ASSOCIATION BETWEEN THE BEHAVIORAL INHIBITION SYSTEM/BEHAVIORAL ACTIVIATION SYSETM, BIG-5, AND SLEEP IN A COLLEGE STUDENT SAMPLE: THE MODERATING ROLE OF NEUROTICISM

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College students are a unique population due to the challenging transition into the independence of adulthood, as well as the increase in academic rigor and social expectations. As a result, health behaviors such as getting enough sleep can often fall to the wayside. There are a variety of reasons for college students to experience sleep disturbances or choose to forgo sleep, and personality characteristics may play a role. Jeffrey Gray's Reinforcement Sensitivity Theory (RST) suggests that the Behavioral Inhibition System (BIS) responds to signals of punishment and non-reward and inhibits movement toward goals, while the Behavioral Activation System (BAS) responds to signals of reward and non-punishment and stimulates movement toward goals. The BAS scales can be further separated into three BAS factors – Drive, Reward, and Fun Seeking. While there are few studies that explore the relationship between BIS/BAS and sleep, one study found that college students higher in BIS were more likely to forgo sleep to study while individuals higher in BAS were more likely to forgo sleep due to work, social life, and entertainment. Additionally, there is evidence linking the Five-Factor Model (FFM) of personality with sleep. Specifically, neuroticism is characterized by a tendency toward distress and negative affect and is associated with poor sleep quality. Extraversion is characterized by sociability and positive affect; some studies suggest that higher extraversion is associated with better sleep quality while others have

found the opposite effect. Moreover, research suggests that neuroticism has a strong positive relationship with BIS and extraversion is positively related to all BAS scales. The present study expanded the literature by providing more insight into how BIS/BAS, the Big Five (i.e., neuroticism and extraversion), and sleep are interrelated in 657 college students. It was hypothesized that BIS would be significantly associated with higher neuroticism, and that BAS would be significantly associated with higher extraversion. It was also hypothesized that BIS and neuroticism would be significantly associated with worse sleep quality, higher levels of insomnia, increased daytime sleepiness, and higher levels of dysfunctional beliefs about sleep. All three BAS factors and extraversion were hypothesized to be significantly associated with sleep quality, levels of insomnia, daytime sleepiness, and dysfunctional beliefs about sleep; these hypotheses were exploratory. Lastly, it was hypothesized that neuroticism would moderate the relationship between BIS and sleep quality, as well as the relationship between BIS and insomnia severity. The hypotheses were partially supported. The results suggested a significant relationship between BIS and neuroticism, and between all BAS factors and extraversion. Higher levels of BIS and neuroticism were both significantly correlated with worse self-reported sleep quality, increased insomnia severity, more daytime sleepiness, and increase dysfunctional beliefs and attitudes about sleep. Extraversion was not significantly related to the domains of sleep assessed in this study. However, participants higher in BAS- Reward Responsiveness and BAS-Drive reported significantly better sleep quality and individuals higher in BAS- Reward Responsiveness also reported significantly lower levels of insomnia severity. Unexpectedly, the results of this study indicate that neuroticism does *not* significantly moderate the relationship between BIS and sleep quality nor the relationship between BIS and insomnia severity. These results are discussed in light of post-hoc analyses, and clinical implications with regards to the association between personality characteristics and sleep in college students.

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CHAPTER I: INTRODUCTION

The unique schedules and obligations of college students make this population particularly vulnerable to sleep disturbances (Dinis & Braganca, 2018). Sleep complaints are highly prevalent in college students with poor sleep quality affecting from 10% to 50% of this population (Dinis & Braganca, 2018). A survey evaluating sleep duration in college students from 26 low-, middle-, and high-income countries found that 39.2% of students reported sleeping for less than six hours per night (Rowland et al., 2015). Additionally, a recent study assessing insomnia, daytime sleepiness, and quality of life in college students across 60 countries found that 57.6% of students experienced insomnia and 27% reported excessive daytime sleepiness (Babicki et al., 2023). Dysfunctional beliefs about sleep (i.e., excessive negative thoughts about getting enough sleep and the impact of disturbed sleep) is also associated with poor sleep quality in a college student population and is linked to poorer sleep hygiene (Jin et al., 2018). Sleep disturbance among college students is associated with a variety of physical and mental health concerns. Poor sleep is strongly related to health risk behaviors (e.g., drug use), can exacerbate symptoms of psychological disorders (e.g., depression and anxiety), and is associated with increased suicidal ideation (Friedrick & Schlard, 2018; Nadorff et al., 2011; Nyer et al. 2013).

BIS/BAS and Sleep

There are many reasons a college student might choose to forgo sleep including to study, meet work obligations, for entertainment, and to participate in social events. Lack of sleep may also occur due to other factors that make it difficult to sleep such as increased stress, difficulty with adjustment, drug and/or alcohol use, or relationship concerns (e.g., roommate troubles). While there are a variety of reasons for college students to experience sleep disturbances, the specific reasons for and perceived benefits of voluntarily neglecting sleep can vary from person-to-person. Some evidence indicates that the reasons for voluntary

sleep deprivation amongst college students differ depending on activation level of the Behavioral Inhibition System (BIS) and Behavioral Activation System (BAS; Gray, 1987).

The BIS responds to signals of punishment and non-reward, is responsible for individual differences in anxiety, and inhibits movement toward goals (Carver & White, 1994), while BAS responds to signals of reward and non-punishment and stimulates movement toward goals (Franken et al., 2005). The BAS scales can be further separated into three BAS factors – Drive, Reward, and Fun Seeking (Carver & White, 1994). The drive subscale reflects motivation to pursue goals, reward responsivity reflects heightened energy and positive affect toward the receipt of rewards, and fun seeking reflects novelty seeking and impulsivity toward the pursuit of pleasure (Johnson et al., 2003; Kelley et al., 2019).

A study by Andersz and Bargiel-Matusiewicz (2018) found that individuals higher in BIS activity were more likely to forgo sleep to study while individuals higher in BAS activity were more likely to forgo sleep due to work, social life, and participation in various types of entertainment. In addition, this study suggested that higher BAS activation was positively correlated with the number of perceived benefits of cutting down sleep while higher BIS activation was positively correlated with the number of perceived losses. Lastly, this study found that individuals who had higher BAS activity in the reward responsiveness subscale more often reported choosing sleep deprivation voluntarily (Andersz & Bargiel-Matusiewicz, 2018).

Five-Factor Model and Sleep

In addition to the BIS/BAS model, research indicates a relationship between the Big Five personality traits (i.e., Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism) of the Five-Factor Model (FFM; Goldberg, 1993) and sleep. Specifically, neuroticism is characterized by a tendency toward distress and negative affect and has largely

been found to be associated with poor sleep quality (Cellini et al., 2017; Duggan et al., 2014; Hintsanen et al., 2014; Stephan et al., 2018). Extraversion is characterized by sociability and positive affect; however, the literature yields mixed results with some studies indicating that higher extraversion is associated with better sleep quality while other studies have found the opposite effect (Gamaldo et al., 2020; Hintsanen et al., 2014; Stephan et al., 2018). Conscientiousness is the tendency to be achievement-striving and self-disciplined and most research has found that higher conscientiousness is related to better sleep quality (Duggan et al., 2014; Hintsanen et al., 2014). Finally, openness is the tendency to be intellectually curious and creative and agreeableness is the tendency toward empathy and cooperation. Generally, openness and agreeableness are not consistently related to sleep quality (Stephan et al., 2018).

Five-Factor Model and BIS/BAS

There is also some research linking the FFM with BIS and BAS. Gray (1987) proposed that BIS and BAS underlie many aspects of behavior and personality, so it is unsurprising that significant research has been conducted assessing the ways in which BIS and BAS relate to the Big Five personality traits of the FFM. For instance, neuroticism has a strong positive relationship with the BIS subscale, and extraversion is positively related to all BAS scales (i.e., BAS-Fun Seeking, BAS-Drive, and BAS-Reward; Keiser & Ross, 2011, Mitchell et al., 2007; Smits & Boeck, 2006). While associations have been identified between BIS and BAS and the other Big Five personality traits (i.e., agreeableness, conscientiousness, and openness to experience), their correlations are less well established.

The Present Study

While there are many studies linking BIS and BAS to the Big Five personality traits and several studies focusing on the Big Five and sleep, there are only a few studies focusing on

BIS and BAS and sleep and no studies that assess the relationship between all three factors. As a result, the present study sought to expand the literature on BIS/BAS and sleep in a college student population. In addition, this study provides further insight into how BIS/BAS, the Big Five (i.e., neuroticism and extraversion), and sleep are interrelated. This has important implications for understanding how sleep is influenced by activation of the motivational systems and expression of certain personality traits in college students. Lastly, this study clarifies the relationship between extraversion and sleep in a college student population as the literature in this area has been mixed.

Overall, the goal of the present study was to examine the complex relationship between BIS and BAS, neuroticism and extraversion, and sleep in a college student population; the work with this population is particularly important, given the inconsistent sleep schedules in college students (Brown et al., 2016). Therefore, the first aim was to examine the relationship between BIS and neuroticism, and the relationship between the BAS factors (i.e., BAS – Fun Seeking, Reward Responsiveness, and Drive) and extraversion. The second aim of the present study was to explore the relationship between the BIS/BAS factors and several domains of sleep including sleep quality, insomnia severity, daytime sleepiness, and dysfunctional beliefs about sleep. The third aim was to assess the relationship between neuroticism and extraversion and the domains of sleep listed above. Lastly, the fourth aim was to assess (1) the moderating role of neuroticism on BIS and sleep quality and (2) the moderating role of neuroticism on BIS and insomnia severity.

CHAPTER II: LITERATURE REVIEW

Sleep and Health

While sleep plays a vital role in both mental and physical health, according to the Centers for Disease Control and Prevention (CDC; 2020), a third of adults in the United States receive less than the recommended amount. Unfortunately, sleep disorders are associated with a variety of common mental health conditions including anxiety disorders (Ramsawh et al., 2009; Richards et al., 2020) and depressive disorders (Fang et al., 2019). Sleep problems are also associated with common physical health conditions such as hypertension (Lo et al., 2018), obesity (Cooper et al., 2018), and cardiovascular disease (Hall et al., 2018). In addition, individuals with sleep disorders experience decreased quality of life (Reimer & Flemons, 2003) and cognitive impairment which can affect domains of working memory, complex attention, and problem solving (Wardle-Pinkston et al., 2019).

Sleep in the College Student Population. Sleep complaints are highly prevalent in college students with poor sleep quality affecting from 10% to 50% of this population (Dinis & Braganca, 2018). College students are a unique population due to the challenging transition into adulthood and having more independence, as well as the increase in academic rigor and social expectations of college. According to Hershner and O'Brien (2018), 70% of college students report sleeping less than eight hours a night during the school week and frequently have delayed circadian rhythms that result in late bedtimes which can be exacerbated by poor sleep hygiene (e.g., technology use before bed, caffeine consumption, etc.) leading to disturbed sleep (Hershner & O'Brien, 2018).

There are a variety of reasons college students may choose to neglect sleep. The increased social pressures, variety of entertainment opportunities, work and school commitments, and unhealthy habits (e.g., drinking, smoking, and high caffeine intake) can lead college students to forgo sleep hygiene behaviors (Dinis & Braganca, 2018; Wang &

Biro, 2021). While the consequences of poor sleep are well documented, many college students view adequate sleep as a luxury and are unaware of the risks associated with insufficient sleep.

Negative Outcomes of Poor Sleep

Physical health. Insufficient sleep can lead to increased stress in college students which can negatively affect their physical health. For example, sleep deficiency is associated with changes in metabolic functioning, as well as imbalance related to the hormones affecting metabolism which can lead to increased appetite with decreased sleep duration (Owens et al., 2017). In addition, sleep duration is strongly associated with hypertension. One study found that individuals who slept less than seven hours per night and more than ten hours per night were more likely to suffer from hypertension (Fang et al., 2019). This is worrisome given that college students are at risk of high blood pressure, as well as weight gain due to decreased physical activity and an increase in unhealthy food options (Darden, 2014). Lastly, research suggests that sleep problems are strongly related to health risk behaviors and lower academic performance (Friedrick & Schlard, 2018). More specifically, poor sleep is strongly related to increased marijuana use, smoking, and alcohol intake (Taylor & Bramoweth, 2010), as well as reduced learning capacity and neurocognitive functioning (Curcio et al., 2006).

Mental Health. Among college students, insufficient sleep is associated with a wide variety of mental health concerns. Research indicates that young adults with insomnia present with more severe symptoms of major depression, generalized anxiety, panic, and phobias (Vollrath et al., 1989) and are also at increased risk for suicidal ideation (Nadorff et al., 2011). Sleep disturbances are also associated with negative affect and mood (Cukrowicz et al., 2006) which could be due to the effects of poor sleep on emotion regulation difficulties and distress tolerance (Cukrowicz et al., 2006). As a result, sleep disturbances can exacerbate

the symptoms associated with mental health diagnoses such as depression. Additionally, a study by Taylor et al. (2011) found that individuals with insomnia experienced higher levels of somatization, obsessive compulsive symptoms, depression, anxiety, and psychiatric distress. Psychological impairment because of sleep disturbances can lead to greater daytime functional impairment (Alapin et al., 2000) and more physical health problems (Lund et al., 2010). Lastly, a study by Nyer et al. (2013) found that college students experiencing depressive symptoms with sleep disturbance tended to experience more extreme anxiety symptoms, hyperarousal, and impaired daily functioning compared to students with depression symptoms who did not have impaired sleep.

