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Predicting suicide-related cognitions: Examining the relationships between sleep, emotion regulation, affect, and executive functioning

by

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A dissertation

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Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the dissertation of STEPHANIE MCMANIMEN find it satisfactory and recommend that it be accepted.

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RE: Study Number IRB-FY2022-79 : Predicting suicide-related cognitions

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Thank you for your responses to a previous review of the study listed above. These responses are eligible for expedited review under OHRP (DHHS) and FDA guidelines. This is to confirm that I have approved your application.

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

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Sincerely,

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Dissertation Abstract--Idaho State University (2023)

Suicide is a leading cause of death in the United States, but efforts to determine mechanisms through which suicide ideation develops have demonstrated inconsistent results. Problems with sleep have been linked to a higher risk of suicide beyond the effects of depression. Deficits in executive function have also been demonstrated by individuals with suicide ideation or attempt histories, as well as poor sleep. However, research findings have been mixed, which may be partly a result of a limited understanding of the effects of affective control on suicide ideation. This inconsistency, paired with a high fatality rate for first suicide attempts, has led to a call for research exploring the development of suicide ideation and its related cognitions to improve prevention efforts. The current study examined the prospective relationship between sleep and suicide-related cognitions (SRCs) through emotion regulation strategies as moderated by executive functioning performances. Additionally, sad affect was induced to explore the impact of affective control on cognitive test performance. Data were collected through Amazon's Mechanical Turk at baseline and one month later at follow-up. Participants were screened to eliminate those failing attention checks or completing the study multiple times from the same location. Structural equation modeling analyses showed that adaptive emotion regulation strategies significantly mediated the relationship between poor sleep and increased SRCs. The *b* path was moderated by complex attention shifting. Although sad affect was successfully induced, it did not impact executive function task performance. Clinical implications and directions for future research exploring these complex relationships, identifying those at increased risk for SRCs, and clarifying potential treatment avenues were discussed.

Keywords: affect, emotion regulation, executive function, sleep, suicide

Chapter I: Introduction

Current state of suicidology

Over the past several decades, suicide rates within in the United States have continued to rise with an estimated 40,000 deaths per year and an approximated 25 attempts for each death (Maris, 2002; Murphy, Xu, & Kochanek, 2013). Although depression and prior attempts are well-known risk factors for suicide, 60% of those who attempt suicide die on the first attempt, underscoring the need for research identifying individuals most at-risk prior to the onset of suicide thoughts and behaviors (STBs; Bostwick et al., 2016).

Although the rates of suicide have generally increased over decades, this low base-rate event is difficult to study and there is a need to adjust conceptualizations of suicide prevention research. As noted by Franklin et al (2017) in their meta-analysis, predicting suicide is complex and difficult. With prior attempts and psychiatric hospitalization as the most accurate individual predictors of future death by suicide, Jobes and Joiner (2019) called for an increased focus on suicide ideation (i.e., thoughts of killing oneself, which may or may not include planning or intent), the third most potent predictor and the tip of the metaphorical "suicide iceberg." They argued that ideation should be included in more research and as an intervention target, particularly as an attempt cannot occur in the absence of ideation, no matter how impulsive the attempt may be, and that far greater amounts of people experience suicide ideation. Indeed, over 10 million adults have thoughts of suicide in the United States alone each year (Substance Abuse and Mental Health Service Administration, 2018). Therefore, targeting suicide ideation and its related cognitions (e.g., hopelessness) would allow for a better understanding of STBs, what factors may contribute to the development of these cognitions, and what mechanisms may play a role in shifting from ideation to action. Furthermore, since more than half of those that die by suicide do so on their first attempt (Bostwick et al., 2016), clarifying pathways to STBs allows for potential treatment for those that would not have otherwise been identified due to no attempt history at the time of death. Thus, the focus of this study was on prospective relationships to suicide-related cognitions (SRCs).

One approach in identifying these potential mechanisms is exploring common factors across the various empirically-supported theories of suicide. One model of psychopathology, the diathesis-stress model, purports that some people have a distal biological or psychological vulnerability to developing psychological disorders, or SRCs in this case, and a more proximal, stressful event takes place and further increases the risk (Mann et al., 1999). In Joiner's Interpersonal Theory of Suicide (ITPS; Joiner, 2005), a combination of thwarted belongingness and perceived burdensomeness contribute to the development of thoughts about death, which escalate to active suicide ideation when the individual is hopeless about a change in their life circumstances. Klonsky and May (2015) proposed the Three-Step Theory of suicide (3ST) in which the first step, the presence of psychological or emotional pain and hopelessness about the future, results in the development of ideation. In the second step, ideation severity depends on if the emotional pain is greater than their perceived social connectedness. The final step, which predicts attempts, is dependent upon the person's willingness to self-injure. Similarly, the Integrated Motivational-Volitional Model of suicide (IMV; O'Connor, 2011) implicates a sense of defeat and inescapability in the development of STBs along with motivational moderators such as maladaptive coping, ruminative cognitive processes, problem solving, and perceived social support. Each of these theories suggests a cognitive inflexibility in response to emotional distress underlies the pathway to suicide ideation. Indeed, Everaert and colleagues (2021) found that a negative interpretation inflexibility (i.e., a bias against revising inaccurate, negative interpretations despite evidence against them) predicted later suicide ideation, which was mediated by one of the cognitions in Joiner's theory – perceived burdensomeness.

However, it is important to consider various transdiagnostic factors in determining suicide risk. Although research has found significant associations with specific events (e.g., traumatic stress, depression), not every person who experiences a challenging event will consider suicide (Bazrafshan et al., 2014). Thus, examining combinations of distal and proximal risk factors will aid in further understanding the ideation to action mechanisms, which has increased in urgency over the past several years due to the COVID-19 pandemic. Although overall suicide rates within the United States declined marginally during 2020, several groups demonstrated increased rates, particularly among racial minorities (Ahmad & Anderson, 2021; Bray et al., 2020). Additionally, anxiety surrounding the global pandemic was associated with an increase in insomnia symptoms and suicide ideation (Kilgore et al., 2020). Therefore, particular attention should be directed toward further understanding the link between sleep problems as a distal risk factor for suicide as nearly 40% of the global population experienced problems with sleep since the beginning of the pandemic (Jahrami et al., 2021).

Problems sleeping: A distal risk factor for suicide

The current study investigated the relationship between sleep and suicide-related cognitions (SRCs) by focusing on insomnia (i.e., problems falling asleep or staying asleep) and nightmares (i.e., terrifying dreams often pertaining to threats of safety or security). There is substantial empirical evidence indicating a link between dysfunctional or problematic sleep and suicide risk (Bernert et al., 2015; Kodaka et al., 2014). Furthermore, it remains a significant predictor even after controlling for depression (Bernert & Nadorff, 2015; Wong, Brower, &

Craun, 2016), indicating sleep problems are unique contributors to STBs and a transdiagnostic risk factor to be further studied.

Problems with sleep are a widespread health concern. A community-based study in the United States determined that over one-third of adult respondents were not receiving sufficient sleep each night (Liu et al., 2016) and approximately 5% experience nightmares at least once per week (Li et al., 2010). Although sleep is implicated in various disorders (e.g., Perlis et al., 2006), it is relevant to the current study as it has demonstrated significant predictive capabilities for STBs. In an examination of national, longitudinal adolescents and young adults, problems with sleep at baseline were associated with STBs one year and six years later (Wong & Brower, 2012). Similarly, Bernert and colleagues (2014) found a prospective relationship between poor subjective sleep quality and suicide death in older adults over a 10-year period, with a particularly high risk period occurring within the first two years of sleep disturbance onset. Additionally, even reliance on sleep medications to fall asleep has shown a tenfold increase in risk for suicide (Gunnell et al., 2013). Thus, more information is needed to understand the biological and psychological mechanisms that result in this increased risk for SRCs as pharmacological interventions do not appear beneficial with respect to suicide mortality.

In addition to the presence of sleep disturbances increasing suicide risk, the duration of these difficulties is also an important factor in estimating risk. Nadorff and colleagues (2013) found that a longer duration of nightmares and insomnia were associated with an increased risk for suicide, independent of depression and other psychopathologies. The authors suggested that these results were indicative of a sense of hopelessness that the problem could be resolved and an increased desire to escape the distress. This hypothesis points toward a potential cognitive process that may underlie this relationship, which is consistent with the commonalities of the previously described theories of suicide.

Cognition as the mechanism linking sleep and suicide

The mechanism by which sleep impacts suicide risk remains unclear. McCall and Black (2013) proposed an impaired disengagement framework in which cognitive control in the form of impaired decision making, problem solving, and basic executive functions interact with other psychological factors to increase the risk for suicide. As studies have demonstrated a link between cognitive function with both sleep (Gevers et al., 2015) and suicide (Richard-Devantoy et al., 2013), it is possible that problems sleeping increase the propensity to engage in SRCs through reduced executive functioning. This is consistent with neuroanatomical findings as it is known that sleep deprivation impairs the functional connectivity of the areas of the brain most associated with cognitive control and overall executive functioning (Gruber & Cassoff, 2014; Yoo et al., 2007; Minkel et al., 2012). With executive functioning impacting a broad range of functional outcomes, research into other outcomes, such as depression, can provide some insight into how sleep and executive function alter susceptibility to later endorsing suicide-related cognitions.

As an indicator for the likelihood of this association, in a study of young adults, Vanderlind et al. (2014) examined the relationship between sleep, executive function, and depression and results indicated that the link between problems sleeping and depression was mediated by deficits in attentional disengagement. Similarly, it is possible that the relationship between sleep and SRCs may also be explained indirectly through the effect on cognitive processes. Problems with sleep may lead to increases in SRCs by impairing performance on tasks such as shifting, inhibition, and flexibility. These deficits may lead to difficulties in effective problem solving for real-life stressors, including engaging in adaptive emotion regulation strategies, which may then lead to increased consideration of suicide as a solution. O'Leary, Bylsma, and Rottenberg (2017) demonstrated that maladaptive emotion regulation was a significant mediator in the cross-sectional and prospective relationships between poor sleep quality and depressive symptoms. This finding is of relevance because it suggests a similar pathway for developing SRCs due to the shared risk factors with depression. Therefore, a transdiagnostic approach to predicting SRCs should include sleep's impact on cognitive processes, both the functioning abilities (e.g., executive function) and the application of these abilities to manage distress (e.g., emotion regulation).

Executive function and its association with sleep and suicidality

Executive functioning (EF) is a set of higher-order functions that schedule lower-order functions to adapt to changing, complex, or ambiguous task demands (Botvinick et al., 2001). A key concept of EF is the ability to select context-specific actions in the face of competing or context-inappropriate actions (Pennington & Ozonoff, 1996) and inhibit prepotent, impulsive responses (Logan, Schachar, & Tannock, 1997). This latent construct is measured by unified yet diverse tasks of inhibition, information updating and monitoring, task switching, and cognitive flexibility (Miyake et al., 2000).

Studies have shown that insufficient sleep over long periods of time has a negative impact across facets of executive function (Khassawneh et al., 2018; Wilckens et al., 2014). Similarly, over short periods of time, a study examining sleep deprivation and cognition found that individuals who are sleep deprived have more intrusive, unwanted thoughts compared to controls (Harrington et al., 2021), suggesting difficulty with attentional control. Furthermore, the sleep deprived group also showed difficulties with suppressing these thoughts as measured by behavioral and psychophysiological indices of down-regulating negative affect, which was hypothesized to be an effect of disrupted prefrontal control that heightens the susceptibility to intrusive thoughts or memories. This would be consistent with the extant literature implicating poor sleep in impaired executive functioning and overall cognitive control (Walker, 2009; Drummond, Paulus, & Tapert, 2006; Nilsson et al., 2005).

Moreover, there is also evidence to suggest a global impairment across the various domains of executive functioning is present in those at a higher risk for STBs (i.e., previous attempts or current ideation) compared to clinical control groups (Bredemeier & Miller, 2015). For example, a meta-analysis found psychiatric patients with suicide attempt histories perform significantly worse compared to healthy controls and patients without attempt histories on the Stroop interference task (Richard-Devantoy, Berlim, & Jollant, 2014). Studies have also shown deficits in interference (Richard-Devantoy et al., 2015), selective attention (Keilp et al., 2013), and decision-making and cognitive control in the prefrontal cortex (Richard-Devantoy et al., 2013) in those at higher risk for suicide. Yet other studies have demonstrated conflicting results with better working memory or task switching in the STBs groups compared to controls (Bredemeier & Miller, 2015), while others show worse flexibility (Miranda et al., 2012, 2013) or working memory (Crandall, Allsop, & Hanson, 2018). Thus, there is a need for clarification on the circumstances under which executive function is related to suicide risk.

Executive functioning and emotional processes

In response to conflicting findings, Allen et al (2019) conducted a review of the extant literature on neurocognition and suicide risk in adults that indicated neurocognitive functioning and affective control interactions may be an underlying pathway to suicide through the various well-researched risk factors and may help to explain disparate findings. Indeed, research on the neuroanatomical factors involved in the development of STBs has shown a link between structures involved in affective processing and emotion generation (Jollant et al., 2011) and that individuals who have attempted suicide have heightened processing of emotionally negative stimuli (Jollant et al., 2008; Thompson & Ong, 2018). Furthermore, difficulties in redirecting attention away from negative emotional information appears to be a transdiagnostic characteristic (e.g., De Raedt & Koster, 2010; Marx et al., 2014), broadening the understanding of suicide risk across psychopathologies. These findings suggest a relationship between emotional processes and executive function.

However, limited research has focused on including emotional responses in consideration of the neuropsychological mechanisms underlying suicide risk. Some studies have found consistent results with increased impulsivity under emotional distress for those with STB histories (Anestis & Joiner, 2011; Hamza et al., 2015). Further research in this area is warranted based on the shared neurobiology between suicidality, EF, and emotion regulation. The extant body of literature has generally implicated the various regions of the prefrontal cortex in EF impairment and found significant differences in structure and function in the prefrontal cortex, limbic, and striatal areas of the brain (van Heeringen & Mann, 2014; van Heeringen et al., 2014; Raust et al., 2007). Similarly, successful emotion regulation involves the processing of affective information in the subcortical limbic regions combined with inhibition from regions in the prefrontal cortex (Comte et al., 2016). With such overlap, it is likely that the heightened processing of negative emotional stimuli impairs the ability to respond appropriately in tasks of executive function due to limited cognitive resources. Thus, a particular focus is needed on the structural relationship between the more distal factors that have known influences on these neural circuits (e.g., insomnia and sleep problems), the proximal factors including affective control (i.e., emotion regulation strategies), executive function, and SRCs (Allen et al., 2019).

