AMBULATORY MONITORING AND PSYCHOPATHY: THE SLEEP STUDY

A Thesis

by

ASHLEY CHRISTINE YAUGHER

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Chair of Committee,	Gerianne Alexander
Committee Members,	John Edens
	Holly Foster
Head of Department,	Douglas Woods

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ABSTRACT

There is an increasing focus on the role of sleep in psychological disorders, including Antisocial Personality Disorder (APD) and Psychopathic Personality Disorder. Consistent with a relationship between sleep and impulsivity, compared to controls, APD patients report lower subjective sleep quality, longer sleep latency, shorter duration of sleep, less habitual sleep efficiency, more sleep disturbances, more use of sleeping medication, and a higher level of daytime dysfunction. Compared to APD less is known about the relation between sleep and symptoms associated with psychopathy.

The current study included objectively measured sleep using an actigraphy device to record activity levels and sleep interruptions in a large sample of 402 (233 f, 169 m) undergraduate college students at Texas A&M University. Significant gender differences were found for age of participants, psychopathy scores, anxiety scores, and antisocial scores. Results indicated that individuals reporting high levels of psychopathy also reported high levels of impulsivity on the questionnaire measures. While a relationship between sleep efficiency and psychopathy was not found in the current study, several mood effects did emerge. Findings of the current study replicate prior research, and support the continuation of examining sleep in individuals with psychopathy as well as mood disorders.

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1. INTRODUCTION

Human sleep is one of the most influential aspects of human functioning and behavior, affecting learning, memory, performance, and various physical and mental ailments (Clinkinbeard et al. 2011). The neurobehavioral models of sleep suggest that sleep deficiency is associated with socially maladaptive changes in emotion, cognition, and behavior similar to behavior change resulting from prefrontal lobe dysfunction or damage (Clinkinbeard et al. 2011). Behavioral deficits associated with prefrontal lobe dysfunction include aggression and impulsivity or inhibition deficits, suggesting sleep deficiencies may increase impulsivity. However, studies examining this relationship have relied primarily on self-report measures such as parent questionnaires, student questionnaires, and administrator questionnaires (Clinkinbeard et al. 2011). The relationship between impulsivity and objective measures of sleep is largely unknown.

Sleep Assessment

Typical sleep alternates between two main sleep stages; Rapid Eye Movement (REM) sleep (approximately 20-25% of sleep cycle) and non-REM sleep. Non-REM sleep has four stages. Stage one sleep and stage two sleep are characterized by less physiological arousal than stages three and four. Stage one sleep is brief, lasting only minutes or five percent of sleep, and stage two is slightly deeper and occupies approximately 50 percent of sleep time.

Stage three and stage four are characterized by high-amplitude, slow delta waves and are termed slow wave sleep (SWS); these stages occupy 10 to 20 percent of sleep time (Lindberg et al. 2008).

Sleep quality and satisfaction are typically measured using self-report questionnaires such as the Pittsburgh Sleep Quality Index (PSQI; a 19 item self-report measure of sleep quality and disturbances for the duration of one month; Semiz et al. 2008) and semi-structured interviews (e.g., Crawley, & Martin, 2006; Semiz et al. 2008). The biological correlates of sleep stages can be measured objectively with polysomnography and fMRIs of the brain during sleep (Lindberg et al. 2003). In addition, actigraphy is a non-invasive method of monitoring rest/activity cycles using an accelerometer capable of sensing even slight wake periods or motion with a minimal resultant force of $0.01 \times g$ (Tworoger et. al. 2005). Unlike other objective methods that require the individual to be monitored in a laboratory setting, actigraphy documents sleep and wakefulness in a naturalistic setting such as the home (Tworoger et al. 2005). Although some argue that actigraphy is not accurate for a sleep-wake-indicator (Pollak et al. 2001), it is valid as a measure of rest and activity levels and sleep can be inferred from the actigraphy data (Tyron, 2004). The validity of actigraphy as a measure of sleep has been established in studies using multiple recording days (Acebo et al. 1999). Actigraph sleep measures include sleep efficiency, total sleep time, total wake time, the number of awakenings, minutes awake after sleep onset, number of awakenings ≥3 minutes, and sleep onset latency (Tworoger et. al. 2005).

Sleep and Externalizing Behavior

Normative sleep changes in duration, latency, and pattern are experienced in the general population from infancy to adulthood (Goldsmith, &Casola, 2006) and at least 10 percent of the population suffers from a clinically significant sleep disorder, including insomnia, narcolepsy, nightmares, sleep walking, and breathing related issues (American Psychiatric Association [DSM-IV-TR], 2000). In addition, the relationship between sleep and sleep deficiencies and psychiatric disorders, substance use, and overall psychological disorders is the focus of increasing research (Goldsmith, & Casola, 2006; Semiz et al. 2008).

Several findings indicate a relationship between altered sleep physiology and elevated impulsivity and aggressiveness. Individuals with Antisocial Personality Disorder (APD), characterized by impulsiveness and antisocial behaviors that violate the rights of others, have been of much interest within these studies. A self-report study comparing 125 male soldiers with Antisocial Personality Disorder (APD) and a control group of 125 military personnel men found patients diagnosed with APD had lower subjective sleep quality, longer sleep latency, shorter duration of sleep, less habitual sleep efficiency, more sleep disturbances, more use of sleeping medication, and a higher level of daytime dysfunction as assessed by a battery of tests, including the PSQI and Aggression Questionnaire (Semiz et al. 2008).

Biological correlates of sleep quantity are also altered in individuals with high impulsivity, criminality, and APD (Lindberg et al. 2003). Studies examining men diagnosed with APD in comparison to healthy controls have found that individuals diagnosed with APD experience higher levels of SWS yet report less sleep satisfaction; sleep less; and have more sleep-wakefulness, and more daytime dysfunction. Sleep research on women with APD has also found increased amounts of SWS as compared to healthy controls (Lindberg et al. 2009). The finding that both men and women with APD experienced increased SWS compared to unaffected adults is noteworthy given that SWS typically decreases with age. The higher amount of SWS in adults with APD has suggested that the disorder may be associated with a delay in brain development and abnormalities in the prefrontal cortex. The possibility that sleep dysfunction contributes to the observed behavioral symptoms of APD is also consistent with findings of negative associations between sleep and externalizing behavior in male juveniles, such that decreases in the quality and quantity of sleep are associated with increases in aggression and impulsivity (Ireland & Culpin, 2006).