Neurocognition. Poor sleep can also have adverse outcomes on cognitive functioning. Research indicates that individuals with sleep disorders have neurocognitive impairment in areas such as mental flexibility, sustained attention, verbal fluency, and general intellectual functioning (Fulda & Schulz, 2001; Khassawneh et al., 2018; Shekleton et al., 2014). Additionally, poor sleep can negatively affect learning, memory, and attention which can impede academic performance (Hershner & O'Brien, 2018). A study by Curcio et al. (2006) found that a student's learning capacity and performance in classes is closely related to sleep quality and quantity and that poor sleep is associated with poor declarative and procedural learning. Impaired neurocognitive functioning because of poor sleep can affect college students' grades and ability to succeed in an academic setting.

Reinforcement Sensitivity Theory

Jeffrey Gray's Reinforcement Sensitivity Theory (RST; Gray, 1990) originally proposed separate processes underlying cognition and emotion that can inter-relate. This theory stemmed from pharmacological research on animals which highlighted how emotional and cognitive processes are commonly interwoven and are difficult to distinguish. Gray's

RST postulated that the ambiguity when trying to separate out emotion and cognitive processes in animal research may be due to genuine overlap between the emotional and cognitive processes in the brain, rather than methodological issues. This theory suggested three fundamental emotion systems: a behavioral approach system (BAS), a fight/flight system (FFS), and a behavioral inhibition system (BIS). According to Gray, these three emotion systems are each elicited by different subsets of reinforcing stimuli that all correspond with separate subsystems in the brain. More specifically, the BIS mediates responses to conditioned signals of punishment or aversive stimuli, is responsible for individual differences in anxiety, and initiates passive avoidance. The BAS mediates responses to conditioned signals of reward, is responsible for individual differences in impulsivity, and initiates behavioral approach. Lastly, the fight-flight system is sensitive to unconditioned punishing events (Jorm et al., 1998).

RST and BIS/BAS Scales. Carver and White's (1994) measure was designed to be a self-report instrument that closely followed Gray's theory. In their scale, BIS reflects concern or worry about receiving punishment and the BAS includes items reflecting goal striving, reward responsivity, novelty seeking, and impulsivity (Kelley et al., 2019). From their research, Carver and White (1994) suggested a four-factor structure with one BIS factor and three BAS factors – Drive, Reward Responsivity, and Fun Seeking. The drive subscale reflects motivation to pursue goals, reward responsivity reflects heightened energy and positive affect toward the receipt of rewards, and fun seeking reflects novelty seeking and impulsivity toward the pursuit of pleasure (Johnson et al., 2003; Kelley et al., 2019). The BIS/BAS scales can be used to assess Gray's aversive (BIS) and appetitive (BAS) motivational systems by measuring individual differences in the reactivity of the BIS and BAS systems (Muller & Wytykowska, 2005).

Neurophysiology of RST and BIS/BAS Scales. While Carver and White's (1994) self-report measure is well validated and widely used in personality and motivation research (Heubeck et al., 1998; Jorm et al., 1998; Leone et al. 2001) it should be noted that the neurophysiological mechanisms associated with BIS/BAS are often overlooked in these studies despite their roots in behavioral neuroscience. However, neurobiological research that utilizes electroencephalography (EEG) has found significant associations between the BIS/BAS scales and differing patterns of anterior asymmetry in resting cortical activity. For example, a study by Sutton and Davidson (1997) found greater left frontal cortical activity to be positively associated with BAS (as measured by the BIS/BAS scales), and greater right frontal cortical activity to be positively associated with BIS. These findings support the notion that behavioral activation and behavioral inhibition are related to anterior asymmetry and may be linked to specific frontal lateralization.

In line with these findings, other studies also reported a significant association between greater left frontal cortical activity and BAS (Coan & Allen, 2003; Harmon-Jones & Allen, 1997). However, these studies did not find a significant association between anterior asymmetry and BIS. As a result, while the EEG literature supports the view that greater left-sided frontal EEG cortical activity is directly associated with high BAS levels, there is some discrepancy about whether BIS is directly associated with right-sided frontal EEG activation (De Pascalis et al., 2010). While more research is still needed in this area, these studies do provide neurophysiological evidence to support the RST's motivational systems of BIS/BAS.

RST Revision. Revisions to Gray's RST (McNaughton & Gray, 2000) have been made to account for new research findings. In the revision, the BAS is still viewed as a reward system that motivates approach behavior in response to all appetitive stimuli (Corr, 2004; Maack & Ebesutani, 2018; Mitchell et al., 2007). The FFS became the Fight-Flight-Freeze-system (FFFS) which is now part of the threat response system and is responsible for

activating the primary avoidance and escape behaviors in response to all aversive stimuli (Corr, 2004; Maack & Ebesutani, 2018; Mitchell et al., 2007). The BIS became responsible for detecting and resolving conflicts among competing goals and underlies the emotion of anxiety (Corr, 2004; Maack & Ebesutani, 2018; Mitchell et al., 2007). More specifically, BIS is responsible for mediating goal conflicts that includes both reward (i.e., BAS) and threat (i.e., FFFS; Corr, 2004; Keiser & Ross, 2011). The BIS will engage the BAS and inhibit the FFFS when the reward is greater than the threat which in turn motivates approach behavior (Bijttebier et al., 2009).

Corr (2013) used the example of going to the dentist to describe the BIS. While a patient may experience motivation to flee from the dentist's chair because of the potential pain involved in a procedure, the conflict between the discomfort of the situation and the reward of getting their teeth fixed activates behavioral inhibition. In this situation, the patient endures the discomfort and inhibits avoidance because the outcome will be rewarding (i.e., BIS interaction with BAS in an inhibitory fashion). In contrast, when the threat is greater the BIS inhibits the BAS and therefore activates the FFFS causing avoidance and escape behaviors (Bijttebier et al., 2009). While in both cases behavior is inhibited, the FFFS and BIS systems differ in their type of avoidance behavior in that the FFFS is active avoidance (pure avoidance/escape) while the BIS is passive avoidance (conflict-related avoidance) and allows cautious approach (or withholding of entry) to a dangerous place (Corr, 2013; McNaughton & Gray, 2000).

Separation of the BIS Scale. In the original version of the RST (Gray, 1990), the FFFS and BIS systems were not adequately distinguished and therefore, were often conflated. The revised version of the RST (McNaughton & Gray, 2000) separates FFFS/fear (also referred to as BIS/fear) and BIS/anxiety to accurately represent their different behavioral functions (Corr & McNaughton, 2012; McNaughton & Corr, 2004). As mentioned

previously, in the revised RST, “the BAS is activated by appetitive stimuli (e.g., food and sexual partners); the FFFS by aversive stimuli (e.g., predators); and the BIS by conflicting stimuli (e.g., coactivation of FFFS and BAS when their motivational tendencies are opposing, as in avoidance–approach conflict seen in many social situations,” Corr, 2013, p. 285). In other words, instead of BIS relating to only conditioned aversive stimuli, it is now presumed to be sensitive to goal conflicts such as between approach and avoidance motivation when they are in conflict.

Thus, it was proposed that the two avoidance systems (i.e., FFFS and BIS) have two distinct jobs: the FFFS/fear (or BIS/fear) is involved in simple active avoidance/escape while the BIS/anxiety is involved in passive avoidance involving goal conflict. A study by Heym et al. (2008) showed that the items in the BIS scale of Carver and White’s (1994) measure, can be divided into subscales for fear (BIS-Fear) and anxiety (BIS-Anxiety). According to this research, these measure the FFFS/fear (or BIS/fear) and BIS/anxiety, respectively. However, it should be noted that support for separation of the BIS scales has been mixed.

There is limited research replicating the Heym et al., (2008) study which suggested the two-factor model of BIS. In addition, Carver and White (1994) did not originally construct the BIS/BAS scales to assess the FFFS/fear dimension so there is less of a theoretical basis for the separation of the BIS scales (Maach & Ebesutani, 2017). Conversely, there have been several factor analytic studies that have provided support for the four-factor structure in which there is one BIS factor and three BAS factors (Cogswell et al., 2006; Leone et al., 2001; Levision et al., 2011; Ross et al., 2002). Moreover, a more recent study found additional evidence to support BIS as a unidimensional factor (Maach & Ebesutani, 2017). Due to limited evidence to support separation of the BIS scales, and particularly in the literature assessing the relationship between BIS/BAS and sleep, the present study utilized the four factor structure with one BIS factor and three BAS factors.

BIS/BAS and Sleep

Carver and White's (1994) BIS/BAS scales have been used in a variety of studies attempting to assess the association between BIS/BAS and areas such as psychopathology (Bijttebier et al., 2009) and risky health behaviors (Voigt et al., 2009). Sleep quality and sleep disturbances have also been assessed in the context of BIS and BAS but to a much lesser extent. One of the first studies to consider this relationship was a study by Moran et al. (2011) which examined the relationship between adherence to continuous positive airway pressure (CPAP) and BIS and BAS in participants with obstructive sleep apnea (OSA). Sixty-three participants took part in this study over the course of at least 30 days, and adherence was defined as use of CPAP for more than 4-hours per night on 70% of nights. Self-report data was collected from the BIS/BAS questionnaire (Carver & White, 1994), the Ways of Coping questionnaire (Folkman & Lazarus, 1988), and the mini-international personality item pool (Mini-IPIP; Donnellan et al., 2006). The results of this study suggested that high BIS was related to lower levels of adherence. In addition, BIS was the strongest predictor of nonadherence, followed by neuroticism, with BIS correctly predicting non-adherence to CPAP in 63.5% of cases. This study did not find evidence that BAS predicted adherence to CPAP.

Interestingly, Copur et al., (2018) performed a similar study investigating BIS and BAS and CPAP adherence but did not find a relationship between BIS and adherence to treatment. This study consisted of 321 mostly male veterans and adherence was defined as use of CPAP for more than 4-hours per night on 70% of nights. Self-report data was collected from the BIS/BAS questionnaire (Carver & White, 1994), Mini-IPIP (Donnellan et al., 2006), positive and negative affect scales (PANAS; Watson et al., 1988), and appetitive motivation scale (AMS; Jackson & Smillie, 2004). The results of this study suggested that BAS-Fun Seeking was the strongest predictor of patient adherence with CPAP therapy. Additionally, a

significant relationship between the personality facets of intellect/imagination and negative affect was found when considering CPAP adherence only (i.e., the time the apparatus was used). These studies supported the need to further explore the relationship between BIS/BAS and sleep.

One study was found that assessed the relationships between BIS/BAS sensitivity, emotion regulation difficulties, and sleep quality to depression, anxiety, and symptoms of stress in a sample of undergraduates (Markarian et al., 2013). The results of this study indicated that individuals higher in BIS and lower in BAS reported emotion regulation difficulties regardless of whether they were good sleepers (i.e., PSQI score < 5) or poor sleepers (i.e., PSQI score > 5). However, invariance testing showed that poor sleep quality was more strongly associated with emotion regulation difficulties and depression and anxiety than good sleep quality. This suggests that while emotion regulation difficulties alone can lead to depression and anxiety symptoms, poor sleep quality may exacerbate these symptoms (Markarian et al., 2013).

Another study was found that assessed the relationship between BIS/BAS activity and reasons for voluntary sleep deprivation among college students (Andersz & Bargiel-Matusiewicz, 2018). This study found that individuals higher in BIS activity were more likely to forgo sleep to study while individuals higher in BAS activity were more likely to forgo sleep due to work, social life, and participation in various forms of entertainment (Andersz & Bargiel-Matusiewicz, 2018). In addition, higher BAS activation was positively correlated with the number of perceived benefits of cutting down on sleep and that higher BIS activation was positively correlated with the number of perceived losses (Andersz & Bargiel-Matusiewicz, 2018). Lastly, this study found that individuals who had higher BAS activity in the Reward Responsiveness subscale more often reported choosing sleep deprivation voluntarily (Andersz & Bargiel-Matusiewicz, 2018).

BIS and BAS and the Five-Factor Model of Personality

Additionally, there is evidence linking the Five-Factor Model (FFM) of personality, BIS, and BAS. A lot of research has been done to assess the ways in which BIS and BAS relate to the Big Five personality traits of the FFM. The integration of the FFM into research on the BIS/BAS scales has helped further develop the RST as findings suggest that these personality traits underlie the components of BIS/BAS (Segarra et al., 2014). Neuroticism and extraversion are the most strongly related to BIS and BAS with neuroticism having a strong positive relationship with all BIS scales and extraversion being positively related to all BAS scales (Keiser & Ross, 2011; Segarra et al., 2014; Smits & Boeck, 2006). However, the associations between BIS and BAS and the other Big Five personality traits (i.e., agreeableness, conscientiousness, and openness to experience) are less well established (Segarra et al., 2014).

Research suggests that individuals higher in neuroticism tend to report more unpleasant emotional experiences and tend to be higher in negative affect as evidenced by studies assessing current mood and longitudinal studies assessing average mood over time (Jylha et al., 2006; Thake & Zelenski, 2013). Conversely, evidence suggests individuals higher in extraversion tend to report more pleasant emotional experiences and tend to be higher in positive affect (Jylha et al., 2006; Thake & Zelenski, 2013). It has been suggested that activation strength of BIS and BAS may underlie the traits of neuroticism and extraversion, respectively, in that BIS leads to greater negative (punishment) reactivity in individuals higher in neuroticism and that BAS creates greater positive (reward) reactivity in individuals higher in extraversion (Thake & Zelenski, 2013). Moreover, both neuroticism and BIS have been linked with emotion regulation difficulties and negative affect (Steel et al., 2008; Wytykowska et al., 2021), as well as being associated with higher levels of emotional distress and mental health problems including symptoms of anxiety and depression (Bijttebier

et al., 2009; Kimbrel et al., 2007; Uliaszek et al., 2009; Wytykowska et al., 2021). Interestingly, lower levels of BAS and extraversion have been implicated in depression symptoms, whereas higher levels and BAS and extraversion have been associated with better mental health (Kasch et al., 2002; McFarland et al., 2006). Due to the association between BIS/neuroticism and BAS/extraversion with negative and positive affectivity, respectively, as well as their relationship with mental health, more research in this area is warranted especially with regards to sleep.

