQI) was significantly correlated with higher negative affect and increased levels of tension, depression, fatigue, and confusion based upon sleep and emotional measures administered at the end of the 7-day period. Furthermore, a study investigated the relationship between emotion regulation difficulties, anxiety symptoms, and depression symptoms on sleep quality in a sample of 459 college students. Participants completed a series of self-report questionnaires and found that poor sleep quality was associated with symptoms of depression and anxiety (Markarian, Pickett, Deveson, & Kanona, 2013). These findings support a relationship between sleep quality and affect. However, the mechanisms through which sleep quality relates to affect and emotional functioning are not yet known.

One possible mechanism underlying the sleep-affect relationship is emotion processing. Emotion processing refers to the way in which an individual perceives, communicates, interprets, and regulates emotion (Young & Widom, 2014). Deficits in emotion processing have been implicated across a range of psychopathology, including: anxiety (Tang & Harvey, 2004), depression (Naranjo, et al., 2011), PTSD (Ehring, & Quack, 2010), eating disorders (Bydlowski et al., 2005), and schizophrenia (Kerns, 2005). Further research has been conducted investigating how deficits in emotion

processing influence the experience of depression and anxiety as well as how the processing of emotions can become biased (i.e., how particular kinds of emotional stimuli are preferentially processed). There are at least three facets of emotional processing biases within the literature: attention bias, interpretation bias, and memory bias (Matthews & MacLeod, 2005).

Attention bias occurs when an individual selectively filters out emotionally valenced information while exaggerating other emotionally valenced information from the environment (e.g., filtering positive stimuli and exaggerating negative stimuli) (Gotlib, McLachlan, & Katz, 1988). Attention bias towards negatively valenced stimuli such as situations, faces, and emotions has been found to occur in individuals with emotional disorders such as depression and anxiety.

In a study conducted examining the attentional processing of emotional information, MacLeod and colleagues (1986), investigated attentional biases in participants with anxious symptoms and control participants. Participants were shown a series of physically or socially threatening words paired with a neutral word. They were asked to read one of the words aloud and to press a button if they saw a dot appear after the word pair disappeared. The results of the study indicate that the anxious participants shift their attention towards emotionally threatening stimuli whereas the control group shifts their attention away from these stimuli. These findings suggest anxious participants process mildly threatening information at a higher rate than the non-anxious controls (MacLeod, Matthews, & Tata, 1986). Similarly, a study was conducted in which participants were shown a series of either threat or non-threat words, and found that individuals with higher levels of state-anxiety were more likely to respond at a faster rate to threat words than neutral words (Mogg, Bradley, De Bono, & Painter, 1997).

In a more recent study by Duque and Vázquez (2015), participants with a current diagnosis of major depressive disorder and those who reported never being depressed were asked to view images of sad, happy, and angry facial expressions while an eye-tracker system recorded gaze duration and eye movement. Participants with clinical depression showed a longer fixation time on sad, but not angry, facial expressions than those who had never been depressed, supporting the hypothesis that individuals with depression have greater difficulty disengaging their attention from negative stimuli. In contrast, the participants with major depressive disorder spent less time than the healthy control group gazing at the happy faces, suggesting a decreased difficulty to disengage when viewing happy facial expressions (Duque & Vázquez, 2015). Similarly, a longitudinal study was conducted investigating the effect of attention bias modification training on attention bias to negatively valenced faces in a clinically depressed population (Beevers et al., 2015). Beevers et al. found a significant reduction of bias towards sad facial expressions between pre- and post-test in individuals who received the training, but not for those who did not receive the training. Additionally, a greater change in attention bias for negatively valenced stimuli was strongly associated with reduction in depressive symptoms post-test compared to pre-test in the training condition but not the control condition. These studies establish a relationship between attentional biases and emotional difficulties. Additionally, these results also indicate that this negative attention bias can lead to increased rates of negative clinical symptoms such as depressive symptoms.

Similar to attention biases, interpretation biases have been evidenced in individuals with symptoms of depression and anxiety. Interpretation bias refers to one's tendency to interpret ambiguous stimuli as threatening (Calvo, Castillo, & Eysenck,

1997). A recent study examined differences in severity of interpretation biases in non-depressed participants and participants with major depressive disorder. Participants were instructed to read a series of catastrophic life events and estimate the probability of each event happening to them after being given the probability of them happening to a demographically similar population. The study showed that individuals with major depressive disorder were more likely to inflate their estimates of probabilities of experiencing aversive events relative to the control group (Korn, Sharot, Walter, Heekeren, & Dolan, 2014).

Similarly, individuals with greater levels of anxiety are more likely than low-anxious individuals to perceive mild threats as more threatening. When presented with images of happy or angry expressions, high-anxious individuals interpreted mildly angry expressions as angrier or more similar to the prototypical expression of anger compared to low-anxious individuals, but no significant differences were found between participants regarding happy expressions (Mitte & Gebhardt, 2014). These results support the idea that individuals with greater symptoms of anxiety and depression are more likely to evidence interpretive biases than non-depressed or non-anxious individuals.

Memory bias, a third aspect of emotional processing bias, refers to selective recall of mood- or threat-congruent memories (Mogg, Mathews, & Weinman, 1987). This recall of mood congruent or threatening information is believed to be due to selective processing, which leads to increased depressed and anxious mood. In order to investigate the relationship between depression and memory bias, researchers investigated the relationship between memory bias and anxiety. They asked a nonclinical control group and participants meeting DSM-III criteria for a generalized anxiety disorder to read a series of threatening or nonthreatening words and to imagine a scene involving the words.

After a 6-minute filler task, the participants were then asked to recall as many of the words as possible when given three-letter-stems for each word. Clinically anxious individuals showed a bias favoring the recall of threatening information compared to the control group (Mathews, Mogg, May, & Eysenck, 1989).

In a more recent study investigating memory bias, researchers showed depressed and non-depressed individuals a series of neutral, negative, and positive adjectives. Participants were asked to rate whether those adjectives were descriptive of themselves and were later asked to recall as many of the adjectives as possible. Individuals with depression recalled a greater number of negative self-referent adjectives and a lower number of positive self-referent adjectives compared to non-depressed individuals (Romero, Sanchez, & Vazquez, 2014). These studies provide support for the link between memory bias and decreased positive and increased negative affect among individuals exhibiting symptoms of anxiety and depression.

Emotional processing biases appear to be affected by an individual's current mood state and it is possible that deficient sleep might exacerbate this relationship via its influence on affect and emotion regulation capabilities. Deficient sleep may alter emotion processing, leading to increased negative affect and decreased positive affect.

The aim of this study was to examine the relationship between sleep quality and affect, mediated by emotion processing bias. To summarize, the current study had nine major hypotheses:

Hypothesis 1a) Attention bias significantly *mediated* the relationship between poor sleep quality and negative affect such that poor sleep quality would positively predict negative attention bias and negative attention bias would positively predict

negative affect controlling sleep quality. The indirect effect ( $a * b$ ) was also hypothesized to be statistically significant.

Hypothesis 1b) Attention bias significantly *mediated* the relationship between poor sleep quality and positive affect such that poor sleep quality would positively predict negative attention bias and negative attention bias would negatively predict positive affect controlling for sleep quality. The indirect effect ( $a * b$ ) was also hypothesized to be statistically significant.

Hypothesis 1c) Attention bias significantly *mediated* the relationship between poor sleep quality and emotion regulation difficulties such that poor sleep quality would positively predict negative attention bias and negative attention bias would positively predict emotion regulation difficulties controlling for sleep quality. The indirect effect ( $a * b$ ) was also hypothesized to be statistically significant.

Hypothesis 2a) Interpretation bias *mediated* the relationship between poor sleep quality and negative affect such that poor sleep quality would positively predict negative interpretation bias and negative interpretation bias would positively predict negative affect controlling for sleep quality. The indirect effect ( $a * b$ ) was also hypothesized to be statistically significant.

Hypothesis 2b) Interpretation bias *mediated* the relationship between poor sleep quality and positive affect such that poor sleep quality would positively predict negative interpretation bias and negative interpretation bias would negatively predict positive affect controlling for sleep quality. The indirect effect ( $a * b$ ) was also hypothesized to be statistically significant.

Hypothesis 2c) Interpretation bias *mediated* the relationship between poor sleep quality and emotion regulation difficulties such that poor sleep quality would positively



predict negative interpretation bias and negative interpretation bias would positively predict emotion regulation difficulties controlling for sleep quality. The indirect effect ( $a*b$ ) was also hypothesized to be statistically significant.

Hypothesis 3a) Memory bias *mediated* the relationship between poor sleep quality and negative affect such that poor sleep quality would positively predict negative memory bias and negative memory bias would positively predict negative affect controlling for sleep quality. The indirect effect ( $a*b$ ) was also hypothesized to be statistically significant.

Hypothesis 3b) Memory bias *mediated* the relationship between poor sleep quality and positive affect such that poor sleep quality would positively predict negative memory bias and negative memory bias would negatively predict positive affect controlling for sleep quality. The indirect effect ( $a*b$ ) was also hypothesized to be statistically significant.

Hypothesis 3c) Memory bias *mediated* the relationship between poor sleep quality and emotion regulation difficulties such that poor sleep quality would positively predict negative memory bias and negative memory bias would positively predict emotion regulation difficulties controlling for sleep quality. The indirect effect ( $a*b$ ) was also hypothesized to be statistically significant.

## **Methods**

### **Participants**

In order to determine the projected sample size required to evaluate the study hypotheses, we identified research examining differences between good and poor sleepers on emotion processing-related variables. Five studies with sufficient, relevant data were identified (MacMahon, Broomfield & Espie, 2006; Jones, Jones, Macphee, Broomfield, & Espie,

2005; Marchetti, Biello, Broomfield, Macmahon, & Espie, 2005; Alapin, Fichten, Libman, Creti, Bailes, & Wright, 2000; Zammit, 1988). Effect sizes from the studies ranged from medium (0.63) to high (0.83). The mean effect size of these studies was (0.73). Power analysis indicated that 62 participants were needed to find an effect size of 0.73 at  $\alpha = .05$  and at power = .80 in regression analyses. A total of 67 participants were included in this study after eliminating those who met exclusion criteria. Participants were between the ages of 18 and 65. Additionally, participants were excluded if they were diagnosed with sleep apnea or use a C-PAP or Bi-Pap machine to aid sleep, had reported experiencing a traumatic brain injury or concussion within the past 6 months, were unable to refrain from taking a predetermined set of medications during the day of testing (e.g., codeine, diazepam, amitriptyline), or had been diagnosed with a DSM-5 mental health disorder within the past year. A complete summary of demographic information can be found in Table 1 below.