Although not specific to the development of SRCs, there is some behavioral evidence that executive functioning task performance is impacted by negative affect. Ballaera and von Muhlenen (2017) examined similarities between depression and experimentally induced sadness on attentional networks. Their results showed that, compared to the depressed participants, the experimental group had a similar narrowing of their attentional spotlight, which resulted in less interference on a flanker test compared to controls. Although this allows them to better ignore distracting information, this narrowed attention may also be maladaptive when other deficits in executive function are present as it may hinder the ability to flexibly think of non-suicidal solutions to environmental stressors.

However, most research has been conducted on “cool” rather than “hot” EF, which may help explain why results are often contrasting (Allen et al., 2019). “Hot” EF occurs when the individual is experiencing heightened emotional arousal and incorporates affective control into neurocognitive testing performance. Therefore, if an individual shows difficulty in emotion regulation (i.e., affective control), which may result from utilizing maladaptive strategies or ineffective adaptive strategies, their ability to disengage from negative stimuli may be impaired. It is well-established that difficulties in emotion regulation is characteristic of suicide attempters (Neacsiu et al., 2018), but research is typically cross-sectional and naturalistic (Ward-Ciesielski et al., 2018). Grove and colleagues (2020) found that suicide cognitions were predictive of poor subjective sleep quality and prolonged affect recovery following a laboratory stress-induction. Although a novel approach, the study used suicide cognitions as the independent variable and more research is needed to identify how sleep, cognition, and emotion regulation interact to increase risk for engaging in STBs. Furthermore, research is particularly needed on EF and these emotional processes to further expand our understanding of the consequences of the previously discussed neuroanatomical overlap with limited cognitive resources.

Emotion regulation definition and theories

Emotion regulation is a process through which an individual appraises and modulates their emotional responses to stressors through the use of various strategies aimed at regulation to enable them to respond appropriately in a given situation (Rottenberg & Gross, 2003; Gratz & Roemer, 2004; Gross, 1998). In addition to effective strategies, maladaptive strategies may include suppression and rumination that appear to be beneficial in the short-term but are ineffective in regulating emotions over longer periods of time (Gross, 1998). As described by Thompson (2019) in a review, maladaptive or difficulties with emotion regulation have also been referred to as emotion dysregulation.

There have been various definitions and operationalizations of emotion regulation that have evolved over years of research. Gross (1998) described a process model in which emotions are regulated through a variety of processes: situation selection (i.e., choosing to enter the person-situation context), situation modification (i.e., changing the situation to alter the emotional impact), attentional deployment (i.e., shifting attention to different aspects of the context to modulate emotional impact), cognitive change (i.e., reframing to positive or neutral meanings), and response modulation (i.e., strategies used to lower physiological and emotional arousal after it is initiated). Gratz and Roemer (2004) proposed a different model to describe emotion regulation processes. In addition to Gross's focus on modulating emotional arousal, this difficulties in emotion regulation model takes into account an inability to effectively modulate emotions, acceptance of emotional experiences, and flexibility of strategies to achieve goals. Thus, their model included four domains: awareness, acceptance, impulse control, and flexibility.

Shortly after, and of particular importance to the suicidology field, Chapman and colleagues (2006) published the experiential avoidance model in which people may engage in a variety of maladaptive behaviors (e.g., self-harm) to avoid experiencing distressing and difficult emotions, which becomes self-reinforcing through classical conditioning. Selby and Joiner (2009) went further with this notion in their emotional cascade model in which these maladaptive behaviors serve as a distraction from distressing "emotional cascades." This model includes cognitive processes such that a negatively-interpreted event may initially cause some minor emotional distress. However, through rumination, that distress is revisited and exacerbated until behaviors like STBs distract the individual and break the cycle. This is similar to the original Gross (1998) model as it is a method of deploying attentional resources toward the event, but it also incorporates the Gratz and Roemer (2004) difficulties with modulating emotional experiences. In support of this model, Selby and colleagues (2013) demonstrated that fluctuations in negative emotions and rumination have a significant, positive association with non-suicidal self-injury, suggesting the behavior is aimed at reducing and distracting from the rumination of the situation eliciting the distress.

Hasking et al (2017) synthesized the common elements of these various models (e.g., environmental stimuli, emotional experience, and cognitive processes) along with self-efficacy and outcome expectations into the cognitive-emotional model. This model explicitly incorporates the anticipated consequences of the emotion regulation strategies (i.e., outcome expectations) as well as the belief in one's ability to successfully navigate a situation (i.e., self-efficacy). Applied to STBs, an individual with high emotional instability and a tendency toward negative reactivity and negative self-evaluations will hold the belief that engaging in self-harm will achieve the goal of emotion regulation. The person may then be more likely to engage in those behaviors when they feel a hopelessness to resist the urge and do not have the ability to use more adaptive emotion regulation strategies.

With regard to the current study, poor sleep also has a negative impact on emotion regulation capacity (Mauss, Troy, & LeBourgeois, 2013). Grove et al (2017) examined sleep quality in a sample of undergraduate students and found that sleep quality was predicted by borderline personality features and difficulties with emotion regulation. Although they suggested the difficulties with emotion regulation contributed to higher arousal at bedtime and subsequent poor sleep quality, the cross-sectional data did not allow for an examination of the bidirectional relationship between sleep and emotion regulation. However, experimental sleep deprivation has demonstrated a causal relationship with affect such that poor sleep or no sleep is associated with a significant increase in negative affect and decrease in positive affect the following day (Kahn-Green et al., 2007; Talbot et al., 2010). This may be a result of sleep's impact on the emotion processing areas of the brain as it impairs the individual's ability to effectively process emotional stimuli (Tucker et al., 2010; Yoo et al., 2007). Even subjective perceptions of poor sleep the night before have been associated with increased emotional reactivity to negative stimuli, further suggesting a cognitive-emotional mechanism underlying the sleep and suicide relationship (Williams et al., 2013).

Emotion regulation: Difficulties versus strategies

It is often unclear which strategies are problematic with respect to SRCs and sleep since studies often investigate difficulties with overall emotion regulation. In a transdiagnostic meta-analytic review of emotion regulation, Aldao and colleagues (2010) found that internalizing disorders were associated with strategies including rumination, avoidance, problem solving, suppression, reappraisal, and acceptance. However, inconsistencies in how emotion regulation is measured (e.g., assessing strategies compared to assessing difficulties with regulation) have contributed to difficulties in identifying potential underlying mechanisms of distress for particular clinical targets.

It has been hypothesized that poor emotion regulation is one mechanism through which suicide ideation transitions into attempts (Law et al., 2015), though problems with operationalization are found within emotion regulation and suicide research, complicating this hypothesis exploration. In a sample of psychiatric outpatients, Harris and colleagues (2018) failed to find a significant effect of emotion regulation on suicidal behavior as it was negated after accounting for posttraumatic stress disorder and borderline personality disorder diagnoses. However, these diagnoses and emotion regulation difficulties may be highly correlated with each other and therefore their independent effects on suicidal behavior could not be established. Indeed, maladaptive strategies have been implicated as an antecedent to suicide attempts in other studies, though more information is needed with regard to suicide ideation and SRCs (Schneidman, 1996; Wyman et al., 2009; Pisani et al., 2013). Difficulties with emotion regulation broadly, however, have been associated with ideation in clinical and non-clinical populations with particular difficulties in the number of strategies a person has to deal with emotions, nonacceptance of emotions, and impulse control (Bradley et al., 2011; Weinberg & Klonsky, 2009; Rajappa et al., 2012).

Using the Difficulties with Emotion Regulation Scale (DERS), Rajappa, Gallagher, and Miranda (2012) found that young adults who had a history of multiple suicide attempts differed significantly from those without STBs on their acceptance of emotional responses and perceptions of limited emotion regulation strategies. Additionally, the latter was found to predict suicide ideation endorsement through hopelessness after controlling for mood and anxiety disorders. This is consistent with Weinberg and Klonsky (2009) who found this domain to be the strongest predictor of ideation when using the DERS. However, this domain assesses a perceived lack of strategies rather than the types of strategies used. Similarly, Richard-Devantoy et al (2017) found that there is a greater risk for suicide when individuals have more difficulty regulating their emotions and lack adaptive coping skills, though limited longitudinal research has made it difficult to disentangle the temporal relationships.

Research has also shown a link between suicide and one's perception of difficulties with emotion regulation. Gratz, Spitzen, and Tull (2020) found an indirect relationship between the frequency of self-harming behaviors to suicide attempts through emotion regulation self-efficacy. Although the authors examined perceptions of self-efficacy rather than objective difficulties regulating emotions or use of specific strategies, this low perceived self-efficacy may contribute to hopelessness in successfully navigating stressful situations and may further reinforce the use of maladaptive strategies. There is a need for more research within suicidology that looks beyond the individual's reaction to the emotional experience (e.g., DERS) and instead identifies specific adaptive or maladaptive strategies that mitigate or increase likelihood of developing SRCs.

Drawing from the broader psychopathology research, Garnefski et al (2001) examined the relationship between cognitive emotion regulation strategies (CERS) and depression and anxiety and found that the adaptive CERS (e.g., refocusing, reappraisal) were negatively associated with depression and anxiety. However, the less adaptive, or maladaptive, CERS (e.g., rumination, blame) were positively related to depression and anxiety. Given the previously described relationships between affect and suicide, it is therefore likely that high use of the maladaptive CERS and low use of adaptive CERS would also be associated with a higher risk for suicide and an increase in suicide-related cognitions.

There is some evidence that different types of strategies impact STBs. McLafferty and colleagues (2020) identified the use of adaptive strategies, and the reduced use of suppression, in reducing STBs in the years after adverse childhood experiences. In another study using an undergraduate population, Ong and Thompson (2019) found that participants who engaged in avoidance strategies were more likely to endorse suicide behaviors, while those that engaged in cognitive reappraisals engaged in fewer suicide behaviors. However, as the authors noted, this study did not account for other known risk factors including affective disorders and cognitive problem-solving abilities.

In a study of neuropsychological systems and suicide ideation, Azadi and colleagues (2020) found that the behavioral inhibition system, which regulates responses to threatening environmental stimuli and is associated with levels of negative affect, was directly related to suicide ideation. However, findings also indicated that this relationship was partially mediated by the frequency of adaptive and non-adaptive CERSs such that high behavioral inhibition was related to an increased use of non-adaptive CERSs, which was then positively associated with suicide ideation. Conversely, high behavioral inhibition was significantly associated with decreased use of adaptive CERS, which did not show a relationship with suicide ideation. Therefore, the strategies an individual employs to help navigate negative emotional experiences may contribute to and increase the risk of STBs when the strategies are non-adaptive or maladaptive in the longer run (e.g., rumination, self-blame, catastrophizing). Yet, the research on specific strategies and how they relate to other distal and proximal suicide risk factors is more limited and inconsistent, possibly due to lack of consistent operationalization of strategies.

There remains a need for research clarifying the mechanism by which adaptive and maladaptive strategies differentially impact the likelihood of developing SRCs. Various studies have demonstrated a link between suicide attempts and more frequent use of maladaptive coping and less frequent adaptive coping to manage stressful situations (Wilson et al., 1995; Botsis et al., 1994). This is in contrast with Neacsiu and colleagues (2018) who failed to find a reduction in adaptive strategies and an increase in maladaptive strategies to regulate emotion in a study comparing healthy controls, participants with major depressive disorder and a history of suicide attempts, and participants with major depressive disorder without a suicide attempt history. Additionally, a study of adolescents found that those who used adaptive emotion regulation strategies were better able to identify and understand their emotions, which was negatively associated with suicide ideation (Quintana-Orts et al., 2020). However, they were not able to demonstrate a link with maladaptive strategies and suicide ideation. These inconsistencies are similar to those found within the suicide and EF literature and are indicative of a need for further research exploring the circumstances by which different strategies are implicated in higher SRC risk.

While there is some evidence of specific strategies affecting the various factors in the sleep and suicide relationship, no research to date has examined all of these variables together with a consideration toward the participant’s affective state as suggested by Allen et al (2019). Importantly, the intensity of affective experiences appears to be related to STBs as more intense affect is associated with engaging in maladaptive self-harming behaviors to regulate emotions more frequently (Osman et al., 1999) and it is also associated with increased ideation and hopelessness (Lynch et al., 2004). Considering cognitions, a clinical population of patients with borderline personality disorder, one that is characteristically high in STBs, showed higher emotional reactivity to an experimental mood induction and poorer performance on a social problem-solving task compared to undergraduate controls (Dixon-Gordon et al., 2011). This relationship may be a result of poor sleeping as a study on sleep deprivation found that participants who were sleep restricted reported greater emotional reactivity to negative images compared to controls, though no differences were found in reactivity to neutral or positive images (Reddy et al., 2017).

There is also research suggesting poor sleep and emotion regulation may contribute to longer affective experiences, which could increase the likelihood of developing SRCs. Grove and colleagues (2020) examined the relationship between sleep quality, negative affective reactivity to a laboratory stressor, and suicide-related cognitions. They found that the participants who endorsed the suicide cognitions showed higher reactivity to the Trier Social Stressor Task and poorer subjective sleep quality. Furthermore, these participants also showed a prolonged affect recovery period compared to those that did not endorse suicide cognitions, suggesting they are experiencing difficulties with regulating their emotions. However, it was unclear if this was the case given that emotion regulation strategies were not directly assessed in the study. In an earlier study, a sample of people with borderline personality disorder showed slower return to affective baseline following manipulation (Hazlett et al., 2012), so it is possible that the broader group of people who endorse SRCs may also show a prolonged return to baseline. Finally, a study of adults who have a history of suicide attempts found that depressed attempters had more difficulty returning to heart rate baseline following a laboratory stressor (Neacsiu et al., 2018). These longer, more intense reactions to emotional stimuli, in conjunction with cognitive inflexibility, may contribute to a sense of hopelessness or helplessness that one's situation might improve, thereby increasing the likelihood of experiencing further SRCs.

Potential relationship between EF and emotion regulation

Taken together, the findings showing more intense and prolonged reactivity may help to explain dissimilar findings regarding EF and suicide risk. If EF abilities interact with emotion regulation strategies, performance on tasks of EF and its significance to SRCs may be dependent upon the types of strategies employed when faced with emotionally-salient stimuli. For example, someone that frequently engages in adaptive strategies but has lower EF may be more susceptible to developing SRCs compared to someone also using adaptive strategies but with higher EF since they may have more cognitive resources to help manage negative emotional experiences and problem-solving situations. Similarly, someone with high EF who engages in maladaptive strategies may be less at risk than someone with low EF as they may be able to disengage from negative stimuli more effectively.