The Five-Factor Model of Personality and Sleep

It is well documented that personality structure plays a role in sleep quality. More specifically, research suggests that there is a relationship between the FFM of personality and sleep quality. The relationship between neuroticism and sleep is consistent across studies and different populations, with most studies indicating that high neuroticism is associated with poor sleep. For example, a longitudinal study examining the association between personality traits and sleep quality in middle-aged and older adults found that participants lower in neuroticism and higher in extraversion had better sleep quality at baseline and over time (i.e., four to ten years later; Stephan et al., 2018). Additionally, studies using college student samples agree that neuroticism is associated with poor sleep quality (Cellini et al., 2017; Duggan et al., 2014; Hintsanen et al., 2014; Stephan et al., 2018), as well as poor sleep hygiene and excessive daytime sleepiness (Duggan et al., 2014). Research indicates that high neuroticism is also associated with more severe symptoms of insomnia and worse nonrestorative sleep quality (Emert et al., 2017). This could be because individuals higher in neuroticism, including college students, have a tendency toward ruminative thoughts, heightened arousal at bedtime, and excessive worry about falling and staying asleep (Emert et al., 2017). As a result, people who are higher in neuroticism may perceive their sleep as less restorative which may affect functioning the next day (Emert et al., 2017).

However, the relationship between extraversion and sleep tends to be more variable across populations. Studies assessing adults and older adults tend to find that higher extraversion is associated with better sleep (Hintsanen et al., 2014; Krizan & Hisler, 2019; Stephan et al. 2018), whereas with college students the opposite effect tends to occur. A study by Mead et al. (2021) found that increased extraversion had a negative relationship with sleep in a sample of college students. This could be due to the social activities and sensation-seeking components of this trait which can negatively affect sleep (Raynor & Levine, 2010). For example, college students higher in extraversion may be more likely to stay up late for social activities which could explain why participants higher in extraversion are more likely to have variable bedtimes and midpoints as well as a shorter sleep duration (Mead et al., 2021). In addition, a study by Raynor and Levine (2010) found that college students higher in extraversion were more likely to smoke cigarettes, consume alcohol, binge drink, and have multiple sexual partners, and were less likely to engage in alcohol-related harm reduction, use condoms, and get enough sleep. Unlike for college students, social activities involving late nights are less common for middle-aged and older adults so extraversion may not negatively affect sleep in these populations the same way it does in college students (Mead et al., 2021).

With regards to conscientiousness, research suggests that higher levels of this trait are related to better sleep quality (Duggan et al., 2014; Hintsanen et al., 2014). In addition, higher conscientiousness has been found to be associated with longer sleep duration, earlier sleep timing (e.g., bedtime, wake time, midpoint), and less variability in total sleeping time (Mead et al., 2021). Research suggests that openness and agreeableness are unrelated to sleep quality (Mead et al. 2021; Stephan et al., 2018). However, because neuroticism and extraversion are the personality traits most strongly related to BIS and BAS, these two traits will be the focus of this study.

Moderating Role of Neuroticism. Due to the well-established relationship between neuroticism and sleep, many studies have assessed the moderating role of neuroticism on sleep. For example, one study assessed whether the relationship between trait mindfulness and sleep quality would be moderated by neuroticism in college students. The results of this study found that neuroticism moderated the relationship between trait mindfulness and sleep quality, in that the path from trait mindfulness to sleep quality was stronger in participants with lower neuroticism and weaker in individuals with higher neuroticism. This study argued that trait mindfulness may be a protective factor against sleep problems for college students with low neuroticism, whereas in college students with high levels of neuroticism, the tendency toward negative affectivity may attenuate this protective influence for improving sleep quality (Ding et al., 2020). A similar study assessed the moderating role of neuroticism on mindfulness practice and sleep quality in oncology nurses. This study found that neuroticism moderated the mindfulness practice-sleep relationship, in that mindfulness practice was only significantly related to better sleep quality at lower levels of neuroticism (Fang et al., 2019).

Another study looked at the moderating role of neuroticism on emotional labor (i.e., surface acting) and sleep problems in a health care setting. Surface acting is defined as "a person's untruthful appearance of a prescribed emotion without attempting to change their authentic feelings, eventually leading to emotional exhaustion" (Yeh et al., 2020, p. 1). This study found that neuroticism significantly moderated the relationship between surface acting and sleep quality. According to this study, performing affective requirements and hiding real emotions in the workplace negatively affects sleep, which is exacerbated in individuals higher in neuroticism who are already more susceptible to negative emotions and poor sleep quality (Yeh et al., 2020). Lastly, one study assessed the moderating role of neuroticism in the relationship between chronotype (i.e., morning and evening chronotype) and depressive

symptoms. Evening-oriented people tend to wake up and go to bed later, and function better in the late afternoon or nighttime. Individuals with an evening chronotype are more susceptible to affective disorders, show poorer educational achievements, and consume stimulants more often than morning-oriented individuals. This study found a significant interaction between morningness-eveningness and neuroticism and indicated that with lower neuroticism, the relationship between eveningness and depressive symptoms was lower (Gorgol et al., 2022).

Across these studies where neuroticism moderated the relationship between some variable and sleep, higher neuroticism was always implicated with poorer sleep. Additionally, these studies suggested that negative affectivity, characteristic of high neuroticism, may play a role in their findings. As mentioned previously, BIS and neuroticism are highly correlated which is consistent with evidence that BIS is coupled with negative affect and is responsible for negative emotions such as fear, anxiety, frustration, anger, guilt, and sadness (Dillard & Peck, 2001; Fowles 1987). Due to the similarities between BIS and neuroticism and evidence suggesting that they both negatively affect sleep, further research is warranted.

Since many studies have found neuroticism to be a moderator that strengthens the relationship between some variable and poor sleep, it is possible that neuroticism may be a moderator in the BIS and sleep quality relationship as well. In addition, due to psychological factors (i.e., negative affectivity and emotion regulation difficulties) potentially implicated in the relationship between BIS, neuroticism, and sleep, insomnia severity will also be assessed. More specifically, the moderating role of neuroticism will be assessed in the BIS and insomnia severity relationship. The insomnia severity index (ISI) will be used to measure insomnia severity as the items in this measure focus more closely on the psychological aspects of poor sleep (e.g., “how worried/distressed are you about your current sleep problem?”) that are typically associated with insomnia.

The Present Study

Purpose of the Present Study. The goal of the present study was to examine the complex relationship between BIS and BAS, neuroticism and extraversion, and sleep in a college student sample. Work with this population is particularly important, given the inconsistent sleep schedules in college students (Brown et al., 2001). Insufficient sleep is associated with a wide variety of mental health concerns including more severe symptoms of depression and anxiety (Vollrath et al., 1989; Taylor et al., 2011) and increased risk for suicidal ideation (Nadorff et al., 2011). Sleep disturbances are also associated with negative affect and mood (Cukrowicz et al., 2006), and can lead to greater daytime functional impairment including lower academic achievement (Alapin et al., 2000), and more physical health problems (Lund et al., 2010). As a result, this study further sought to evaluate how BIS and BAS activation, along with personality traits, is associated with sleep in college students.

While there are many studies linking BIS and BAS to the Big Five personality traits, several studies focusing on the Big Five and sleep, and a few studies focusing on BIS and BAS and sleep, no studies were found that assess the relationship among all three factors. As a result, the proposed study expanded the literature by providing more insight into how BIS/BAS, the Big Five (i.e., neuroticism and extraversion), and sleep are interrelated. More specifically, this study explored the moderating role of neuroticism on BIS and two domains of sleep (i.e., sleep quality and insomnia severity). This has important implications for understanding how sleep is influenced by activation of the motivational systems and expression of certain personality traits in college students. Additionally, the proposed study sought to clarify the relationship between extraversion and sleep in a college student population and expanded the literature on the role of BIS/BAS in sleep as there is little research in this area.

In the proposed study, the Mini-International Personality Item Pool (Mini-IPIP) was used to measure each of the five-factor model traits. The Mini-IPIP has been found to have good criterion validity with the Carver and White (1994) BIS/BAS scales in a sample of undergraduate students (n = 216). In addition, the neuroticism and extraversion scales on the Mini-IPIP are related with the BIS and BAS scales, respectively (Donnellan et al., 2006). The Pittsburg Sleep Quality Index (PSQI) is a self-report measure and was used to assess global sleep quality along seven dimensions: sleep duration, sleep disturbance, sleep quality, sleep efficiency, sleep latency, use of sleep medication, and daytime dysfunction in this study. Previous studies assessing the relationship between BIS/BAS and sleep used the PSQI to assess the effects of these systems on sleep quality in college students (Andersz & Bargiel-Matusiewicz, 2018; Markarian et al., 2013). The Insomnia Severity Index (ISI) was used to assess the nature, severity, and impact of insomnia and the abbreviated Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS-16) was used to examine sleep related cognitions such as beliefs, attitudes, and expectations about sleep and insomnia. Lastly, the Epworth Sleepiness Scale (ESS) was used to measure the average level of daytime sleepiness.

The ISI, DBAS-16, and ESS are some of the most commonly used measures to assess insomnia severity, dysfunctional beliefs about sleep, and daytime sleepiness in college students, respectively, (Friedrich & Schlarb, 2018; Gardani et al., 2022) and were therefore used in this study. In addition, the ISI, DBAS-16, and ESS have not yet been utilized in the limited research available exploring the relationship between BIS/BAS and sleep. As a result, the use of these well validated sleep measures expanded the literature on the relationship between BIS/BAS and various domains of sleep.

Hypotheses and Analyses Performed

Hypothesis one: Higher levels of BIS will be significantly associated with:

a. higher neuroticism as measured by the Mini-IPIP
b. worse sleep quality as measured by the PSQI
c. higher levels of insomnia as measured by the ISI
d. increased daytime sleepiness as measured by the ESS
e. higher levels of dysfunctional beliefs about sleep as measured by the DBAS-16

Analysis of Hypotheses 1a-e: Five separate correlation analyses were performed to explore the relationships between BIS and (a) neuroticism, (b) sleep quality, (c) insomnia severity, (d) daytime sleepiness, and (e) dysfunctional beliefs about sleep.

Hypothesis two: Higher levels of all BAS factors (i.e., BAS – Fun Seeking, Reward Responsiveness, and Drive) will be significantly associated with:

a. higher extraversion as measured by the Mini-IPIP
b. sleep quality as measured by the PSQI
c. levels of insomnia as measured by the ISI
d. daytime sleepiness as measured by the ESS
e. dysfunctional beliefs about sleep as measured by the DBAS-16

Analysis of Hypotheses 2a-e: Fifteen separate correlation analyses were performed to explore the relationships between all three BAS factors (i.e., BAS – Fun Seeking, Reward Responsiveness, and Drive) and (a) neuroticism, (b) sleep quality, (c) insomnia severity, (d) daytime sleepiness, and (e) dysfunctional beliefs about sleep. Hypothesis two is more exploratory due to limited research on the BAS factors and sleep.

Hypothesis three: Higher neuroticism as measured by the Mini-IPIP will be significantly associated with:

a. worse sleep quality as measured by the PSQI
b. higher levels of insomnia as measured by the ISI
c. increased daytime sleepiness as measured by the ESS
d. higher levels of dysfunctional beliefs about sleep as measured by the DBAS-16

Analysis of Hypotheses 3a-d: Four separate correlation analyses were performed to explore the relationships between neuroticism and (a) sleep quality, (b) insomnia severity, (c) daytime sleepiness, and (d) dysfunctional beliefs about sleep.

Hypothesis four: Higher extraversion as measured by the Mini-IPIP will be significantly associated with:

a. worse sleep quality as measured by the PSQI
b. levels of insomnia as measured by the ISI
c. daytime sleepiness as measured by the ESS
d. dysfunctional beliefs about sleep as measured by the DBAS-16

Analysis of Hypotheses 4a-d: Four separate correlation analyses were performed to explore the relationships between extraversion and (a) sleep quality, (b) insomnia severity, (c) daytime sleepiness, and (d) dysfunctional beliefs about sleep. Hypothesis four is more exploratory due to the mixed findings on the relationship between BAS and sleep and the limited research in this area with college students.

Hypothesis five: Neuroticism will moderate the relationship between BIS and sleep quality. More specifically, it is assumed that high levels of neuroticism will strengthen the relationship between BIS and worse sleep quality.

Analysis of Hypothesis Five: To determine whether neuroticism was a significant moderator of the relationship between BIS activation and sleep quality, a moderation analysis was conducted using the Hayes PROCESS macro in SPSS (Hayes, 2018). The dependent variable was sleep quality, and the independent variable was BIS.

Hypothesis six: Neuroticism will moderate the relationship between BIS and insomnia severity. More specifically, it is assumed that high levels of neuroticism will strengthen the relationship between BIS and higher levels of insomnia severity.

Analysis of Hypothesis Six: To determine whether neuroticism was a significant moderator of the relationship between BIS activation and insomnia severity, a moderation analysis was conducted using the Hayes PROCESS macro in SPSS (Hayes, 2018). The dependent variable was insomnia severity, and the independent variable was BIS.

CHAPTER III: RESEARCH METHODS

Participants

The current study recruited 727 participants through the SONA online recruitment platform. The participants were undergraduate students enrolled in introductory psychology. To be eligible for this study, participants needed to be over the age of 18 and had to be proficient in the English language. Several validity checks were embedded throughout the survey, and data from participants who failed two or more validity checks were excluded from present analyses. Additionally, participants who did not complete the survey in its entirety or who input invalid responses in the free textboxes were excluded. A total of 657 participants were included in the final analyses.

