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THE ROLE OF EMOTION REGULATION IN SLEEP AND SUICIDE

A PRELIMINARY ANALYSIS

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ABSTRACT

Although the relationship between sleep problems and suicide has been well established, there has been little investigation as to why this association exists. Emotion regulation has been suggested as a possible mediator in this association (Littlewood et al., 2017), but it has not been formally tested. The current work sought to determine whether depleted emotion regulation capacity mediates the association between poor sleep continuity and suicidal ideation. A sample of 29 undergraduate participants (22 female, 7 male) wore a Camntech MotionWatch 8 to objectively assess sleep fragmentation over three nights. Emotion regulation capacity was determined using resting respiratory sinus arrhythmia (RSA), and self-report measures of belongingness and unlovability were collected to determine desire to die. Bootstrapping techniques were used to determine whether resting RSA mediates the association between sleep fragmentation and unlovability and belongingness. Results indicated that there was no evidence to support any association between sleep fragmentation, resting RSA, and unlovability or belongingness. It is unclear whether these non-significant findings are due to lack of power or to a non-existent effect. Using the results of this preliminary analysis to improve the confidence in future findings, we recommend increasing the sample size by oversampling clinical populations, extending the time recording sleep fragmentation from 3 to 14 nights, and establishing adequate temporal precedence for mediational analysis.

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The Role of Emotion Regulation in Sleep and Suicide: A Preliminary Analysis

With over 40,000 Americans dying by suicide each year, suicide has become a significant public health concern (CDC, 2016). Despite the numerous risk and protective factors for suicide established in the literature (see Bernert et al., 2017), there is a lack of understanding as to exactly how these factors contribute to increased risk of suicidal thoughts and behaviors. One particular important, but understudied, risk factor for suicide and psychopathology is sleep disturbance (Littlewood et al., 2017; Zuromski et al., 2017; Chu et al., 2016). Considering that 35% of American adults do not sleep the recommended 7-8 hours per 24 hours (CDC, 2011), poor sleep is a very prevalent risk factor for suicidal thoughts and behaviors. However, despite the prevalence of inadequate sleep, we do not understand which specific sleep problems contribute to the risk process, nor *how* these sleep problems increase suicide risk. This understanding may help clinicians properly recognize risk conferred by problems of sleep continuity, as well as develop a more theory-driven focus of sleep related suicide risk.

While a lack of theoretical perspective has limited this research, the Interpersonal-Psychological Theory of Suicide (IPTS) can provide a basis for understanding sleep-suicide. According to this theory, an individual must possess both the desire to die and the capacity to kill themselves in order to engage in suicidal behavior (VanOrden et al., 2010). The desire to die results from feelings of perceived burdensomeness (e.g., others would be better off without me; I am expendable) and thwarted belongingness (e.g., I don't fit in anywhere). When a person is hopeless about these states, active suicidal ideation can occur. In order for active suicidal ideation to progress to suicidal behaviors, the capability to kill oneself must be acquired. This capability is acquired through habituation and opponent processes, resulting in lowered fear of

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death and increased pain tolerance. These three factors (perceived burdensomeness, thwarted belongingness, and acquired capacity for suicide) are identified as principle causes of suicide. Sleep problems, mental health problems, and other risks contribute to suicide by influencing these factors. In fact, poor sleep has been shown to disrupt interpersonal processes, including conflict resolution and conflict prevention, likely contributing to feelings of loneliness and lack of reciprocal care (Gordon & Chen, 2014). Similarly, low quality sleep has been shown to have a bi-directional relationship with loneliness, with rumination mediating this relationship (Zawadzki et al., 2013). In investigations directly testing the relationship between sleep problems and the IPTS, insomnia has been found to be associated with perceived burdensomeness and thwarted belongingness, with thwarted belongingness mediating the relationship between insomnia and suicidal ideation (Nardoff et al., 2014; Chu et al., 2016). However, insomnia and other sleep problems were not significantly related to the acquired capacity for suicide (Nardoff et al., 2014). A lack of association between sleep problems and acquired capacity is consistent with findings indicating that insomnia, reduced sleep efficiency, and sleep onset latency are associated with reduced pain tolerance (Siverston et al., 2015). This implies that sleep problems alone may not be sufficient to cause the development of suicidal behaviors, but they contribute to suicidal ideation and the desire to die.