Table 1  
*Demographic Information for Participants*

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<b>Age</b>	
Mean	22.26
Standard Deviation	5.25
<b>Gender</b>	
Male	23 (32.9%)
Female	46 (65.7%)
<b>Ethnicity</b>	
American Indian	2 (2.9%)
Asian	2 (2.9%)
Caucasian	54 (77.1%)
Hispanic	10 (14.3)
Other	1 (1.4%)

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## Materials

The study was completed using MediaLab software on a Windows 7 PC in an office-sized room.

**Pittsburgh Sleep Quality Index.** The PSQI task is a 25-item self-rated questionnaire which assesses sleep quality over the past month (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The seven component scores are: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Component scores 1, 3 and 6 are based on single item responses, component scores 2, 5, and 7 are summations of two or more item responses, and component 4 is a calculation based on the number of hours asleep divided by the number of hours in bed. The total score was calculated based on the sum of all seven components. The total score was used in the analyses.

**Insomnia Severity Index.** The ISI is a 7-item self-report measure used to assess insomnia symptom severity (Bastien et al., 2001). The measure assesses severity of sleep onset, sleep maintenance, and early morning awakening problems, sleep dissatisfaction, interference of sleep difficulties with daytime functioning, noticeability of sleep problems

by others, and distress caused by the sleep difficulties. A 5-point Likert scale is used to rate each item (e.g., 0 = no problem; 4 = very severe problem), yielding a total score ranging from 0 to 28. The total score is interpreted as follows: absence of insomnia (0-7); sub-threshold insomnia (8-14); moderate insomnia (15-21); and severe insomnia (22-28). The ISI was included into the study as a potential additional predictor variable for post-hoc analyses.

**Positive and Negative Affect Schedule.** The PANAS is a 20-item self-report measure of positive and negative affect developed by Watson, Clark, and Tellegen (1988).

Participants were asked to rate the extent to which they have experienced each particular emotion on average throughout their life, with reference to a 5-point scale. The scale points are: 1 ‘very slightly or not at all’, 2 ‘a little’, 3 ‘moderately’, 4 ‘quite a bit’ and 5 ‘very much’. This measure was used to assess for trait levels of positive and negative affect. The total positive and total negative scores were assessed as potential outcome variables.

**Social Events Questionnaire.** The SEQ task was constructed to examine whether participants would produce catastrophic interpretations of mildly negative social events as well as measure positive event discount interpretations (Vassilopoulos, 2006).

Catastrophizing refers to the tendency to dwell on the worst possible outcome of a given situation whereas discounting is one’s tendency to view positive events as having less positive or negative implications (Beck, Emery, & Greenberg, 1985). Participants were asked to read a series of twenty short vignettes consisting of negative or positive social situations and to respond to a series of questions asked afterward involving how they interpret the situation and how likely they felt it would happen to them. The negative total SEQ score was analyzed as a hypothesized mediator.

**Dot-Probe Task.** The Dot-Probe Task was constructed to measure attentional biases (Beevers et al., 2015). The task was completed by using Direct RT software within the MediaLab software. In this task, two images measuring 15 ¼” by 15 ¾” depicting either an emotional (happy or sad) and neutral facial expression from the KDEF stimuli database (Calvo & Lundqvist, 2008) were presented concurrently one inch to the left and one inch to the right of a fixation point for 1,000 ms. Following the stimuli offset, a probe in the form of an “O” would appear on the screen in the same location as one of the images, randomly behind either the emotional or neutral image with equal frequency. The task consisted of a total of 192 trials (96 trials per block) with 12 pairs of sad and neutral images and 12 pairs of happy and neutral images randomly presented four times within each block of trials. Response latencies were recorded from correct responses only. Attention bias scores were calculated with the following formula:  $\frac{1}{2}[(TpLe - TpTe) + (LpTe - LpLe)]$ , where T= top position, L= lower position, p= probe, and e= emotional (positive/negative) stimulus. The negative total Dot-Probe Task score was analyzed as a hypothesized mediator.

**Memory Recall Task.** Memory bias will be assessed based on a validated measure created by Tarsia et al. (2003), in which a total of 16 “depressive,” 16 “anxious,” 16 “neutral,” and 16 “happy” words were presented on a screen for 6s and then participants were asked to rate them on their emotionality (1= not at all, 2= a little bit, 3= moderately, 4= quite a bit, and 5= very) after each word, followed by a fixation cross for 1 s. Following the presentation of the words, the participants were then asked to write down as many of the words from the previous task they could remember given a five minute period. The words used were rated by judges and matched for length and frequency. The negative total Memory Recall score was analyzed as a hypothesized mediator.

**Difficulties in Emotion Regulation Scale.** The DERS is a 36-item self-report measure used to assess emotion regulation difficulties. More specifically, the DERS items were chosen to reflect difficulties within the following dimensions of emotion regulation: (a) awareness and understanding of emotions; (b) acceptance of emotions; (c) the ability to engage in goal-directed behavior, and refrain from impulsive behavior, when experiencing negative emotions; and (d) access to emotion regulation strategies perceived as effective. The DERS total score was analyzed as a hypothesized outcome variable.

**Patient Health Questionnaire-9.** The PHQ-9 is a 9-item self-report measure of depressive symptoms (Kroenke, Spitzer, & Williams, 2001). The measure asks questions involving negative thoughts or feelings of depression. The PHQ-9 total score was included in the analyses as a potential covariate.

**Generalized Anxiety Disorder-7.** The GAD-7 is a validated 7-item self-report measure used in assessing anxious symptoms (Spitzer, Kroenke, Williams, & Lowe, 2006). The questionnaire asks participants to rate the severity of anxiety-related symptoms such as intense fear or inability to relax. The GAD-7 total score was included in the analyses as a potential covariate.

## **Procedure**

Participants completed the study individually in an approximately 10'X 15' room on a windows computer with a 22" screen facing one of the walls with a 3' X 10' window to the participant's left. The researcher sat quietly directly behind the participant throughout the study. Upon arrival to the research lab, participants were provided with a consent form with general information about the scope, goal, and procedures of the study. They were informed that participation is voluntary and they may terminate participation

at any point without penalty. They were asked to read the consent form and whether they had any questions about the experiment.

After obtaining informed consent, participants first completed a brief demographic questionnaire, and then completed the ISI and the PSQI. Following completion of the initial questionnaires, participants began the first part of the Memory Recall Task, in which they were shown a series of words and asked to rate the emotional valence of each word. The PANAS questionnaire was administered between the presentation of the first and last portion of the Memory Recall Task in order to eliminate recency effects on the free recall portion of the memory task. After completing the PANAS, participants were then provided a full five minutes to recall as many words as possible from the first part of the Memory Recall Task. Next, participants completed the Dot-Probe Task in which they were shown a series of faces followed by a probe and were required to press either the left or right key based on the probe's location on the screen. Participants then went on to complete the SEQ, which asked them to read and rate a series of social events. After completion of the SEQ, participants were given the final series of questionnaires consisting of the DERS, PHQ-9, and the GAD-7. After completion of these measures, participants were asked if they had any questions regarding the experiment, and thanked for their participation. The whole study lasted approximately 60 minutes. Participants obtained research credits upon completion of the study.

### **Plan of Analyses**

Multiple regression models were used to examine the nine hypotheses. Prior to analyses, the three primary statistical assumptions of regression models, i.e., normality of all continuous variables, linearity between predictors and outcomes as well as

homoscedasticity, were checked. Mediation models for all hypotheses were tested using the product-of-coefficient approach (MacKinnon et al 2002; MacKinnon, 2008). First, multiple linear regression analyses were performed to see if sleep quality predicted the mediators (the “a” paths) while controlling for any significant covariates (i.e., age, gender, ethnicity, depression, and anxiety). Any non-significant covariates were removed and the analyses were re-run with only the significant covariates in the model. Next, the indirect effects of the mediators (the “b” path) and the direct effects (effect of predictors on outcomes controlling for mediators; the “c” path) were assessed by including predictors, mediators, and covariates into the models.

### Results

Data were analyzed by multiple regression analyses, with a special focus on examining whether emotion processing biases mediated the relationship between sleep quality and emotion regulation. Preliminary tests were needed in order to check the assumptions of linear regression. The normality assumption of all variables was examined. Skewness and kurtosis statistics showed that the variables being investigated were within limits of normal distribution, confirmed by examination of the frequency histograms and normal probability plots for this data.

Zero-order correlations were performed to check the relationships between all major variables (Table 2). There was a strong positive relationship between sleep quality and all three control variables (*Insomnia Severity Index*:  $r = .670, p < .001$ , *Patient Health Questionnaire -9*:  $r = .340, p < .001$ , and the *Generalized Anxiety Disorder -7*:  $r = .261, p < .01$ ). However, none of the mediator or outcome variables were correlated with total sleep quality. The means, standard deviations, and t-scores for the two predictor variables (PSQI and ISI) and three predictor variables (PANAS



Positive, PANAS Negative, and DERS) are shown in tables 3, 4, and 5. T-tests were run for each of the predictor-outcome relationships with either gender (male or female) or race (white or non-white) included in the analyses as a predictor. Additionally, a regression analysis was done to test each predictor-outcome relationship with age included in the analysis as a predictor.