In line with this, a study by Korkmaz et al (2020) found that individuals who had a history of suicide attempts had more difficulties with problem solving compared to healthy controls. However, this relationship changed with the additional consideration of facets of "emotional intelligence" such that problem solving improved with higher levels of emotional awareness and identification. Their results suggested that an inability to adaptively navigate emotional experiences interacts with difficulties in problem solving stressful situations, which in turn may increase the likelihood of considering suicide as a solution to their problem. It is possible that this association results from individuals feeling overwhelmed by intense emotional experiences without a clear understanding of their ability to regulate emotions through various strategies, which pulls attentional resources toward emotional processes and away from basic executive functions involved in problem solving (Foran & O'Leary, 2013). Therefore, emotion regulation and the strategies that are used in this process may be integral in understanding the complex associations between various suicide risk factors and a potential avenue for mitigating this risk.

Research directly examining the executive function and emotion regulation relationship, however, is limited as they are often assessed as covariates rather than investigating potential interactions between them and how that impacts psychopathology. There is evidence of a significant link between poor performance on executive function tasks and increased ruminative thinking (Whitmer & Banich, 2007), so it is possible that a similar association exists with other maladaptive forms of emotion regulation in addition to rumination. Furthermore, this could also be impacted by poor sleep as the relationship between insomnia and increased rumination is mediated by poor attentional control (Cox et al., 2018). With poor sleep impacting an individual's ability to effectively and adaptively regulate emotions (Reddy et al., 2017), it is important to further examine the complex structural relationships between these factors to determine under which conditions these factors can increase suicide risk. However, since most research has focused on measuring the reaction to the emotion (e.g., DERS) rather than the reaction to the situation (e.g., CERQ), more research is needed to further understand if specific strategies are part of the cognitive mechanism underlying the relationship between problems sleeping and an increased risk for suicide.

Considering interactions between emotion regulation, executive function, and sleep, Cox et al (2019) examined the role of executive function and emotion regulation difficulties on rumination following insomnia symptoms. Using a self-report measure of executive function, the results showed that insomnia prospectively predicts executive dysfunction and difficulties with emotion regulation, which then predicted increased rumination. Importantly, their results indicated that effective emotion regulation relied on executive function abilities. Therefore, disruptions in executive function, possibly dependent upon affective interference, may then impair the ability to adaptively regulate emotions and could result in increased psychological distress. However, this study only examined difficulties with emotion regulation rather than the use of particular strategies. Therefore, it remains unclear if specific emotion regulation strategies (e.g., maladaptive or adaptive) are differentially impacted by poor sleep and executive function, though the Cox et al (2019) findings suggest that the impact of strategies used is moderated by executive function abilities. Research is needed to determine if there are differential effects of executive function performance on adaptive and maladaptive emotion regulation strategies.

Current study

The focus of the current study was to further understand the structural relationships between sleep, executive function, emotion regulation, and SRCs. To add to the extant literature, the study had two time points, one month apart, and included an affect manipulation during the second time point to further explore the role of "hot" cognitions and to serve as a proxy for how participants may react to and recover from emotionally-salient stimuli in daily life. A meta-analysis of internet-based affect induction procedures found that sadness and general negative affect, but not positive affect, could be effectively induced and that video methods frequently resulted in greater effect sizes (Ferrer, Grenen, & Taber, 2015). Therefore, participants viewed a video clip to induce sad affect. Due to gaps in the literature regarding emotion regulation and executive function on suicide risk, the current study also examined the structural relationships in four separate models across these two time points. Based on previously described literature, it was hypothesized that:

1. As shown in Figure 1, the relationship between problems sleeping at baseline and SRCs at follow-up would be mediated by higher baseline levels of maladaptive emotion regulation strategies (ERS) and lower levels of adaptive ERS.
2. Also shown in Figure 1, the relationships between the baseline ERS mediators and SRCs at follow-up would be moderated by baseline executive function.
3. As shown in Figure 2, the relationship between baseline problems sleeping and SRCs at follow-up will be mediated by affect following a mood induction procedure. This mediation would be moderated by executive function task performance following mood induction.
4. As shown in Figure 3, the relationship between baseline problems sleeping and SRCs at follow-up would be mediated by prolonged affect recovery (i.e., continued negative affect after completing EF tasks) following a mood induction procedure. This mediation would be moderated by executive function task performance following the mood induction.
5. As shown in Figure 4, the relationship between executive function task performance at baseline and at follow-up would be moderated by negative affect immediately following the mood induction procedure.

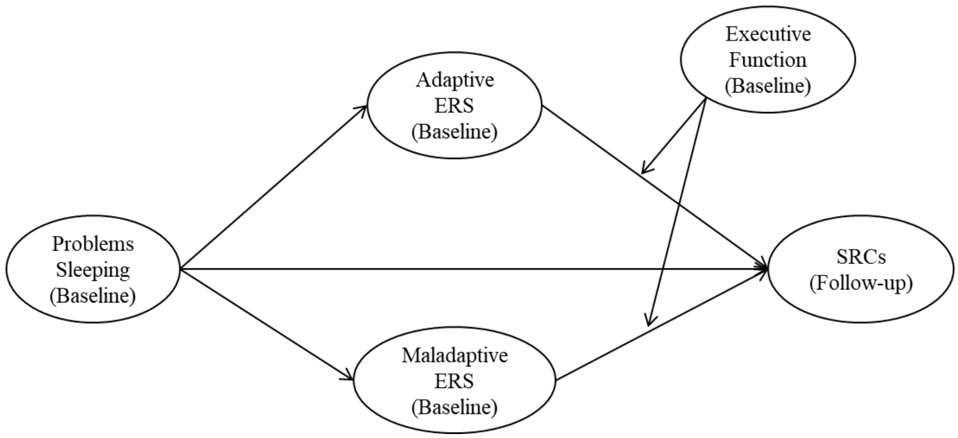


Figure 1. Hypothesized structural model with executive function moderating the mediation between problems sleeping, emotion regulation strategies, and SRCs.

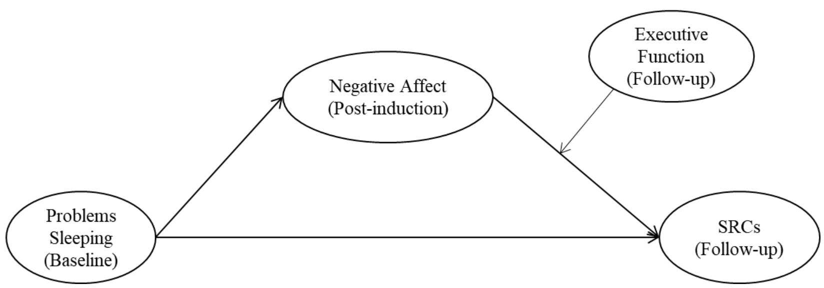


Figure 2. Hypothesized structural model showing a mediation of the prospective sleep and SRCs relationship through negative affect change following mood induction and moderated by post-induction executive function.

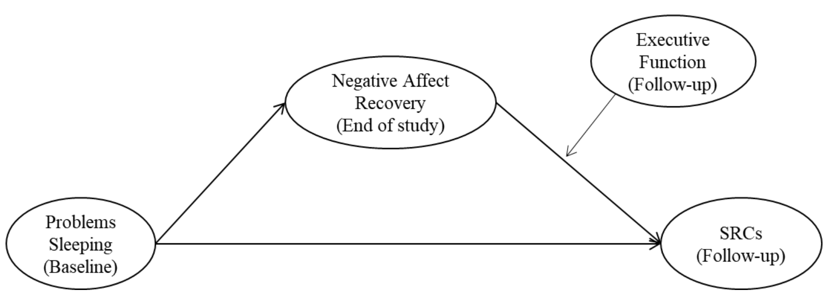


Figure 3. Hypothesized structural model showing a mediation of the prospective sleep and SRCs relationship through prolonged negative affect recover following mood induction and moderated by post-induction executive function.

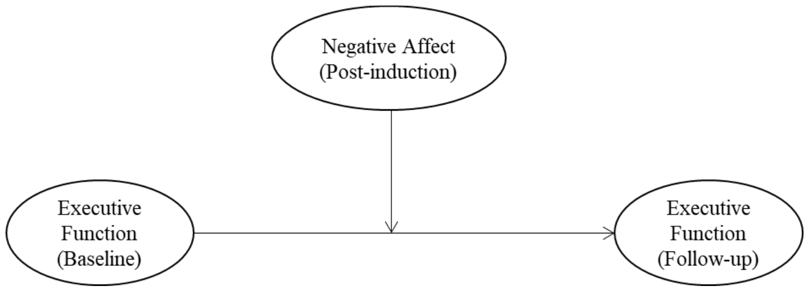


Figure 4. Hypothesized structural model showing a moderation of the relationship between baseline and follow-up executive function task performance by negative affect.

Chapter II: Method

Power and Recruitment

The full hypothesized model, shown in Figure 1, had 22 observed variables and five latent variables using structural equation modeling to analyze the relationships between variables. This gave the model a minimum of over 100 degrees of freedom. The smallest hypothesized model, shown in Figure 4, had 13 observed variables and three latent variables, which results in 76 degrees of freedom. According to MacCallum, Browne, and Sugawara (1996), approximately 200 participants total would be needed for the power to detect a model with a good fit (RMSEA = .05) to test the largest model (i.e., Figure 1) and approximately 220 participants to test the smallest model (i.e., Figure 4). A total of 327 participants were included in the baseline data with 220 at the follow-up stage, consistent with anticipated attrition levels (Daly & Nataraajan, 2015). Participants were recruited from Amazon's Mechanical Turk (MTurk). Participation was restricted to individuals who are at least 18, able to speak and read English, and reside within the United States. They received $2.00 for completing the baseline portion of the study and $3.00 for completing the follow-up with a chance to be randomly selected to receive a $50 gift card.

Data Quality

Due to the nature of the remote data collection, a variety of attention-check questions were interspersed throughout the questionnaire portions of the study to monitor participant effort and attention (Berinsky et al., 2014). Similar to Meade and Craig (2012), participants were given several "bogus" (e.g., "I am paid bi-weekly by leprechauns") or instructed response questions and incorrect answers were flagged for careless responding. Failure to pass at least half of the attention checks resulted in the participant's data being discarded and payment denied, which was stated in the informed consent. Similarly, to prevent multiple completions using fraudulent accounts, participation was restricted to one completion per location as collected by Qualtrics. This was consistent with recommendations for remote research as the prevalence of bots and "farming" increases across crowd-sourcing research platforms (e.g., Ahler et al., 2019; Moss et al., 2021). Using multiple validity and poor data quality indicators, 1711 of 2038 total HITs, most of which were flagged due to Qualtrics geolocation data, were identified as invalid and were not included in the current study. This exclusion rate was comparable to recent research using MTurk (Chmielewski & Kucker, 2020; Webb & Tangney, 2022).

Participants

Demographic information is available in Table 1 for baseline (N=327) and follow-up (N=220). In addition to the data in the table, participants provided information on religiosity and military service as potential covariates. For religiosity, a slight majority identified as belonging to any religion (52.0% at baseline, 52.2% at follow-up) with approximately one-third of those individuals attending religious services at least monthly (37.3% at baseline, 35.0% at follow-up). For military service, 5.2% at baseline and 5.9% at follow-up endorsed a history of military service. As data were collected during the COVID-19 pandemic in 2022, information regarding infection severity was also collected. At baseline, 21.4% reported ever having a confirmed case of COVID-19. Of these, 13% (n=9) were hospitalized, 10.1% (n=7) received oxygen treatment, and 7.2% (n=5) were placed on ventilators. Twelve participants were diagnosed with COVID-19 between baseline and follow-up, all of which were reportedly mild cases.

Table 1. Sociodemographic information for participants at the baseline and follow-up stages of the study.

	Baseline	Follow-Up
Age		
Mean	39.1	41.9
SD	12.0	12.4
Range	18-76	21-76
	%	**%**
Sex Assigned at Birth		
Male	48.6	45.0
Female	51.4	55.0
Gender Identity		
Man	48.6	44.8
Woman	50.5	54.7
Other	0.9	0.5
Race or Ethnicity*		
White, Non-Latino/a	67.1	68.8
White, Latino/a	14.0	9.9
Black or African American	9.8	11.4
Asian	8.5	9.9
Native American or Alaska Native	1.2	1.5
Middle Eastern or North African	0.6	0.5
Native Hawaiian or Pacific Islander	0.3	1.0
Sexuality		
Heterosexual	82.9	87.2
Gay or Lesbian	2.4	2.5
Bisexual	13.1	8.9
Asexual	0.9	1.5
Pansexual	0.6	0.0
Education		
High School or Less	7.3	7.4
Some College	15.3	18.2
Technical Degree or Certificate	2.1	2.5
Associate's Degree	8.0	9.9
Bachelor's Degree	52.0	45.8
Master's Degree	13.1	12.8
Doctorate Degree (PhD, MD, JD)	2.1	3.5
Income		
Less than $25,000	14.3	16.2
$25,000 - $49,999	29.0	26.3
$50,000 - $74,999	26.8	24.2
$75,000 or more	29.9	33.3
Employment*		
Full-Time	72.8	75.4
Part-Time	14.4	12.3
Unemployed, Seeking Work	5.8	4.9
Unemployed, Not Seeking Work	3.1	3.0
Retired	2.4	3.0
Student	1.5	2.0
On Disability	0.6	0.5

* Percentages exceed 100% as participants could select multiple options

Measures

SRCs.

SRCs were assessed using multiple measures to obtain the full spectrum of suicide-related thoughts and behaviors. These assessed current and past suicide attempts and ideation severity. In addition, the broader range of suicide cognitions were captured, as these are integral components of suicide risk assessments and theories (e.g., thwarted belongingness, hopelessness, perceived burdensomeness).

Suicide Cognitions Scale (SCS). The SCS (Rudd et al., 2014) is an 18-item measure assessing suicide-related beliefs (e.g., hopelessness, perceived burdensomeness) on a 4-point Likert scale. Wiblin and colleagues (2021) identified a four-factor solution using a military population that included unlovability (e.g., beliefs about being innately flawed or worthless), unbearability (e.g., inability to cope with the distress), unsolvability (e.g., perceived inability to change expected outcomes), and negative urgency (e.g., a sense of immediacy). The latter of these two factors have also been found to fit well as a single factor in non-military populations (Ellis & Rufino, 2014). However, most recent research indicates predominant influence from a general factor, indicating a unidimensional structure for community samples (Moscardini et al., 2021). Studies of the SCS's psychometrics have demonstrated good to excellent properties including internal consistency, convergent validity, sensitivity to treatment response, incremental validity, and test-retest reliability (Bryan et al., 2014; Ellis & Rufino, 2014; Wiblin et al., 2021). It has also shown to be a significant predictor of current suicide ideation (Bryan, Rozek, & Khazem, 2019) and a discriminator between people that attempt suicide, engage in non-suicidal self-injury, or are part of a control group (Bryan et al., 2014). The unidimensional structure evidenced excellent internal consistency ($\alpha_{baseline}$=.984, $\alpha_{follow\text{-}up}$=.980).