While sleep is a reliable predictor of suicide, this relationship is complicated for a variety of reasons. Sleep problems commonly co-occur with psychological conditions known to confer risk for suicide, including major depression, generalized anxiety disorder, borderline personality disorder, and post-traumatic stress disorder (Baglioni et al., 2011). One explanation for this is that there are many overlapping features between sleep problems and mental health problems. For example, insomnia and major depression share many diagnostic criteria in common: trouble

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sleeping, negative mood changes, and negative cognitive changes. However, despite the co-occurrence of sleep problems and major depression, a meta-analysis reveals that insomnia remains an independent predictor of suicide when depression is statistically controlled (Pidgeon, Pinquart, & Conner, 2012). However, it appears that only certain sleep problems are uniquely related to suicide. For example, when depression was included as a covariate in the relationship between sleep disturbances and desire to die, the relationship persisted, but when it was included as a covariate in the relationship between nightmares and desire to die, the relationship disappeared. These findings suggest that specific sleep problems have different effects on suicide risk. There are many sleep problems that may be relevant to suicide, including sleep onset latency, sleep duration, sleep quality, sleep continuity, and nightmares. A lack of specificity to which sleep problem is being investigated makes the relationship between sleep and suicide more difficult to determine. Additionally, while the most common measures used to determine sleep problems are self-report measures, technological advances have allowed objective measures, such as actigraphy and polysomnography, to become more available. The use of these measures, which may be more sensitive, provide another level of complexity to the study of this relationship. In summary, not only is the study of sleep-suicide limited by a lack of theoretical perspectives, but also by the overlap in characteristics of comorbid mental health problems, by the diversity of sleep problems themselves, and the means to measure them.

While there has been little formal investigation of possible mechanisms behind the sleep-suicide association, there have been proposed explanations of this relationship. McCall and Black (2013) propose a number of possible explanations as to how insomnia increases risk of suicide. For example, to explain how sleep serves as a proximal risk to suicide, they describe the entanglement of circadian processes of sleep and mood. Additionally, they propose that

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hyperarousal and impairment of serotonin functioning brought on by sleep problems have implications on suicide risk. In terms of psychological mechanisms, dysfunctional beliefs about sleep and deficient problem solving were proposed as possible mediators. While these factors can possibly explain why sleep problems increase risk of suicide, emotion regulation functioning may better explain this relationship. Indeed, a recent systematic review of the sleep-suicide literature indicates that problematic emotion regulation strategies may potentially account for the relationship between sleep problems and suicide (Littlewood et al., 2017).

Emotion regulation as a potential mechanism

Despite its theoretical support, emotion regulation has received little formal investigation in sleep-suicide literature. Emotion regulation refers to the automatic or controlled process of initiating, inhibiting, or modulating emotional experience, expression, and physiological reactions (Gross, 1998). The goal of emotion regulation is to respond in a context-appropriate fashion and to achieve optimal engagement in the environment (Gruber & Cassoff, 2014). When this process is disrupted, maladaptive patterns of thinking and behavior develop, such as social isolation or the inability to accomplish tasks. Indeed, disruption of emotion regulation is often regarded as a diathesis of mental health problems, especially mood disorders. Conversely, adaptive emotion regulation can be a source of resilience against developing such problems (Tugade & Fredrickson, 2004).

Emotion regulation is intimately tied to our physiology and its ability to respond flexibly to a changing internal and external environment. Typically, efforts to change physiological reactions to emotions occur after the emotion is generated through the process of response modulation (Gross, 1998). The ability for the heart to respond flexibly to differing emotional

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demands, such as transitioning from an increased heart rate during arousal to a lower rate when relaxed, is indicative of response-focused emotion regulation efforts. This flexibility is reflected in parasympathetic processes, specifically vagal tone. Respiratory sinus arrhythmia (RSA) refers to the variation in heart rate due to respiration, a pattern that reflects the parasympathetic nervous system input to the heart via the vagus nerve. Resting levels of heart rate variability (HRV), an index of vagal tone, has become an important objective measure of the capacity for emotion regulation, reflecting the ability for the autonomic nervous system to respond flexibly to environmental and physiological demands (Appelhans & Luecken, 2006). Higher levels of HRV reflect higher levels of parasympathetic or vagal tone, and are associated with greater capacity for self-regulation. Decreased high frequency HRV has been identified as a marker of transdiagnostic vulnerability to psychopathology, reflecting not only a deficit in adaptive responding, but also impaired self-regulatory and executive functioning (Beuchaine, 2015). Indeed, low resting HRV, like disrupted emotion regulation, has been identified as a risk for generalized anxiety disorder (Thayer, Friedman, & Borkovec, 1996), major depression (Rechlin, Weis, Spitzer, & Kaschka, 1994), and bipolar disorder (Cohen et al., 2003). However, while low HRV is indicative of risk of psychopathology, high HRV is associated with resiliency towards these problems. High resting HRV is positively associated with self-reported emotion regulation and constructive coping skills (Fabes & Eisenberg, 1997). Altogether, HRV is a reliable and relatively non-invasive marker for emotion regulation capacity.