Table 2

*Correlations between key continuous variables*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Total PSQI Score	--	0.670**	0.195	-0.191	0.163	-0.122	-0.175	0.105	0.340**	0.261*	0.109	0.013	-0.051
2. Total ISI Score		--	0.309**	-0.345**	0.282	-0.314**	-0.040	0.181	0.542**	0.278*	0.035	0.010	0.032
3. DERS			--	-0.338**	0.630**	-0.025	0.063	0.038	0.609**	0.592**	0.107	0.153	-0.079
4. PANAS Positive Score				--	-0.279*	-0.129	0.034	-0.228	-0.242*	-0.136	-0.132	0.069	-0.191
5. PANAS Negative Score					--	-0.207	0.163	0.022	0.678**	0.737**	0.058	0.059	0.163
6. Negative Interpretation Bias						--	-0.208	-0.076	-0.218	-0.025	0.045	-0.251*	0.032
7. Negative Attention Bias							--	-0.279*	0.100	0.118	-0.234	0.108	-0.047
8. Negative Memory Bias								--	0.070	-0.151	-0.048	-0.241*	-0.181
9. PHQ9									--	0.760**	-0.082	0.035	0.058
10. GAD7										--	-0.041	0.181	0.007
11. Age											--	-0.2-7	0.040
12. Gender												--	-0.128
13. Ethnicity													--

\*\*: Correlation is significant at the .01 level

\*: Correlation is significant at the .05 level

Table 3

*Gender Differences on Outcomes (0=Male; 1=Female)*

	Males		Females		Standardized $\beta$	$t$	$p$
	M	SD	M	SD			
Total PSQI Score	7.35	3.54	7.43	2.83	0.064	0.495	0.622
Total ISI Score	9.22	5.05	9.33	4.94	0.074	0.583	0.562
Positive PANAS	31.78	6.14	32.61	5.43	0.035	0.275	0.785
Negative PANAS	21.04	6.48	21.87	6.85	0.136	1.086	0.281
DERS Total Score	70.09	22.70	86.35	22.38	0.215	1.160	0.250

Table 4

*Ethnicity Differences on Outcomes (0=White, 1=Non-White)*

	White		Non-White		Standardized $\beta$	$t$	$p$
	M	SD	M	SD			
Total PSQI Score	7.24	3.11	8.00	2.90	0.11	0.91	0.37
Total ISI Score	8.70	5.00	11.40	4.24	0.24	1.96	0.06
Positive PANAS	32.48	6.00	31.80	4.26	-0.04	-0.31	0.76
Negative PANAS	20.74	6.25	24.67	7.52	0.27	2.23	0.29
DERS Total Score	82.76	22.98	88.13	21.30	0.14	1.16	0.25

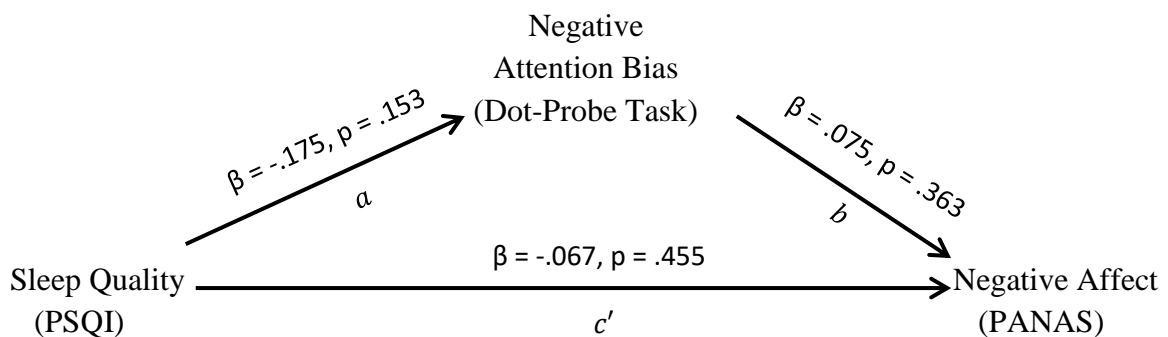
Table 5

*Age Differences on Outcomes*

	Age		Standardized $\beta$	$t$	$p$
	M	SD			
Total PSQI Score	7.41	3.06	-.12	-.95	0.35
Total ISI Score	9.29	4.94	0.04	0.35	0.73
Positive PANAS	32.33	5.65	-0.12	-0.98	0.33
Negative PANAS	21.59	6.69	0.08	0.64	0.52
DERS Total Score	83.83	22.58	0.15	1.20	0.23

### Hypothesis 1a: Sleep Quality, Attention Bias, and Negative Affect

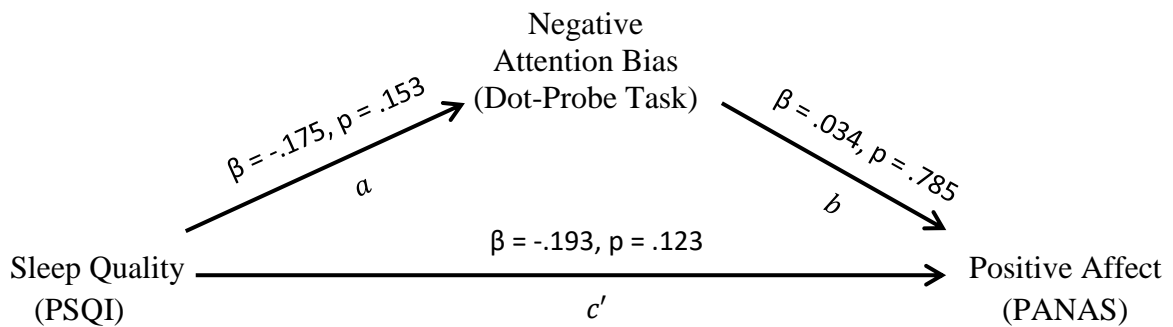
A detailed description of the regression analyses are described in the “Plan of Analyses” section. The “a” path regressed negative attention bias on sleep quality. No significant covariates were found here. The analysis showed that there was no significant relationship between sleep quality and negative attention bias ( $p > .05$ ). Next, the “b” path regressed negative affect on negative attention bias, controlling for depressive and anxious symptoms. Controlling for these variables, there was no statistically significant relationship between negative attention bias and negative affect ( $p > .05$ ). Lastly, the “c” path was assessed by including the predictor, mediator, and covariates into the model to predict negative affect. Again, the relationship was not significant ( $p > .05$ ). Results entered into Prodclin software with alpha at .05 indicated that the mediated effect was not significant ( $ab = 0.029$ , asymmetric confidence interval (ACI) =  $[-0.119, 0.029]$ , n.s.). See figure 1 for the standardized betas and significance of the model.



**Figure 1**

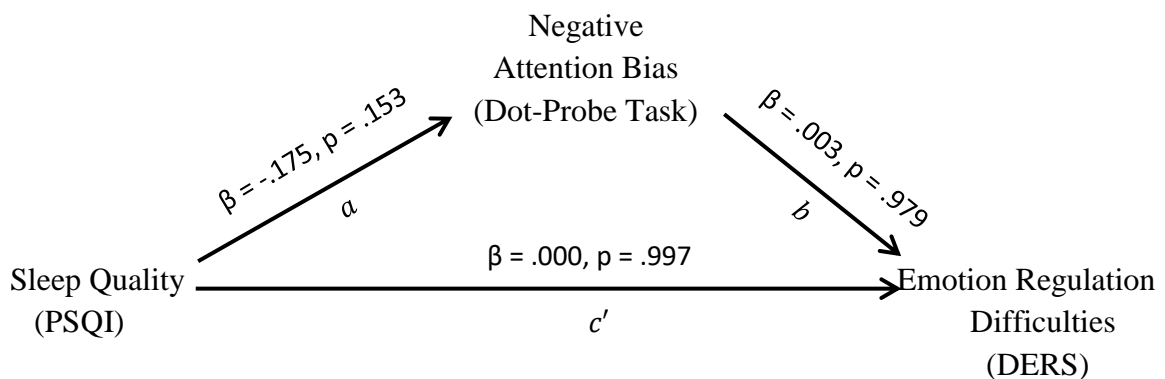
**Hypothesis 1b: Sleep Quality, Attention Bias, and Positive Affect**

Similar analyses were carried out to test hypothesis 1b. Attention bias did not significantly mediate the relationship between sleep quality and positive affect. There was also direct relationship between sleep quality and positive affect. The mediated effect was not significant ( $ab = -0.011$ ,  $ACI = [-0.106, 0.071]$ , n.s.). See figure 2 for the standardized betas and significance of the model.

**Figure 2**

### Hypothesis 1c: Sleep Quality, Attention Bias, and Emotion Regulation Difficulties

Hypothesis 1c also used the same method of analysis. There was no significant predictive relationship between sleep quality and negative attention bias or between negative attention bias and difficulties in emotion regulation, controlling for depressive symptoms ( $p > .05$ ). Lastly, direct effect, including the predictor, mediator, and covariate (depressive symptoms) into the model to predict difficulties in emotion regulation was not significant ( $p > .05$ ). The mediated effect was not significant ( $ab = -0.003$ ,  $ACI = [-0.285, 0.275]$ , n.s.). See figure 3 for the results of the model.

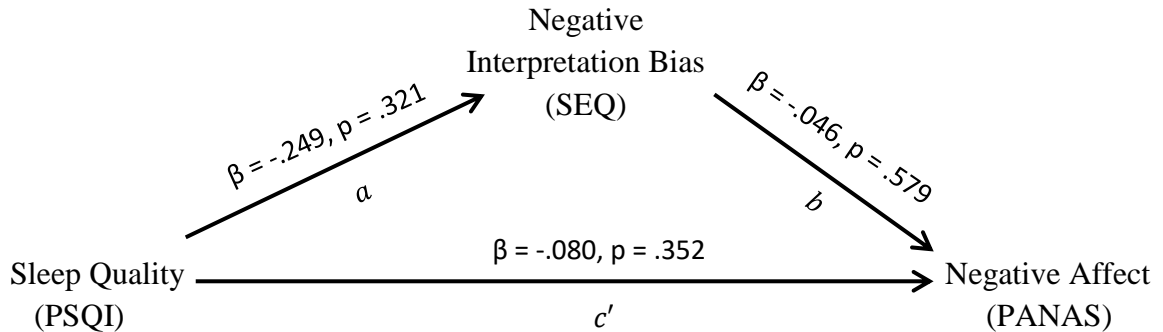


**Figure 3**

### Hypothesis 2a: Sleep Quality, Interpretation Bias, and Negative Affect

The analysis first investigated the significance of the mediator by regressing negative interpretation bias on to sleep quality, including gender in the model as a covariate, then by including interpretation bias, depression, and anxiety into the model predicting negative affect. There was no statistically significant relationship between sleep quality and negative interpretation bias or between negative interpretation bias and negative affect ( $p > .05$ ). Lastly, the direct path was assessed by including the predictor, mediator, and covariates (anxiety and depression) into the model to predict negative affect, which was not significant ( $p > .05$ ). The product-of-coefficient approach shows

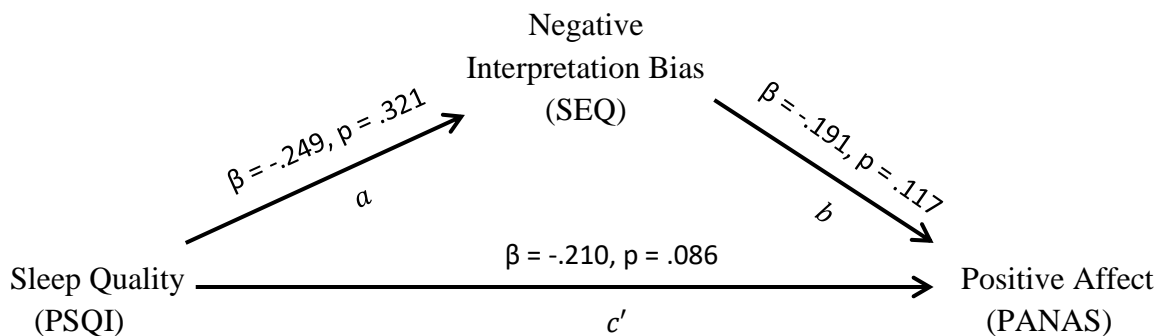
that the mediated effect was not significant ( $ab = 0.400$ ,  $ACI = [-0.031, 0.072]$ , n.s.). See figure 4 for the standardized betas and significance of the model.