Research on other disorders associated with impulsivity (e.g., bipolar, conduct disorder, ADHD) have also found altered sleep physiology, such that individuals reporting higher levels of impulsivity have more stage one sleep and less stage four sleep (Harty et al. 2010). Impulsivity was also associated with subjective reports of less sleep satisfaction, less total sleep, and more sleep-wakefulness. Interestingly, individuals with bipolar disorder were found to experience less SWS, stage three sleep, and stage four sleep, but more REM sleep. These results suggest that the increased level of SWS seen in individuals with APD is disorder specific. Finally, findings from actigraphy research have shown lower levels of sleep efficiency and overall sleep time in impulsive individuals (Boonstra et al. 2007; Ireland, & Culpin, 2006; Lindberg et al. 2003; Tworoger et al. 2005).

Psychopathic Traits and Sleep

Impulsivity and aggression are both features of APD and psychopathy (Wilson, Frick, & Clements, 1999). Psychopathy includes the chronic antisocial behavior component (which is shared with APD), but also includes the lack of emotional bonds and empathy (which is not a hallmark of APD) (Harty et al. 2010). Psychopathy is not a codeable psychiatric disorder. Yet, many clinicians and researchers consider psychopathy a much more serious personality disorder than APD (Blair, Mitchell, & Blair, 2005).

In addition to impulsivity and aggressiveness, psychopathy includes affective traits such as lack of empathy, lack of nervousness, and interpersonal deficits (Wilson, Frick, & Clements, 1999). For these reasons, psychopathy is of interest to researchers of both forensic and non-forensic populations. Psychopathy is more easily identified in forensic settings (i.e. jails, prisons, probation groups) but is also present in the general population (i.e. non-forensic settings). In fact, previous researchers have found the base rate for psychopathy in forensic settings to between 15 and 25 percent, but more recently have suggested the it may be closer to nine percent when using more sensitive measures (Rogers &Rogstad, 2010) and in non-forensic settings the base rate is less than five percent when using self-report measures such as the Personality Assessment Inventory (Salekin, Trobst, &Krioukova, 2001). In community samples, those scoring high on psychopathy are more often men (1/10 men vs. 1/100 women), which also influences the base rates of this disorder (Salekin, Trobst, &Krioukova, 2001).

Increasing research suggests an association between sleep dysfunction and symptoms associated with psychopathy. Yet, there are few studies examining the relationship between sleep and this personality disorder. To address this gap, the current research used actigraphy to provide precise information about activity levels and sleep interruptions in a sample of undergraduate college students at Texas A&M University. Actigraphy was used to examine the association between sleep quality and dysfunctional, impulsive, and psychopathic behaviors. Sleep and wakefulness are differentiated by body movement and can be accurately identified using wrist actigraphy (Tryon, 2004). We hypothesized that individuals with high levels of psychopathy and impulsivity would have more interrupted sleep schedules. We also hypothesized that individuals with high levels of psychopathy and impulsivity would report lower sleep efficiency and satisfaction.

Although much research in the past has concerned male sleep wakefulness and its relation to APD, few have included women in their samples. Also, within previous samples there is little if any investigation of the disorder of psychopathy. We will use the construct of psychopathy as it defines a much more diagnostically significant sub-set of individuals. Specifically, the current study included the triarchic model of psychopathy which includes three main constructs; meanness, boldness, and disinhibition (Patrick, Fowles, & Krueger, 2009). These three constructs explain the hypothesized main components of psychopathy; lack of regard for the rights of others, dominance, and impulsivity.

In view of the greater prevalence rate of externalizing disorders in men compared to women, this study also included measurement of digit ratios, a proxy measure of prenatal androgen action. Increased prenatal androgens are associated with the greater expression of male-typical behavior, including disorders with sex-biased prevalence rates (Lutchmaya et al. 2004), so including digit ratios may be informative in understanding the determinants of psychopathy and related traits.

2. METHOD

Participants

This study included 402 undergraduate college students at Texas A&M University (169 men). Sample size was determined following power recommendations by Cohen (1992) with alpha set at .05, and effect size estimates were based on meta-analytic findings showing a medium effect size for the relationship of psychopathy and risk assessment (Dolan, & Doyle, 2000), recidivism studies in several societies (Cooke, 2006), and a meta-analysis of children with impulsive traits (i.e., ADHD) and the relationship to sleep disturbance (limb movement) showing a smaller effect size ($d_{=}$.26) (Sadeh, Pergamin, & Bar-Haim, 2006). The current study received approval from the Texas A&M Institutional Review Board (IRB2012-0117). Participants completed the experiments as partial fulfillment of course requirements and did not receive any financial compensation for their participation. All participants were 18 years and older (range 18-27, *M*= 18.59, *SD*= .98). Participants were not identified by name; and were assigned a number once they began the experiment.

Measures

A short demographics questionnaire and three behavioral questionnaires were included in the initial test battery. General sleep patternswere assessed using The Pittsburgh Sleep Quality Index (PSQI), a widely-used 19 item self-report measure of sleep quality and disturbances covering a duration of one month (Buysse et al. 1989). Levels of impulsivity were measured using The Barratt Impulsiveness Scale (BIS-11), a 30 item self-report questionnaire that has been validated in impulsive and normal populations (Swann et al. 2001). The BIS-11 consists of attentional impulsivity, motor impulsivity, and non-planning impulsivity subscales. This impulsivity measure has been validated and shown to reliably predict impulsive behavior (Stanford et al. 2009). Psychopathic traits were measured using The Triarchic Psychopathy Measure (TriPM), a 58-item self-report questionnaire that measures three specific constructs of psychopathy (boldness, meanness, and disinhibition) (Patrick et al. 2009). The TriPM items have been validated with adolescents and adults (age 14 and older) and allows for psychopathy to be measured in a self-report format.