To our knowledge, no research has been conducted to examine the role of HRV in the link between sleep and risk for suicide. This is despite HRV being able to provide converging evidence regarding which sleep problems affect emotion regulation. Specific sleep problems seem to have a negative impact on emotion regulation capacities. Problems of sleep continuity,

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or problems maintaining a sleep episode, seem to be particularly disruptive to emotion regulation. When determined experimentally, forced awakenings had more negative impact on next day positive affect than reduced sleep duration (Finan, Quartana, & Smith, 2015). Sleep disruptions and poor sleep continuity reflect an inability to restore the process of emotion regulation during deep sleep. This is supported by evidence indicating that when individuals are unable to achieve deep, rapid eye movement (REM) sleep, they were more emotionally reactive than those who experienced awakenings but achieved REM sleep (Rosales-Legarde et al., 2012). Results from HRV analysis support these findings; sleep disturbance was the only subscale of the Pittsburgh Sleep Quality Index that was associated with decreased HRV (Hovland et al., 2013).

Similarly, disrupted emotion regulation and maladaptive emotion regulation strategies are related to the development of suicidal ideation and suicide-related behaviors. Anestis and colleagues (2011) found that lowered distress tolerance was associated with increased perceived burdensomeness and thwarted belongingness, and increased negative urgency was found to be associated with acquired capability for suicide. Additionally, emotion regulation difficulties have been shown to be associated with suicide-related behaviors, particularly deliberate self-harm (DSH). Specifically, Gratz and Roemer (2008) found that lack of access to emotion regulation strategies and lack of emotional clarity distinguish those with frequent DSH from those without frequent DSH. While DSH is defined as intentional self-harm without suicidal intent (Chapman et al, 2004), poor emotion regulation has also been related to suicide attempts in military service members (Bryan, Rudd, & Wertenberger, 2013). Results from HRV analysis support this link between problems of emotion regulation and suicidal behavior; suicide attempt history is associated with decreased high frequency HRV during stressful situations (Wilson et al., 2016).

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Taken together, we can see that inadequate sleep continuity and emotion regulation are risks for suicidal ideation. With the prevalence of inadequate sleep in America, and the relationship between sleep problems and suicidal ideation, understanding the mechanism behind this relationship is an issue of public health and safety. However, because of a lack of theoretical perspectives explaining this relationship, as well as the diversity of sleep problems, this relationship has not yet been deeply explored. While previous work has identified possible mechanisms of sleep-suicide, these mechanisms have yet to be tested. Additionally, previous work neglects to include emotion regulation as a possible mechanism, despite robust theoretical support of its relationship to both sleep and suicide.

Therefore, the present study seeks to investigate the mechanism behind sleep discontinuity and suicide risk. While there is a robust literature to support the relationship between sleep, emotion regulation, and suicide ideation, there has not been a formal investigation to assess this. To achieve this, we will objectively assess sleep continuity over three days and later record HRV at rest, and determine suicidal ideation through belongingness and unlovability. In the present study we will examine whether (1) sleep continuity is related to belongingness and unlovability and (2) whether emotional regulation capacity, as reflected in resting HRV, mediates this relationship.

Method

Participants

29 undergraduate psychology students ($n=22$ female, mean age = 21, age range = 18-29) provided informed consent to participate in the investigation. Participants were recruited from a participant pool for course credit. Prior to informed consent, participants were screened in a

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phone interview to determine eligibility. Only participants between the ages of 18 and 45 were asked to participate. Participants were excluded from the study if any of the following conditions were met: the use of beta-blockers, major tranquilizers, or tricyclics; presence of existing heart condition or asthma; diagnosis of schizophrenia spectrum or other psychotic disorders; or developmental disability. The first two exclusion criteria were used to remove possible confounds from the electrocardiography (ECG) data.