Interpersonal Needs Questionnaire (INQ). The INQ is a 15-item scale that assesses two proximal contributors to suicidality – thwarted belongingness (TB) and perceived burdensomeness (PB) (Van Orden et al., 2012). Each item was rated on a 7-point Likert scale with higher scores indicating higher TB or PB within the scale range of 15 to 105. Van Orden et al (2012) found scores for each scale were predictive of suicide reporting one month later (OR =1.83 TB, 1.64 PB) and increases in suicide ideation severity one month later (IRR =1.007-1.009 TB, 1.050-1.051 PB) after controlling for baseline suicidality. Both subscales evidenced good to excellent internal consistency (TB: $\alpha_{baseline}$=.866, $\alpha_{follow-up}$=.897; PB: $\alpha_{baseline}$=.970, $\alpha_{follow-up}$=.972).

Beck Hopelessness Scale (BHS). The BHS (Beck & Steer, 1993) is a 20-item self-report scale of hopelessness about the future that occurred over the past week. Items were rated on a dichotomous True/False scale. Psychometric properties have evidenced good test-retest reliability, internal consistency, convergent validity, and discriminant validity (Bouvard et al., 1992; Steed, 2001). The BHS has demonstrated good predictive validity for death by suicide (Brown et al., 2006). Although studies with clinical populations have found multi-factor solutions, Hanna and colleagues (2011) determined a single factor solution was most appropriate for a non-clinical population similar to the proposed study. The scale showed excellent internal consistency for the current study ($\alpha_{baseline}$=.913, $\alpha_{follow-up}$=.937).

Columbia-Suicide Severity Rating Scale (C-SSRS). The C-SSRS (Posner et al., 2008) is a 12-item scale that assesses the severity of STBs over the past month and lifetime. Each item in the first half of the scale was rated on a binary Yes/No scale with each additional item increasing in ideation severity ranging from a more passive thought (i.e., wish to be dead) to active thoughts and plans (i.e., specific method and plan with intent to act). For those that endorsed a history of attempts, the second half of the measure allowed for more nuanced understanding of past suicide attempts including the method and lethality of the most recent and most severe attempts, though this study only used data on ideation. The C-SSRS has demonstrated good predictive, incremental, convergent, and discriminant validity as well as sensitivity to change reliability (Greist et al., 2014; Kerr et al., 2013; Madan et al., 2016; Posner et al., 2011). Additionally, it has been found to be superior in sensitivity and specificity to another widely-used measure of suicide risk, item 9 on the Patient Health Questionnaire, and lends itself to more comfort in reporting true STBs compared to a traditional clinical interview (Viguera et al., 2015).

Affective States

Negative affect was induced by having the participants in the experimental condition watch a short video clip from the 1979 film *The Champ* in which a young child is shown in distress following the death of his father. This clip has been validated and utilized to successfully increase negative affective states of research participants (Ferrer, Grenen, & Taber, 2015). The effect of the sadness prime was measured using the sadness domain of a modified version of the Positive and Negative Affective Schedule – Expanded Form (PANAS-X; Watson & Clark, 1999), a self-report measure of positive and negative affective states. Compared to the original and most widely-used PANAS for measuring state affect change (Joseph et al., 2020), the PANAS-X includes more discrete emotions, including sadness, which lends to more sensitivity to change than using the broader positive and negative affect domains (Harmon-Jones et al., 2016). Furthermore, the PANAS has demonstrated good reliability, though there have been concerns about sensitivity to transient fluctuations in affect (Rossi & Pourtois, 2012). The sadness domain of the PANAS-X includes five items (i.e., sad, blue, downhearted, alone, and lonely). To increase sensitivity to changes, participants were asked to complete the scale based on how they were feeling in the moment with a visual analog scale rather than a 4-point Likert scale. Participants viewed a sliding scale for each discrete emotion and were asked to move an indicator along the bar to indicate the intensity of that emotion in the moment. Similar adaptations have been utilized in prior studies examining laboratory affect manipulations (Dixon-Gordon et al., 2017).

Sleep

Pittsburgh Sleep Quality Index (PSQI). The PSQI is an 18-item self-report of sleep quality over the prior month (Buysse et al., 1989). The participants rated their sleep quality across domains including latency, efficiency, duration, subjective sleep quality, use of medications, sleep disturbance, and daytime dysfunction, which combined to form a composite score with higher scores indicating worse sleep quality. The PSQI has evidenced good internal consistency, reliability, and validity across studies (for a review, see Mollayeva et al., 2016).

Insomnia Severity Index (ISI). The ISI is a 7-item scale assessing the nature, severity, and impact of insomnia for the past month (Bastien et al., 2001). Each item was rated on a 5-point Likert scale with higher scores indicative of more severe insomnia. It has demonstrated adequate internal consistency and validity compared to sleep diaries and polysomnography (Bastien et al., 2001). It has also shown good sensitivity and specificity in detecting insomnia problems within a community sample (Morin et al., 2011). In the current study, the ISI demonstrated good internal consistency ($\alpha_{baseline}$=.876, $\alpha_{follow\text{-}up}$=.886).

Dysfunctional Beliefs and Attitudes about Sleep (DBAS). The DBAS is a 16-item scale measuring the beliefs about the causes and consequences of the reporter's insomnia, expectations, perceived control over sleep, and sleep-promoting practices (Morin, Vallières, &

Ivers, 2007). Thus, in addition to capturing the impact of insomnia, it also assesses sleep-hygiene related practices to extend beyond what is captured by the ISI. All items were rated on a 10-point Likert scale with higher scores indicative of more problems sleeping-related beliefs. The DBAS has demonstrated adequate internal consistency and test-retest reliability (Morin et al., 2007). The scale evidenced excellent internal consistency for this sample ($\alpha_{baseline}$=.923, $\alpha_{follow\text{-}up}$=.927).

Nightmare Distress Questionnaire (NDQ). The NDQ is a 13-item questionnaire assessing various aspects of distress resulting from idiopathic and posttraumatic nightmares including nighttime distress, impact on sleep, and impact on daytime reality perception (Belicki, 1992). Items are rated on 5-point Likert scales with higher scores suggesting more distress stemming from nightmares. The NDQ's three factors have demonstrated good internal consistency (Bockermann, Gieselmann, & Pietrowsky, 2014). The overall scale demonstrated good consistency ($\alpha_{baseline}$=.761, $\alpha_{follow\text{-}up}$=.735).

Emotion Regulation Strategies

Cognitive Emotion Regulation Questionnaire (CERQ). The CERQ (Garnefski et al., 2001) is a 36-item self-report inventory that assesses various adaptive and maladaptive strategies for regulating emotion. Adaptive strategies are divided into five domains (i.e., positive refocusing, positive reappraisal, putting into perspective, and refocus on planning and acceptance) and maladaptive strategies are divided into four domains (i.e., rumination, self-blame, blaming others, and catastrophizing). Each item was rated on a 5-point Likert scale to assess the frequency with which the individual uses the strategy to help manage their emotions. The overall scale and the nine domains demonstrated good test-retest reliability in the initial study with youth (Garnefski et al., 2001). Later research found good factorial reliability, validity, and internal consistency in samples of adults reporting anxiety and depression (Garnefski &

Kraaij, 2007; Wen et al., 2021). All subscales and the total scale showed internal consistency ranging from good (Rumination $\alpha_{baseline}$=.799) to excellent (Catastrophizing $\alpha_{baseline}$ =.930).

Executive Function

The executive function assessments were hosted through Psytoolkit, which is an online service that allows researchers to choose from a library of experiments or set-up and run their own reaction time experiments remotely (Stoet, 2010, 2017). Comparison studies have found that the online Psytoolkit experiments demonstrated similar results to in-lab based reaction time experiments (Kim et al., 2019) and using MTurk recruitment methods (Crump et al., 2013). Similarly, Armitage and Eerola (2020) found strong agreement between the in-lab Psytoolkit and the online Psytoolkit using a convenience sample, indicating differences in internet speeds between participants did not adversely impact findings. Four tests were used to assess the various components of executive functioning: Cued Task-Switching, Corsi Backward Block Tapping, Go/No-Go, and Matrix Reasoning Item Bank Test. These tests were chosen as the tasks have demonstrated activation in frontal, parietal, and striatal areas of the brain, which overlaps with the areas activated during emotion regulation tasks (Morawetz et al., 2017; Phan et al., 2002).

Cued Task-Switching (CTS). The CTS paradigm (Meiran, 1996) assessed the participants ability to switch between two tasks based on a cue. Switching tasks reliably show activation in the inferior frontal junction and posterior parietal cortex with domain-preferential activation in the dorsal premotor cortex for perceptual switching tasks such as the CTS (Kim et al., 2012). The participants were presented with a fixation cross at the center of the screen and then one of two cues (i.e., *color* or *shape*). Then they saw a shape appear on the screen that was either a circle or a square and either yellow or blue. The participant then pressed one of two keys indicating their answer based on the given cue: the *b* key for yellow or circle and the *n* key for blue or square. Two outcome variables were used as they assess slightly different facets of attention switching: congruity cost percent errors and switch cost percent errors. A trial is congruent if both sets of task demands require the same response key, while the trial is incongruent if the task rules require opposing responses. The congruity cost percent errors variable is calculated as the number of errors in incongruent trials minus the errors in congruent trials, divided by the total number of trials completed. Higher scores on congruity cost percent errors indicate lower switching abilities. For switch cost, a trial is considered a repeat if the same cue is given compared to the previous trial (e.g., color and color), and a switch trial is one in which the cues differ (e.g., color and shape). The switch cost percent errors variable is calculated as the number of errors in switch trials minus errors in repeat trials, divided by the total number of trials completed. Higher scores on switch cost percent errors indicate lower switching abilities.

Corsi Backward Block Tapping (CBBT). The computerized CBBT (Kessels et al., 2000) is a measure of visuospatial working memory. Rottschy and colleagues (2012) identified activation in the broad fronto-parietal network during working memory tasks. For visuospatial tasks specifically, activation was strongest in the bilateral posterior superior frontal gyrus (dorsal premotor cortex), superior parietal lobule, precuneus, and right inferior parietal cortex. For this study, participants were presented with nine blocks scattered across a screen and watched as they individually flashed a different color. They were asked to remember the order in which they changed color and click on the blocks in the reverse order of that sequence. The number of blocks that flash increased after each trial to obtain a working memory span for the participant. Research has demonstrated its validity as a measure of nonverbal working memory in the original manual form of the task and in the computerized versions, which have shown to be comparable (Berch et al., 1998; Claessen et al., 2014; Vandierendonck et al., 2004). Backward span was used for analyses. Higher scores of CBBT indicate better visuospatial working memory.

Go/No Go (GNG). The GNG task measures the participant's impulsivity or capacity not to respond (Verbruggen & Logan, 2008). A review of functional neuroimaging studies identified this paradigm as predominantly coordinating activation of the fronto-striatal circuit for action withholding and ventral attention network for interference processes (Zhang et al., 2017). More specifically, activations were demonstrated in the right triangular part of the inferior frontal gyrus, right angular gyrus, right supplementary motor area, left insula, and right pallidum. During this task, participants were presented with a fixation cross at the center of the screen and then one of two stimuli appeared: a green oval telling them to "Go" and press the space bar or a red oval telling them to "No-Go" and withhold pressing the space bar. The number of "Go" trials exceeded the number of "No-Go" trials such that participants typically became faster after viewing the "Go" stimulus several times in a row and found it more difficult to then withhold their response when presented with the "No-Go" stimulus. The outcome measure used for this paradigm was the number of commission errors the participant made.

Matrix Reasoning Item Bank Test (MaRs-IB). The MaRs-IB is a brief measure of nonverbal problem solving during which the participant must identify a pattern in abstract shapes and then choose one of four additional abstract shapes that will complete the pattern (Chierchia et al., 2019). This test was developed as an open-access alternative to the widely-used and validated Raven's Progressive Matrices (Raven, 2007) for adolescents and adults. Similar to working memory tasks, these abstract reasoning tasks have demonstrated activation in frontoparietal and visual cortices (e.g., Morin et al., 2023). Specifically, activation is seen throughout the bilateral lateral prefrontal cortex, bilateral lateral parietal cortex/cerebellum, bilateral dorsomedial prefrontal cortex, left anterior insula, and right frontal pole. In the test, participants were presented with a 3x3 matrix where one cell is empty and they were asked to choose which of four options completed the matrix. This was then repeated for a duration of 8 minutes with 30-second time limits per item. Chierchia and colleagues (2019) created three sets of 80 stimuli each, which allows for test-retest comparisons. For the current study, the follow-up condition included one of the alternative stimuli sets to reduce practice effects from baseline. Two outcome variables were used: total correct, which is impacted by processing speed, and percent accuracy.

Covariates and Demographics

As previously discussed, a variety of non-target variables may influence the targeted variables in the proposed model. Information regarding demographics, anxiety, depression, trauma, and COVID-19 were collected to control for these effects when possible. Participants completed a basic demographic questionnaire that assesses their age, sex and gender identity, race and ethnicity, sexual orientation, education, occupational status, and income.

Psychopathology. Depression was assessed using the Center for Epidemiological Studies Depression Scale – Revised (CESD-R; Eaton et al., 2004; Radloff, 1977). This 20-item measure assesses the frequency of depressive symptoms over the prior week with each item rated on a 4-point Likert scale. The scale demonstrated excellent internal consistency ($\alpha_{baseline}$=.966, $\alpha_{follow-up}$=.964). Anxiety was assessed using the Generalized Anxiety Disorder Screener (GAD-7; Spitzer et al., 2006). The GAD-7 is a 7-item self-report measuring the frequency of anxiety-related symptoms over the past two weeks and evidenced excellent internal consistency ($\alpha_{baseline}$=.936, $\alpha_{follow-up}$=.945). Trauma was measured using the expanded PTSD Checklist for

DSM-5 (PCL-5) with the Life Events Checklist to assess for any traumatic experiences and to control for the symptoms the participant was continuing to experience (Weathers et al., 2013). This scale showed excellent internal consistency ($\alpha_{baseline}$=.974, $\alpha_{follow\text{-}up}$=.974).