**Figure 4**

#### **Hypothesis 2b: Sleep Quality, Interpretation Bias, and Positive Affect**

Again, there was no statistically significant relationship between sleep quality and negative interpretation bias or between negative interpretation bias and positive affect ( $p > .05$ ). Both the indirect ( $ab = 0.042$ ,  $ACI = [-0.036, 0.160]$ , n.s.) and direct effects were not significant. See figure 5 for the standardized betas and significance of the model.

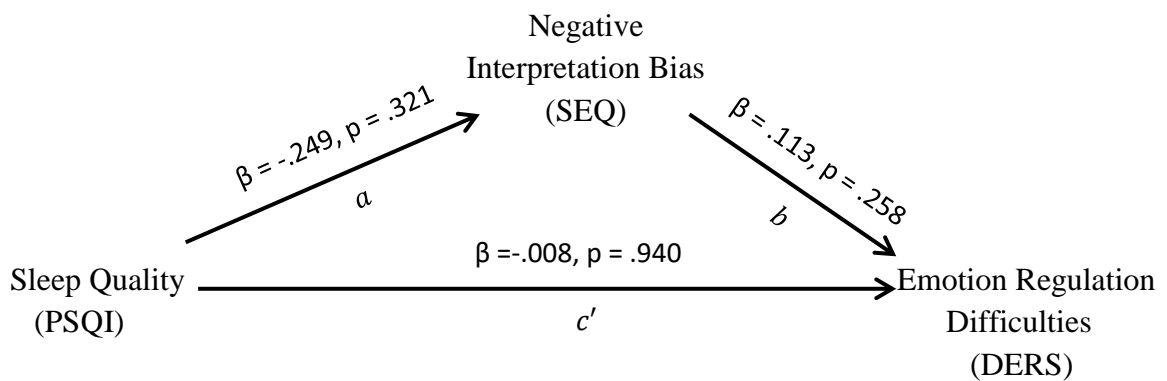


**Figure 5**

### Hypothesis 2c: Sleep Quality, Interpretation Bias and Emotion Regulation

#### Difficulties

There was no statistically significant relationship between sleep quality and negative interpretation bias or between negative interpretation bias and difficulties in emotion regulation ( $p > .05$ ). Assessing the direct path between sleep quality and emotion regulation difficulties including negative interpretation bias and depression into the model, there was no significance ( $p > .05$ ). The mediated effect was not significant ( $ab = -0.099$ ,  $ACI = [-0.424, 0.105]$ , n.s.). See figure 6 for the results of the model.

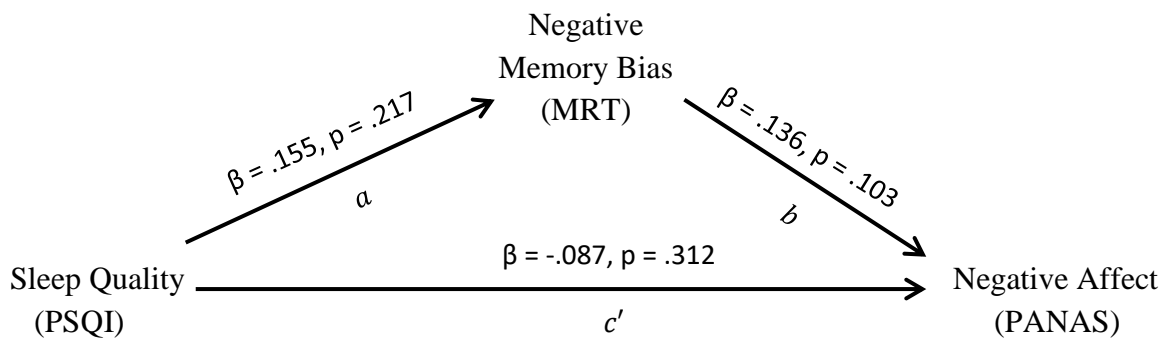


**Figure 6**



### Hypothesis 3a: Sleep Quality, Memory Bias, and Negative Affect

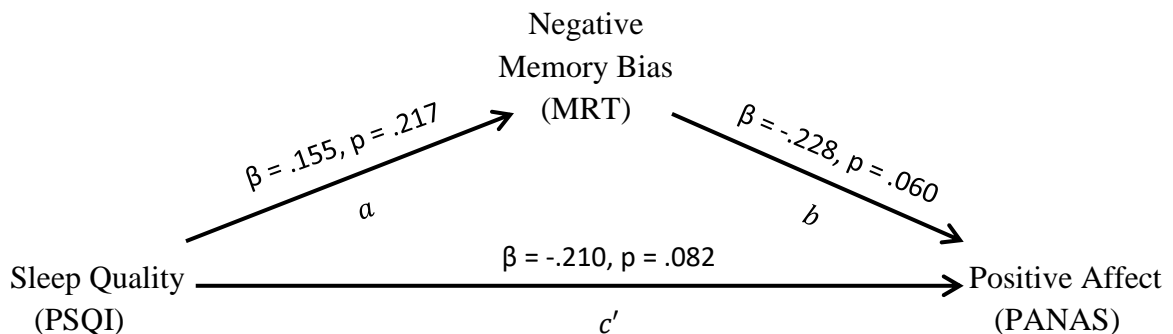
Similar analyses were carried out to examine hypothesis 3a. There were no statistically significant direct and indirect effects of sleep quality on memory bias. Memory bias did not mediate the relationship between sleep quality and negative affect ( $ab = .046$ ,  $ACI = [-0.027, 0.162]$ , n.s.). See figure 7 for the standardized betas and significance of the model.



**Figure 7**

### Hypothesis 3b: Sleep Quality, Memory Bias, and Positive Affect

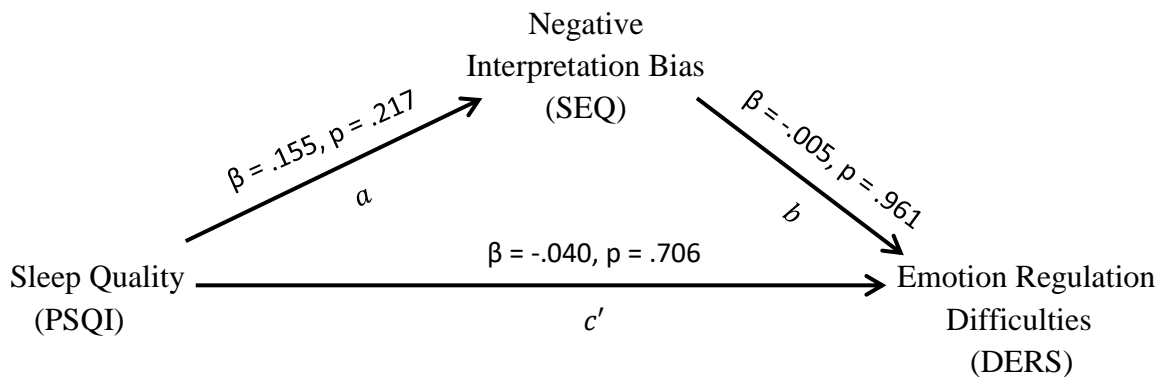
There were no statistically significant relationships between the IV and mediator or the mediator and DV ( $p > .05$ ). Neither the direct effect nor the mediated effect were significant ( $ab = -0.064$ ,  $ACI = [-0.218, 0.037]$ , n.s.). See figure 8 for the standardized betas and significance of the model.



**Figure 8**

### Hypothesis 3c: Sleep Quality, Memory Bias, and Emotion Regulation Difficulties

There was no significant relationship between sleep quality and emotion regulation difficulties. Memory bias also did not mediate this relationship ( $ab = -0.005$ ,  $ACI = [-0.250, 0.232]$ , n.s.). See figure 9 for the results of the model.

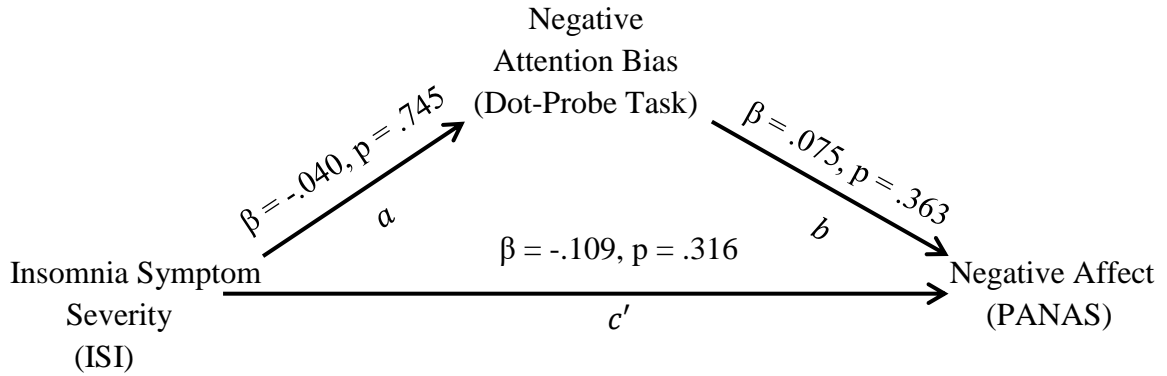


**Figure 9**

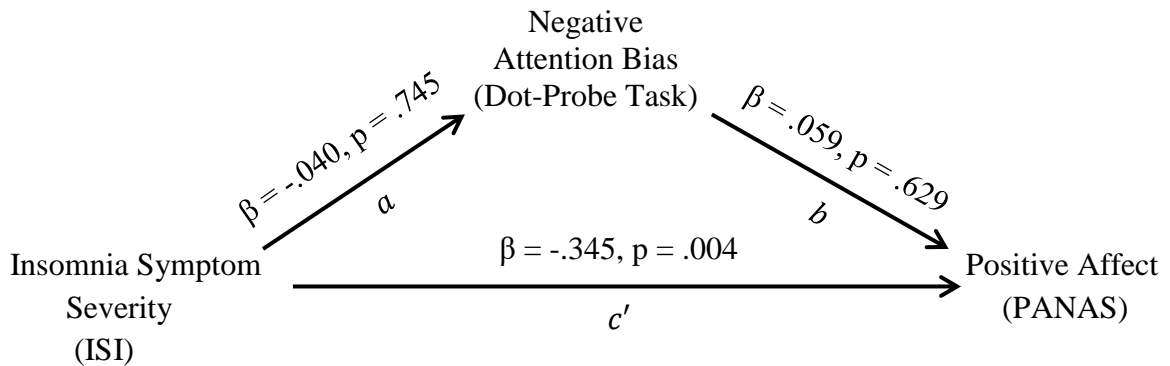
**Exploratory analyses.** Due to the non-significant results found by using the total sleep quality score as a predictor variable, exploratory analyses were conducted by using insomnia severity as a predictor variable.