In order to evaluate possible confounds of mood, 103 participants (61 women, 42 men) completed a negative affect measure. Negative affectivitywas measured using the antisocial, anxiety, borderline, and depression scales of the Personality Assessment Inventory (PAI), an adapted 96- item self-report questionnaire that measures these constructs reliably in adult populations and is used frequently in both clinical and non-clinical populations (PAI; Morey, 1991). Variations of these individual scales have been used in several college and clinical populations (Kurtz, Morey, &Tomarken, 1993; Salekin et al. 2001; Diamond, & Magaletta, 2006; Jacobo et al. 2007, DeShong, & Kurtz, 2013) and have demonstrated good reliability and validity. Furthermore, Harty et al. (2010)

adapted several PAI scale items for use in their study concerning antisocial personality disorder and sleep.

Objective measures include digit ratios and actigraphy. The ratio of the second and fourth digits was included as a putative measure of androgen action during fetal development such that lower ratios are thought to demonstrate more male-typical prenatal development (Lutchmaya et al. 2004; Manning et al. 2003). Digit ratios are determined by measuring the distance in millimeters from the basal crease to the tip of the finger with digital vernier calipers.

Sleep and wakefulness were documented with a small accelerometer (i.e., 16 grams) that provides a reliable and noninvasive method of continuously measuring the intensity and duration of gross motor movement. Actigraphy is widely used in the measurement of human and nonhuman primate activity and rest cycles. The small watch-like actigraph (Actiwatch, AW64, PhilipsRespironics) records “counts” representing the amount and magnitude of acceleration summed up during each epoch, such that higher numbers represent a combination of higher frequency and intensity of movements. In the current study, accelerometers were initialized to capture movement counts within 15 second intervals. Research on actigraphic sleep assessment has concluded that the validity of actigraphic sleep measurement exceeds many psychological and medical tests (Tryon, 2004). Sleep efficiency was measured with average percent sleep throughout the week. Previous studies have used average percent sleep to examine the percent of time spent sleeping while in bed (Sadeh, Gruber, &Raviv, 2003). In addition, previous studies have found average percentages of sleep to be 80.9% in adults (Lauderdale et al. 2006).

Procedure

Participants were tested individually in two sessions, each lasting approximately 30 minutes in length. In the first session, participants were provided written informed consent, and the lengths of the second and fourth digits (2D:4D) were measured with digital vernier calipers by two independent raters and averaged to achieve the final digit ratio (the interrater reliability for the raters for ratio one and ratio two was high, α = .87). Self-report questionnaires were administered on a computer located in a quiet room using secure online survey software (Qualtrics, Survey Software). Once the questionnaires were completed, a preprogrammed actiwatch was placed on the participant's preferred wrist. Participants were instructed to wear the watch continuously for a period of seven days and given instructions to keep the watch dry and secure to the wrist. A small marker button was pressed to record the onset of rest and awakening times.

Part two of the study was scheduled for seven days after the initial appointment. After one week, participants returned the watch in the same room and received a debriefing form which contained contact information and a brief explanation of the study. For 299 participants part two only included the previously described protocol, and for 103 participants part two also included the administration of the PAI in paper format to complete. All participants completed both part one and part two of the study. However, due to technical and participant error, means were substituted by gender for less than six percent of the participants (participant data subbed for variables of interest ranged from .5% to 6%).

3. RESULTS

Sex Differences

A one-way between subjects analysis of variance (ANOVA) was conducted to examine differences between men and women on the behavioral measures (see Table 1 in Appendix A for a summary of the means, SD and effect sizes). No significant gender differences were found for PSQI scores, BIS-11 scores, total PAI Depression scores, total PAI Borderline scores, digit ratios, percent sleep, or sleep time in minutes (*d*'s ranging from .03 to .19Cohen, 1992). However, results showed that men and women in the study differed significantly on several study variables with effects sizes (*d*) ranging from .25 to 1.12. Women included in the current study were younger than men, $F(1, 400) = 6.49$, $p < .05$. On measures assessing psychopathic personality traits, women reported significantly lower levels of psychopathy as measured by the TriPM than men, $F(1, 400) = 125.56$, $p < .00$, and women reported significantly lower scores on the PAI Antisocial scale than men, $F(1, 101) = 8.11$, $p < .01$. On measures included to assess confounds of mood, women reported significantly higher levels of anxiety than men, $F(1, 101) = 5.39$, $p < .05$. Furthermore, on the subjective sleep quality measure (PSQI) results approached significance, such that women reported higher scores or less subjective sleep quality than did men, $F(1, 400) = 3.26$, $p = .07$.

As a result of the significant sex differences reported above, the relationship between digit ratios and all sex-linked variables were examined by computing Pearson product-moment correlation coefficients. There was no correlation between digit ratio and age, sleep time in minutes, percent sleep, subjective sleep scores, TriPM scores, PAI Anxiety scores, PAI Depression scores, or PAI Antisocial scores (see Table 2 in Appendix A for correlation coefficients, overall means, and standard deviations). However, there was a significant positive correlation between digit ratio and impulsivity scores and between digit ratio and PAI Borderline scores, such that increases in digit ratios (e.g. more female typical) were correlated with increases in both impulsivity and borderline scores. Pearson product-moment correlation coefficients were also computed to assess the relationship between measures showing significant sex differences (i.e., age, TriPM scores, anxiety scores, and antisocial scores). Age was not significantly correlated with any of the study measures. TriPM scores were positively correlated with impulsivity scores, PAI Borderline scores, and PAI Antisocial scores. PAI Anxiety scores were positively correlated with impulsivity scores, subjective sleep scores, PAI Depression scores, and PAI Borderline scores. Finally, PAI Antisocial scores were positively correlated with impulsivity scores, TriPM scores as noted above, PAI Depression scores, and PAI Borderline scores.