COVID-19. Due to the ongoing nature of the COVID-19 pandemic and recent literature indicating executive dysfunction resulting from severe infection (Di Pietro et al., 2021; Ortelli et al., 2021; Rabinovitz et al., 2020; Woo et al., 2020), participants were also asked if they had been diagnosed with COVID-19, when they were diagnosed and how severe it was (e.g., symptom duration, hospitalization), and if they continued to experience symptoms (i.e., long-haulers). Although a history of infection did not disqualify participants, exploratory analyses were planned to control for or test for differences in the structural relationships if a sufficient number of participants reported severe infections.

Procedure

Participants were recruited through Amazon's Mechanical Turk (MTurk). Following informed consent, they completed the baseline self-report and behavioral EF measures. All participants with valid data were invited back to complete the follow-up portion one month later where approximately two-thirds were randomly assigned to the experimental condition and one-third to the control condition to minimize costs and maximize statistical power. All procedures were identical between conditions with the exception of the added video prime and post-video affect rating for the experimental group. During this second session, they again completed the self-report measures for the time between baseline and follow-up, viewed the sadness prime, and completed the EF measures. Affective states were measured prior to the prime, immediately following the prime, and after completion of the EF tasks. At the end of each session, all participants were provided with a list of resources (e.g., crisis hotline number, link to a local psychologist search) to minimize any risk of taking part in the study.

Planned Analyses

Data were first inspected for normality, which included statistics (i.e., skewness and kurtosis) and visual data displays (i.e., histograms and P-P plots). Statistics from -1.96 to 1.96 were considered normal, or were considered symmetric and non-clustered, with more extreme values indicating significant skew or kurtosis (Kim, 2013). Non-normally distributed data were transformed using square root, logarithmic, or inverse transformations for moderate, substantial, and severely skewed distributions. If the transformations did not improve skewness or kurtosis to approximate a normal distribution, the original variable was retained and used in analyses. The affect manipulation was analyzed with pre-video and post-video affect ratings in paired-samples t-tests using SPSS with significant differences indicating a change in affect and an effective manipulation.

Data were analyzed in *M-Plus* using structural equation modeling (SEM; Muthén & Muthén, 2012). SEM allows for the simultaneous assessment of hypothesis-driven models that include multiple independent and dependent variables (Lomax & Schumacker, 2004). First, the measurement models were examined using various fit indices to determine if the observed indicators fit the hypothesized latent variables. The chi-square test of model fit analyzed the difference between the population covariance matrix and the implied covariance matrix with a non-significant test indicating good fit (i.e., p>.05). However, due to the test's sensitivity in large samples, a chi-square to degrees of freedom ratio of approximately 2 was also considered good fit (Hoyle, 2012; Hu & Bentler, 1995; 1999; Lomax & Schumacker, 2004). Given this sensitivity, the Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis Index

(TLI), and Comparative Fit Index (CFI) were also used to estimate model fit. The RMSEA was considered a good fit if the values fall below 0.08, while the TLI and CFI were both considered acceptable with indices between 0.90 and 0.95 and considered good if above 0.95 (Lomax & Schumacker, 2004). Multiple measurement models were assessed, one for each latent variable across both waves of the study. For example, the measurement model for sleep problems had two latent sleep variables, one for baseline and one for follow-up, each with four observed indicators (i.e., ISI, PSQI, DBAS, and NDQ scores for each wave of the study). Once the measurement model demonstrated good fit indices, the structural relations of the latent variables as shown in Figures 1-4 were tested while controlling for covariates with adjustments made based on non-significant paths and modification index values to improve overall model fit.

Chapter III: Results

Descriptive analyses and normality

With regard to suicide-related cognitions, 31.3% reported past month suicide ideation at baseline and 23.2% at follow-up. Inspection of visual data displays (i.e., histograms and P-P plots) as well as statistics (i.e., z-statistics for skewness and kurtosis) revealed substantial positive skews for the following variables: baseline SRC (z=6.95), follow-up SRC (z=8.25), baseline INQ PB (z=6.38), and follow-up INQ PB (z=7.28). Log transformations were used for these variables and the final skewness statistics are available in Table 2. Similarly, the baseline (z=5.92) and follow-up (z=5.20) BHS variables showed a moderate, positive skew, and they were transformed with the square root transformation to approximate normality. Descriptive information, normality, and correlational information for the SRC variables are provided in Table 2. The significant correlations among variables suggest they are measuring the same construct. Regarding interpersonal factors, 41.3% reported elevated levels of perceived burdensomeness and 29.4% reported elevated thoughts of thwarted belongingness (Silva et al., 2023). For the BHS, 23.3% endorsed mild, 23.5% endorsed moderate, and 9.5% endorsed severe hopelessness. On the SCS-R, 38.2% denied any suicide-related cognitions (i.e., score of zero) with an overall mean of 16.94 (SD=21.11).

Table 2. Descriptive information and correlation matrix for suicide-related cognition variables.

			Z Test Statistics		Correlations						
	M	SD	Skewness	Kurtosis	1	2	3	4	5	6	7
Baseline SRCs											
1. SCS[a]	1.49	0.23	4.37	-4.75							
2. INQ PB[a]	1.06	0.31	3.36	-5.51	.83***						
3. INQ TB	29.12	12.56	0.66	-2.36	.45***	.48***					
4. BHS[b]	2.06	1.31	-0.74	-3.74	.67***	.67***	.58***				
Follow-Up SRCs											
5. SCS[a]	1.44	0.21	5.77	-1.46	.71***	.70***	.44***	.59***			
6. INQ PB[a]	1.01	0.30	4.74	-2.98	.65***	.76***	.43***	.53***	.80***		
7. INQ TB	28.14	13.87	2.18	-2.24	.44***	.48***	.67***	.48***	.56***	.59***	
8. BHS[b]	1.94	1.43	0.47	-3.49	.51***	.50***	.49***	.75***	.70***	.59***	.60***

Note: [a]Log transformed, [b]Square root transformed, *** $p < .001$

With regard to sleep, baseline (z=7.82) and follow-up (z=6.42) NDQ scale scores showed substantial positive skew and were log transformed to better approximate normality. Using the most conservative method, square root transformations for ISI ($z_{baseline}$=-5.56; $z_{follow\text{-}up}$=-3.20), DBAS ($z_{baseline}$=-5.30; $z_{follow\text{-}up}$=-2.72), and PSQI ($z_{baseline}$=-3.80; $z_{follow\text{-}up}$=-4.16) resulted in more skewed distributions. Thus, the original scale variables were retained as there is no transformation targeting kurtosis only. Descriptive statistics and correlations between sleep variables are provided in Table 3. Similar to the SRCs, the positive, significant correlations among all sleep variables indicate that they are measuring a similar construct. For the ISI, 39.4% had no clinically-significant insomnia symptoms, 38.6% were subthreshold, 20.5% endorsed moderate insomnia, and 1.5% endorsed severe insomnia. Regarding dysfunctional beliefs about sleep, only 26.9% of the sample had realistic expectations about sleep, indicating the majority hold thoughts or act in ways that are counter to good sleep hygiene practices. For sleep quality, 56.3% endorsed quality on the PSQI (Global Score > 6) that was indicative of poor sleep and insomnia. For nightmares, 71.3% endorsed never or rarely having nightmares while 3.1% reported frequent nightmares.

Table 3. Descriptive information and correlation matrix for sleep variables.

			Z Tests Statistics		Correlations						
	M	SD	Skewness	Kurtosis	1	2	3	4	5	6	7
Baseline Sleep											
1. ISI	9.40	6.18	0.67	-3.17							
2. NDQ[a]	1.51	0.90	3.48	-0.34	.35***						
3. DBAS	5.34	2.14	-1.09	-2.26	.50***	.28***					
4. PSQI	6.50	4.03	2.95	-2.14	.77***	.27***	.38***				
Follow-Up Sleep											
5. ISI	8.52	6.35	2.15	-2.37	.73***	.33***	.39***	.69***			
6. NDQ[a]	1.51	0.09	3.33	-0.52	.25***	.30***	.27***	.24***	.40***		
7. DBAS	5.01	2.20	-0.15	-2.81	.36***	.24***	.65***	.28***	.49***	.32***	
8. PSQI	6.85	4.38	1.91	-1.81	.69***	.30***	.29***	.77***	.82***	.35***	.39***

Note: [a]log transformed, *** $p < .001$

For executive function, outcome measures for the CBBT and CTS switching cost error rates at both time points did not require transformation based on visual data displays and the skewness and kurtosis statistics, shown in Table 4. Taken together with the symmetry of the histograms and P-P plots, there was a substantial positive skew for CTS congruity cost percent errors at follow-up (z=5.46) and moderate positive skews for the following variables: baseline CTS congruity cost percent errors (z=4.89), MaRs-IB number correct ($z_{baseline}$=3.15; $z_{follow-up}$=3.63), MaRs-IB overall accuracy ($z_{baseline}$=2.51; $z_{follow-up}$=2.01), and Go/NoGo commission errors ($z_{baseline}$=9.85; $z_{follow-up}$=8.53). The CTS congruity cost error rate was log transformed and all other executive function variables were square root transformed to approximate normal distributions. Descriptive information and intercorrelations are provided in Table 4. As the variables show no or small correlations, these appear to be capturing more distinct facets of executive functioning rather than a general concept. The majority of participants performed within the expected range (i.e., 3 to 7) for visuospatial working memory span, with just 5.3%

performing low (span=2) and 2.4% performing highly (span=8). For perceptual reasoning, participants averaged 25.85 correct answers (SD=6.43, range 7-49) for an overall accuracy of 46.90% (SD=15.96) on the MaRs-IB. This is somewhat different from normative data which showed an accuracy of 69.15% and 22.67 correct answers (Chierchia et al., 2019). However, that data was collected from a sample with higher education and recruited around an academic campus, which would result in a sample with better overall performances. On the GNG task, 28.2% made no commission errors, 23.2% made one error, 20.4% made two errors, and the remaining 28.2% made three or more errors. This is a consistent with prior research which identified an average of 2.82 errors (SD=2.25 errors) for a non-clinical sample (McNab et al., 2008). For task switching, participants had a mean of 7.81% error responses for switching trials (SD=16.89) and 9.90% for incongruent trials (SD=14.63). This is similar to the normative 6.26% and 8.08% error rates for switching and incongruent trials, respectively (Li et al., 2019).

Table 4. Descriptive information and correlation matrix for transformed executive functioning variables.

			Z Test Statistics		**Correlations**				
	M	SD	Skewness	Kurtosis	1	2	3	4	5
Baseline EF									
1. Corsi Backward Span	4.82	1.30	-0.22	0.01					
2. CTS Switch Cost PE	0.08	0.17	2.00	0.97	-.05				
3. CTS Congruity Cost PE[a]	1.05	0.69	2.75	4.57	-.09	.15**			
4. MaRs-IB Correct[a]	5.04	0.63	-0.04	1.38	.17*	.05	-.06		
5. MaRs-IB Accuracy[a]	0.67	0.12	0.12	-2.77	.20**	.01	-.12*	.41***	
6. GNG Commissions[a]	1.12	0.83	0.26	-3.27	.09	.04	.00	.04	-.17**
Follow-Up EF									
1. Corsi Backward Span	4.92	1.27	-1.37	-0.39					
2. CTS Switch Cost PE	0.07	0.15	1.71	0.77	.16				
3. CTS Congruity Cost PE[b]	0.03	0.05	2.77	3.75	-.08	.27***			
4. MaRs-IB Correct[a]	5.16	0.77	1.56	-0.91	.18*	.01	-.02		
5. MaRs-IB Accuracy[a]	0.68	0.13	0.14	-2.65	.12	-.14*	-.14*	.59***	
6. GNG Commissions[a]	1.15	0.82	0.94	-1.68	.17*	-.12	-.01	-.05	-.10

[A] Square root transformed, [b] log transformed, * $p < .05$, ** $p < .01$, *** $p < .001$

For emotion regulation strategies, descriptive statistics and correlations between subscales are provided in Table 5. As shown in the table, the majority of these variables showed a moderate negative skew. However, despite reducing skewness to a more normal value, transformations for the variables resulted in distributions that were more asymmetric around the midpoint and worsened the kurtosis statistics even with the most conservative transformation. Therefore, the original scale variables were retained. The percentages of participants using the strategies either frequently or almost always (i.e., rating items 4 or 5) are as follows: self-blame=18.0%, acceptance=30.3%, rumination=22.3%, positive refocusing=34.9%, refocus on planning=42.5%, positive reappraisal=40.7%, putting into perspective=28.7%, catastrophizing=14.4%, and blaming others=12.8%. Of note, the correlations between subscales below are positive, which may appear counterintuitive for adaptive and maladaptive cognitive coping strategies. However, these findings are largely consistent with prior research showing weak, positive or nonsignificant, negative correlations between scales within each domain (e.g., catastrophizing and positive reappraisal; Garnefski & Kraaij, 2006; Garnefski et al., 2001). Positive relationships between seemingly opposite strategies may be reflective of multiple strategy use. For example, one may initially catastrophize distressing events before recognizing that as a less adaptive approach and employing a more positive reappraisal strategy.

Table 5. Descriptive information and correlation matrix for emotion regulation strategy variables.

			Z Test Statistics		**Correlations**							
	M	SD	Skewness	Kurtosis	1	2	3	4	5	6	7	8
Baseline Adaptive												
1. Acceptance	3.32	0.94	-5.55	1.19								
2. Positive Reframing	3.27	1.05	-2.84	-1.97	.23***							
3. Refocus on Planning	3.64	0.88	-3.84	0.73	.15**	.54***						
4. Positive Reappraisal	3.51	1.01	-3.56	-1.11	.10	.61***	.76***					
5. Putting into Perspective	3.21	0.98	-3.06	-1.08	.32***	.44***	.40***	.47***				
Baseline Maladaptive												
6. Self-Blame	2.85	1.06	-1.29	-2.78	.50***	0.04	0.02	-0.05	.23***			
7. Rumination	3.13	0.92	-2.50	-0.80	.39***	.17**	.29***	.21***	.24***	.54***		
8. Catastrophizing	2.61	1.04	0.72	-3.45	.25***	.15**	0.04	0.05	.29***	.46***	.47***	
9. Blaming Others	2.51	1.11	1.82	-3.22	.31***	.17**	.12*	0.1	.22***	.31***	.32***	.54***

* $p < .05$, ** $p < .01$, *** $p < .001$

Descriptive analyses for covariates indicated 66% (n=216) of baseline participants endorsed a Criterion A traumatic event in their lifetime with an average PCL-5 total of 24.86 (SD=20.89). Approximately one-third of participants at follow-up (n=74) endorsed traumatic events with a mean PCL-5 total of 24.43 (SD=20.96). Endorsement of depressive symptoms (Baseline: M=36.00, SD=17.29; Follow-up: M =33.81, SD=17.33) and anxiety symptoms (Baseline: M=12.85, SD=5.62; Follow-up: M=12.08, SD=5.87) were similar across time points. For religiosity, 37.3% at baseline and 21.7% at follow-up reported attending religious services at least on a monthly basis. These variables and demographic information were entered into structural models as covariates when appropriate.