**Negative attention bias as a mediator.** Using the same method of analyses for hypothesis 1a, 1b, and 1c the indirect path between insomnia symptoms and the three outcome variables (negative affect, positive affect, and emotion regulation difficulties) through negative attention bias was assessed. The mediated effect was not significant for negative affect ( $ab = -0.004$ ,  $ACI = [-0.036, 0.021]$ , n.s.), positive affect ( $ab = -0.009$ ,  $ACI = [-0.026, 0.017]$ , n.s.), or emotion regulation difficulties ( $ab = -0.000$ ,  $ACI = [-0.041, 0.039]$ , n.s.). Similarly, the direct effect between insomnia symptoms and negative affect, as well as emotion regulation difficulties were non-significant ( $p > .05$ ). However, the direct effect of insomnia symptoms on positive affect was significant at  $p < .01$ . Figures

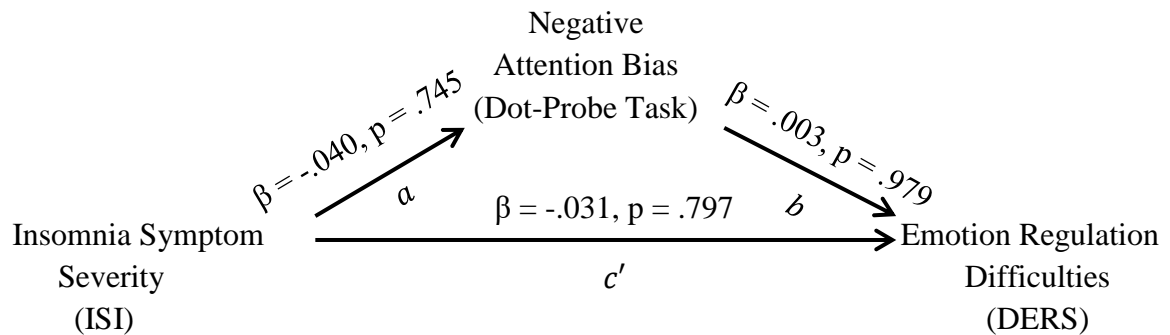
10, 11, and 12 display the three models with negative attention bias as a mediator between insomnia symptoms and the three outcome variables.



**Figure 10**



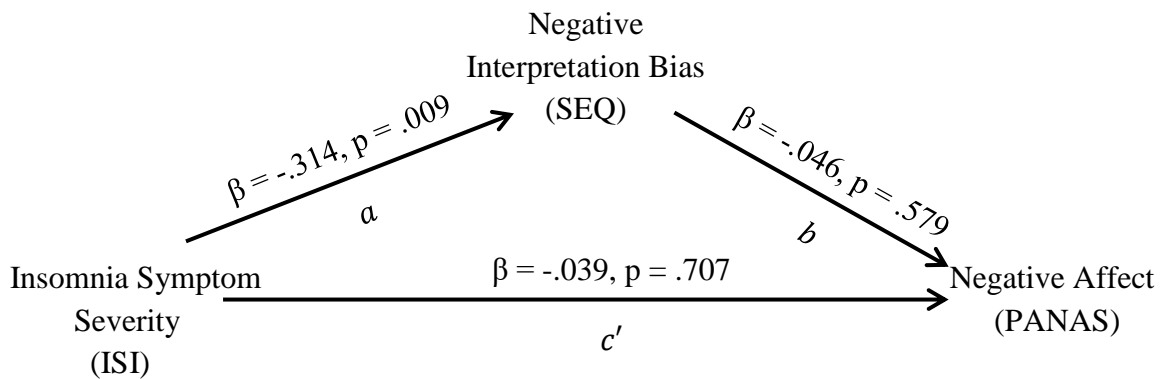
**Figure 11**



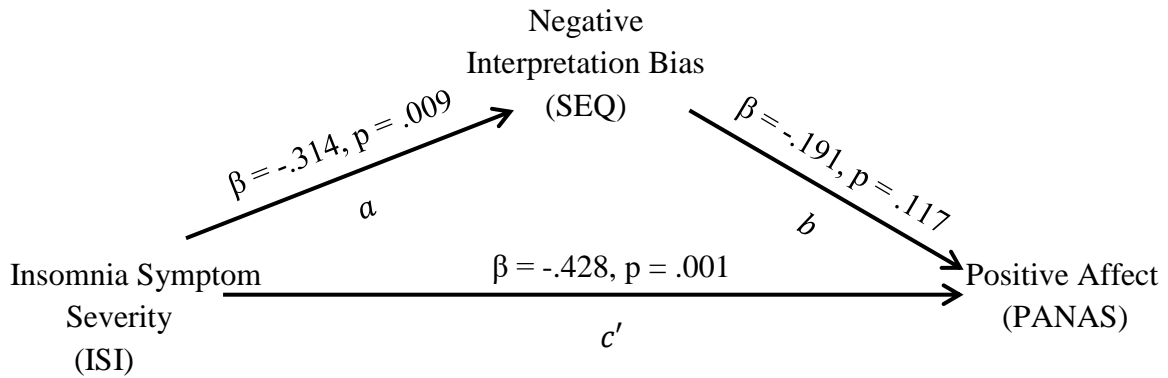
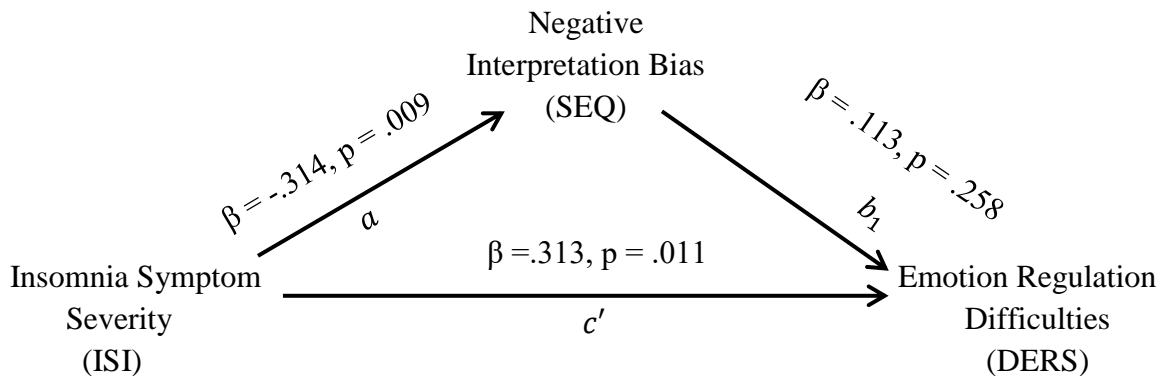
**Figure 12**

*Negative interpretation bias as a mediator.* Using methods similar for hypothesis 2a, 2b, and 2c, the indirect effect between insomnia symptoms and the three outcome

variables (negative affect, positive affect, and emotion regulation difficulties) through negative interpretation bias was assessed. Insomnia symptom severity significantly predicted negative interpretation bias ( $p < .01$ ), although it was opposite to the hypothesized direction. Regressing the three outcome variables onto negative interpretation bias resulted in non-significance ( $p > .05$ ). The direct effect between insomnia symptoms severity and negative affect was also non-significant ( $p > .05$ ) with a non-significant mediated effect ( $ab = 0.020$ ,  $ACI = [-0.048, 0.098]$ , n.s.). Conversely, the models with positive affect and emotion regulation difficulties both displayed a significant direct effect in the hypothesized direction ( $p < .01$ ), although the mediated effects were not significant ( $ab = 0.068$ ,  $ACI = [-0.011, 0.183]$ , n.s.;  $ab = -0.163$ ,  $ACI = [-0.513, 0.101]$ , n.s. respectively). Figures 13, 14, and 15 display the three mediation models.