Power Analysis

To assess the sample size needed for linear regression, an *a priori* statistical power analysis was performed using G*Power v. 3.1.9.7. This study was powered to answer hypothesis 1b which sought to assess the relationship between BIS and sleep quality. Two studies were found that reported the effect size for the relationship between BIS activation as measured by the BIS/BAS scale and sleep quality as measured by the PSQI. Andersz and Bargiel-Matusiewicz, (2018) reported a small size correlation coefficient of (r= 0.26, N= 223) and Markarian et al. (2013) reported a small size correlation coefficient of (r= 0.14, N= 459). Because these two previous studies reported a small sized effect between BIS activation and sleep quality, the *a prior* power analysis was performed using a small effect size (f^2= .02). The power analysis used the power of .80, a Type I error rate of .05, and included one predictor (i.e., BIS). This analysis suggested that 395 participants would be needed to detect a small effect size between BIS activation and sleep quality. An additional *a priori* power analysis was conducted for the moderation analysis to determine the sample size needed for a small effect size (f^2= .02). The power analysis used the power of .80, Type I error rate of .05,

and included three predictors (i.e., BIS, neuroticism, and BIS X neuroticism). This analysis suggested that 550 participants would be needed to detect a small effect size to explore the role of neuroticism in the relationship between BIS and sleep quality. However, 727 participants were recruited to account for attrition, incompletions, etc.

Measures and Questionnaires

Demographic Questions. The participants demographic information was collected including age, sex, gender identity, race, ethnicity, and SES related questions (i.e., parent's level of education). In addition, information about the participants' lifestyle (e.g., past and current drug use) and medication use was obtained.

Sleep Questionnaires. Several measures of sleep were included in the survey to assess various domains of sleep including sleep quality, insomnia severity, daytime sleepiness, and attitudes and beliefs about sleep.

Pittsburg Sleep Quality Index (PSQI). The PSQI is a widely used retrospective self-report measure that includes 19-items and evaluates subjective sleep quality over the previous month. This questionnaire assesses seven clinical domains of sleep difficulties including sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. These seven domains are then scored as a single factor of global sleep quality. Each domain is scored on a scale from 0-3, with the global score ranging from 0 to 21 and a higher score indicates poorer sleep quality. The analysis of psychometric properties of the PSQI shows good internal consistency (Cronbach's alpha = .80; Carpenter & Andrykowski, 1998).

Insomnia Severity Index (ISI). The ISI is a self-report questionnaire that includes seven items evaluating the nature, severity, and impact of insomnia that has occurred over the past two weeks. The domains include (1) the severity of insomnia problems with regards to

(a) falling asleep, (b) staying asleep, and (c) problems waking up too early, (2) satisfaction with current sleep pattern, (3) how noticeable the sleep problems and impairment are to others, (4) level of worry/distress about sleep problems, and (5) the extent the sleep problems interfere with daily functioning. A 4-point Likert scale is used to rate each item (e.g., 0 = no problem and 4 = very severe problems), and sums to a total score ranging from 0-28, with a higher score suggesting more severe symptoms of insomnia. The total score is interpreted based on cutoff ranges of 0-7 = no clinically significant insomnia, 8-14 = subthreshold insomnia, 15-21 = clinical insomnia (moderate severity), and 22-28 = clinical insomnia (severe). The ISI demonstrates good internal consistency (Cronbach's alpha = .74; Bastien et al., 2001).

Epworth Sleepiness Scale (ESS). The ESS is an 8-item self-report questionnaire and is used to measure the average level of daytime sleepiness in adults. Participants are asked to rate how likely they are to doze or fall asleep in eight different day-to-day situations (e.g., watching television) on a scale of 0 ("would never doze") to 3 ("high chance of dozing"). The sum of all eight items is used to calculate the total score, with higher scores indicating increased daytime sleepiness. Analysis of the psychometric properties of the ESS indicates good internal consistency (Cronbach alpha = .88; Johns, 1992).

Abbreviated Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS-16). The DBAS-16 includes 28-items and measures five components of sleep including expectations about sleep requirements, consequences of insomnia, sleep medication, worry and helplessness about insomnia and global dysfunctional beliefs score. The responses are recorded on a Likert scale, from 0 = strongly disagree to 10 = strongly agree, in which the participants are asked to rate their agreement for each statement. The component scores are calculated by averaging the means of the corresponding items for a certain scale, and a total score is derived from the mean of all summed scores. Higher scores indicate more

dysfunctional beliefs about sleep. An abbreviated version of the DBAS-16 (i.e., DBAS-16) was validated by Morin et al. (2007) to be used in sleep research and reduce participant burden. The abbreviated version, the DBAS-16, was used for this study. The abbreviated version includes 16 of the original items and reflects four main themes (i.e., consequences of insomnia, worry about sleep, sleep expectations, and medication use; Morin et al., 2007). The DBAS-16 is administered and scored the same way as the original measure and has demonstrated the ability to discriminate between individuals with and without insomnia. Analysis of the psychometric properties of the DBAS-16 indicates good internal consistency (Cronbach alpha = .80; Morin et al., 1993).

Personality questionnaires. The literature suggests that individual differences in personality traits may be contributing to sleep disturbances. Brief measures of personality were used in this study to explore individual differences in traits such as neuroticism and extraversion, as well as sensitivity to threat and reward.

BIS/BAS Scales. The Behavioral Inhibition Scale (BIS) and Behavioral Activation Scale (BAS) is a 20-item self-report measure used to assess the behavioral manifestations of Gray's (1970, 1981) reinforcement sensitivity theory (Carver & White, 1994). This measure contains four scales: one BIS-scale and three BAS-scales: BAS-Drive, BAS-Reward, and BAS-Fun Seeking. The 7-items for the BIS-scale measure an individual's sensitivity to a negative situation or negative emotions experienced from such situations (Dierickx et al., 2022). Since the revision of the RST (McNaughton & Gray, 2000), the BIS was separated into two subscales which now includes BIS-Anxiety and BIS-Fear. The BIS-Anxiety subscale contains four items, and the BIS-fear subscale contains three items, with the BIS-total score being the sum of the two subscales. The 13-items for the BAS-scale measures an individual's response to reinforcement (BAS-Reward), how motivated the individual is to pursue this reinforcement (BAS-Drive), and how much they seek novel and potentially reinforcing

stimuli (BAS-Fun Seeking; Dierickx et al., 2022). The responses are recorded on a 4-point Likert scale with 1 = strongly agree and 4 = strongly disagree, with higher responses indicating more sensitivity to a scale. The analysis of psychometric properties of the BIS/BAS scales indicates good internal consistency (Cronbach's alpha = 0.66 to 0.76; Carver & White, 1994)

Mini-IPIP. The mini-IPIP includes 20-items and is a shortened version of the 50-item International Personality Item Pool (IPIP). The IPIP was originally designed to measure the Big Five personality traits of neuroticism, extraversion, openness, agreeableness, and conscientiousness. The mini-IPIP is a short measure of the five-factor model personality traits and was developed for when use of the lengthier IPIP is not feasible. This self-report measure includes 20 items describing a behavior (e.g., "Am the life of the party"), and participants are instructed to indicate how true the phrase is for them. The participants are asked to rate their agreement or disagreement with each phrase on a 7-point Likert scale with 1 = disagree strongly and 7 = agree strongly. The analysis of psychometric properties of the mini-IPIP indicates good internal consistency (Cronbach's alpha $\geq$ 0.60; Donnellan et al., 2006).

Validity Checks. Participants were presented with five validity items while taking the Qualtrics survey to ensure the items are being answered appropriately and that they are paying attention. Examples of validity items include, "Are you an alien from outer space?" and "What is 5 x 3?" and will be embedded within the survey items. The participants were excluded if they answered less than 80% of the validity questions correctly.

Procedures

The participants were recruited from East Carolina University using the SONA online system and included undergraduate students enrolled in the introductory psychology course. The survey was made available through the online Qualtrics platform and could be completed from any location with internet using a desktop/laptop computer, smart phone, or tablet. At

the start of the survey, the participants were provided with informed consent, as well as a brief description of the study's purpose. Next, the participants were directed to the first part of the survey which included items related to demographic information (e.g., age, sex, gender, race, ethnicity, SES, etc.). The second part of the survey asked participants to complete sleep-related questionnaires, and then lastly, they were asked to complete personality measures. After completion of the survey, participants were provided with a debriefing statement and the researcher's email address to whom they were informed could be contacted with any questions. All participants who completed the study were awarded one credit to their SONA account.

CHAPTER IV: RESULTS

Statistical analyses were conducted using the computer software IBM SPSS Statistics 26 Software. All data was inspected for missing information. Of the 657 participants included in this study, 622 participants reported their age; the mean age was 18.69 years (SD = 2.454). Of the 657 participants, 65.2% indicated that they were assigned Female at birth. Seven participants (1.0%) identified themselves as American Indian/Alaska Native, 13 participants (1.9%) identified themselves as Asian, 108 (16.2%) identified themselves as Black or African American, 2 participants (.3%) identified themselves as Native Hawaiian or Other Pacific Islander, 476 participants (71.4%) identified themselves as White or European American, 35 participants (5.2%) identified themselves as multi-racial, and 16 participants (2.4%) identified themselves as Unknown or Other. Of the 657 participants, 655 reported their ethnicity with 48 (7.2%) of the sample identifying as Hispanic/Latinx and 607 (91.0%) identifying as not Hispanic/Latinx. See Table 1 for demographic information.

Table 1

Demographic Information of the Participants

Race	***n* (%)**
American Indian/Alaska Native	7 (1.0%)
Asian	13 (1.9%)
Black or African American	108(16.2%)
Native Hawaiian or Other Pacific Islander	2 (.3%)

White or European American	476 (71.4%)
Multi-racial	35 (5.2%)
Unknown or Other	16 (2.4%)

Ethnicity	***n* (%)**
Hispanic/Latinx	48 (7.2%)
Not Hispanic/Latinx	607 (91.0%)

Note. The table includes the participants self-reported race (N = 657) and ethnicity (N = 655).

Hypothesis one. Complete data was available for all 657 participants. Correlational analyses were performed to assess the relationships between BIS, personality traits, and several domains of sleep. Specifically, it was hypothesized that higher levels of BIS would be significantly associated with (a) higher neuroticism as measured by the Mini-IPIP, (b) worse sleep quality as measured by the PSQI, (c) higher levels of insomnia as measured by the ISI, (d) increased daytime sleepiness as measured by the ESS, and (e) higher levels of dysfunctional beliefs about sleep as measured by the DBAS-16.

As hypothesized, correlational analyses revealed that BIS (M = 20.45, SD = 2.498) was significantly positively correlated with neuroticism (M = 12.30, SD = 2.879), r = .281, n = 657, p < .001, 95% CI [.209, .350]. Additionally, as expected, BIS was significantly positively correlated with worse self-reported sleep quality (M = 7.98, SD = 3.201), r= .177, n = 657, p < .001, 95% CI [.101, .250], insomnia severity (M = 7.74, SD = 5.174), r = .177, p < .001, 95% CI [.102, .250], daytime sleepiness (M = 7.85, SD = 4.086), r = .200 p < .001, 95% CI [.125, .272], and dysfunctional beliefs and attitudes about sleep (M = 3.42, SD = 1.625), r = .253, p < .001, 95% CI [.179, .323]. These findings suggest that people who are

characterized by increased levels of behavioral inhibition endorse higher levels of neuroticism, as well as worse sleep quality, increased insomnia severity, daytime sleepiness, and dysfunctional beliefs about sleep. An analysis of psychometric properties of the PSQI (α = .730), ISI (α = .848), ESS (α = .753), and DBAS-16 (α = .863) indicates good internal consistency of the measures. Tables 2 and 3 show zero-order correlations for all the variables mentioned above.

Of note, the mean score on the PSQI was 7.98 (SD = 3.201) indicating that, on average, the participants in this sample reported significant sleep disturbances (i.e., a score of <5 indicates normal sleep quality). The mean score on the ISI was 7.74 (SC = 5.174) indicating that, on average, the participants indicated no clinically significant insomnia (i.e., cutoff scores is 0-7) bordering on subthreshold insomnia (i.e., cutoff score is 15-21). The mean score on the ESS was 7.85 (SD = 4.086) indicating that, on average, the participants in this sample indicated normal levels of daytime sleepiness (i.e., a score of 0-10 indicates normal levels of daytime sleepiness). Lastly, the mean score on the DBAS-16 was 3.42 (SD = 1.625) indicating that, on average, the participants did not have unrealistic expectations for sleep (i.e., a score ≥ 4 indicates normal expectations and beliefs about sleep). Table 2 shows the means and standard deviations of the sleep measures mentioned above.

Table 2

Zero-Order Correlations for measures of BIS/BAS and Sleep (N = 657)

	PSQI	ISI	ESS	DBAS-16
BIS	.177**	.177*	.200**	.253**
BAS-FS	-.061	.025	.072	.019
BAS-RR	-.092*	-.084*	.029	.043
BAS-Drive	-.107*	-.060	-.015	.002

M	7.98	7.74	7.85	3.42
SD	3.201	5.174	4.086	1.625

Note. PSQI = Pittsburg Sleep Quality Index; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale; DBAS-16 = Dysfunctional Belief About Sleep Scale; BIS = Behavioral Inhibition System; BAS-FS = Behavioral Activation System – Fun Seeking; BAS-RR = Behavioral Activation System – Reward Responsiveness; BAS-Drive = Behavioral Activation System – Drive

*$p < .05$, **$p < .01$

Hypothesis two: Complete data was available for all 657 participants. Correlational analyses were performed to assess the relationships among the factors of BAS (i.e., BAS – Fun Seeking, Reward Responsiveness, and Drive) with personality traits and several domains of sleep. Specifically, it was hypothesized that higher levels of all BAS factors (i.e., BAS – Fun Seeking, Reward Responsiveness, and Drive) would be significantly associated with (a) higher extraversion as measured by the Mini-IPIP, (b) sleep quality as measured by the PSQI, (c) levels of insomnia as measured by the ISI, (d) daytime sleepiness as measured by the ESS, and (e) dysfunctional beliefs about sleep as measured by the DBAS-16.