Regressions

Preliminary analyses were conducted to assess whether gender, age, digit ratios, BIS-11 scores, PSQI scores, and TriPM scores significantly predicted our variables of interest (Percent Sleep and Sleep Time variables) by conducting a simultaneous multiple regression for each dependent variable. Of particular interest was whether there was a unique contribution of the psychopathy measure score (TriPM) or impulsivity score (BIS-11) after gender, postnatal testosterone (digit ratio), subjective sleep score (PSQI), and age of the participant were included in the model. The overall regression used to predict percent sleep scores was not significant (F (6, 395) = 0.90, p>.05, R^2 = .013) (see Table 3 in Appendix A for a summary ofSS, *df*, MS, *F*-statistic, and associated *p*-values). Furthermore, no main effects emerged from the model (see Table 4in Appendix A for a summary of B values, Beta coefficients, *SE*, *T*-values, and *p*-values).

Preliminary analyses were also conducted to assess the variables of interest using sleep time in minutes as the independent variable. The overall regression was not significant (F (6, 395) = 1.40, p>.05, R^2 = .02) (see Table 5 in Appendix A for a summary of statistical details). However, of the predictors investigated, BIS-11 scores were a significant predictor of sleep time (in minutes) (β = -.134, t(395) = -2.00, p< .05). That is, after controlling for age, gender, digit ratio, PSQI scores, and TriPM scores, BIS scores accounted for 1% of the variance in percent sleep, such that a one-point increase in BIS scores resulted in a 1.55 predicted decrease in sleep time. Table 6 in Appendix A summarizes the associated B values, Beta coefficients, standard errors, t-values, and p-values.

To examine the potential confound of mood, a hierarchical regression was included in analyses with two steps in the model. The first model included anxiety, depression, borderline and antisocial PAI scales as predictors of percent sleep. The second model included age, sex, digit ratios, impulsivity scores, subjective sleep scores, and psychopathy scores as predictors of percent sleep. Model one of the regression was significant (F (4, 98) = 2.96, p<.05, R^2 = .11) (see Table 7 in Appendix A for a summary of statistical details). Of the predictors investigated, depression was a significant predictor of percent sleep (β = -.43, t(98) = -3.15, p< .01) (see Table 8in Appendix A for a summary of statistical details), and anxiety was trending toward significance (β = .24, t(98) = 1.78, p = .08). That is, after controlling for anxiety, borderline, and antisocial traits, a one-point increase in depression level resulted in a .12 decrease in percent sleep or sleep efficiency. Depression levels accounted for nine percent of the variance in percent sleep. Model two of the hierarchical regression was trending toward significance (F (10, 92) = 1.68, p = .096, R^2 = .16). However, none of the additional predictors were significant. In fact, even after entering anxiety (β = .29, t(92) = 1.78, p = .052) it was still trending toward significance in model 2, and depression (β = -.39, t(92) = -2.61, p<05) was a significant predictor of percent sleep in model 2. That is, after controlling for anxiety, borderline, antisocial, age, gender, digit ratio, BIS score, PSQI score, and TriPM score, a one-point increase in depression resulted in a .11 predicted decrease in percent sleep. Depression levels still accounted for six percent of the variance in percent sleep. In addition, the PAI Depression subscales (i.e., cognitive, affective, and physiological) were examined to ensure that the physiological component was not the sole predictor of percent sleep, due to its inclusion of questions concerning sleep and activity levels. A simultaneous multiple regression was conducted with all three depression subscales in the model. The overall regression was significant (F (3, 98) = 4.81, p<.01, R^2 = .13). Of the predictors investigated, the affective subscale was a significant predictor of percent sleep (β = -.44, t (98) = -3.07, p< .00), however of the other predictors entered in the model both the cognitive and physiological subscales were not significant predictors of percent sleep.

Furthermore, the variables of interest were categorized as dichotomous and dummy coded to interpret high and low scores of individuals in the sample. To analyze those with high levels of sleep a multiple regression was conducted in which included those with the cutoff of higher than 80 percent of sleep as good quality sleep, and those lower with poor sleep efficiency and quality (Lauderdale et al. 2006). To analyze those with psychopathy scores in the top five percent of the sample (Salekin, Trobst, & Krioukova, 2001) they were dummy coded as high and low based on the cut score of 84 points on the total TriPM. To analyze high and low impulsivity scores a cut score of 74 was used to categorize highly impulsive and less impulsive individuals (Stanford, et al., 2009). In community samples a cut score of 60T is generally acceptable for those with psychopathology on the antisocial, borderline, anxiety, and depression scales of the PAI (Kurtz, Morey, & Tomarken, 1993; Salekin et al. 2001; Diamond, & Magaletta, 2006; Jacobo al. 2007, DeShong, & Kurtz, 2013).

To examine whether individuals reporting high levels of psychopathic and impulsive traits on the questionnaires had lower sleep efficiency as measured by actigraphy, a logistic regression was conducted with the dependent variable as discrete (i.e., 1, 2) rather than continuous. Results showed that high or low psychopathy scores (Wald = .04, β = .21, p = .85, e^{β} = 1.23) and high or low impulsivity scores (Wald = .27, β = -.34, p = .60, e^{β} = .71) were not significant predictors of percent sleep. Furthermore, high or low sleep efficiency scores were not significant predictors of higher impulsivity (Wald = .52, β = -.02, p = .47, e^{β} = .99) or higher psychopathy scores (Wald = .05, β = .00, p = .83, e^{β} = 1.00). Other analyses to examine the effects of cut scores included yielded similar, non-significant results. However, when digit ratio, TriPM scores, and percent sleep scores were entered as predictors of high and low impulsivity TriPM scores were a significant predictor (Wald = 16.53, β = .04, p = .00, e^{β} = 1.05) (see Table 9 in Appendix A for a summary of the Exponentiations of *β,* B coefficients, standard errors, Wald, and *p*-values). That is, after controlling for digit ratio and percent sleep, a one-point increase in psychopathy score participants were 1.05 times more likely to be higher on impulsivity.