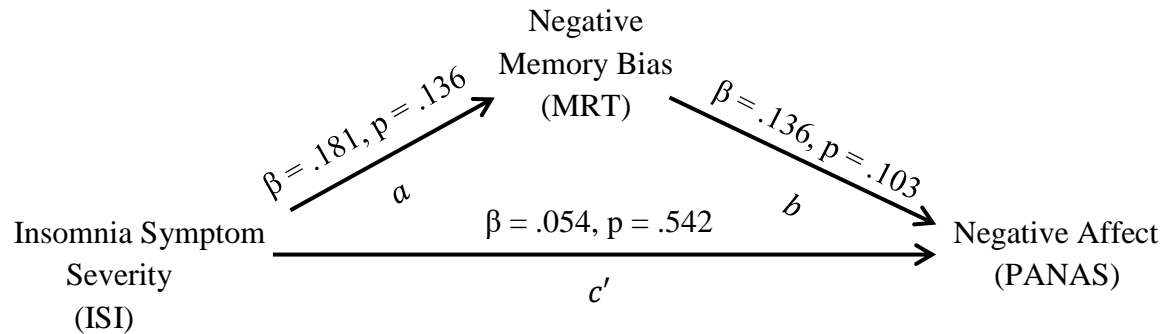


**Figure 13**

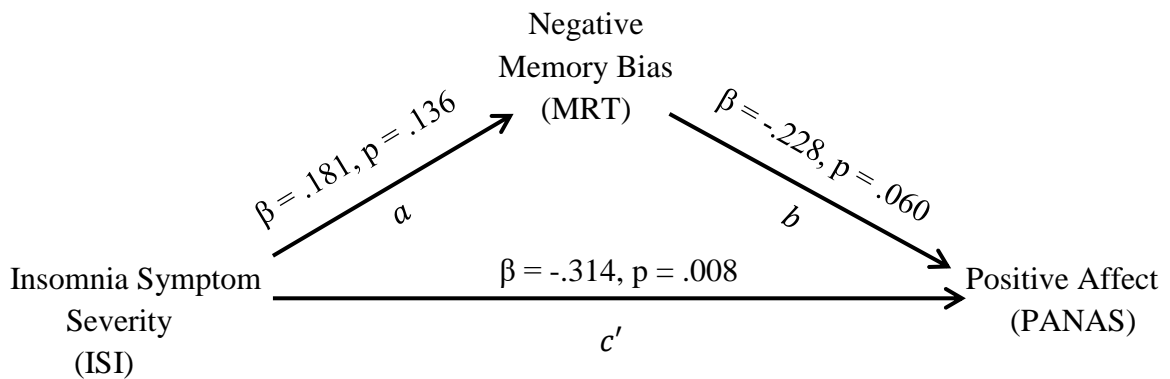
**Figure 14****Figure 15**

**Negative memory bias as a mediator.** In order to determine the indirect relationship between insomnia symptoms and the three outcome variables, negative memory bias was regressed onto insomnia severity, and then the three outcome variables were regressed onto negative memory bias. None of the mediation models had any significant paths ( $p > .05$ ). The mediated effect was not significant for negative affect ( $ab = .033$ ,  $ACI = [-0.008, 0.099]$ , n.s., see figure 16), positive affect ( $ab = -.046$ ,  $ACI = [-0.133, 0.007]$ , n.s., see figure 17), or emotion regulation difficulties ( $ab = -0.004$ ,  $ACI = [-0.175, 0.163]$ , n.s., see figure 18) as the outcome variables. Analysis of the direct effect between insomnia symptoms and positive affect was significant when including negative memory bias in the model ( $p < .01$ ). However, the direct effects between insomnia symptoms and the other two outcome variables were not significant when including

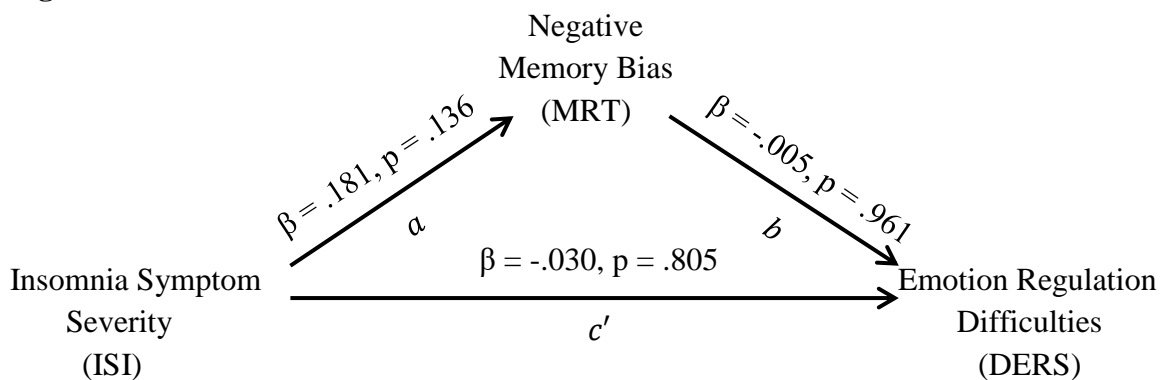
negative memory bias in the model ( $p > .05$ ). The results were presented in Figures 16, 17 and 18.



**Figure 16**



**Figure 17**



**Figure 18**

## Discussion

The goal of this study was to investigate whether emotion processing biases (attention, interpretation, and memory) mediated the relationships between poor sleep

quality and emotion regulation /affect. This resulted in a total of nine specific hypotheses. In each of the three mediation models, poor sleep quality (PSQI) did not significantly predict the three emotion processing biases. The three biases also did not significantly predict any of the three outcome variables, i.e., emotion regulation, negative affect and positive affect. Due to the lack of significant findings, nine additional models using insomnia symptoms as a predictor were examined.

When using the PSQI as the predictor variable, there were no significant relationships between the PSQI and any mediators (“a” paths) or between PSQI and outcome variables controlling for the mediators (“c” paths) in the 9 models. Additionally, there were no significant relationships between the mediators and outcome variables (“b” paths). Based on the correlations in Table 1, this is to be expected. However, this is inconsistent with prior research investigating the relationship between sleep quality and affect/emotion regulation (Pickett, Barbaro, & Mello, 2016; Bouwmans, Bos, Hoenders, Oldehinkel, & de Jonge, 2017). One of the hypothesized reasons for the non-significant findings when using the PSQI was that the study primarily took place during the summer, when students had better sleep quality such that the mean PSQI score was 7.45 (SD=3.06) on a measure with a range of 0-21. However, when looking at the original development of the measure, the measure resulted in a mean of 7.4 and a standard deviation of 5.1 (Buysse et al, 1988). Therefore, the range does not appear to be limited in this study

Several factors may account for the non-significant findings. First, there are limited data to support a causal relationship between emotion processing biases and emotion regulation difficulties or affect. Therefore, it is possible that the three outcome variables may in fact be significant mediators of the relationships between predictor

variables and the three emotion processing biases. Additionally, the mediation measures may not have been valid in assessing emotion processing biases due to a lack of interest among some participants. Several participants showed signs of boredom during those tasks. At least one participant fell asleep during the Dot-Probe Task. However, this participant's data was kept because they likely experience poor sleep quality and deleting this data would be eliminating information important to the study. Outliers in the attention bias task were eliminated by deleting any reaction times above and below 2 standard deviations of their mean response times. Second, the different time frame of measures may have affected the findings. The ISI assesses symptoms within the past two weeks whereas the PSQI assesses symptoms for the previous month. The longer time frame of PSQI may make it more susceptible to rater biases. Participants might have been more biased when attempting to recall sleep over the previous month compared to the past two weeks. Similarly, studies have shown that measures that are closer in timeframe are more closely correlated (Clark & Watson, 1995). The ISI, a measure assessing insomnia symptoms over the past two weeks may be more closely related to the mediator variables, which are based on current functioning, than the one month assessment of sleep quality from the PSQI. Finally, some of the component scales of the PSQI (e.g., self-rated sleep quality) may be more predictive of poor sleep quality than the total score. Additional analyses may be investigated to include specific component scores as predictors instead of the total score to determine if a specific subscale is a significant predictor.

Due to the lack of significant findings with sleep quality as a predictor, insomnia symptoms were assessed as another potential independent variable. When looking at the three models with negative attention bias mediating the relationship between insomnia



symptoms and the three outcomes, there were not any significant relationships between insomnia symptoms and negative attention bias. This bias also did not significantly predict to the three outcomes. However, insomnia symptoms negatively predicted positive affect. This is consistent with previous research showing that, as insomnia symptoms increase in severity, positive affect decreases.

Insomnia symptoms were significantly related to negative interpretation bias. However, it was opposite to the expected direction. As insomnia symptoms increased, negative interpretation bias decreased. This directionality could be attributed to the fact that when individuals experience increased sleep deficiency or lack of sleep, they are more likely to discount their experiences or attribute their reactions to their lack of sleep (Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010). Therefore, individuals who score higher on the ISI (i.e., experience greater insomnia symptoms) are less likely to blame themselves for negative social situations and are more likely to discount their experiences. In addition to a significant relationship between the predictor (ISI) and mediator (negative interpretation bias), we also see a significant direct relationship between insomnia symptoms and positive affect as well as emotion regulation difficulties when including negative interpretation bias in the model, both in the expected direction. When insomnia symptoms increase in severity, we see a direct increase in emotion regulation and decrease in positive affect.

### **Clinical Implications**

The data provide support for the role of emotional distress (i.e. anxious and depressive symptoms) in sleep quality, affect, and emotion regulation. We see multiple significant correlations between the two psychological measures (i.e. the PHQ-9 and GAD-7) and the sleep measures (i.e. PSQI and ISI) as well as between the measures of

emotional functioning (i.e., PANAS and DERS). Additionally, exploratory analyses indicated a significant relationship between insomnia symptoms and emotional distress. This relationship is consistent with the current literature showing that insomnia symptoms are negatively tied to emotional functioning. Based on this information, it is important to consider emotional and psychological functioning when working with clients reporting sleep difficulties, or conversely, looking at sleep problems with clients reporting emotional or psychological difficulties. This study displays the importance of assessing a client's sleep hygiene with a client reporting emotional distress and, conversely, assessing for emotional distress when working with clients reporting sleep difficulties.

### **Limitations of the present study**

This study has several limitations. These limitations, broadly speaking, can be classified as either design limitations or population limitations. Each of these limitations will be examined in further detail below.

**Design limitations.** In hindsight, there are a few issues with the experimental design of this study. First and foremost, the study was a cross-sectional design, which limits the ability to determine the temporal relationships between sleep, emotion processing biases and emotion regulation. For example, by externally restricting and extending ones sleep, we can see how emotion processing biases change based on the amount of sleep provided. Additionally, differences in the time frame of various measures could potentially explain why, in the analyses, sleep quality was not significantly correlated with any of the three dependent variables (i.e. positive affect, negative affect, or emotion regulation difficulties). The PSQI looked at the participant's functioning in the past month, the ISI looked at the past two weeks, and other measures,

such as the PANAS and DERS, looked at their trait level or typical way of responding. These differences might have negatively affected the data. The final issue with the experimental design is the time required for participation. Study typically lasted 60 minutes. Another limitation to the study is that participants may have had low engagement in the task (e.g., falling asleep either due to boredom or tiredness), which could have affected their performance, thus negatively affecting the reliability of the measures.

**Participant limitations.** Because our sample is collected solely from a student population receiving class credit for their participation, it is possible that many participants were not putting effort into the tasks. In fact, there had been two participants that had fallen asleep during the dot-probe task whose data needed to be removed. It is likely that the level of interest in the study was low, which negatively affected the reliability of the mediation measures. In a larger, more clinically based sample, it is likely that we would see different, more significant results. Lastly, it is important to mention that this study included college students attending Idaho State University between the ages of 18 and 47. The majority of the sample was white and female, and it is possible that we might observe different results in a wider demographic sample.