As expected, correlation analyses revealed that extraversion (M = 12.41, SD = 4.101) was significantly positively correlated with BAS-Fun Seeking (M = 12.37, SD = 2.037), r = .394, p < .001, 95% CI [.327, .457], BAS- Reward Responsiveness (M = 17.64, SD = 1.923), r = .195, p < .001, 95% CI [.121, .268] and BAS-Drive (M = 11.23, SD = 2.188), r = .274, p < .001, 95% CI [.202, .344]. Additionally, correlation analyses revealed that sleep quality (M = 7.98, SD = 3.201) was significantly negatively correlated with BAS- Reward Responsiveness (M = 17.64, SD = 1.923), r = -.092, p < .05, 95% CI [-.168, -.016] and BAS-Drive (M = 11.23, SD = 2.188), r = -.107, p < .01, 95% CI [-.182, -.030]. Moreover, insomnia severity (M = 7.74, SD = 5.174) was significantly negatively correlated with BAS- Reward

Responsiveness (M = 17.64, SD = 1.923), r = -.084, p < .05, 95% CI [-.160, -.008]. These findings suggest that people who are characterized by increased levels of behavioral activation within the domains of fun-seeking, reward responsiveness, and drive, endorse higher levels of extraversion. Individuals higher in reward responsiveness and drive tend to report better sleep quality, and individuals higher in reward responsiveness report lower insomnia severity. Tables 2 and 3 show zero-order correlations for all the variables mentioned above.

Table 3

Zero-Order Correlations for measures of BIS/BAS and Personality (N = 657)

	BIS	BAS-FS	BAS-RR	BAS-Drive
Neuro	.281**	.059	.064	.021
Extra	.001	.394**	.195**	.274**
Agree	.068	.125**	.233**	.037
Cons	-.069	-.045	.148**	.109**
Open	.064	.147**	.127**	.128**
M	20.45	12.37	17.64	11.23
SD	2.498	2.036	1.925	2.188

Note. Neuro = Neuroticism; Extra = Extraversion; Agree = Agreeableness; Cons = Conscientiousness, Open = Openness; BIS = Behavioral Inhibition System; BAS-FS = Behavioral Activation System – Fun Seeking; BAS-RR = Behavioral Activation System – Reward Responsiveness; BAS – Drive = Behavioral Activation System – Drive

*$p < .05$, **$p < .01$

Hypothesis three. Complete data was available for all 657 participants. Correlational analyses were performed to assess the relationships among neuroticism and several domains of sleep. Specifically, it was hypothesized that higher neuroticism as measured by the Mini-IPIP would be (a) significantly associated with worse sleep quality as measured by the PSQI, (b) higher levels of insomnia as measured by the ISI, (c) increased daytime sleepiness as measured by the ESS, (d) and higher levels of dysfunctional beliefs about sleep as measured by the DBAS-16.

As hypothesized, correlational analyses revealed that neuroticism (M = 12.30, SD = 2.878) was significantly positively correlated with worse sleep quality (M = 7.98, SD = 2.878), r = .284, p < .001, 95% CI [.212, .353], insomnia severity (M = 7.73, SD = 5.178), r = .316, p < .001, 95% CI [.245, .383], daytime sleepiness (M = 7.84, SD = 4.092), r = .226, p < .001, 95% CI [.152, .297], and dysfunctional beliefs and attitudes about sleep (M = 3.42, SD = 1.625), r = .286, p < .001, 95% CI [.214, .355]. These findings suggest that people who are characterized by higher levels of neuroticism tend to report worse sleep quality, increased insomnia severity, daytime sleepiness, and dysfunctional beliefs about sleep. Table 3 shows zero-order correlations for all the variables mentioned above.

Hypothesis four. Complete data was available for all 657 participants. Correlational analyses were performed to assess the relationships among extraversion and several domains of sleep. Specifically, it was hypothesized that higher extraversion as measured by the Mini-IPIP would be (a) significantly associated with, worse sleep quality as measured by the PSQI, (b) levels of insomnia as measured by the ISI, (c) daytime sleepiness as measured by the ESS, (d) and dysfunctional beliefs about sleep as measured by the DBAS-16.

Correlational analyses revealed that extraversion (M = 12.41, SD = 4.101) was negatively correlated with sleep quality (M = 7.98, SD = 3.201), r = -.017, p = .669 , 95% CI [-.093, .060], lower insomnia severity (M = 7.73, SD = 5.178), r = -.023, p = .563, 95% CI [-

.099, .054], daytime sleepiness (M = 7.84, SD = 4.092), r = -.055, p =.155 , 95% CI [-.131, .021], and dysfunctional beliefs and attitudes about sleep (M = 3.42, SD = 1.625), r = -.035, p = .367, 95% CI [-.111, .041]. While these correlations did *not* reach significance, these findings suggest that people who are characterized by increased levels of extraversion tend to report better sleep quality, lower insomnia severity, daytime sleepiness, and dysfunctional beliefs about sleep. Table 4 shows zero-order correlations for all the variables mentioned above.

Table 4

Zero-Order Correlations for measures of Sleep and Personality (N = 657)

	Neuro	Extra	Agree	Cons	Open
PSQI	.284**	-.017	.090*	-.118**	-.029
ISI	.311**	-.023	.112**	-.132**	-.065
ESS	.224**	-.055	.029	-.172**	-.020
DBAS-16	.286**	-.035	.106**	-.098*	-.043
M	12.30	12.41	14.98	13.73	14.06
SD	2.878	4.104	3.196	3.457	2.940

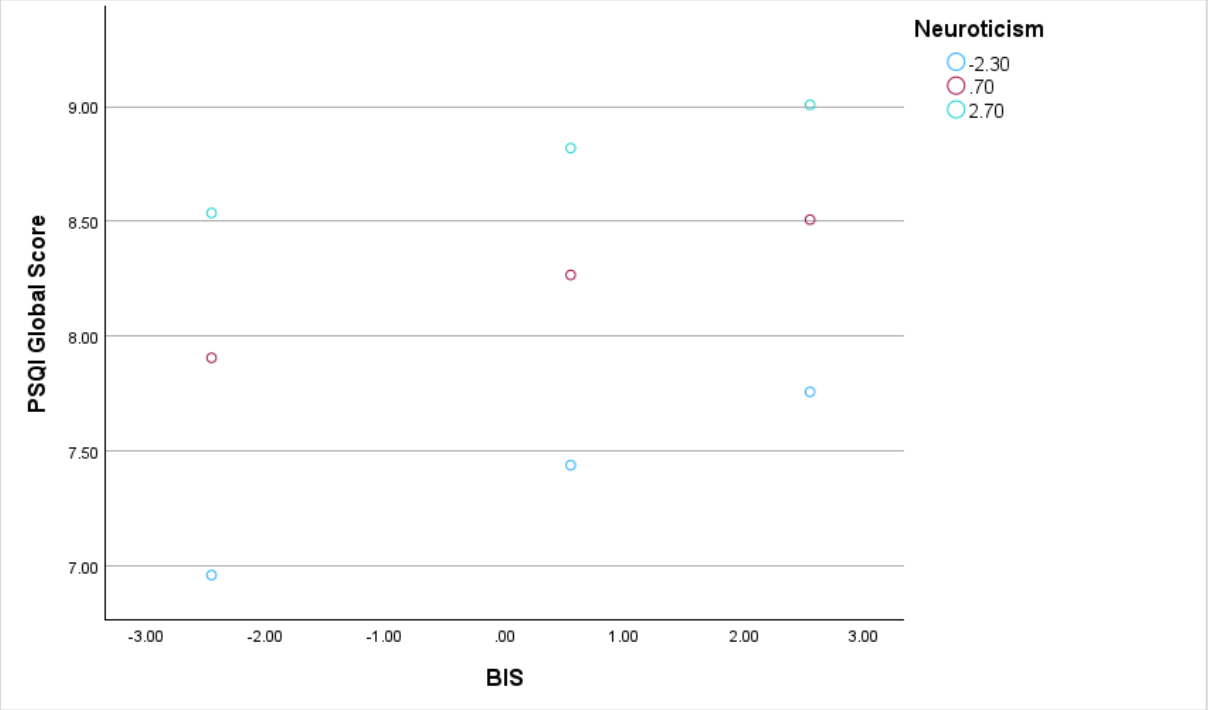
Note. Neuro = Neuroticism; Extra = Extraversion; Agree = Agreeableness; Cons = Conscientiousness, Open = Openness; PSQI = Pittsburg Sleep Quality Index; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale; DBAS-16 = Dysfunctional Belief About Sleep Scale; BIS = Behavioral Inhibition System; BAS-FS = Behavioral Activation System – Fun Seeking; BAS-RR = Behavioral Activation System – Reward Responsiveness; BAS-Drive = Behavioral Activation System – Drive

*$p < .05$, **$p < .01$

Hypothesis five. Data was available for 653 participants. A moderation analysis was performed to assess the relationship between BIS and sleep quality with neuroticism moderating this relationship. Specifically, it was hypothesized high levels of neuroticism will strengthen the relationship between BIS and worse sleep quality. The results indicate that neuroticism did *not* significantly moderate the relationship between BIS and sleep quality ($F(3, 653) = 21.8884$, $p = .4484$, $R2 = .0914$). See Figure 1 below.

Figure 1

Relationship Between BIS and Sleep Quality with Neuroticism as the Moderator



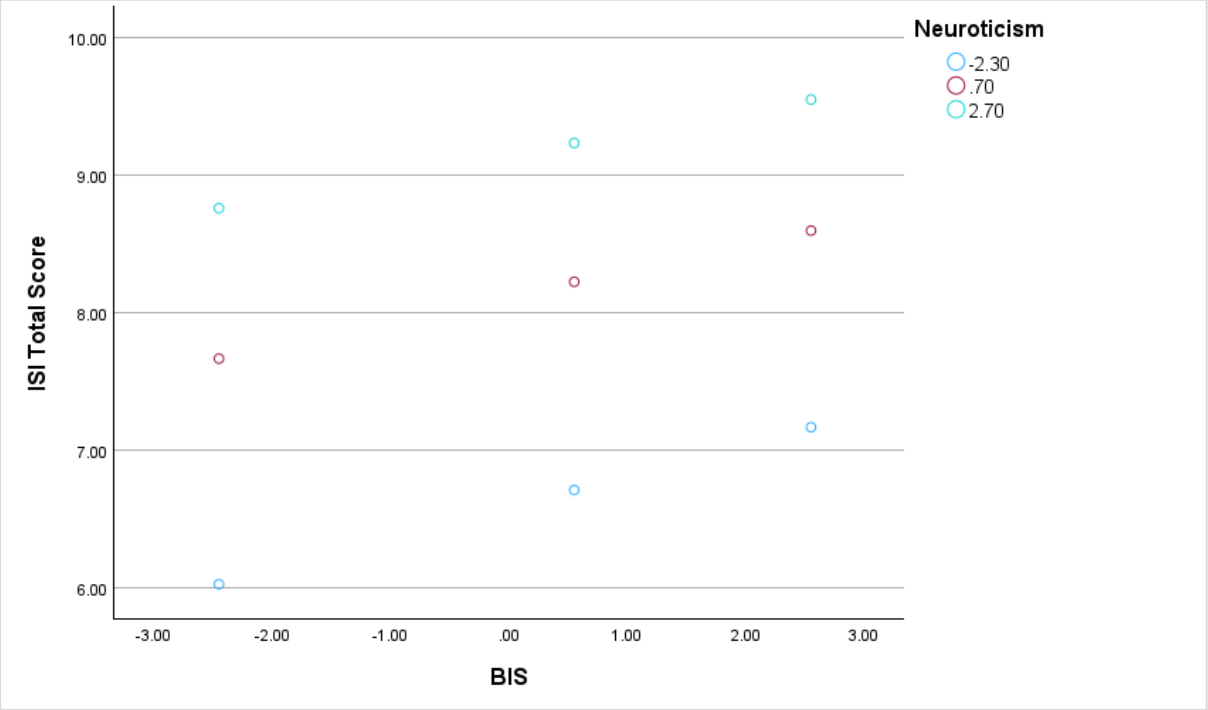
Note. PSQI = Pittsburg Sleep Quality Index; BIS = Behavioral Inhibition System

Hypothesis six: Data was available for 653 participants. A moderation analysis was performed to assess the relationship between BIS and insomnia severity with neuroticism moderating this relationship. Specifically, it was hypothesized that high levels of neuroticism will strengthen the relationship between BIS and higher levels of insomnia severity. The

results indicate that neuroticism did *not* significantly moderate the relationship between BIS and insomnia severity ($F(3, 653) = 25.8308$, $p = .6118$, $R2 = .1061$). See Figure 2 below.

Figure 2

Relationship Between BIS and Insomnia Severity with Neuroticism as the Moderator



Note. ISI = Insomnia Severity Index; BIS = Behavioral Inhibition System

Post-hoc Analyses

Given the noted correlations among neuroticism and BIS, it was decided to explore the potential of unique relationships/contributions of these variables to specific sleep variables of interest including sleep quality, insomnia severity, daytime sleepiness, and dysfunctional attitudes and beliefs about sleep.