Materials

Actigraphy. Sleep continuity was determined by the sleep fragmentation index provided by the Camntech MotionWatch 8 (MW8). The MW8 is a light-weight, three-axis, waterproof wrist worn accelerometer. The MW8 provides a reliable and valid measure of sleep fragmentation, as well as other sleep dimensions (Landry, Bestm & Liu-Ambrose, 2015; Elbaz et al., 2012). A single sleep fragmentation score was obtained by averaging the sleep fragmentation index over three nights.

Respiratory Sinus Arrhythmia (RSA). Levels of parasympathetically-based capacity for emotion regulation were measured as resting levels of RSA, specifically high frequency heart rate variability. RSA data were obtained using a MindWare technologies 2000 D Impedance Cardiograph with spot electrodes placed in the tetra polar configuration (Thayer et al., 2008). Artifacts and abnormal heartbeats in the ECG data were visually inspected and corrected. HRV Analysis Software, Version 3.1.0 (MindWare Technologies, Gahanna, OH) was used to determine RSA from the ECG data. RSA values can range from 0 to 10, with higher values reflecting a higher emotion regulation capacity (Appelhans & Luecken, 2006). ECG data were collected while the participant was sitting at rest. Resting RSA was determined over continuous

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recording for ten -minutes. However, for the sake of stability of the data, only the last five minutes of ECG data were used for analysis.

The Suicide Cognition Scale (SCS; Rudd et al., in press) Unlovability Subscale. The unlovability subscale of the SCS consists of 12-items from the 18-item scale. Using the SCS, participants are asked to endorse their beliefs on their current situation using a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), with higher scores reflecting increased feelings of unlovability. Unlovability refers to the belief that one is worthless or fundamentally flawed (e.g., I am unworthy of love), accompanying feelings of burdensomeness (e.g., No one can help solve my problems). Indeed, the unlovability subscale has been found to be significantly related to the perceived burdensomeness subscale of the interpersonal needs questionnaire (Bryan et al., 2014). Additionally, the unlovability subscale of the SCS has been found to explain suicidal thoughts and behaviors, as well as predict future suicide attempts. Coding of the unlovability subscale was done in accordance with the two-factor model proposed by Elis and Rufino (2014). Internal reliability for this sample was good for the unlovability subscale at $\alpha = .89$.

The Interpersonal Support Evaluation List (ISEL; Cohen & Hoberman, 1983) Belongingness Subscale. The ISEL belongingness subscale consists of 4 items of the 12-item scale. Items on the ISEL ask whether a statement is true about a participant, and is measured using a 4-point Likert scale, ranging from 1 (definitely false) to 4 (definitely true), with higher scores reflecting increased feelings of belongingness. The belongingness subscale measures one's perception as to whether they feel like they are part of a group that they can identify and socialize (Brookings & Bolton, 1988). The ISEL belongingness subscale is also closely related to

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the construct of thwarted belongingness, and was used to develop a measure of this construct (VanOrden et al, 2012). Internal reliability for this sample was good the belongingness subscale at $\alpha = .84$.

Procedure

Following informed consent, participants were given a wrist actigraph to be continuously worn for the next four days and three nights. On the fourth day, participants returned to complete questionnaires, including the ISEL and SCS. Questionnaires were administered using Qualtrics online survey software. Later, participants had their heart rate continuously recorded while viewing a series of nature pictures for ten minutes. This was used to determine resting RSA.

Data Analytic Strategy

To examine whether emotion regulation capacity, operationalized as RSA when a person is at rest, mediates the association between sleep fragmentation and belongingness and unlovability, simple mediation analyses using non-parametric bootstrapping was conducted (Preacher & Hayes, 2008) via PROCESS to examine indirect effects. Bias-corrected 95% confidence intervals were generated to test the significance of the indirect effect of sleep fragmentation on unlovability and belongingness through resting RSA. If the confidence interval includes 0, then the indirect effects fail to reach significance. Measures of unlovability and belongingness were centered before all regression analyses.

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These analyses will serve as preliminary analyses of the association between sleep fragmentation, RSA, belongingness and unlovability. This investigation lacked the power to determine any associations between these variables, and any associations that are discovered are likely spurious. However, this analysis will be carried out in order to structure future analyses using more complete data. As such, results from this investigation are merely illustrative of the method of analysis and reporting of results. Interpretations of this data should be done with extreme caution.