### **Future Directions**

To address the limitations mentioned above, future studies could include measures that assess sleep quality/problems, emotion processing biases and affect using the same time frame (e.g., the last two weeks or the last month). Additionally, including participants of different demographic characteristics will likely increase the external validity of the study and make the findings more generalizable to the general population. Data collection at multiple time points will allow for hypothesized causation between the

predictor and criterion variables. By collecting data across multiple times of the year, results will likely be more representative of the population's average sleep quality annually and therefore have more significant results.

The relationship between sleep quality and emotion regulation is complex. The goals of the present study were to clarify this relationship by investigating three emotion processing biases as mediators. None of these mediators were significant. Study design and participant pool may partially explain the non-significant findings. Insomnia symptom severity was found to significantly predict negative interpretation bias and positive affect. Modifications of study design, alterations in data collection time and identification of other emotion-processing tasks in future studies are necessary to understand the variables that mediate the relationship between sleep quality and emotion regulation.

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### Appendix A- Demographic Questionnaire

Please answer the following questions.

1. How old are you? \_\_\_\_\_ Years
2. What is your sex? \_\_\_\_\_ Male \_\_\_\_\_ Female
3. What is your marital status? \_\_\_\_\_ Single without partner  
   \_\_\_\_\_ Single with partner, not cohabiting  
   \_\_\_\_\_ Single with partner, cohabiting  
   \_\_\_\_\_ Married  
   \_\_\_\_\_ Divorced  
   \_\_\_\_\_ Widowed  
   \_\_\_\_\_ Other (please specify) \_\_\_\_\_
4. What is your ethnicity? \_\_\_\_\_ African American  
   \_\_\_\_\_ American Indian  
   \_\_\_\_\_ Asian  
   \_\_\_\_\_ Caucasian  
   \_\_\_\_\_ Hispanic  
   \_\_\_\_\_ Indian  
   \_\_\_\_\_ Other (please specify) \_\_\_\_\_
5. What is your occupation? \_\_\_\_\_
6. What is your handedness when writing? Left \_\_\_\_\_ Right \_\_\_\_\_ Both \_\_\_\_\_
7. Please list the type and amount of medications that you are currently using:  
     medication \_\_\_\_\_ dose \_\_\_\_\_  
     Everyday \_\_\_ As needed \_\_\_  
     \_\_\_\_\_   
     Everyday \_\_\_ As needed \_\_\_  
     \_\_\_\_\_   
     Everyday \_\_\_ As needed \_\_\_  
     \_\_\_\_\_   
     Everyday \_\_\_ As needed \_\_\_
8. Approximately how many hours did you sleep last night? \_\_\_\_\_
9. How many hours do you usually sleep per night? \_\_\_\_\_
10. How many caffeinated beverages have you consumed today? \_\_\_\_\_  
     How much caffeine do you usually drink (per day)? \_\_\_\_\_

11. How much alcohol or other recreational drugs have you used today? \_\_\_\_\_

How much do you usually use (per week)? \_\_\_\_\_

12. Have you had a head injury? \_\_\_\_\_

How long ago did you have a head injury? \_\_\_\_\_

What part of your head was injured? (front, left side, top, back, right side) \_\_\_\_\_

13. Have you been diagnosed with sleep apnea? \_\_\_\_\_

Do you use a C-Pap or Bi-Pap machine? \_\_\_\_\_

## Appendix B- PSQI

### INSTRUCTIONS

The following questions relate to your usual sleep habits during the **past month** only. Your answers should indicate the most accurate reply for the **majority** of days and nights in the past month. Please answer all questions.

1. During the past month, what time have you usually gone to bed at night?

BED TIME \_\_\_\_\_ (Please enter the clock time, e.g., 10:30pm)

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

NUMBER OF MINUTES \_\_\_\_\_

3. During the past month, what time have you usually gotten up in the morning?

GETTING UP TIME \_\_\_\_\_ (Please enter the clock time, e.g., 06:00am)

4. During the past month, how many hours of *actual sleep* did you get at night? (This may be different than the number of hours you spent in bed)

HOURS OF SLEEP PER NIGHT \_\_\_\_\_

**During the past month, how often have you had trouble sleeping because you...**

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
5a. Cannot get to sleep within 30 minutes	0	1	2	3
5b. Wake up in the middle of the night or early morning	0	1	2	3
5c. Have to get up to use the bathroom	0	1	2	3
5d. Cannot breathe comfortably	0	1	2	3
5e. Cough or snore loudly	0	1	2	3
5f. Feel too cold	0	1	2	3

5g. Feel too hot	0	1	2	3
5h. Have bad dreams	0	1	2	3
5i. Have pain	0	1	2	3

5j. Other reason(s), please describe: \_\_\_\_\_

	<b>Not during the past month</b>	<b>Less than once a week</b>	<b>Once or twice a week</b>	<b>Three or more times a week</b>
How often in the past month have you had trouble sleeping because of the above reason(s)?	0	1	2	3

6. During the past month, how would you rate your sleep quality overall?

Very Good	Fairly Good	Fairly Bad	Very Bad
0	1	2	3

7. During the past month, how often have you taken medicine to help you sleep (prescribed or “over the counter”)?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
0	1	2	3

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
0	1	2	3

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
0	1	2	3



10. Do you have a bed partner or roommate?

No bed partner or roommate	Partner or roommate in other room	Partner in same room, but not same bed	Partner in same bed
0	1	2	3

**If you have a roommate or bed partner, ask him/her how often in the past month you have had...**

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a. Loud snoring	0	1	2	3
b. Long pauses between breaths while asleep	0	1	2	3
c. Legs twitching or jerking while you sleep	0	1	2	3
d. Episodes of disorientation or confusion during sleep	0	1	2	3
e. Other restlessness while you sleep; please describe _____	0	1	2	3
_____				

**During the past month, how often have you had trouble sleeping because you...**

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
11a. Feel hot flashes	0	1	2	3
11b. Feel general nervousness	0	1	2	3
11c. Had memories or nightmares of a traumatic experience	0	1	2	3

11d.	Had severe anxiety or panic, not related to traumatic memories	0	1	2	3
11e.	Had bad dreams, not related to traumatic memories	0	1	2	3
11f.	Had episodes of terror or screaming during sleep without fully awakening	0	1	2	3
11g.	Had episodes of “acting out” your dreams, such as kicking, punching, running, or screaming	0	1	2	3

**Appendix C- ISI**

Please answer about the **past 2 weeks** (including today), and circle one answer for each question.

1. Please rate the current (i.e., *the past week*) severity of your insomnia problem(s).

	None	Mild	Moderate	Severe	Very Severe
a. Difficulty falling asleep:	0	1	2	3	4
b. Difficulty staying asleep:	0	1	2	3	4
c. Problem waking up too early:	0	1	2	3	4

2. How satisfied/dissatisfied are you with your current sleep pattern?

Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
0	1	2	3	4

3. To what extent do you consider your sleep problem to interfere with your daily functioning (e.g., daytime fatigue, ability to function at work/daily chores, concentration, memory, mood, etc.)?

Not at All Interfering	A Little	Somewhat	Much	Very Much Interfering
0	1	2	3	4

4. How noticeable to others do you think that your sleeping problem is in terms of impairing the quality of your life?

Not at All Noticeable	A Little	Somewhat	Much	Very Much Noticeable
0	1	2	3	4

5. How worried/distressed are you about your current sleep problem?

Not at All Worried	A Little	Somewhat	Much	Very Much Worried
0	1	2	3	4

## Appendix D- Memory Recall Task

### Appendix A. List of primed and unprimed words used as stimuli divided by category and their mean length (*L*) and frequency (*F*)

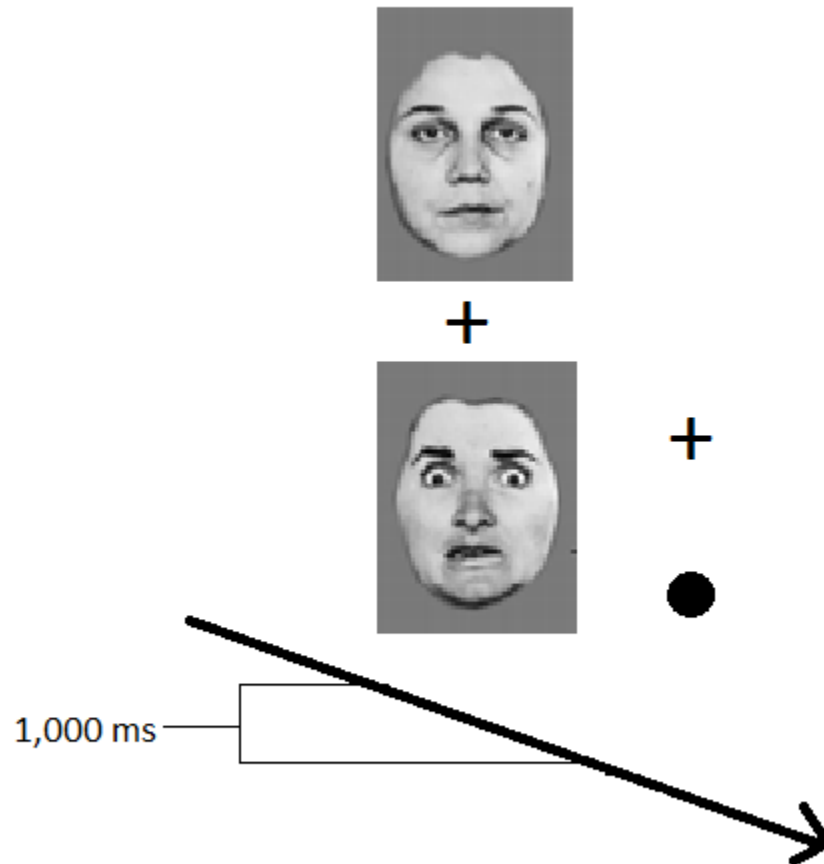
Primed words	Unprimed words	Primed words	Unprimed words
<i>Depression relevant</i>		<i>Anxiety relevant</i>	
Awful	Alone	Accident	Cancer
Crying	Death	Afraid	Coffin
Disappointed	Deprived	Ambulance	Danger
Exhausted	Deserted	Attack	Disaster
Failure	Despair	Casualty	Disease
Grief	Discouraged	Collapse	Disgrace
Guilty	Dismal	Criticism	Embarrassed
Hopeless	Dreadful	Emergency	Fear
Isolated	Dull	Harm	Nervous
Lost	Gloomy	Mistake	Pain
Misery	Horrible	Murder	Persecuted
Rejected	Pessimistic	Panic	Strangled
Terrible	Sad	Paralysed	Suffocate
Tortured	Suffering	Tragedy	Terrified
Unfortunate	Suicide	Uneasy	Victim
Upset	Worthless	Urgent	Worry
<i>L</i> = 7.25, <i>F</i> = 33.53	<i>L</i> = 7.19, <i>F</i> = 36.31	<i>L</i> = 7.06, <i>F</i> = 32.16	<i>L</i> = 7.19, <i>F</i> = 30.72
<i>Emotional positive</i>		<i>Neutral</i>	
Affection	Beauty	Branch	Bag
Applause	Dear	Chair	Bowl
Art	Fantasy	Fork	Chin
Charm	Festivity	Garage	Corner
Comfort	Freedom	Ink	Curtains
Dream	Friend	Kettle	Elbow
Joyful	Fun	Material	Furniture
Kind	Happy	Oats	Glass
Kiss	Heaven	Paper	Hat
Laugh	Hope	Pole	Item
Lucky	Hug	Potato	Pencil
Miracle	Lovely	Seat	Pipe
Peace	Music	Stove	Product
Spring	Pleasant	Table	Shoes
Tickle	Sunset	Umbrella	Street
Victory	Warmth	Window	String
<i>L</i> = 5.75, <i>F</i> = 57.88	<i>L</i> = 5.69, <i>F</i> = 64.81	<i>L</i> = 5.31, <i>F</i> = 54.28	<i>L</i> = 5.31, <i>F</i> = 53.88