PSQI, ISI, Neuroticism, and BIS. Post-hoc multiple regression analyses were performed to determine which variable best predicted sleep quality as measured by the global PSQI. A model including BIS and neuroticism significantly predicted sleep quality ($F(2, 654) = 32.566$, $p < .001$, $R2 = .091$). Of those two predictors, both neuroticism ($b = .254$, $p < .001$) and BIS ($b = .105$, $p = .007$) emerged as significant predictors of sleep quality as measured by

the global PSQI. A second post-hoc multiple regression analysis was performed to determine which variables best predicted insomnia severity as measured by the ISI. A model including BIS and neuroticism significantly predicted insomnia severity ($F(2, 654) = 36.190$, $p < .001$, $R2 = .100$). Of those two predictors, both neuroticism ($b = .284$, $p < .001$) and BIS ($b = .097$, $p = .012$) emerged as a significant predictor of insomnia severity as measured by the ISI.

Additional post-hoc regression analyses were run to determine whether BIS and neuroticism significantly predicted the seven component scores of the PSQI (i.e., subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction). A model including BIS and neuroticism significantly predicted subjective sleep quality $F(2, 654) = 13.430$, $p < .001$, $R2 = .039$), sleep latency $F(2, 654) = 12.392$, $p < .001$, $R2 = .037$), sleep duration $F(2, 653) = 4.331$, $p = .014$, $R2 = .013$), sleep disturbances $F(2, 654) = 25.607$, $p < .001$, $R2 = .073$), use of sleep medications $F(2, 654) = 16.469$, $p < .001$, $R2 = .048$), and daytime dysfunction $F(2, 654) = 26.658$, $p < .001$, $R2 = .075$). The only model that was not significant was the model including habitual sleep efficacy $F(2, 653) = .186$, $p = .830$, $R2 = .001$). Across all six significant models, neuroticism emerged as a significant predictor of subjective sleep quality ($b = .166$, $p < .001$), sleep latency ($b = .169$, $p < .001$), sleep duration ($b = .082$, $p = .043$), sleep disturbances ($b = .267$, $p < .001$), use of sleep medications ($b = .202$, $p < .001$), and daytime dysfunction ($b = .185$, $p < .001$). The predictor BIS only emerged as a significant predictor of daytime dysfunction ($b = .158$, $p < .001$). See Appendix D for a breakdown of the items that make up the seven component scores of the PSQI.

Additional post-hoc regression analyses were run to determine whether BIS and neuroticism significantly predicted the seven items of the ISI. A model including BIS and neuroticism significantly predicted all seven items including: item-1 ($F(2, 652) = 29.306$, $p <$

.001, *R2* = .080), item-2 $F(2, 650) = 18.308$, $p < .001$, *R2* = .050), item-3 $F(2, 650) = 14.279$, $p < .001$, *R2* = .042), item-4 $F(2, 647) = 6.841$, $p = .001$, *R2* = .021); item-5 $F(2, 650) = 28.205$, $p < .001$, *R2* = .077), item-6 $F(2, 650) = 18.882$, $p < .001$, *R2* = .055), and item-7 $F(2, 653) = 25.499$, $p < .001$, *R2* = .072). Across all significant models, only neuroticism emerged as a significant predictor of all seven items including: item-1 (b =.260, $p < .001$), item-2 (b = .223, $p < .001$), item-3 (b = .190, $p < .001$), item-4 (b = .127, $p = .002$), item-5 (b = .237, $p < .001$), item-6 (b = .173, $p < .001$), and item-7 (b = .209, $p < .001$). However, BIS emerged as a significant predictor of item-5 (b = .102, $p = .010$), item-6 (b = .117, $p = .003$), and item-7 (b = .122, $p = .002$). Item-5 states: "how noticeable to others do you think your sleep problem is in terms of impairing the quality of your life," item- 6 states: "how worried/distressed are you about your current sleep problem," and item-7 states: "to what extent do you consider your sleep problem to interfere with your daily functioning (e.g. daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood, etc.) currently."

DBAS-16, ESS, Neuroticism, and BIS. Lastly, post-hoc multiple regression analyses were performed to determine which variables best predict dysfunctional beliefs and attitudes about sleep as measured by the DBAS-16. A model including only BIS and neuroticism significantly predicted dysfunctional beliefs about sleep $F(2, 654) = 42.061$, $p < .001$, *R2* = .114. Of those two predictors, both neuroticism (b = .233, $p < .001$) and BIS (b = .187, $p < .001$) emerged as a significant predictor of dysfunctional beliefs about sleep as measured by the DBAS-16. A second post-hoc multiple regression analysis was performed to determine which variables best predict daytime sleepiness $F(2, 654) = 25.070$, $p < .001$, *R2* = .071. Of these two predictors, both neuroticism (b = .184, $p < .001$) and BIS (b = .148 $p < .001$) emerged as significant predictors of daytime sleepiness as measured by the ESS.

CHAPTER V: DISCUSSION

Summary of Results and Relevant Implications

The goal of this study was to examine the complex relationship between BIS and BAS, neuroticism and extraversion, and sleep in a college student sample. Due to the inconsistent sleep schedules of college students and the negative effects of poor sleep on mental and physical health, daily functioning, and academic achievement, this study sought to further expand the literature on how BIS and BAS activation, along with personality traits, influences sleep in this population.

BIS/BAS and Neuroticism/Extraversion. As expected, the results suggested a significant relationship between BIS and neuroticism, and between all BAS factors and extraversion. These findings indicate that individuals higher in BIS (i.e., responds to signals of punishment and non-reward, is responsible for individual differences in anxiety, and inhibits movement toward goals) are also higher in neuroticism (i.e., increased tendency toward distress and negative affect), while individuals higher in all three BAS factors (i.e., responds to signals of reward and non-punishment and stimulates movement toward goals) are also higher in extraversion (i.e., increased tendency toward sociability and positive affect). This is consistent with prior research suggesting that the personality traits of the FFM underlie the components of BIS/BAS (Segarra et al., 2014), with neuroticism being most strongly related to BIS and extraversion most strongly related to BAS (Keiser & Ross, 2011; Segarra et al., 2014; Smits & Boeck, 2006).

BIS, Neuroticism, and Sleep. As replicated in this study and found in many other studies, BIS and neuroticism are highly correlated as they both seem to be related to negative affect and negative emotions such as fear, anxiety, frustration, anger, guilt, and sadness (Dillard & Peck, 2001; Fowles 1987). Moreover, it has been suggested that higher BIS activation may underlie the traits of neuroticism, in that BIS leads to greater negative

(punishment) reactivity in individuals higher in neuroticism (Thake & Zelenski, 2013), which is consistent with the results of this study. Notably, BIS and neuroticism have been implicated in mental health problems such as higher levels of anxiety and depression.

There are many psychological factors that can lead to and exacerbate sleep disturbances. Individuals higher in BIS and neuroticism may be at higher risk for experiencing sleep problems due to a tendency toward negative affectivity, negative emotions, and overall increased difficulty with emotion regulation (Johnson et al., 2003; Jylha & Isometsa, 2006). In turn, these individuals may be more likely to experience ruminative thoughts at night, heightened arousal at bedtime, and excessive worry about falling and staying asleep, which may lead to perceptions of less restorative sleep and impair daily functioning (Emert et al., 2017).

The present study replicated and expanded on previous findings by exploring the relationship between BIS and neuroticism with more diverse measures of sleep including sleep quality, insomnia severity, daytime sleepiness, and dysfunctional beliefs and attitudes about sleep. As expected, the results suggested that BIS and neuroticism were both, by themselves, significantly and positively correlated with all the domains of sleep explored in this study. Specifically, higher levels of BIS and neuroticism were both significantly correlated with worse self-reported sleep quality, increased insomnia severity, more daytime sleepiness, and increased dysfunctional beliefs and attitudes about sleep. These findings are consistent with the literature, as several studies have found neuroticism to be associated with poor sleep quality (Cellini et al., 2017; Duggan et al., 2014; Hintsanen et al., 2014; Stephan et al., 2018), excessive daytime sleepiness (Duggan et al., 2014), and more severe symptoms of insomnia (Emert et al., 2017).

While there is limited research on the relationship between BIS and sleep, the finding that BIS is negatively associated with several domains of sleep aligns with the studies available. For example, one study found that individuals higher in BIS were more likely to report emotion regulation difficulties (Markarian et al., 2013). The participants with emotion regulation difficulties were also more likely to report poor sleep quality and symptoms of depression and anxiety (Markarian et al., 2013). The results of the present study are also in line with the study by Andersz and Bargiel-Matusiewicz (2018) which found that college students higher in BIS activity were more likely to forgo sleep to study, compared to participants higher in BAS, and that students higher in BIS reported more perceived losses (i.e., negative consequences) after forgoing sleep to participate in some other activity (e.g., studying).

Overall, the results of this study are in line with other research in this area and suggests that BIS and neuroticism are significantly correlated with worse self-reported sleep quality, increased insomnia severity, more daytime sleepiness, and increased dysfunctional beliefs and attitudes about sleep.

BAS, Extraversion, and Sleep. Correlational analyses revealed that extraversion was *not* significantly related to the domains of sleep measured in this study. However, the relationship did trend toward higher levels of extraversion being related to better sleep quality, as well as lower levels of insomnia severity, daytime sleepiness, and dysfunctional beliefs and attitudes about sleep. This result is consistent with the variability in the literature with regards to the relationship between extraversion and sleep. Especially in college student populations, extraversion has been found to be associated with increased participation in social activities and higher levels of sensation seeking. As a result, some studies have suggested that extraversion negatively affects sleep in college students (Mead et al., 2021; Raynor and Levine, 2010). However, several studies have found the opposite effect with

higher levels of extraversion being associated with better sleep (Hintsanen et al., 2014; Krizan & Hisler, 2019; Stephan et al. 2018), as some researchers have posited that higher extraversion is linked to lower stress and positive affectivity which is beneficial for sleep (Schneider, Rench, Lyons, & Riffle, 2012). While the correlation between extraversion and the domains of sleep investigated in this study did not reach significance, the relationship did trend toward higher levels of extraversion being related to better sleep. However, more research in this area is needed to parse out these inconsistencies, especially within a college student population.

As replicated in this study and found in many other studies, all factors of BAS (i.e., BAS-Fun Seeking, BAS-Reward, and BAS-Drive) were significantly and positively correlated with extraversion (Keiser & Ross, 2011, Mitchell et al., 2007; Smits & Boeck, 2006). This is consistent with the literature as it has been suggested that activation strength of BAS may underlie the traits of extraversion, in that BAS creates greater positive (reward) reactivity in individuals higher in extraversion (Thake & Zelenski, 2013). While the correlation between extraversion and sleep did not reach significance, the results of this study indicated that participants higher in BAS- Reward and BAS-Drive do report significantly better sleep quality. Moreover, individuals higher in BAS- Reward Responsiveness also reported significantly lower levels of insomnia severity.

The drive subscale (i.e., BAS-Drive) reflects motivation to pursue goals and reward responsivity (i.e., BAS-Reward) reflects heightened energy and positive affect toward the receipt of rewards. As a result, it is possible that individuals higher in BAS-Drive and BAS-Reward may be prioritizing their sleep, and therefore sleeping better, to reach their goals or gain some reward. Sleep plays a vital role in cognitive functioning abilities including mental flexibility, sustained attention, verbal fluency, and general intellectual functioning (Fulda & Schulz, 2001; Khassawneh et al., 2018; Shekleton et al., 2014). Additionally, sleep quality

and quantity have been found to affect a student's learning capacity, as well as declarative memory, procedural learning, and attention which can impact academic performance (Curcio et al., 2006; Hershner & O'Brien, 2018). As a result, individuals higher in BAS-Drive or BAS-Reward may be prioritizing their sleep and sleeping better in order achieve a desired goal or obtain some reward (e.g., better grades).

This result is also in line with the findings of Andersz & Bargiel-Matusiewicz (2018) which found that higher BAS-Reward activation is positively correlated with the number of perceived benefits of cutting down sleep and found that college students higher in BAS-Reward activation more often reported choosing sleep deprivation voluntarily (Andersz & Bargiel-Matusiewicz, 2018). As a result, individuals higher in the BAS-Reward subscale may perceive more benefits to cutting down on sleep, and may therefore perceive and report better sleep, especially if missing out on sleep helps them to obtain a reward (e.g., good grades, social interactions, etc.)

Moderation Analyses. Unexpectedly, the results of this study indicated that neuroticism did *not* significantly moderate the relationship between BIS and sleep quality nor the relationship between BIS and insomnia severity. While both BIS and neuroticism were significantly correlated with sleep quality and insomnia severity, neuroticism did not significantly strengthen the relationship between BIS and these two domains of sleep. While more research needs to be done in this area to elucidate the complex relationship between these variables, several possible explanations are described below through post-hoc analyses.

Post-hoc Analyses

The findings reported in this study provide support for the significant and positive correlation between BIS and neuroticism, as well as between BIS and sleep, and neuroticism and sleep. Due to the significant correlations between BIS and neuroticism with sleep quality,

insomnia severity, dysfunctional beliefs and attitudes about sleep, and daytime sleepiness, post hoc multiple regression analyses were performed and have been interpreted below.

PSQI, ISI, Neuroticism, and BIS. Post-hoc multiple regression analyses revealed that a model including BIS and neuroticism significantly predicted sleep quality as measured by global PSQI. Both neuroticism and BIS emerged as significant predictors of global PSQI. To explore this finding further, additional regression analyses were performed to determine whether BIS and neuroticism significantly predicted the seven subcomponent scores of the PSQI (i.e., subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction). The results revealed that six of the seven models were significant, excluding habitual sleep efficiency, and that neuroticism was a significant predictor of the six component scores (excluding habitual sleep efficiency).