Sex Differences: Regressions

The analyses reported above showed no significant influences of gender, and showed no significant effects in regression models ran in addition to the above reported models. Given the sex differences above with the variables of mood, PAI scales were included in the following analyses. As suggested by previous researchers (Constantinescu & Hines, 2012) to assess whether gender influenced the previous models to a greater extent than previously predicted and as suggested by the significant gender differences in variables of interest, a simultaneous multiple regression with the variables of interest was conducted separately for men and women. Results for model 1 of the first regression indicated that subjective sleep score, digit ratio, age, impulsivity score, psychopathy score, PAI antisocial score, PAI anxiety score, PAI depression score, and PAI borderline scores were not significant predictors of percent sleep for men, F (9, 32) = ,p> .05, R^2= .28 (see Table 10 in Appendix A for a summary of statistical details). Furthermore, no main effects emerged from the model (see Table 11in Appendix A for a summary of statistical details).

Results for model 1 of the second regression indicated that of the predictors entered, the model was not a significant predictor of percent sleep for women, F (9, 51) = 1.01, p>.05, R^2= .15 (see Table 10 in Appendix A for a summary of statistical details). However,of the predictors investigated, PAI depression T-scores were a significant predictor of percent sleep for women (β = -.45, t (51) = -2.09, p<05), but not for men (β = -.22, t (32) = -.87, p>00) (see

Table 11in Appendix A for a summary of statistical details). That is, after controlling for subjective sleep score, digit ratio, age, impulsivity score, psychopathy score, PAI antisocial score, PAI anxiety score, and PAI borderline score, a one-point increase in depression level resulted in a .10 point predicted decrease in percent sleep for women. PAI depression score accounted for 7 percent of the variance in percent sleep or sleep efficiency for women.

4. CONCLUSION

The aim of the current study was to examine whether individuals with high levels of psychopathy and impulsivity would have more interrupted sleep schedules. We also sought to examine whether individuals with high levels of psychopathy and impulsivity would report lower sleep efficiency and satisfaction. Objective measures of sleep included actigraphy, a watch-like device that was worn by a large number (n = 402) of young women and men for seven days to record daily activity levels and is sensitive enough to provide detailed sleep efficiency output (Tryon, 2004). Self-report measures included the BIS-11 a measure of impulsivity; the TriPM a measure of psychopathy; and the PSQI a measure of sleep satisfaction. In addition, a putative measure of prenatal androgen action, digit ratios, was included to examine possible biological influences on these behaviors (Lutchmaya et al. 2004). Contrary to our main hypotheses, no effects emerged for individuals scoring higher on impulsivity or psychopathy. In addition, subjective sleep quality was not significantly lower in those scoring high on impulsive and psychopathic measures.

For a smaller number of participants (n = 103) the PAI measures of mood (depression, and anxiety) and additional personality variables (borderline, and antisocial personality) were included to examine the association between mood and sleep variables. In general, compared to men, women reported lower levels of impulsivity, psychopathy, and antisocial behavior. In addition, compared to men, women reported higher levels of anxiety and depression. These findings are consistent with well-established differences in both personality traits and sex differences in the prevalence of internalizing and externalizing disorders. Specifically, women often experience higher prevalence of internalizing disorders such as anxiety and depression than men, and men often experience higher prevalence of externalizing disorders such as antisocial personality disorder and ADHD (Kessler et al. 2005). A similar pattern of sex difference in subclinical levels of related traits supports a dimensional view of psychopathology.

Research on both internalizing and externalizing behaviors and personality traits has found that women experience internalizing disorders at a higher rate than men, particularly depression. For example, in research on prevalence ratio, approximately 30 percent in women versus approximately 26 percent of men in their samples experience depression, whereas, approximately 15 percent of women experience alcohol abuse (an externalizing behavior) versus 40 percent of men (Kendler, & Meyers, 2013). Researchers have found that these sex differences begin in childhood and become more pronounced in early adulthood (Hicks et al. 2007). It may be that the large gender differences seen in the current study of college aged women and men also reflect the greater expression of externalizing disorders in early adulthood. Furthermore, the expression of internalizing and externalizing disorders is different for men and women (Leadbeater et al. 1999), such that the expressions of a given disorder are different between sexes. These differences occur because interpersonal vulnerability is higher among women than men, and gender-roles are such that it may be more acceptable for men to act aggressively or for women to act depressed. In addition, the established sex differences in internalizing and externalizing behaviors has suggested a role for the sexual differentiation of the brain. For example, psychopathy and externalizing disorders may be associated with higher levels of testosterone or less serotonin in men compared to women (Cale, &Lilienfeld, 2002). However, the absence of strong associations between digit ratios and these traits in the present study suggest other factors better explain the sex differences in psychopathy and externalizing disorders, at least in this age group.

Consistent with previous research (Stanford et al. 2009), there were no sex differences in impulsivity. Furthermore, no significant sex differences in sleep were found, although there was a tendency for women to experience lower sleep efficiency as measured by percentage of time in bed spent sleeping; however, sleep time in minutes was higher for women than for men. Prior research has found mixed findings for sex difference in sleep efficiency. Previous research has found differences in sleep patterns amongst men and women, such that women spend more time in bed but report less sleep satisfaction (Thomas et al. 2013). Furthermore, previous studies have found that as people age they also spend more time in bed (Thomas et al. 2013). The current findings support prior evidence that in general, women show greater sleep time, poorer sleep quality, and greater negative affectivity compared to men (Mong et al. 2011). Goldsmith and Casola (2006) also support these findings, and additionally report that anxiety and depression have a significant impact on sleep and various sleep disorders. Findings from the current study indicated that higher levels of depression, even in the subclinical range, result in lower levels of sleep efficiency, especially for women. Similarly, the higher levels of anxiety predicted in lower levels of sleep efficiency even when controlling for gender and other variables of interest. These results suggest that sleep is highly sensitive to mood states and so these findings from the current study add to our understanding of psychopathology and sleep.

The current study replicates previous findings that impulsivity and psychopathy are strongly related (Wilson, Frick, & Clements, 1999). As predicted, these variables were significantly related and add to our understanding of externalizing disorders in sleep behaviors and sleep efficiency. Furthermore, findings suggest that overall, higher impulsivity levels result in decreased sleep time in minutes. Although not found in the current study, previous studies have demonstrated that those with less sleep efficiency, more sleep disturbances, and higher levels of antisocial traits also express aggression and impulsivity (Semiz et al. 2008). It may be that the low prevalence rate of externalizing disorders such as antisocial personality disorder and psychopathy in community samples and college samples such as the one used in the present research are responsible for our negative findings.