Affect Manipulation

Ratings for individual PANAS-X Sadness items were compared for the experimental and control groups to determine if there were any affective differences between groups prior to the manipulation. Descriptive information for each item is available in Table 6. Affect between the experimental and control groups before the manipulation were compared by independent-samples t-tests. Affect prior to and immediately post-video were compared by paired-samples t-tests within each group. There were no significant differences for any of the five items between groups at the start of the follow-up phase: Sad ($t(218)=-.51$, $p=.61$), Blue ($t(218)=.15$, $p=.88$), Downhearted ($t(218)=-.01$, $p=.99$), Alone ($t(218)=.19$, $p=.85$), Lonely ($t(218)=.31$, $p=.75$). Ratings prior to and immediately post-video were compared in paired-samples t-tests for the experimental group, and each item showed a significant increase in affective intensity: Sad ($t(139)=13.80$, $p<.001$), Blue ($t(139)=10.46$, $p<.001$), Downhearted ($t(139)=11.55$, $p<.001$), Alone ($t(139)=5.48$, $p<.001$), and Lonely ($t(139)=7.49$, $p<.001$). As expected, the experimental group's affect immediately prior to the EF tasks was significantly more intense compared to that of the control group for all items: Sad (*t*(218)=9.06, *p*<.001), Blue (*t*(218)=6.42, *p*<.001), Downhearted (*t*(218)=7.02, *p*<.001), Alone (*t*(218)=2.30, *p*<.05), and Lonely (*t*(218)=2.87, *p*<.01). Except for the Sad item (*t*(139)=2.63, *p*<.01), there were no significant differences within the experimental group pre-manipulation compared to post-EF task completion. Following EF task completion, the experimental group did not significantly differ from the control group on any affect ratings: Sad (*t*(218)=-1.11, *p*=.27), Blue (*t*(218)=.-.55, *p*=.59), Downhearted (*t*(218)=.46, *p*=.65), Alone (*t*(218)=.07, *p*=.94), Lonely (*t*(218)=.07, *p*=.95). This indicated the induced negative affect was generally brief and they broadly returned to their initial affect prior to completing follow-up self-reports.

Table 6. Descriptive information for PANAS-X items by group and rating point.

	Experimental Group						**Control Group**			
	Pre-Video		*Post-Video*		*Post-EF*		*Pre-EF*		*Post-EF*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Sad	22.73	28.07	60.09	29.17	27.34	27.11	20.58	28.75	22.71	29.21
Blue	22.84	28.32	53.19	31.27	25.53	27.28	23.48	29.92	23.22	30.35
Downhearted	23.91	28.98	57.25	32.04	25.93	27.39	23.85	30.65	27.97	33.62
Alone	27.78	30.83	40.29	33.18	26.96	29.42	28.68	34.55	27.31	33.77
Lonely	25.74	30.75	41.74	33.37	26.00	28.56	27.25	34.18	26.32	33.51

Among the variables of interest, SRCs correlated with sleep such that increased problems sleeping were associated with higher endorsements of the various SRC variables as expected. Similarly, for the emotion regulation variables, the individual SRC variables generally showed positive correlations with the more maladaptive strategies and negative correlations with the more adaptive strategies as hypothesized. For executive functioning, contrary to hypotheses, the SRC variables were generally uncorrelated indicating no strong relationship between the concepts as measured in this study.

Table 7. Correlations between SRC outcome variables and sleep, emotion regulation, and cognition observed indicators.

	INQ PB	INQ TB	BHS	SCS
Executive Function				
Corsi Max Span	-.05	.08	.00	-.11
Switch Cost PE	.03	.01	.03	.10
Congruency Cost PE	.08	.05	.00	.09
MaRs-IB Correct	-.04	.00	.02	-.08
MaRs-IB Accuracy	-.21***	-.01	.02	-.21***
Go/No-Go Commissions	.13*	.07	.14*	.11
Sleep				
ISI	.46***	.25***	.42***	.44***
NDQ	.39***	.23***	.31***	.36***
DBAS	.54***	.19***	.37***	.50***
PSQI	.28***	.19***	.35***	.28***
Emotion Regulation Strategies				
Self-Blame	.45***	.27***	.46***	.44***
Acceptance	.23***	.02	.22***	.25***
Rumination	.32***	.14*	.29***	.29***
Positive Reframing	-.03	-.33***	-.25***	-.06
Refocus on Planning	-.17**	-.36***	-.33***	-.21***
Positive Reappraisal	-.15**	-.41***	-.39***	-.21***
Putting into Perspective	.00	-.15***	-.05	.03
Catastrophizing	.52***	.27***	.38***	.49***
Blaming Others	.45***	.19***	.32***	.48***

* $p < .05$, ** $p < .01$, *** $p < .001$

Structural Equation Modeling

Measurement Models

Latent sleep constructs were supported by the measurement model with baseline and follow-up sleep variables, $\chi^2(17)=34.58$, $p<.01$, RMSEA=.06, CFI=0.98, TLI=0.97. Baseline ISI (β =.94), NDQ (β =.37), DBAS (β=.54), and PSQI (β=.82) all loaded significantly onto a baseline sleep factor, and the follow-up ISI (β=.94), NDQ (β=.40), DBAS (β=.53), and PSQI (β=.83) loaded onto a follow-up sleep factor, all $p<.001$. Baseline and follow-up sleep factors were significantly correlated, β =.80, $p<.001$.

The initial adaptive and maladaptive emotion regulation strategy latent variables were not supported due to intercorrelations of the Acceptance and Putting into Perspective domains. Both domains significantly loaded onto adaptive and maladaptive strategy factors, which then demonstrated poor fit indices. These two domains were dropped from analyses to create more distinct factors. The resulting model showed adequate fit, $\chi^2(10)=23.54$, $p < .01$, RMSEA=.06, CFI=0.98, TLI=0.96. The Adaptive factor consisted of Positive Reframing (β=.66), Refocus on Planning (β=.82), and Positive Reappraisal (β=.91) strategies, all $p < .001$. The Maladaptive factor consisted of Self-Blame (β=.70), Rumination (β=.80), Catastrophizing (β=.61), and Blaming Others (β=.41), all $p < .001$. Adaptive and Maladaptive factors were significantly correlated, $\beta = .20$, $p < .01$.

For executive function, all executive function variables were attempted to fit two EF latent constructs. However, as indicated by the correlation matrix in Table 4, most of the observed indicators are not correlated with one another, and the model failed to converge using both waves of data in the same model. Thus, separate baseline and follow-up measurement models were assessed. Using the baseline observed indicators to estimate a latent variable of EF showed a poor model fit, $\chi^2(5)=8.53$, $p=.13$, RMSEA=.05, CFI=0.60, TLI=0.20. Similar poorly-fitting results were obtained with follow-up EF variables in a separate latent model, $\chi^2(6)=17.88$, $p<.05$, RMSEA=.10, CFI=0.55, TLI=0.24. As a result, executive function variables were entered into structural models individually rather than as a uniform, latent variable.

The SRC measurement model demonstrated adequate fit indices, $\chi^2(21)=40.87$, $p < .01$, RMSEA=.05, CFI=0.94, TLI=0.90. A baseline SRC factor included significant loadings from INQ Burdensomeness (β=.87), INQ Belongingness (β=.58), C-SSRS SI (β=.91), BHS (β=.76), and SCS (β=.91), all $p < .001$. A follow-up SRC factor included significant loadings from INQ

Burdensomeness (β=.86), INQ Belongingness (β=.66), BHS (β=.72), and SCS (β=.91), all p <.001.

The final measurement model, Sad Affect, was also supported with good fit indices, $\chi^2(3)$=2.08, p =.56, RMSEA=.00, CFI=1.00, TLI=1.00. All individual PANAS-X items completed immediately prior to the cognitive tasks at follow-up significantly loaded onto the factor: Sad (β=.93), Blue (β=.95), Downhearted (β=.96), Alone (β=.67), and Lonely (β=.72).

Structural Models

Hypothesis 1: The relationship between problems sleeping at baseline and SRCs at follow-up would be mediated by higher baseline levels of maladaptive emotion regulation strategies (ERS) and lower levels of adaptive ERS.

The first structural model analyzed the mediation of the sleep and SRC relationship by emotion regulation strategies. All demographic variables, depressive symptoms, anxiety, and posttraumatic stress were entered into the model and subsequently dropped if not significantly related with variables of interest. Additionally, follow-up sleep and baseline SRCs were initially included as covariates, but they were dropped due to suspected multicollinearity. Specifically, adding both timepoints into the model resulted in opposing betas (e.g., baseline sleep to $SRC_{baseline}$, β=.43, and $SRC_{follow\text{-}up}$, β=-.39), the two factors are highly correlated (r=.80), and the betas were in the same direction when tested individually in a multiple regression predicting to an SRC variable (e.g., $ISI_{baseline}$ b=.02, $ISI_{follow\text{-}up}$ b=.32, $NDQ_{baseline}$ b=.02, $NDQ_{follow\text{-}up}$ b=.05) but suggested multicollinearity between variables (e.g., VIF greater than 4, Tolerance less than 0.25, Eigenvalues near zero). Taken together, these indicators suggest that the model interpretation is likely distorted and more susceptible to both Type I and Type II errors if both timepoints are included (O'Brien, 2007). The final model controls for depressive symptoms and posttraumatic stress at baseline. The overall model, shown in Figure 5, demonstrated acceptable fit indices (χ^2(119)=288.04, p <.01, RMSEA=.07, CFI=0.94, TLI=0.93, and χ^2/df ratio of 2.42) and explained 53.2% of the variance in SRCs. Due to lack of significance, the direct path between the sleep and SRC latent variables was held at zero for this model. As hypothesized, the total indirect effect of sleep on SRCs was significant (95% bootstrap CI [.017, .464]) and adaptive strategies mediated the relationship between sleep and SRCs (95% bootstrap CI [.001, .058]). Problems sleeping was associated with less frequently use of adaptive strategies at baseline (β=-.13, p<.05), which in turn was associated with higher SRCs at follow-up (β=-.20, p<.001). Conversely, the mediation between sleep and SRCs through maladaptive strategies was not significant (95% CI [-.004, .436]). However, the paths were significant such that problems sleeping were positively associated with more use of maladaptive strategies (β=.84, p<.001), which was then related to increased SRC endorsement at follow-up (β=.23, p<.05). For covariates, depression was positively related to both sleep (β=.54, p<.001) and SRCs (β=.50, p<.001), while posttraumatic stress was positively associated with sleep (β=.48, p<.001). Anxiety and demographic variables were not significantly related to the variables of interest in this model after controlling for depression and posttraumatic stress.

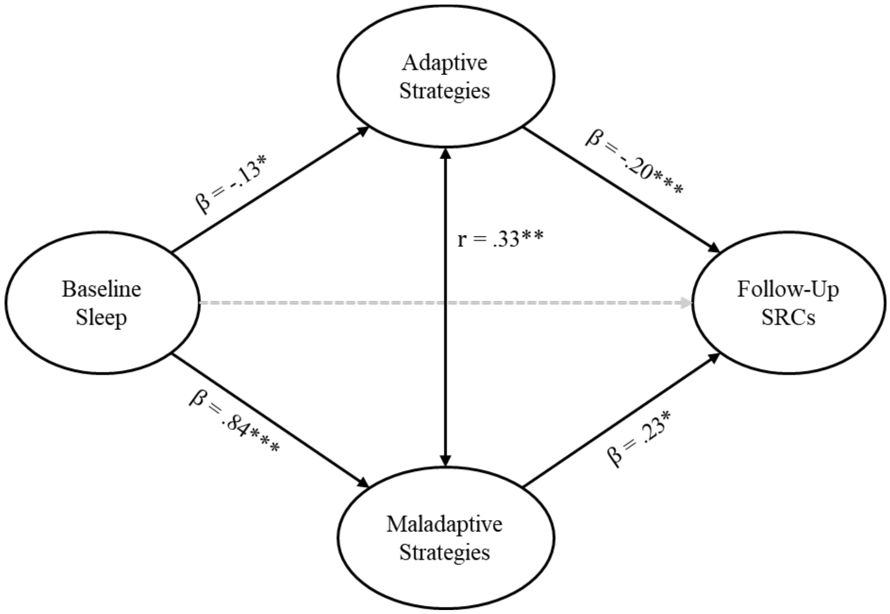
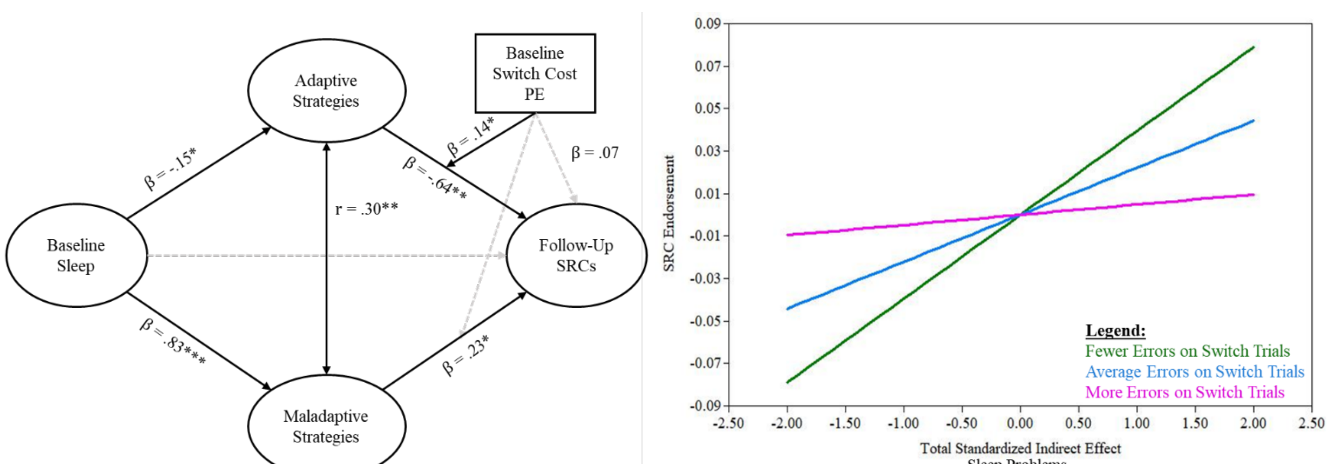


Figure 5. Structural model for Hypothesis 1 showing the mediation of the sleep and suicide-related cognitions relationship by emotion regulation strategies. Covariates and observed variables are not included in the figure for simplification. Note: * p<.05, **p<.01, ***p<.001.