Results

Correlational analyses were conducted to determine the association between sleep fragmentation, resting RSA, and unlovability and belongingness. Consistent with our estimates of power, none of these correlations were significant ($p > .05$). However, it is unclear whether these non-significant findings are due to a lack of statistical power or because there is truly no association between sleep fragmentation, resting RSA, and unlovability and belongingness. As such, these results should be interpreted with caution. Nonetheless, these bivariate correlations, along with descriptive statistics, are presented in Table 1.

Typically, when correlational analyses yield no significant results, mediational analyses ought not to be conducted. However, for the goals of practicing conducting, reporting, and interpreting these analyses, they were completed anyway.

Results for analysis of the model in which we examined if resting RSA mediates the relationship between sleep fragmentation and unlovability can be found in Figure 1. As seen in Figure 1, there were no significant association between sleep fragmentation, resting RSA, or

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unlovability. Similarly, analysis of the indirect effect of sleep fragmentation on unlovability was insignificant (*point estimate* = -.013, 95% *BCI* = -.18, .04).

Results for the mediation of sleep fragmentation and belongingness by resting RSA are presented in Figure 2. As was the case for unlovability, there were no significant associations between sleep fragmentation, resting RSA, or belongingness. Analysis of the indirect effect was insignificant (*point estimate* = -.003, 95% *BCI* = -.06, .01). Taken together, both mediational models show that there is no evidence to support the mediation of resting RSA in the association between sleep fragmentation and unlovability or belongingness.

Discussion

The purpose of this study was to determine the mechanism explaining the association between disrupted sleep and suicidal ideation. Emotion regulation, having good theoretical support was identified as a possible mediator in this relationship. Thus, aim of this investigation was to determine whether emotion regulation mediated the association between disrupted sleep and suicidal ideation. Emotion regulation capacity, determined via resting RSA, was measured in each participant, as well as sleep fragmentation using sleep actigraphy. Suicidal ideation was operationalized in terms of the constructs composing desire to die in the IPTS. Thwarted belongingness was determined using the ISEL belongingness subscale, and perceived burdensomeness was determined using the unlovability subscale of the SCS.

We were unable to detect any evidence that there is an association between sleep fragmentation, resting RSA, and unlovability or belongingness. These results are inconsistent with previous investigations establishing the association between sleep discontinuity, emotion regulation, and suicidal ideation (Nadorff et al., 2014; Hovland et al., 2013; Rajappa et al.,

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2011). One possible explanation for the inconsistent findings is that the present study had considerable methodological limitations, which likely hindered our ability to adequately examine the hypotheses. For instance, due to our small sample size, we had low statistical power to detect the hypothesized effects, which introduces the possibility of Type II error. Furthermore, our dataset was quite homogenous, such that all participants were recruited from an undergraduate subject pool, which may make it more difficult to detect an effect. Hence, sampling individuals from a clinical population (e.g., inpatient mental health) in addition to those from higher functioning populations, would allow us to better characterize the full range of sleep disturbances, emotion regulation, and suicidal ideation. The outcome of power analysis suggests that for a medium effect size at significance level of .05, including 25 additional participants from a community sample would provide adequate power to detect the indirect effect of sleep fragmentation on unlovability and belongingness via emotion regulation capacity. It is also noteworthy that this investigation focused only on specific components of the IPTS, namely desire to die via thwarted belongingness and perceived burdensomeness. Rather than assessing sleep fragmentation and emotion regulation in the context of the entire interpersonal-psychological theory, only the component related to the development of suicidal ideation was assessed.

An additional explanation as to why the results bore no significant findings was our choice of measures for the constructs of interest. Specifically, our use of sleep actigraphy to assess sleep fragmentation may explain why there were no significant associations between sleep fragmentation, emotion regulation, and suicidal ideation. Prior investigations assessing these relationships relied on self-report measures to determine sleep characteristics (Nardoff et al., 2014; Hovland et al., 2013). Similarly, while resting RSA has become a common measure of

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emotion regulation capacity, much of the research done on the association between emotion regulation, sleep (Palmer & Alfano, 2017), and suicide (Bryan et al., 2013; Brown et al., 2002) relies on self-report measures. Using these unconventional measures may explain why we were unable to detect an effect that is established in the literature.