**Appendix E- PANAS**

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way on average. Use the following scale to record your answers:

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

1. \_\_\_\_\_ Interested
2. \_\_\_\_\_ Distressed
3. \_\_\_\_\_ Excited
4. \_\_\_\_\_ Upset
5. \_\_\_\_\_ Strong
6. \_\_\_\_\_ Guilty
7. \_\_\_\_\_ Scared
8. \_\_\_\_\_ Hostile
9. \_\_\_\_\_ Enthusiastic
10. \_\_\_\_\_ Proud
11. \_\_\_\_\_ Irritable
12. \_\_\_\_\_ Alert
13. \_\_\_\_\_ Ashamed
14. \_\_\_\_\_ Inspired
15. \_\_\_\_\_ Nervous
16. \_\_\_\_\_ Determined
17. \_\_\_\_\_ Attentive
18. \_\_\_\_\_ Jittery
19. \_\_\_\_\_ Active
20. \_\_\_\_\_ Afraid

**Appendix F- Dot Probe Task**

### Appendix G- SEQ

Please read each description as though you were in the described situations and then answer the questions below it.

1. You're having a conversation with a classmate before class starts, when it becomes apparent that he/she is interested in what you are saying.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

2. You made a trip with your friends and, on the way back, you overhear a friend telling others that the trip would not have been as amusing without you.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

3. You are being interviewed for a job and after the interview was over, you ask the interviewer about your performance. The interviewer replies that you did well

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

4. You invite a person you find attractive to go to get coffee together and he/she accepts the invitation.

a) *How positive or negative do you believe the event is?*

very negative

very positive

**-5   -4   -3   -2   -1   0   1   2   3   4   5**

b) *How probable do you believe it is to happen to you?*

not at all likely

extremely likely

0 1 2 3 4 5 6 7 8

5. You give a speech in front of an audience full of students and when the speech is over you are applauded

a) *How positive or negative do you believe the event is?*

very negative

very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*

not at all likely

extremely likely

0 1 2 3 4 5 6 7 8

6. You go to dinner with a person you find attractive and after the dinner he/she wishes you goodnight saying that they had a good time.

a) *How positive or negative do you believe the event is?*

very negative

very positive

**-5   -4   -3   -2   -1   0   1   2   3   4   5**

b) *How probable do you believe it is to happen to you?*

not at all likely

extremely likely

0 1 2 3 4 5 6 7 8

7. You explain an idea for a project to your university teacher and he/she listens to you, smiling.

a) *How positive or negative do you believe the event is?*

very negative

very positive

**-5   -4   -3   -2   -1   0   1   2   3   4   5**

b) *How probable do you believe it is to happen to you?*

not at all likely

extremely likely

0 1 2 3 4 5 6 7 8

8. A fellow student introduces you to a group of friends, making complimentary remarks about you.



a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

9. A friend of your roommate (and a perfect stranger to you) comes home to extend him/her and invitation to a birthday party. Before leaving, he/she extends the same invitation to you.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

10. You walk up to a group of classmates talking about something. Once they see you approaching, they stop talking and make room for you in their group, laughing.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

1. You are hosting a study party with some classmates. When they leave, your roommate tells you that you made a fool of yourself.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

2. You meet someone at a party and spend a long time talking to him/her. You enjoyed the conversation but later you overhear him/her telling someone else what a boring party it was.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

3. You get a job in a company but, after a while, you realize that you are not very close with your new co-workers.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

4. You walk on the street and you see someone from one of your classes. The person looks at you and walks to the other side of the road.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

5. Some people in a class of yours throw a party but they don't invite you.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

6. It's your birthday and you invite your friends to your place to celebrate. Initially, your friends accept the invitation, but later they call you to say that something happened and they won't be coming.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

7. You make a new friend and spend a lot of time together for a few days. However, his/her texting becomes more and more infrequent while he/she tells you that he/she cannot see you due to work overload.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

8. You are talking with your friend about something. Suddenly, an argument emerged and your friend became angry, mildly criticized you and left.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*  
 not at all likely extremely likely

**0 1 2 3 4 5 6 7 8**

9. Your roommate, whom you hang out with and enjoy living with, lets you know that he/she is moving out next semester.

a) *How positive or negative do you believe the event is?*  
 very negative very positive

**-5 -4 -3 -2 -1 0 1 2 3 4 5**

b) *How probable do you believe it is to happen to you?*

not at all likely

extremely likely

0 1 2 3 4 5 6 7 8

10. You find out that an old friend that you have not seen for many years came to your town without paying a visit to you.

a) *How positive or negative do you believe the event is?*

very negative

very positive

-5 -4 -3 -2 -1 0 1 2 3 4 5

b) *How probable do you believe it is to happen to you?*

not at all likely

extremely likely

0 1 2 3 4 5 6 7 8

**Appendix H- DERS**

Please carefully read each of the statements below and circle the number that best describes how often you do the following things in order to manage your emotions during times of distress.

	<b>Almost Never (0-10%)</b>	<b>Sometimes (11-35%)</b>	<b>About Half the Time (36-65%)</b>	<b>Most of the Time (66-90%)</b>	<b>Almost Always (91- 100%)</b>
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
1 I am clear about my feelings.				1 2 3 4 5	
2 I pay attention to how I feel.				1 2 3 4 5	
3 I experience my emotions as overwhelming and out of control.				1 2 3 4 5	
4 I have no idea how I am feeling.				1 2 3 4 5	
5 I have difficulty making sense out of my feelings.				1 2 3 4 5	
6 I am attentive to my feelings.				1 2 3 4 5	
7 I know exactly how I am feeling.				1 2 3 4 5	
8 I care about what I am feeling.				1 2 3 4 5	
9 I am confused about how I feel.				1 2 3 4 5	
10 When I'm upset, I acknowledge my emotions.				1 2 3 4 5	
11 When I'm upset, I become angry with myself for feeling that way.				1 2 3 4 5	
12 When I'm upset, I become embarrassed for feeling that way.				1 2 3 4 5	
13 When I'm upset, I have difficulty getting work done.				1 2 3 4 5	
14 When I'm upset, I become out of control.				1 2 3 4 5	
15 When I'm upset, I believe that I will remain that way for a long time.				1 2 3 4 5	
16 When I'm upset, I believe that I'll end up feeling very depressed.				1 2 3 4 5	
17 When I'm upset, I believe that my feelings are valid and important.				1 2 3 4 5	
18 When I'm upset, I have difficulty focusing on other things.				1 2 3 4 5	

<b>Almost Never (0-10%)</b>	<b>Sometimes (11-35%)</b>	<b>About Half the Time (36-65%)</b>	<b>Most of the Time (66-90%)</b>	<b>Almost Always (91-100%)</b>
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>

19	When I'm upset, I feel out of control.	1	2	3	4	5
20	When I'm upset, I can still get things done.	1	2	3	4	5
21	When I'm upset, I feel ashamed with myself for feeling that way.	1	2	3	4	5
22	When I'm upset, I know that I can find a way to eventually feel better.	1	2	3	4	5
23	When I'm upset, I feel like I am weak.	1	2	3	4	5
24	When I'm upset, I feel like I can remain in control of my behaviors.	1	2	3	4	5
25	When I'm upset, I feel guilty for feeling that way.	1	2	3	4	5
26	When I'm upset, I have difficulty concentrating.	1	2	3	4	5
27	When I'm upset, I have difficulty controlling my behaviors.	1	2	3	4	5
28	When I'm upset, I believe that there is nothing I can do to make myself feel better.	1	2	3	4	5
29	When I'm upset, I become irritated with myself for feeling that way.	1	2	3	4	5
30	When I'm upset, I start to feel very bad about myself.	1	2	3	4	5
31	When I'm upset, I believe that wallowing in it is all I can do.	1	2	3	4	5
32	When I'm upset, I lose control over my behaviors.	1	2	3	4	5
33	When I'm upset, I have difficulty thinking about anything else.	1	2	3	4	5
34	When I'm upset, I take time to figure out what I'm really feeling.	1	2	3	4	5
35	When I'm upset, it takes me a long time to feel better.	1	2	3	4	5
36	When I'm upset, my emotions feel overwhelming.	1	2	3	4	5

**Appendix I- PHQ-9**

Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	1	2	3	4
2. Feeling down, depressed, or hopeless	1	2	3	4
3. Trouble falling or staying asleep, or sleeping too much	1	2	3	4
4. Feeling tired or having little energy	1	2	3	4
5. Poor appetite or overeating	1	2	3	4
6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down	1	2	3	4
7. Trouble concentrating on things, such as reading the newspaper or watching television	1	2	3	4
8. Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual	1	2	3	4
9. Thoughts that you would be better off dead or of hurting yourself in some way	1	2	3	4

**Appendix J- GAD-7**

Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all	Several days	More than half the days	Nearly every day
1. Feeling nervous, anxious, or on edge	1	2	3	4
2. Not being able to stop or control worrying	1	2	3	4
3. Worrying too much about different things	1	2	3	4
4. Trouble relaxing	1	2	3	4
5. Being so restless that it is hard to sit still	1	2	3	4
6. Becoming easily annoyed or irritable	1	2	3	4
7. Feeling afraid as if something awful might happen	1	2	3	4