Hypothesis 2: The relationships between the baseline ERS mediators and SRCs at follow-up would be moderated by baseline executive function.

For the next hypothesis, because the latent executive function variable was not supported, observed executive function indicators were tested individually as moderators of the paths between emotion regulation strategies and SRCs in the previous structural model. Additionally, all demographic variables were again included and dropped from the model if they were nonsignificant. There were no significant main effects or interactions for visuospatial working memory (Corsi), impulsivity (GNG), or problem solving (MaRs-IB).

However, significant interactions were observed for the attention shifting variables. When including the simpler switch cost percent errors in the model as a moderator, there was a significant main effect of adaptive ERS (β=-.64, p<.01) similar to that of the original structural model with more frequent use of adaptive strategies associated with less endorsement of SRCs. Maladaptive ERS were also associated with increased SRCs in this model (β=.23, p<.05). There was no significant direct effect of switching (i.e., the ability to appropriately shift between rule sets), nor was the interaction for the path between maladaptive ERS and SRCs significant. However, switching moderated the *b* path (β=.14, p<.05) as shown in Figure 6a. This model explained 55.9% of variance in SRCs. Overall, switching moderated the mediation of poor sleep and SRCs by adaptive strategy use. Next, various levels of the moderator were examined to explore how it impacted the mediated relationship for an overall indirect effect (i.e., combined effect of sleep, adaptive ERS, and EF) on SRCs as displayed in Figure 6b. Notably, while the slope for poorer EF (i.e., more errors on switch trials) was relatively flat, there was an increase in SRC endorsement with *better* attention shifting when including the effects of poor sleep. Thus, while simple attention shifting is typically implicated in *lower* suicide risk, when sleep is poor, participants who were better at shifting attention were more likely to endorse SRCs. Potential explanations for this finding are elaborated on in the next section.



a. **b.**

Figure 6. (a) Structural mediation model with baseline switch cost percent errors moderating the adaptive ERS and SRC path. (b) Total indirect effect of sleep on SRCs through

adaptive strategy use by EF ability. Covariates and observed variables are not included in the figure for simplification. Note: * $p<.05$, ** $p<.01$, *** $p<.001$.

The overall model with congruency cost, or the more complex attention shifting measure (i.e., accurately shifting rule sets with competing behavioral responses), as the moderator is shown in Figure 7a. This model explained 55.1% of the variance in SRCs. When congruency cost was included, the effect of adaptive ERS on endorsement of SRCs became positive (β=1.42, p>.05). Importantly, however, this path was no longer significant and should not be interpreted on its own. Maladaptive ERS continued to demonstrate a significant relationship with increased SRCs (β=-.11, p<.05). There was no moderation of EF on this path, but the congruency cost percent errors moderated the path between adaptive ERS and SRCs (β=-.11, p<.05). Next, different levels of the moderators were examined to further explore the effect it had on the mediated relationship, which was displayed as the total indirect effect (i.e., combined effect of sleep, adaptive ERS, and EF) on SRC endorsement in Figure 7b. As shown in the figure, for participants with better complex attention shifting abilities (i.e., fewer errors on incongruent trials), the total indirect of poor sleep on SRCs is reduced. However, as hypothesized, more errors (i.e., poorer EF) was associated with more SRC endorsement. There was no significant direct effect of congruity cost on SRCs (β=.04, p=.48). Potential explanations for this finding are detailed further in the Discussion section.

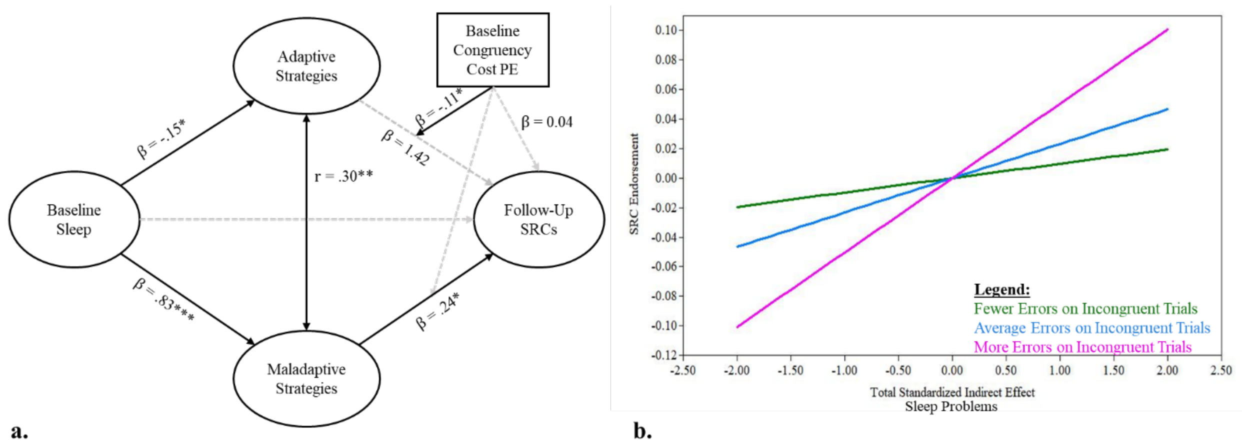


Figure 7. (a) Structural mediation model with baseline congruency cost percent errors moderating the adaptive ERS and SRC path. (b) Total indirect effect of sleep on SRCs through adaptive strategy use by EF ability. Covariates and observed variables are not included in the figure for simplification. Note: * *p*<.05, ***p*<.01, ****p*<.001.

Hypothesis 3: the relationship between baseline problems sleeping and SRCs at follow-up would be mediated by affect following a mood induction procedure. This mediation would be moderated by executive function task performance following mood induction.

The moderated mediation model shown in Figure 2 was also examined using the observed indicators of executive functioning one at a time. The measurement model with baseline sleep, follow-up SRCs, and post-induction affect demonstrated acceptable fit indices, $\chi^2(58)=122.66$, $p<.001$, RMSEA=.06, CFI=0.97, TLI=0.96. The structural model included depression, anxiety, posttraumatic stress, and demographic covariates, which were dropped if nonsignificant with the variables of interest. For the executive functioning variables, none of them evidenced a significant main effect on SRCs nor an interaction with affect on SRCs. Therefore, state affect did not appear to interact with EF to predict SRC endorsement. The structural model without EF demonstrated good fit indices, except the significant chi-square test of model fit, which is likely due to the large sample size, $\chi^2(95)=181.65$, $p <.001$, RMSEA=.07, CFI=0.95, TLI=0.94. As shown in Figure 8, both the *a* path (β=.47, p<.001) and *b* path (β=.18, p<.05) were significant indicating problems sleeping are associated with increased sadness, which is then predictive of increased endorsement of SRCs (95% bootstrapped CI [.017, .198]). Regarding the covariates, depression (β=.62, p<.001) and identifying as non-heterosexual (β=.14, p<.05) were related to increased SRCs, while depression (β=.49, p<.001) and posttraumatic stress (β=.51, p<.001) were related to increased problems with sleep.

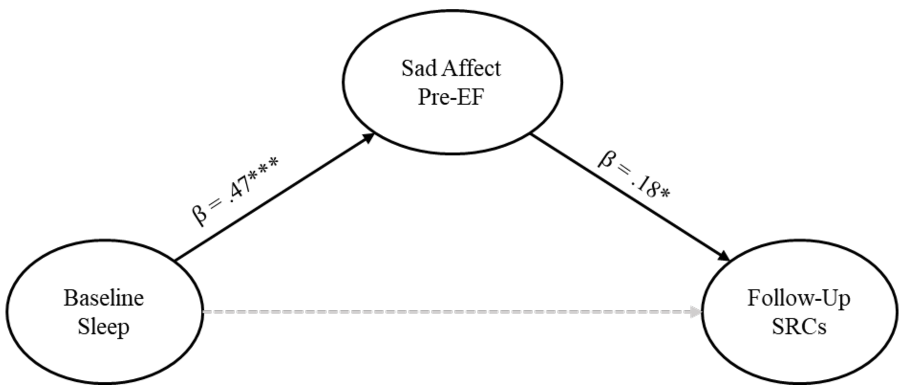


Figure 8. Structural relationship between baseline problems sleep, sad affect prior to completing EF tasks, and follow-up SRCs. Covariates and observed variables are not included in the figure for simplification. Note: * p<.05, **p<.01, ***p<.001.

Hypothesis 4: The relationship between baseline problems sleeping and SRCs at follow-up will be mediated by prolonged affect recovery (i.e., continued negative affect after completing EF tasks) following a mood induction procedure. This mediation will be moderated by executive function task performance following the mood induction.

Next, this model was tested using the affect following completion of the cognitive tasks to determine if differences in affect recovery mediated the sleep and SRC relationship with EF variables moderating the *b* path. The overall measurement model demonstrated good fit indices,

$\chi^2(58)=97.04$, $p<.01$, RMSEA=.05, CFI=0.98, TLI=0.98. However, when the paths between latent variables were added, as shown in Figure 9, the *a* and c' paths were not significant for the combined groups, nor was it significant or statistically different for either group of those who were given the affect manipulation or those who were not when comparing chi-square statistics using multiple group analyses (*a* path: $\chi^2(1)=0.16$, $p>.05$; *c'* path: $\chi^2(1)=0.28$, $p>.05$). This model demonstrated acceptable fit indices, $\chi^2(81)=164.96$, $p<.001$, RMSEA=.07, CFI=0.96, TLI=0.95. The model controlled for the effect of depression on each variable of interest (SRCs $\beta=.34$, $p<.05$; affect $\beta=.55$, $p<.001$; sleep $\beta=.43$, $p<.001$), as well as for the effect of posttraumatic stress on sleep ($\beta=.55$, $p<.001$). In comparison with Figure 8, these result suggests that problems with sleep have an immediate, negative impact on sad affect, however, this reactivity is transient and not maintained longer than several minutes following emotional stimulus removal (95% bootstrapped CI [-.226, .160]).

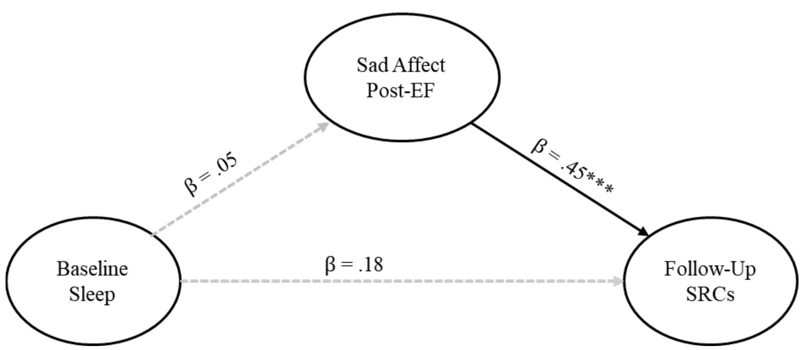


Figure 9. Structural relationship between baseline problems sleep, sad affect immediately following completion of EF tasks, and follow-up SRCs. Covariates and observed variables are not included in the figure for simplification. Note: ***$p<.001$.

Hypothesis 5: The relationship between executive function task performance at baseline and at follow-up would be moderated by negative affect immediately following the mood induction procedure.

Since the executive functioning latent variable was not supported, the impact of affect on executive function was tested for each observed variable independently. Demographic factors, depression, anxiety, and posttraumatic stress were entered into the model as covariates. When not significant, these covariates were dropped from the model. As displayed in Table 8, with the exception of CTS switch cost, all baseline executive function variables were significantly related to their follow-up counterparts. However, none of the relationships were moderated by sad affect following mood induction. There were additional significant effects from covariates. Identifying as non-heterosexual was associated with better visuospatial working memory (Corsi; β=.22, p<.01). Age was negatively related to the number of correct responses obtained on the perceptual reasoning task (MaRs-IB; β=-.16, p<.01). Female sex assigned at birth was related to higher overall accuracy (β=.13, p<.01) and more correct responses (β=.12, p<.05) on the perceptual reasoning task.

Table 8. Main and interaction effects of baseline cognition and pre-task affect on follow-up cognitive task performance**.**

	Main Effects		
	EF	Affect	Interaction
Executive Function Variable			
Corsi Backward Span	.31***	.36	-.08
CTS Switch Cost PE	.03	.09	-.01
CTS Congruity Cost PE	.17*	-.76	.06
MaRs-IB Correct Responses	.46***	-.07	-.01
MaRs-IB Accuracy	.75***	-.10	.01
GNG Commission Errors	.32***	-.05	.01

Note: Values are standardized betas; *p<.05, ** $p < .01$, *** $p < .001$

Chapter IV: Discussion

Review of Findings and Implications

The purpose of this study was to examine the complex relationship between problems with sleep and increases in suicide-related cognitions while building upon past findings with consideration of the impact of state affect and cognitive processes. The impact of sleep on emotion regulation strategy use and executive functioning abilities were explored as one explanatory mechanism for this association. Some of the hypotheses were supported using this non-clinical participant sample. The overall association between problems with sleep and SRCs was observed, with more subjective difficulty sleeping at baseline significantly predicting an increased endorsement of SRCs at the one-month follow-up. This was consistent with prior findings from longitudinal studies (e.g., Bernert & Nadorff, 2015; McManimen, 2020; McManimen et al., 2021; Wong & Brower, 2012; Wong et al., 2011).

Emotion regulation strategies were explored as a potential mechanism for this sleep-suicide relationship. In contrast to the initial CERQ validation study (Garnefski et al., 2001), some factors were associated with both the more adaptive and less adaptive strategies. These included acceptance of the distressing event (e.g., learning to live with it, accepting it cannot change) and putting it into perspective (e.g., believing others have it worse or that it could be worse). As Aldao and colleagues (2010) categorized strategies as adaptive or maladaptive based on their associations with positive and negative long-term outcomes, respectively, these two typically adaptive scales loading along with the maladaptive ones may be due to the types of distressing situations that the person is attempting to regulate. For example, accepting that depression is chronic and not modifiable may foster hopelessness. Similarly, putting distress into perspective by comparing one's circumstances to worse outcomes may be dismissive of internal states. Thus, both may be used maladaptively. For those individuals, learning to appropriately employ these strategies could be a treatment target. Specifically, learning to live with distress that is out of one's control without fighting to regain control or place blame is one of the basic tenants of dialectical behavior therapy, one of the gold-standard treatments for patients experiencing chronic suicide ideation (Linehan, 2014).