The above notwithstanding, exploring the extent that sleep fragmentation, resting RSA, and suicidal ideation relate to one another has important implications. If there is no association between sleep fragmentation, resting RSA, and suicidal ideation, then this exploration would reevaluate the theoretical basis of this hypothesis. If there is an association that this investigation could not determine, then this exploration would help develop future directions to better test this association. Using past research as an example, it is reasonable to believe that an increase in sleep fragmentation leads to an increase in suicidal ideation, which can be explained by decreased emotional regulation capacity. Investigation of the association between sleep fragmentation and resting RSA may suggest that fragmented sleep disrupts the restoration emotional regulation processes. Consequently, with lower capability to regulate emotions, maladaptive patterns of thinking may emerge, including suicidal thoughts.

In addition to the glaring methodological concerns discussed above, there are other limitations worth considering. For example, this research design violates the temporal precedence assumed in causal mediation. Although sleep fragmentation was assessed over three days previous to the collection, RSA data and psychometric data were obtained concurrently. When assessing mediation cross sectionally, results can be biased and misleading, and cannot be used to imply causality (Maxwell & Cole, 2007). More specifically, in a half-longitudinal design, as is used in this investigation, partial mediation can be assessed, but we cannot test whether the

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mediator fully mediates the association (Cole & Maxwell, 2003). Another change to the time scale of data collection that would yield more insightful data would be to change sleep actigraphy collection period from 3 nights to 14 nights. Van Someren (2007) suggests that when using actigraphy to objectively determine sleep characteristics, a 14 night recording period not only increases reliability in measurement but also can determine week-to-week variability often found in people with insomnia.

The choice of the IPTS as a theoretical framework for understanding suicidal thoughts and behaviors has strengths but also weaknesses. The strengths of the IPTS lies in its ability to predict suicidal ideation and behaviors based on its component constructs, thwarted belongingness, perceived burdensomeness, and acquired capability for suicide. Core to the IPTS is its explanation of the transition between suicidal ideation, suicidal behavior, and lethal suicide attempt using these three constructs (VanOrden, 2010). However, by focusing on these factors the IPTS neglects the direct influence of other established risk factors, such as sleep problems. Rather than these other risk factors directly influencing suicidal thoughts and behaviors, the IPTS claims that the effect of these risk factors on suicide are fully mediated by the three constructs of the IPTS. Thus, investigating suicidal ideation in the context of the IPTS limits the scope of this research to the specific constructs of IPTS, which may explain the non-significant findings of the present study.

An alternative theoretical framework to examine the sleep-suicide association is the Fluid Vulnerability Theory (FVT). FVT states that risk for suicidal thoughts and behaviors is dynamic and changes over time as a function of acute and stable risk factors. Factors that influence risk of suicide are categorized into broad domains of cognitive, affective, physiological, and behavioral

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functioning (Rudd, 2006). These domains, which make up the “suicidal mode”, are mutually influential, and are thought to be the means through which acute and stable risk factors interact to contribute to the transition from suicidal ideation to suicidal behavior. That is, when all four domains of the suicidal mode are activated (i.e., heightened), an acute suicidal episode is thought to occur. The ease of transition into an acute suicidal episode is related to an individual’s baseline risk, an amalgamation of stable risk factors such as persistent mental health problems and past suicide attempts. Following a period of acute risk, which is inherently time limited, an individual returns to baseline risk. The strength of the FVT relative to the IPTS is its ability to predict suicide risk within individuals across time, as well as stable, between-person differences in risk. However, attempts to integrate the IPTS and FVT provide the most predictive power. Wolfe-Clark and Bryan (2017) suggest that the IPTS is useful in determining *who* is at higher risk for suicide whereas the FVT is useful in determining *when* a person is at heightened risk for suicide, and by integrating these theories we may better describe suicidal thoughts and behaviors. Using this integrated perspective is especially useful in understanding the sleep-suicide association; the IPTS offers specific and easily testable factors, which describe how a person develops suicidal thoughts and behaviors, and the FVT can explain when these thoughts and behaviors may peak.

While there were many limitations, this investigation also had strengths. While we characterized the use of under-utilized measures to determine sleep fragmentation and suicide as a potential explanation for why an effect wasn’t determined, using such methods permits us to investigate whether the findings in the literature are consistent across valid methodologies. Much of the sleep-suicide literature is dependent on self-report to characterize sleep problems. In order to investigate these findings using less common measures, we used sleep actigraphy and resting

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RSA as objective, valid measures to assess sleep fragmentation and emotion regulation capacity, respectively.