Interestingly, BIS only significantly predicted the daytime dysfunction subcomponent of the PSQI. The daytime dysfunction component is made up of two items including, (1) "during the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?" and (2) "during the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?" This finding is in line with previous studies which suggest that 27% of college students report feeling fatigued during the day (Babicki et al., 2023). Additionally, poor sleep is associated with psychological impairment (e.g., anxiety and depression) which can lead to worse daytime functioning (Alapin et al., 2000). Compared to the other subcomponents of the PSQI, the daytime dysfunction subcomponent is the most likely to capture the psychological consequences of poor sleep including excessive daytime fatigue and difficulty finding the motivation to get things done during the day. This could be a possible explanation for why BIS only significantly predicted the daytime sleepiness subcomponent of the PSQI. See

Appendix D for a breakdown of the items that make up the seven component scores of the PSQI.

A similar pattern was identified with regards to the ISI. Post-hoc multiple regression analyses revealed that a model including BIS and neuroticism significantly predicted insomnia severity as measured by the ISI. The insomnia severity index specifically assesses for symptoms of insomnia, and as such, focuses more on the quantitative aspects of an insomnia diagnosis (e.g., please rate how difficult it is for you to fall asleep/stay asleep? and how satisfied/dissatisfied are you with your current sleep problems?). However, items five, six, and seven focus more on the psychological aspects of insomnia, including: (item-5) "how noticeable to others do you think your sleep problem is in terms of impairing the quality of your life," (item-6) "how worried/distressed are you about your current sleep problem," and (item-7) "to what extent do you consider your sleep problem to interfere with your daily functioning (e.g. daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood, etc.) currently." Notably, while neuroticism was a significant predictor of all seven items on the ISI, BIS was only a significant predictor of items five, six, and seven which focus more on the psychological components of insomnia.

DBAS-16, ESS, Neuroticism, and BIS. Post-hoc multiple regression analyses revealed that a model including BIS and neuroticism significantly predicted dysfunctional beliefs and attitudes about sleep as measured by the DBAS-16. Interestingly, both neuroticism and BIS emerged as a significant predictor of DBAS-16 scores. An additional post-hoc multiple regression analysis revealed that a model including BIS and neuroticism significantly predicted daytime sleepiness as measured by the ESS. Again, both neuroticism and BIS emerged as a significant predictor of ESS scores.

The DBAS-16 was designed to evaluate sleep-disruptive cognitions including faulty beliefs about sleep, worry, and attentional bias (Morin et al., 2007). For example, some

individuals hold unrealistic expectations about the quality and quantity of sleep they need each night and worry excessively when these requirements are not obtained (Morin et al., 2003; Morin et al., 2007). Others experience anxiety surrounding the potential consequences of a poor night's sleep on their daytime functioning and tend to bias their attention toward any evidence of daytime sleepiness or fatigue. Additionally, excessive daytime sleepiness, as measured by the ESS, has been found to be associated with anxiety, depression, and negative affect (Slater & Steier, 2012). Moreover, one study found that symptoms of fatigue and anxiety explain about 48% of the variability in daytime sleepiness, which suggests that fatigue and anxiety may be influencing individuals' perceptions and emotional experiences of daytime sleepiness (Smith et al., 2017).

These findings are in line with the post-hoc analyses mentioned previously as BIS significantly predicted the daytime dysfunction subcomponent of the PSQI, as well as items five, six, and seven on the ISI which focus on the psychological effects of poor sleep (i.e., effect of sleep impairments on quality of life, worry/distress about sleep, and sleep interference with daily functioning and mood). Due to the link between BIS and neuroticism with emotion regulation difficulties and higher levels of negative affect, it is possible that these personality traits, and specifically BIS, have a greater effect on the domains of sleep that are impacted more strongly by psychological factors.

BIS, Neuroticism, and Sleep

Individuals higher in BIS are more sensitive to punishment, or non-reward related effects. BIS inhibits behavior that may lead to negative or painful outcomes and thus causes inhibition of movement toward goals, especially if the chance of negative/punishing outcomes (e.g., failure) is high. As a result, individuals higher in BIS activation are thought to be more prone to anxiety after a negative/punishing outcome has occurred (Carver & White, 1994). Additionally, BIS functioning is believed to be responsible for the experience of

negative feelings such as fear, anxiety, frustration, and sadness in response to signals of punishment or non-reward (Carver & White, 1994). Studies suggest that BIS is linked to negative affect, more negative and less positive emotions (Steel et al., 2008), and indicate that higher levels of BIS predict emotional disorders in adults including anxiety and depression symptoms (Bijttebier et al., 2009; Kimbrel et al., 2007; Wytykowska et al., 2021).

With regards to sleep, higher exposure to negative emotions in daily life can certainly impact sleep and a poor night's sleep can exacerbate negative feelings (e.g., anxiety, sadness, etc.) during the day (Sing and Wong, 2010). Moreover, chronic sleep disturbances are a significant risk factor for the emergence of new or exacerbation of pre-existing psychological disorders (Andersz & Bargiel-Matusiewicz, 2018). Research suggests that teenagers/young adults who sleep poorly tend to have lower self-esteem, higher mental arousal and greater severity of psychosomatic symptoms than teenagers/young adults who sleep better (Brand et al., 2005; Andersz & Bargiel-Matusiewicz, 2018).

Overall, unrealistic expectations, perceptions, and excessive worry about the consequences of a poor night sleep on daytime functioning seem to feed into the emotional distress, heightened arousal, and anxiety/worry that are associated with disturbed sleep. As a result, individuals higher in BIS activation may be more susceptible to the psychological factors known to impact sleep. Due to the strong correlation between BIS and neuroticism, the heightened levels of anxiety and negative affectivity characteristic of these personality traits may explain why BIS (and neuroticism) are both significant predictors of the DBAS-16 and ESS, as well as the daytime sleepiness subcomponent of the PSQI and items five, six, and seven (i.e., effect of sleep impairments on quality of life, worry/distress about sleep, and sleep interference with daily functioning and mood) of the ISI, all of which focus more on the psychological aspects of poor sleep.

Conclusions and Clinical Implications

The goal of this study was to examine the complex relationship between BIS and BAS, neuroticism and extraversion, and sleep in a college student sample. The results suggest a significant relationship between BIS and neuroticism, and between all BAS factors and extraversion. With regards to the domains of sleep assessed in this study, higher levels of BIS and neuroticism were both significantly correlated with worse self-reported sleep quality, increased insomnia severity, more daytime sleepiness, and increased dysfunctional beliefs and attitudes about sleep. Extraversion was not significantly related to the domains of sleep measured in this study. However, participants higher in BAS- Reward Responsiveness and BAS-Drive reported significantly better sleep quality and individuals higher in BAS- Reward Responsiveness also reported significantly lower levels of insomnia severity. Unexpectedly, the results of this study suggest that neuroticism does *not* significantly moderate the relationship between BIS and sleep quality nor the relationship between BIS and insomnia severity. While both BIS and neuroticism were significantly correlated with sleep quality and insomnia severity, neuroticism did not significantly strengthen the relationship between BIS and these two domains of sleep.

Post-hoc multiple regression analyses revealed that neuroticism and BIS were significant predictors of all domains of sleep assessed in this study including global sleep quality, insomnia severity, dysfunctional beliefs and attitudes about sleep, and daytime sleepiness. Notably, neuroticism significantly predicted six of seven subcomponents of the PSQI and all seven items on the ISI. However, BIS was only a significant predictor of one subcomponent of the PSQI (i.e., daytime sleepiness) and items five, six, and seven (i.e., effects of sleep impairments on quality of life, worry/distress about sleep, and sleep interference with daily functioning and mood, respectively) on the ISI. Due to the link between BIS and neuroticism with emotion regulation difficulties and higher levels of negative affect, it is possible that these personality traits, and specifically BIS, may have a

greater effect on the domains of sleep that are impacted more strongly by psychological factors.

This study has important clinical implications. College students are a unique population in that they are experiencing many life changes including increased independence, living with roommates and away from family, higher levels of academic rigor, and unique social responsibilities. As a result, poor sleep and insomnia is common in this group especially given that sleep is often viewed as a luxury that many students will choose to forgo due to homework, social life, work responsibilities, etc. (Andersz & Bargiel-Matusiewicz, 2018). Among college students, insufficient sleep is associated with a wide variety of mental health concerns including more severe symptoms of depression and anxiety (Vollrath et al., 1989; Taylor et al., 2011) and increased risk for suicidal ideation (Nadorff et al., 2011). Sleep disturbances are also associated with negative affect and mood (Cukrowicz et al., 2006) which could be due to the effects of poor sleep on emotion regulation difficulties and distress tolerance (Cukrowicz et al., 2006). Psychological impairment due to disturbed sleep can lead to greater daytime functional impairment (Alapin et al., 2000) and more mental and physical health problems in college students (Lund et al., 2010).

In this study, college students higher in BAS- Reward and BAS-Drive reported significantly better sleep quality and individuals higher in BAS- Reward also reported significantly lower levels of insomnia severity. It is possible that individuals higher in BAS-Reward and BAS-Drive may be prioritizing their sleep, and therefore sleeping better, in order to reach their goals or gain some reward. This result is in line with the findings of Andersz and Bargiel-Matusiewicz (2018) which found that higher BAS-Reward activation is positively correlated with the number of perceived benefits of cutting down sleep and found that individuals higher in BAS-Reward activation more often reported choosing sleep deprivation voluntarily (Andersz & Bargiel-Matusiewicz, 2018). As a result, individuals

higher in the BAS-Reward subscale may perceive more benefits to cutting down on sleep, and may therefore perceive and report better sleep, especially if missing out on sleep helps them to obtain a reward (e.g., good grades, social interactions, etc.). Additionally, while the association between extraversion and the domains of sleep did not reach significance, there was a significant correlation between all BAS factors and extraversion. Since extraversion is characterized by positive affectivity and is associated with lower levels of anxiety and depression (Gamaldo et al., 2020; Stephan et al., 2018), it is possible that these personality traits may have a protective effect against sleep disturbances.

However, for college students higher in BIS and neuroticism, the results of this study suggest that they are at higher risk for experiencing worse sleep quality, higher levels of insomnia severity, dysfunctional beliefs about sleep, and daytime sleepiness. Many college students can let health behaviors such as getting enough sleep, eating healthy, and exercising fall to the wayside. As a result, for college students higher in BIS and neuroticism, the risk of experiencing poor sleep and daytime fatigue may be higher which may then have negative effects on mental health and academic achievement. Due to the link between neuroticism and BIS with higher levels of anxiety and negative affectivity (Wytykowska et al., 2021), as well as the link between sleep disturbances and poor mental health (Friedrick & Schlard, 2018; Nadorff et al., 2011), these personality characteristics should be considered when assessing sleep problems especially in a college student population.

Limitations

The findings of this study discussed above should be considered in light of limitations. The first limitation of this study was the group of participants recruited. All the college students who participated in this study were current students of a general psychology class. As such, many of the participants were 18-years old (mean age was 18.69 years; SD =

2.454) and freshmen in their first semester of college. It is possible that a sample of upperclassman or un-traditional college students may have yielded different results.

Another limitation was the reliance on self-report measures to examine the various domains of sleep assessed in this study. Self-report measures rely on participant insight and recollection which can sometimes be biased or limited. Future studies should utilize more objective measures to measure sleep such as actigraphy.

Lastly, this was an online study, so the survey measures were completed virtually by the participants. As a result, the researcher was not present to ensure accurate responding or to answer participant questions. While validity measures were embedded throughout the survey, the online format of this study could increase the chance of inaccurate responding or poor effort on the survey measures.

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APPENDIX A: DEMOGRAPHIC MEASURES

Demographic Questions

1. **Birth Date (MM/DD/YYYY): _____**

Age: _____ years

2. **What is your biological sex?**

Male
Female
Intersex
Other (please specify): _____
I'd prefer not to say

3. **What is your gender?**

Female/Woman
Male/Man
Transgender/ Gender queer/non-binary
Unspecified

4. **What is your Race**

American Indian/Alaska Native
Asian
Black or African American
Native Hawaiian or Other Pacific Islander
White or European American
Multi-racial
Unknown or other: _____

5. **Ethnicity**

Hispanic/Latinx
NOT Hispanic/Latinx

6. **Do you live with a roommate?**

Yes
No

Alcohol and Substance Use-Related Questions

Now, we would like to learn more about your drinking and substance-use habits. Please keep in mind that your responses will be kept **strictly confidential.**

Please answer the following questions about your use of alcohol and other substances **over the past month**.

One drink equals:   

12 oz. Beer	5 oz. Wine	1.5 oz. Liquor (one shot)

1. Over the past month, how often did you consume drinks containing alcohol?

- Never
- Monthly or less
- 2-4 times a month
- 2-3 times a week
- 4 or more times a week

2. Over the past month, how many alcoholic drinks have you had on a typical day when you were drinking alcoholic beverages?
    - 0
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10+
    - I prefer not to answer

3. Over the past month, on average how often did you consume caffeinated drinks (i.e., coffee, caffeinated tea, energy drinks, caffeinated soda)?

- Never
- Monthly or less
- 2-4 times a month
- 2-3 times a week
- 4 or more times a week

4. Over the past month, how many cups or cans of caffeinated drinks (i.e., coffee, caffeinated tea, energy drinks, caffeinated soda) have you had on a typical day when you were drinking caffeinated beverages?
    - 0
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
    - 8

- 9
- 10+
- I prefer not to answer

5. Over the past month, how often have you used marijuana (e.g., a joint, pot, weed, hash, or hash oil) or cannabis?
   - 0
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10
   - 11
   - 12
   - 13
   - 14
   - 15
   - 16
   - 17
   - 18
   - 19
   - 20
   - 21
   - 22
   - 23
   - 24
   - 25
   - 26
   - 27
   - 28
   - 29
   - 30
   - 31+
   - I prefer not to answer

6. Over the past month, how often have you used a medication for anxiety or sleep (e.g., Xanax, Ativan or Klonopin)? This could be medication prescribed for you or not prescribed for you.
   - 0
   - 1
   - 2
   - 3
   - 4

- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
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- 25
- 26
- 27
- 28
- 29
- 30
- 31+
- I prefer not to answer

7. Over the past month, how often have you used medication for ADHD (e.g., Adderall, Ritalin)? This could be medication prescribed for you or not prescribed for you.
   - 0
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
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- 16
- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26
- 27
- 28
- 29
- 30
- 31+
- I prefer not to answer

8. Over the past month, how often have you used nicotine (e.g., cigarette smoking, chewing tobacco, vaping, patches, gum, etc.).