Although not measured in the current study, somatization symptoms have been hypothesized to influence negative affectivity that is experienced in those scoring high on antisocial personality measures (Wilson et al. 1999). Previous studies have included different measures such as sleep journals, measures of somatization symptoms, other measures of negative affectivity, semi-structured interviews, polysomnography, and fMRIs (Crawley & Martin, 2006; Semiz et al. 2008, Lindberg et al. 2003). It may be that the actiwatch method of measuring sleep was not as sensitive to sleep efficiency as previous studies have used biological measurements that were not accessible in the current study. In addition, these differences in sleep efficiency may be less apparent in young adults or require different measurement techniques within this population. Future research could include measures of somatization along with negative affectivity to improve the understanding of those with antisocial and psychopathic traits and to better understand the relationship between these traits and negative affectivity.

Furthermore, although the current study replicated sex differences in disorder relevant behavior, the results of the regression analyses did not support the proposed relationship between sleep efficiency and impulsivity or between sleep and psychopathy. Prior studies had shown a relationship between impulsivity and sleep, such that as impulsivity increases subjective sleep quality and sleep efficiency decreases (Boonstra et al. 2007; Ireland & Culpin, 2006; Lindberg et al. 2003; Tworoger et al. 2005; and others). Previous studies have shown that the variables of interest, subjective sleep satisfaction and sleep efficiency, are affected by both gender and high levels of antisocial traits (Lindberg et al. 2003). Although the current study did not replicate these findings, this may be due to the high number of participants that had high sleep efficiency included in the sample. Furthermore, consistent with previous research on externalizing disorders such as psychopathy (Rogers &Rogstad, 2010), the community sample of participants did not tend to score in the clinical range on several scales in the current study.

More recent studies concerning sleep and reactive aggression, which is related to impulsivity, suggest that poor sleep schedules and poor sleep efficiency may be causal factors in the development of violence and impulsivity (Kamphuiset al. 2012). Furthermore, they report that forensic populations may be at heightened risk for developing emotional dysregulation due to sleep disturbances. In addition, recent studies concerning externalizing disorders such as borderline personality disorder have found that these individuals experience an altered non-REM and altered REM sleep (Fleischer et al. 2012). Studies concerning sleep and externalizing behaviors have recently examined the extent to which these diurnal preferences and sleep quality are genetically influenced (Barclay et al. 2011). They found that poor sleep quality is associated with externalizing behavior, and that there is a moderate genetic influence as seen in twin studies. Finally, more recent studies concerning male-typical sleep patterns in studies examining children with autism spectrum disorders have found that alterations in sleep maintenance and initiation results in altered learning, memory, and behavior (Kotagal, & Broomall, 2012). These findings support the suggestions made previously concerning the bidirectional relationship with sleep and externalizing disorders, but also provides implications for improvement of poor sleep efficiency to improve the previously described deficits.

Limitations of the current study include the overrepresentation of Caucasian students in the sample (over 40 percent). Limitations also include having a restrictive age of our population, due to the college sample. The current study was also greatly limited in the small number of scores obtained in the clinical range on the measures used in the study. Finally, the sample had high, normal levels of sleep, and a larger sample of young adults with poorer sleep outcomes may be more informative. Given the large sample size and the objective measures of sleep, sex differences in sleep appear small in young adults, and increase in later life.

The current study may have also been limited by the reliance on self-report measures. Participants completed several self-report measures during phase one and phase two of the current study, however, it may be beneficial for future studies to include observational data or other-report to validate levels of impulsivity and psychopathy. Furthermore, the current study is limited by the use of full scale scores, rather than the subscale scores often reported in studies. Often the subscale scores are reported in studies concerning psychopathy and sleep, including the TriPM, PAI scales, and BIS-11 (Kurtz, Morey, &Tomarken,

1993; Patrick et al. 2009; Stanford et al. 2009). For the purposes of the current study we were interested in overall expression of externalizing disorders, however, future studies could include specific subscales to examine the effects of individual subscale characteristics on sleep efficiency. Finally, the current study was limited by lack of inclusion of additional measures of mood variables. Future studies may include other negative affectivity measures to control for the effects seen in the current study. In addition, other demographic information such as socioeconomic measures were not included and may provide more detailed information regarding sleep efficiency and sleep hygiene. In addition, due to the genetic basis of several of the disorders investigated in the current study and especially antisocial behaviors, future studies may benefit from including relatives such as parents or siblings in the study design.

Future studies should include young adult populations, as there has been a great deal of research in the areas of children and older adults with psychopathology. Future research should also include more focus on other affective implications due to the large effect mood had on sleep efficiency in the current study. Furthermore, future research should focus on populations with participants with poorer sleep efficiency; as noted previously examining young adults with poorer sleep outcomes may be informative.

Examining the possibility that sleep impacts the variables of interest would be informative in future studies due to the potential bidirectional relationship between these variables. Furthermore, it may be useful to include multiple measurements of impulsivity and other variables. For example, measuring impulsivity during the initial visit and upon return to the second visit may demonstrate more accurate impulsivity scores. In addition, it may be that lower sleep efficiency is a result of psychopathy score or impulsivity scores; however, it may be that higher levels of impulsivity or psychopathy are a result of persevering low levels of sleep efficiency. Results showed that taken together, percent sleep, sleep time in minutes, subjective sleep score, digit ratios, and impulsivity predicted psychopathy scores well, but were not significant predictors. In addition, higher impulsivity was related to higher psychopathy scores in the current study, and it may be that this bidirectional relationship applies to the variables of interest listed previously. Furthermore, previous researchers have suggested that sleep disturbances may increase aggressive and antisocial behaviors, not the other way around (Semiz et al. 2008). This is an interesting finding due to the fact that researchers may overlook this bidirectional relationship and as such may suggest the wrong interpretations of causal relationships. Based on our study design we cannot state that sleep did not alter their level of impulsivity or whether it is a character trait, so future studies could include measures to examine these influences on individuals with externalizing behaviors such as impulsivity. Furthermore, future studies could include several testing sessions rather than two to examine whether changes in sleep influenced changes in mood, behavior, and externalizing disorder expressions.