This preliminary investigation provides opportunities to improve the methodology to better examine the association between sleep fragmentation, emotion regulation, and suicidal ideation. As noted previously, increasing the sample size and recruiting from clinical populations will increase power to detect associations between these variables should they exist. We also noted that measuring RSA apart from the psychometric data would strengthen the causality of the mediational model (Maxwell & Cole, 2007; Cole & Maxwell, 2003). Additionally, by expanding the period assessing sleep fragmentation from 3 days to 14 days allows for more reliable measure of sleep, as well as allowing for determining effects of week-to-week variability (Van Someren, 2007). Another important direction that this research ought to explore is the temporal dynamics of sleep problems in the suicide risk process, consistent with the FVT. Such investigations would require assessing suicidality and sleep at multiple points longitudinally. Each of these recommendations moves us closer to understanding the full scope of the sleep-suicide association.

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Appendix A

Table 1.

Descriptive Statistics and Bivariate Correlations

	M	SD	Sleep Fragmentation	Resting RSA	Unlovability	Belongingness
Sleep Fragmentation	24.07	10.40	-	.074	-.228	.043
Resting RSA	6.77	1.18	.074	-	-.326	-.110
Unlovability	16.55	5.36	-.228	-.326	-	-.230
Belongingness	12.31	3.27	.043	-.110	-.230	-

Note. None of these correlations were significant at $p = .05$.

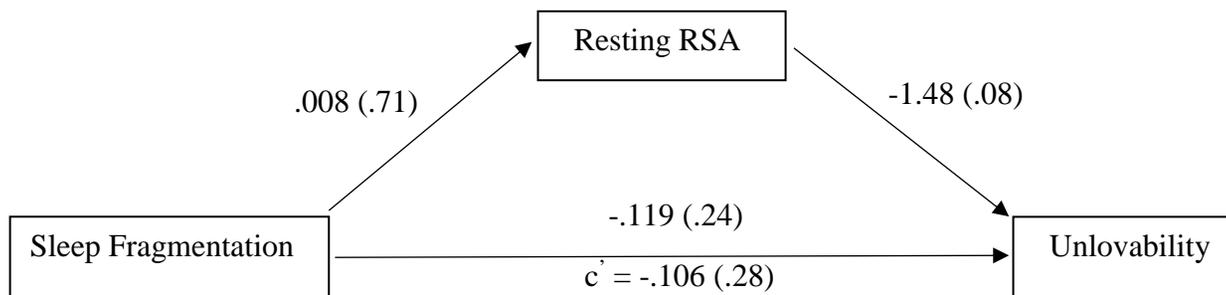


Figure 1. *Regression coefficients for relationship between sleep fragmentation and unlovability as mediated by resting RSA. Levels of significance for each regression coefficient are included in parentheses beside the coefficients.*

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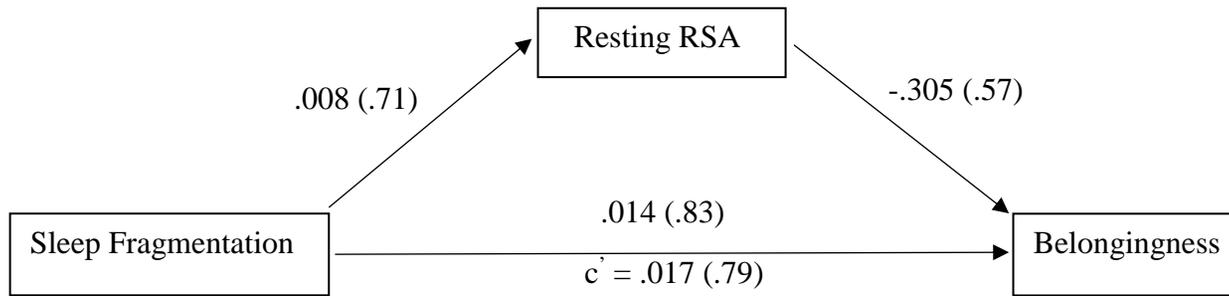


Figure 2. Regression coefficients for relationship between sleep fragmentation and belongingness as mediated by resting RSA. Levels of significance for each regression coefficient are included in parentheses beside the coefficients.