- Never
- Monthly or less
- 2-4 times a month
- 2-3 times a week
- 4 or more times a week

9. Over the past month, how often have you used nicotine (e.g., cigarette smoking, chewing tobacco, vaping, patches, gum, etc.) <u>on a typical day</u>?
    - 0
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10+
    - I prefer not to answer

Socioeconomic Status (SES)-Related Questions

1. **What is the highest level of education completed by your parent or a guardian (e.g, mother, father, grandmother, grandfather, legal guardian, adoptive/foster parents)?**

- Less than 12 years
- High school graduate/GED
- Some college/AA degree
- College graduate (Bachelor's degree)
- Graduate or professional degree: Master's or Doctorate degree (MD, PhD, JD)

2. **What is the highest level of education completed by your other parent or a guardian (e.g, mother, father, grandmother, grandfather, legal guardian, adoptive/foster parents)?**

- Less than 12 years
- High school graduate /GED
- Some college/AA degree
- College graduate (Bachelor's degree)
- Graduate school degree: Master's or Doctorate degree (MD, PhD, JD)

APPENDIX B: SLEEP MEASURES

1. *Pittsburg Sleep Quality Index (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 _____

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 _____

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 _____

For each of the remaining questions, check the one best response. Please answer all questions.

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

   a) Cannot get to sleep within 30 minutes

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

   b) Wake up in the middle of the night or early morning

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

   c) Have to get up to use the bathroom

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

   d) Cannot breathe comfortably

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

e) Cough or snore loudly

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

f) Feel too cold

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

g) Feel too hot

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

h) Had bad dreams

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

i) Have pain

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

j) Other reason(s), please describe_____

How often during the past month have you had trouble sleeping because of this?

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

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

Very good
Fairly good
Fairly bad
Very bad

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_____

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_____

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 _____

10. Do you have a bed partner or roommate?

    No bed partner or roommate _____

    Partner/roommate in other room _____

    Partner in same room, but not same bed _____

    Partner in same bed _____

2. Insomnia Severity Questionnaire (ISI)

The Insomnia Severity Index has seven questions. For each question, please CIRCLE the number that best describes your answer.

Please rate the CURRENT (i.e. LAST 2 WEEKS) SEVERITY of your insomnia problem(s).

Insomnia Problem	None	Mild	Moderate	Severe	Very Severe
1. Difficulty falling asleep	0	1	2	3	4
2. Difficulty staying asleep	0	1	2	3	4
3. Problems waking up too early	0	1	2	3	4

4. How SATISFIED/DISSATISFIED are you with your CURRENT sleep pattern?

Very Satisfied	Satisfied	Moderately Satisfied	Dissatisfied	Very Dissatisfied

5. How NOTICEABLE to others do you think your sleep problem is in terms of impairing the quality of your life?

Not at all Noticeable	A Little	Somewhat	Much	Very Much Noticeable

6. How WORRIED/DISTRESSED are you about your current sleep problem?

Not at all Worried	A Little	Somewhat	Much	Very Much Worried

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

Not at all Interfering	A Little	Somewhat	Much	Very Much Interfering

3. Epworth Sleepiness Scale

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired?

This refers to your usual way of life in recent times.

Even if you haven't done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the **most appropriate number** for each situation:

0 = would **never** doze

1= **slight chance** of dozing

2= **moderate chance** of dozing

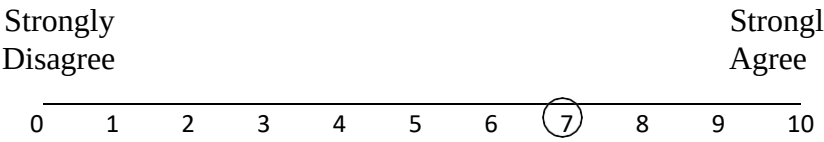
3= **high chance** of dozing

It is important that you answer each question as best as you can.

Situation	**Chance of Dozing**
Sitting and reading	0 1 2 3
Watching TV	0 1 2 3
Sitting, inactive in a public place (e.g., theater or a meeting)	0 1 2 3
As a passenger in a car for an hour without a break	0 1 2 3
Lying down to rest in the afternoon when circumstances permit	0 1 2 3
Sitting and talking to someone	0 1 2 3
Sitting quietly after a lunch without alcohol	0 1 2 3
In a car, while stopped for a few minutes in the traffic	0 1 2 3

4. Dysfunctional Beliefs about Sleep Scale

Several statements reflecting people's beliefs and attitudes about sleep are listed below. Please indicate to what extent you personally agree or disagree with each statement. There is no right orwrong answer. For each statement, circle the number that corresponds to your own personal belief. Please respond to all items even though some may not apply directly to your ownsituation.



1. I need 8 hours of sleep to feel refreshed and function well during the day.

0 1 2 3 4 5 6 7 8 9 10

2. When I don't get proper amount of sleep on a given night, I need to catch up on the next day by napping or on the next night by sleeping longer.

0 1 2 3 4 5 6 7 8 9 10

3. I am concerned that chronic insomnia may have serious consequences on my physical health.

0 1 2 3 4 5 6 7 8 9 10

4. I am worried that I may lose control over my abilities to sleep.

0 1 2 3 4 5 6 7 8 9 10

5. After a poor night's sleep, I know that it will interfere with my daily activities on the next day.

0 1 2 3 4 5 6 7 8 9 10

6. In order to be alert and function well during the day, I believe I would be better off taking asleeping pill rather than having a poor night's sleep.

0 1 2 3 4 5 6 7 8 9 10

7. When I feel irritable, depressed, or anxious during the day, it is mostly because I did not sleepwell the night before.

0 1 2 3 4 5 6 7 8 9 10

8. When I sleep poorly on one night, I know it will disturb my sleep schedule for the whole week.

0 1 2 3 4 5 6 7 8 9 10

9. Without an adequate night's sleep, I can hardly function the next day.

0 1 2 3 4 5 6 7 8 9 10

10. I can't ever predict whether I'll have a good or poor night's sleep.

0 1 2 3 4 5 6 7 8 9 10

11. I have little ability to manage the negative consequences of disturbed sleep.

0 1 2 3 4 5 6 7 8 9 10

12. When I feel tired, have no energy, or just seem not to function well during the day, it is generally because I did not sleep well the night before.

0 1 2 3 4 5 6 7 8 9 10

13. I believe insomnia is essentially the result of a chemical imbalance.

0 1 2 3 4 5 6 7 8 9 10

14. I feel insomnia is ruining my ability to enjoy life and prevents me from doing what I want.

0 1 2 3 4 5 6 7 8 9 10

15. Medication is probably the only solution to sleeplessness.

0 1 2 3 4 5 6 7 8 9 10

16. I avoid or cancel obligations (social, family) after a poor night's sleep.

0 1 2 3 4 5 6 7 8 9 10

APPENDIX C: PERSONALITY MEASURES

5. *BIS/BAS Scale*

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do notleave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be.Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses. Choose from the following four response options:

1 = very true for me (4)
2 = somewhat true for me (3)
3 = somewhat false for me (2)
4 = very false for me (1)

1. A person's family is the most important thing in life. _____
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness. _____
3. I go out of my way to get things I want. _____
4. When I'm doing well at something I love to keep at it. _____
5. I'm always willing to try something new if I think it will be fun. _____
6. How I dress is important to me. _____
7. When I get something I want, I feel excited and energized. _____
8. Criticism or scolding hurts me quite a bit. _____
9. When I want something I usually go all-out to get it. _____
10. I will often do things for no other reason than that they might be fun. _____
11. It's hard for me to find the time to do things such as get a haircut. _____
12. If I see a chance to get something I want I move on it right away. _____

13. I feel pretty worried or upset when I think or know somebody is angry at me. _____

14. When I see an opportunity for something I like I get excited right away. _____

15. I often act on the spur of the moment. _____

16. If I think something unpleasant is going to happen I usually get pretty "worked up." _____

17. I often wonder why people act the way they do. _____

18. When good things happen to me, it affects me strongly. _____

19. I feel worried when I think I have done poorly at something important. _____

20. I crave excitement and new sensations. _____

21. When I go after something I use a "no holds barred" approach. _____

22. I have very few fears compared to my friends. _____

23. It would excite me to win a contest. _____

24. I worry about making mistakes. _____

6. *Mini-IPIP*

Here are 20 statements; please evaluate the extent to which you agree with them. Please answer honestly with regard to how you see yourself in the present moment, not how you would like to be in the future. There are no incorrect answers nor any answers that are inherently more desirable than others.

1	2	3	4	5
Very Inaccurate	Moderately Inaccurate	Neither Inaccurate nor Accurate	Moderately Accurate	Very Accurate

1. I am the life of the party. _____
2. I sympathize with others' feelings. _____
3. I get chores done right away. _____
4. I have frequent mood swings. _____
5. I have a vivid imagination. _____
6. I don't talk a lot. _____
7. I am not interested in other people's problems. _____
8. I often forget to put things back in their proper place. _____
9. I am relaxed most of the time. _____
10. I am not interested in abstract ideas. _____
11. I talk to a lot of different people at parties. _____
12. I feel others' emotions. _____
13. I like order. _____
14. I get upset easily. _____
15. I have difficulty understanding abstract ideas. _____

16. I keep in the background. _____

17. I am not really interested in others. _____

18. I make a mess of things. _____

19. I seldom feel blue. _____

20. I do not have a good imagination. _____

APPENDIX D: Pittsburgh Sleep Quality Index Component Scores

Below is a list of the seven subcomponents of the PSQI and the questions that are used to obtain each component score:

Component 1: Subjective sleep quality

- Question 9: During the past month, how would you rate your sleep quality overall?

Component 2: Sleep Latency

- Question 2: During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
- Question 5a: During the past month, how often have you had trouble sleeping because you cannot get to sleep within 30 minutes?

Component 3: Sleep Duration

- Question 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).

Component 4: Sleep Efficiency

- Question 1: During the past month, what time have you usually gone to bed at night?
- Question 3: During the past month, what time have you usually gotten up in the morning?
- Question 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).

Sleep efficiency = (# hours slept from question 4 /# hours in bed calculated from questions 1 and 3) X 100%

Component 5: Sleep Disturbance

During the past month, how often have you had Not during Less than Once or Three or more trouble sleeping because you…

- Question 5a: Cannot get to sleep within 30 minutes.
- Question 5b: Wake up in the middle of the night or early morning.
- Question 5c: Have to get up to use the bathroom.
- Question 5d: d. Cannot breathe comfortably.
- Question 5e: Cough or snore loudly.
- Question 5f: Feel too cold.
- Question 5g: Feel too hot.
- Question 5h: Have bad dreams.
- Question 5i: Have pain.
- Question 5j: Other reason(s), please describe: (free textbox)

Component 6: Use of Sleep Medication

- Question 6: During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?

Component 7: Daytime Dysfunction

- Question 7: During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?
- Question 8: During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

APPENDIX E: IRB EXEMPTION LETTER

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** ·
rede.ecu.edu/umcirb/

Notification of Exempt Certification

From: Social/Behavioral IRB
To: Gillian Falletta
CC: Daniel Everhart
Date: 7/7/2023
Re: UMCIRB 23-001062
Association between the Behavioral Inhibition System/Behavioral Activation System, the Big-5, and Sleep Quality

I am pleased to inform you that your research submission has been certified as exempt on 7/6/2023. This study is eligible for Exempt Certification under category # 2C.

It is your responsibility to ensure that this research is conducted in the manner reported in your application and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your profession.

This research study does not require any additional interaction with the UMCIRB unless there are proposed changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB for review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for exempt status. If more substantive review is required, you will be notified within five business days.

Document	Description
BIS-BAS.pdf(0.01)	Surveys and Questionnaires
Debriefing and list of resources (1) (1).docx(0.01)	Additional Items
Demographic Measures_IRB1 (3) (1) (6).docx(0.01)	Data Collection Sheet
Demographic Measures_IRB1 (3) (1) (6).docx(0.01)	Surveys and Questionnaires
dysfunctional_beliefs_and_attitudes_about_sleep_16_items.pdf(0.01)	Surveys and Questionnaires
Epworth Sleepiness Scale (ESS).pdf(0.01)	Surveys and Questionnaires
InsomniaSeverityIndex (ISI).pdf(0.01)	Surveys and Questionnaires
Mini-IPIP.docx(0.01)	Surveys and Questionnaires
PSQI-Instrument.pdf(0.01)	Surveys and Questionnaires
Recruitment script for SONA (1) (1) (2) (3).docx(0.01)	Recruitment Documents/Scripts
Survey Consent Paragraph for Exempt Research 2 20 20 (1) (1).docx(0.01)	Consent Forms
Thesis Proposal Final.docx(0.01)	Study Protocol or Grant Application
Validity Check Questions.docx(0.01)	Surveys and Questionnaires

For research studies where a waiver or alteration of HIPAA Authorization has been approved, the IRB states that each of the waiver criteria in 45 CFR 164.512(i)(1)(i)(A) and (2)(i) through (v) have been met. Additionally, the elements of PHI to be collected as described in items 1 and 2 of the Application for Waiver of Authorization have been determined to be the minimal necessary for the specified research.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418