Clearly, further research is needed in the area of psychopathy and sleep. There are limited studies that have been conducted concerning this relationship, and as such making causal statements as noted previously is difficult. Future research is needed in order to understand the direction of causality and may result in several therapeutic implications. Future research should examine the effects of sleep deprived individuals scoring high on impulsivity and externalizing behaviors as compared to controls. Studies that have previously used sleep deprivation within their designs have shown inhibited responses, faster incorrect responses, and respond with more reactivity toward negativestimuli (Anderson,&Platten, 2011). Thus, it is recommended that future studies also include re-testing individuals during the study to examine changes in both trait and state characteristics.

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APPENDIX A

Table 1. Descriptive Statistics for Variables of Interest by Gender

Variables	Male *M* (SD)	Female *M* (SD)	Effect Sex (*d*)
Age	18.74 (1.21)	18.49 (.76)	0.25*
<u>Self-Report Measures</u>			
PSQI	5.09 (2.25)	5.56 (2.78)	-0.19
BIS-11	62.10 (9.38)	60.52 (10.86)	0.16
TriPM	67.04 (13.41)	52.56 (12.33)	1.12***
PAI-ANX (T)	51.33 (8.46)	56.21 (11.67)	-0.48*
PAI-DEP (T)	51.74 (9.38)	53.62 (12.12)	-0.17
PAI-BOR (T)	56.69 (10.20)	56.30 (10.98)	0.04
PAI-ANT (T)	59.17 (10.33)	53.36 (10.06)	0.56**
<u>Objective Measures</u>			
Digit Ratio (mm)	0.963 (.034)	0.968 (.032)	-0.15
Percent Sleep	89.97 (6.21)	89.20 (10.86)	0.03
Sleep Time (min)	482.54 (157.87)	502.05 (136.63)	-0.13

Note. N = 402 (PAI *N* = 103). **p*<.05 (two-tailed), ***p*<.01 (two-tailed), ****p*<.00 (two-tailed)

Table 2. Overall Means, Standard Deviations, and Correlations for Predictors and Dependent Variables

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Age											
2. Sleep Time (min)	-.05										
3. Percent Sleep	-.05	.22**									
4. Digit Ratio	.07	.03	-.07								
5. BIS Score	-.04	-.08	-.07	.10*							
6. PSQI Score	.07	-.04	.01	.02	.17**						
7. TriPM Score	.02	.00	-.04	-.01	.35**	.05					
8. PAI Anxiety	.02	-.07	-.02	.07	.22*	.22*	-.08				
9. PAI Depression	.08	-.01	-.27**	.14	.28**	.36**	.10	.64**			
10. PAI Borderline	.00	-.04	-.10	.20*	.44**	.14	.26**	.64**	.65**		
11. PAI Antisocial	-.06	-.07	-.00	.16	.43**	.01	.69**	.15	.20*	.49**	
Mean	18.59	493.85	90.23	.966	61.19	5.36	58.65	54.22	52.85	56.46	55.73
Standard Deviation	.98	146.06	5.67	.033	10.28	2.58	14.64	10.71	11.07	10.62	10.52

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). Variables 1-8 (N = 402), and variables 8-11 (N = 103) Means and Standards Deviations were derived from non-standardized variables. Means and standard deviations for unstandardized values.

Table 3. ANOVA Summary Table for Overall Model Predicting Percent Sleep With Six Predictors (TriPM Score, Age, Digit Ratio, PSQI Score, BIS-11 Score, and Sex)

Source	SS	*df*	MS	*F*	*p*
Regression	173.09	6	28.85	0.90	.496
Residual	12693.65	395	32.14		
Total	12866.74	401			

Note. The above table shows sum of squares, degrees of freedom, mean square, F statistic, and p values for all predictors used in the analysis. As indicated by the values above, the set of predictors used in this model was not significant in predicting percent sleep: Significant at the $p<0.05$ level.

Table 4. Summary Table of Coefficients for Predicting Percent Sleep

Predictor	B	B	Std Err	t-value	p-value
Intercept		108.01	9.81	11.01	.00
Age	-0.49	-0.28	0.29	-0.96	.34
Sex	0.03	0.36	0.67	0.53	.60
Digit Ratio	-0.07	-11.53	8.68	-1.33	.19
BIS 11 Score	-0.07	-0.04	0.03	-1.20	.23
PSQI Score	0.02	0.04	0.11	0.38	.71
TriPM Score	0.00	0.00	0.02	0.01	.99

Note. The above table shows the B coefficients, standard errors, t-values, and p values for all predictors used in the analysis. As indicated by the values above, none of the variables were significant predictors of percent sleep: Significant at the $p<0.05$ level.

Table 5. ANOVA Summary Table for Overall Model Predicting Sleep Time in Minutes with Six Predictors (TriPM Score, Age, Digit Ratio, PSQI Score, BIS-11 Score, and Sex)

Source	SS	*df*	MS	*F*	*p*
Regression	178102.71	6	29683.79	1.40	.21
Residual	8376999.59	395	21207.59		
Total	8555102.30	401			

Note. The above table shows sum of squares, degrees of freedom, mean square, F statistic, and p values for all predictors used in the analysis. As indicated by the values above, the set of predictors used in this model were not significant in predicting Sleep Time in minutes: Significant at the $p<0.05$ level.

Table 6. Summary Table of Coefficients for Predicting Sleep Time in Minutes

Predictor	β	B	Std Err	t-value	p-value
Intercept		458.96	252.08	1.82	.07
Age	-0.05	-7.04	7.55	-0.93	.35
Sex	0.10	28.51	17.31	1.65	.10
Digit Ratio	0.04	178.13	222.88	0.80	.43
BIS 11 Score	-0.11	-1.55	.78	-2.00	.047
PSQI Score	-0.03	-1.89	2.89	-0.65	.51
TriPM Score	0.09	0.91	0.61	1.49	.14

Note. The above table shows the B coefficients, standard errors, t-values, and p values for all predictors used in the analysis. As indicated by the values above, higher BIS-11 scores were a significant predictor of sleep time (in minutes): Significant at the $p<0.05$ level.

Table 7. ANOVA Summary Table for Overall Model Predicting Percent Sleep With Hierarchical Regression (Model 1: PAI Scales; Model 2: Age, Sex, Digit Ratio, PSQI Score, TriPM Score, and BIS-11 Score)

	Source	SS	*df*	MS	*F*	*p*
Step 1	Regression	101.85	4	25.46	2.96	.02
	Residual	841.95	98	8.599		
	Total	943.80	102			
Step 2	Regression	145.98	10	14.60	1.68	.10
	Residual	797.81	92	8.67		
	Total	943.80	102			

Note. The above table shows sum of squares, degrees of freedom, mean square, F statistic, and p values for all predictors used in the analysis. As indicated by the values above, the set of predictors used in this model were not significant in predicting percent sleep: Significant at the $p<0.05$ level.

Table 8. Hierarchical Summary Table of Coefficients for Predicting Percent Sleep

	Predictor	β	B	Std Err	t-value	p-value
Step 1	Intercept		94.60	2.04	46.30	.00
	PAI ANX	0.24	0.07	0.04	1.78	.08
	PAI DEP	-0.43	-0.12	0.04	-3.15	.00
	PAI BOR	0.00	0.00	0.05	0.01	.99
	PAI ANT	0.05	0.01	0.03	0.41	.68
Step 2	Intercept		112.36	11.52	9.76	.00
	PAI ANX	0.29	0.08	0.04	1.97	.05
	PAI DEP	-0.39	-0.11	0.04	-2.61	.01
	PAI BOR	-0.01	-0.00	0.05	-0.03	.97
	PAI ANT	-0.02	-0.01	0.05	-0.12	.90
	Age	-0.11	-0.35	0.32	-1.07	.29
	Sex	-0.14	-0.85	0.74	-1.14	.26
	Digit Ratio	-0.11	-10.53	9.98	-1.05	.29
	BIS 11 Score	0.01	0.00	0.03	0.06	.96
	PSQI Score	-0.06	-0.01	0.13	-0.51	.61
	TriPM Score	0.04	0.01	0.03	0.23	.82

Note. The above table shows the B coefficients, standard errors, t-values, and p values for all predictors used in the analysis. As indicated by the values above, higher depression t-scores in model 1 was a significant predictor of percent sleep, and both anxiety t-scores and depression t-scores were significant predictors of percent sleep in model 2: Significant at the $p<0.05$ level.

Table 9. Summary Table of Coefficients for Predicting High Vs. Low Impulsivity Levels *(BIS-11)*

Predictor	e^{β}	β	Std Err	Wald	p-value
Intercept	0.00	-12.19	5.77	4.46	.04
Digit Ratio	10467.04	9.26	16.53	3.32	.07
TriPM Score	1.05	0.04	0.49	16.53	.00
Percent Sleep	0.98	-0.02	4.46	0.49	.48

Note. The above table shows the B coefficients, standard errors, Wald-values, and p values for all predictors used in the logistic regression analysis. As indicated by the values above, higher psychopathy scores were a significant predictor of impulsivity scores: Significant at the $p<0.05$ level.

Table 10. ANOVA Summary Table for Regression Model Split By Gender for Predicting Percent Sleep With Nine Predictors (PSQI Score, Digit Ratio, BIS-11 Score, Age, TriPM Score, PAI Anxiety Score, PAI Depression Score, PAI Borderline Score, and PAI Antisocial Score)

	Source	SS	*df*	MS	*F*	*p*
Step 1	Regression	135.96	9	15.11	1.35	.25
	Residual	358.64	32	11.21		
	Total	494.60	41			
Step 2	Regression	65.62	9	7.29	1.01	.44
	Residual	367.69	51	7.21		
	Total	433.31	60			

Note. The above table shows sum of squares, degrees of freedom, mean square, F statistic, and p values for all predictors used in the analysis. As indicated by the values above, the set of predictors used in this model were not significant in predicting percent sleep: Significant at the $p<0.05$ level.

Table 11. Model Summary Table of Coefficients for Predicting Percent Sleep by Gender

		Predictor	β	B	Std Err	t-value	p-value
Male	Model 1	Intercept		117.71	18.51	6.36	.00
		PSQI Score	-0.36	-0.73	0.41	-1.77	.09
		Digit Ratio	-0.15	-15.55	16.40	-0.95	.35
		BIS Score	0.00	0.00	0.06	0.03	.98
		Age	-0.13	-0.40	0.54	-0.74	.46
		TriPM Score	-0.10	-0.02	0.07	-0.35	.73
		PAI ANX	0.13	0.05	0.09	0.59	.56
		PAI DEP	-0.22	-0.08	0.09	-0.87	.39
		PAI BOR	0.04	0.01	0.08	0.15	.88
		PAI ANT	0.20	0.07	0.09	0.72	.48
Female	Model 1	Intercept		114.48	15.30	7.48	.00
		PSQI Score	0.11	0.10	0.14	0.77	.45
		Digit Ratio	-0.18	-16.94	13.18	-1.29	.21
		BIS Score	0.03	0.01	0.03	0.20	.84
		Age	-0.05	-0.19	0.46	-0.41	.69
		TriPM Score	-0.01	-0.00	0.04	-0.05	.96
		PAI ANX	0.13	0.03	0.05	0.54	.59
		PAI DEP	-0.45	-0.10	0.05	-2.09	.04
		PAI BOR	0.32	0.08	0.07	1.13	.26
		PAI ANT	-0.26	-0.07	0.06	-1.23	.22

Note. The above table shows the B coefficients, standard errors, t-values, and p values for all predictors used in the analysis. As indicated by the values above, men in model 1 did not show significant predictors in the model, and in model 1 higher depression t-score was a significant predictor of percent sleep for women only: Significant at the $p<0.05$ level.