Building upon prior findings, the remaining emotion regulation strategies significantly mediated the sleep-SRC relationship. For the less adaptive strategies, there was a significant positive relationship between sleep disturbances and SRCs such that poor sleep was associated with more frequent use of maladaptive strategies, which in turn predicted an increase in SRC endorsement. For more adaptive strategies, poorer sleep was associated with less frequent ERS usage, which was then related to decreased SRC endorsement at follow-up. Thus, the link between sleep and suicide risk is at least partially explained through the types of emotion regulation strategies one employs. Risk is increased when using the strategies that either aim to place blame on oneself or others, catastrophizing the impact of the distressing event on one's life, or ruminating on the thoughts and emotions regarding the event.

Notably, the higher frequency maladaptive strategy use in the context of poor sleep does not appear to be a result of depressive sequelae since the model controlled for depressive symptoms. This relationship may help to explain the widely observed affective consequences of poor sleep and the potential mechanism that begins the bidirectional cascade between depression and sleep problems (O'Leary et al., 2017). Although difficulty sleeping is a symptom of depression, poor sleep may be a precursor to the cascade. For instance, after a night of poor sleep, someone may be less inclined to participate in social activities or have a quicker, negative reaction to emotionally-salient social interactions due to fatigue, which may lead to rumination at night and further sleep disruption. Over time, this pattern can build upon itself and someone with a vulnerability toward depression may then experience the depressogenic cognitions, which further influence sleep (e.g., rumination), creating a cyclical relationship.

For the strategies associated with lower suicide risk (e.g., distraction from the distressing event, refocusing on strengths to overcome the distress, using it as a learning experience, and looking at the positive side of the distressing event), individuals were less likely to engage in these strategies when their sleep was poor. This is in in line with previous research showing poor or disrupted sleep impacts emotion regulation strategy selection. For example, Killgore and colleagues (2008) found that sleep deprivation reduces engagement in positive reappraisal as a means of coping with stressors due to temporarily increased prefrontal lobe dysfunction. Furthermore, when instructed to engage in this adaptive strategy, those with poorer sleep quality are less able to formulate the reappraisals to aid in emotion modulation (Mauss et al., 2013). For instance, one may see an acquaintance in a store and wave to them but receive no acknowledgment from that other person. Someone with adequate sleep may be able to identify multiple reappraisals of the situation (e.g., *they did not see me*, *they were in a rush*, or *they do not like me*), while someone with poor sleep may struggle to provide multiple possible reappraisals and perseverate on the initial negative interpretation. The positive or neutral explanations allow the individual to focus on external causes of not being acknowledged compared to focusing only on the internal, negative explanation. Paired with an overall decrease in positive emotion generation following poor sleep (McGlinchey et al., 2011), the confluence of fewer and ineffective adaptive strategies with low positive emotion can create an internal state more susceptible to suicide-related cognitions. In this example, the individual with poor sleep and low positive emotions would be more likely to generate a negative explanation of the ambiguous situation (i.e., *they hate me*) rather than a positive or neutral reappraisal. Over time, these negative interpretations could increase someone's sense of social disconnectedness and depressive symptoms, making them more likely to experience SRCs.

Furthermore, the relationship between adaptive emotion regulation strategy use and endorsement of suicide-related cognitions was moderated by a facet of executive functioning, simple and complex attention shifting. For the simple attention shifting (CTS switch cost percent errors), the total indirect effect suggested that the better performance, or fewer errors when switching between rule sets, was associated with higher endorsement of SRCs. At face-value, this result is counter to the existing literature demonstrating attentional control is protective against suicide. Most research found worse attentional control in samples endorsing suicide ideation or prior attempts, but there are notable differences between the current study and past literature (for a review, see Bredemeier & Miller, 2015). Specifically, in previous studies, attentional control was typically operationalized using the Stroop or Trails tasks, samples are psychiatric and often recruited via inpatient services, and researchers do not assess fatigue as a covariate. It is possible that the typical result of worse shifting with higher suicide risk may be nonsignificant or opposite when factoring in fatigue in a general population sample or with computerized cognitive tests. Past studies also largely utilized response times to determine worse performance, which were not included with the current study due to the remote data collection. Perhaps those with higher risk levels take longer to complete an attention shifting task but do so more carefully than those at lower suicide risk (i.e., fewer errors but longer reaction times), which would indicate different findings based on the outcome variable. However, if this were true, it would likely carry over into the complex attention shifting variables for similarly counterintuitive findings. Therefore, it appears more likely that the current finding is less reliable and a result of imprecise measurement given the convergence of prior findings across various settings and diagnostic categories.

As previously described, these switch cost errors occur when the participant fails to appropriately shift which rule is applied for a given trial. There is no consideration of whether or not the behavioral response differs between rule sets. As a result, impulsive responses may be counted as correct because they were still responding to the prior trial's rule when the required behavioral response is identical for the previous and current cue (i.e., the trials are congruent). This complicates the understanding of this finding as it is unclear if the participants with fewer errors were impulsively responding, and the limited variability (i.e., no or very few errors) in the impulsivity measure (GNG) does not allow for exploration of this potential confounding variable with this sample size. Another explanation may be that the finding is unstable and would not be significant with larger sample sizes. Finally, it is possible that attempts at shifting attention when fatigued are ineffective, leading to frustrations when the deployed adaptive ERS do not reduce distress. However, this hypothesis is outside the realm of this study since only strategy use was assessed, not *difficulties* in using the strategies. Future studies may explore that relationship with other emotion regulation measures, such as the difficulty engaging in goal-directed behaviors subscale of the DERS (Gratz & Roemer, 2004).

Alternatively, the complex attention shifting variable (CTS congruency cost percent errors) takes the behavioral responses into account and only examines errors committed on trials where the behavioral response to the different rule sets requires pressing different response keys. Therefore, accidental correct answers are less likely to cloud the interpretation of the findings, making this outcome measure a purer attention shifting variable compared to the shift cost errors. Indeed, this variable showed the expected moderation. The total indirect effect of sleep on SRC endorsement through adaptive ERS was moderated such that more errors (low complex attention shifting abilities) was associated with higher endorsement of SRCs at follow-up. This means that the participants with poorer sleep engage in fewer adaptive emotion regulation strategies, and when they do, those with lower EF do not have the attentional resources available to devote to problem-solving the distressing situation and the content of their cognitions related to it. Slopes for the participants with better attention shifting (fewer or average number of errors) were relatively flat, indicating that better baseline abilities may diminish the negative impact of sleep problems on SRCs.

Clinically, this finding is important as it identifies a vulnerability factor that may be targeted in treatment when overall emotional distress is relatively low compared to a suicidal crisis. For example, patients with more difficulty in complex attention shifting may benefit from psychoeducation regarding compensatory strategies and practice with implementation so that they are better able to navigate a crisis despite fewer attentional resources. Such compensatory strategies may include reducing distractions when in environments where they need to focus on problem-solving, using “cheat sheets” for making decisions or applying emotion regulation strategies effectively, or limiting demands on attention by working out decisions on paper.

Additionally, lower attention shifting abilities may identify which patients would benefit from sleep-focused treatments. While research has demonstrated better sleep improves executive functioning (e.g., Miró et al., 2011), these results indicated a mechanism through which the preservation of limited attentional resources is particularly beneficial, by enabling them to engage in those adaptive cognitive emotion regulation strategies effectively. Sleep interventions may include insomnia-specific treatment such as Cognitive Behavioral Therapy for Insomnia (CBT-I; Rossman, 2019) for those that have clinically significant difficulties falling asleep or staying asleep. For the broader patient population with daily fatigue not resulting from insomnia, a sleep hygiene approach may be more appropriate. This would include restricting time in bed, maintaining a consistent sleep schedule, and limiting caffeine among other behaviors (Friedrich & Schlarb, 2018). By intervening at an early stage in this relationship, clinicians may stop the progression toward SRCs as the patients would have more cognitive resources to devote to modulating emotional responses to stressors (i.e., employing adaptive regulation strategies).

For those already experiencing suicide-related cognitions, while the mechanism of change has not yet been identified, there is evidence from at least one randomized control trial that even a brief CBT-I intervention delivered through a primary care setting can reduce the intensity of suicide ideation (Pigeon et al., 2019). Regarding low shifting abilities often identified in these populations (Bredemeier & Miller, 2015), sleep interventions would likely facilitate their ability to engage in traditional cognitive-behavioral therapy approaches by freeing cognitive resources necessary to engage in treatment components requiring cognitive flexibility as sleep improves cognitive performances (Miró et al., 2011). Although no study examining executive functioning deficits as a predictor of poor treatment outcomes in a high suicide risk population was identified, there is some evidence to suggest that lower cognitive abilities including complex decision making, may inhibit a patient's ability to learn, retain, and implement cognitive strategies in other psychiatric samples (Bates et al., 2006; Lucas et al., 2021). For suicide specifically, freeing these resources to engage in treatment by first targeting poor sleep would likely be crucial for beneficial treatment outcomes as brief CBT for suicide (BCBT; Bryan & Rudd, 2018) includes cognitive reappraisals, emotion regulation, and problem solving, all of which depend upon cognitive control abilities.

The remaining executive functioning variables were not significant moderators of the mediated relationship between sleep and SRCs, nor did they have direct effects on SRC endorsement. Previous research showed that sleep difficulties and disturbances were associated with lower executive functions in both community and clinical samples (Lowe et al., 2017; McCall & Black, 2013; Nilsson et al., 2005; Walker, 2009). The reasons for the non-significant relationships among sleep, executive functions, and emotion regulation variables are unclear and may be multiply determined. This may be because visuospatial working memory, impulsivity, and perceptual reasoning are less influenced by sleep problems, not as critical to cognitive emotion regulation strategies compared to attention shifting, or may be more proximal suicide risk factors. The measures used in this study were chosen as they assessed different facets of executive function while minimizing the impact of response times. With remote studies, there is some concern that reaction time variables are sensitive to variations in internet and computer processing speeds, so the traditional speeded measures (e.g., Trails) were not used for this remote study (Stewart et al., 2017). Additionally, traditional measures such as a digit span test are subject to dishonesty when used remotely (e.g., writing numbers to be remembered). Instead, the measures chosen for this study were ones similar to the more traditional measures, limited the impact of dishonesty and speed, and had a demonstrated overlap in activation patterns with emotions (Morin et al., 2023; Rottschy et al., 2012; Zhang et al., 2017). Given the mixed findings on EF and suicide risk based on the type of sample and the specific tests used, different results may be obtained with other measures of working memory, inhibition, and problem solving or within a clinical sample. Specifically, Bredemeier and Miller (2019) noted that findings between research studies appeared to be dependent upon the type of sample studied with more consistent findings for patients with depression compared to mixed diagnostic, bipolar, or psychotic patient populations. Furthermore, as Allen et al (2019) discussed in their review, cognitive performances differ based on the emotional context in which performance is measured, with worse cognition occurring during higher affective states. A general population sample is unlikely to be experiencing the significant emotional distress that a psychiatric inpatient or even an outpatient sample experiences while participating in research. Therefore, the effect of broad poor sleep quality on executive function may not be strong enough to be detected in a non-clinical sample of this size. Another possibility includes the operationalization of sleep in this study. It is possible that using a more proximal measure of sleep quality or disturbances (i.e., polysomnography, actigraphy, sleep diary) may be better for detecting significant impacts on cognition in general populations. The current study used more distal measures assessing sleep quality and disturbances over the course of days to months, but findings may differ when including proximal indicators such as actigraphy (e.g., sleep quality in the previous night) or acute sleep deprivation.

The current study also aimed to examine the impact of experimentally induced sad affect on executive functioning. Unfortunately, the data did not support the hypothesis that an increase in sadness, induced by the video used in this study, impairs executive functioning by pulling attentional resources away from these cognitive functions. The lack of significance was not attributed to the manipulation as the participants in the experimental group rated the PANAS-X Sadness items significantly more intense following the video than they did immediately prior to it. Instead, the induced negative affect may not be sufficient to cause impairments in EF. It is possible that a similar induction using a clinical outpatient or psychiatric inpatient sample may produce exacerbations in negative affect that lessen cognitive performances. Such a finding would be consistent with the breadth of literature described previously demonstrating executive function deficits in clinical populations as even mildly depressed participants show lower cognitive control with negatively-valenced distractors (Masuyama et al., 2018). Similarly, research has shown attentional deficits in remitted major depressive disorder when in a euthymic state and a graded link with depressive severity (McDermott & Ebmeier, 2009; Paelecke-Habermann et al., 2005), which suggests that stronger affective states may be necessary to elicit the hypothesized interaction between cognition and emotion.

However, this study utilized a sample more similar to the general population. A study by Grove and colleagues (2020) used an undergraduate student population in a laboratory-stressor paradigm and found that suicide-related cognitions were predictive of poor sleep quality, increased reactivity to the stress paradigm, and prolonged affective recovery. The difference in findings between the Grove study and the current one may be reflective of the type of induction, with a laboratory stressor (e.g., giving an impromptu speech to an unfriendly audience) being more salient and thus more effective than viewing a sad video remotely. Future research may consider using laboratory stressors such as the Trier Social Stress Test to induce the emotional interference. This would allow for researchers to further explore the impact of limited cognitive resources being split between heightened emotions and a neuropsychological test on SRCs. More salient emotional manipulations would not be ethically feasible with remote data collection as risk assessment cannot be effectively incorporated. Additionally, the operationalization of sleep likely impacted the extent of the findings observed in the current study. For instance, the Vanderlind et al (2014) study used objective actigraphy measures of sleep, which resulted in observing more immediate impacts of poor sleep quality on cognitive performance compared to the comparatively distal self-reports of past-month sleep habits.

Limitations

This study has several limitations. First, all data were collected remotely via MTurk, which introduces a higher risk of invalid data. Efforts were made to reduce this risk by including attention checks throughout the study and by using geolocation restrictions so that “bot farms” could not monopolize all of the available study HITs. A large majority of HIT attempts were deemed to be invalid due to failing attention checks or attempting the study from identical geolocations, but it is still possible that a few of the participants that were included in the analyses were not fully attending to the tasks or were answering questions in a random manner. However, this is a limitation of all research as in-person studies are also subject to suboptimal participant effort. An additional concern for remote data collection of EF is inconsistency in reaction times, which was mitigated by limited the number of EF variables that incorporated timing into the score. For example, rather than using reaction times for the GNG, the number of omission errors was analyzed.

Additionally, the current study utilized a short-term longitudinal design to explore the relationship between sleep and SRCs. Since some research has shown a dose-response of chronic sleep problems on suicide risk (Khader et al., 2020; Nadorff et al., 2013; Tanskanen et al., 2001), limiting the data collection to a one-month interval also limits the possibility of capturing this chronic effect. The participants in this study who endorsed poor sleep quality, insomnia, or nightmares did so for their current sleep habits. Data were not collected on the duration of sleep problems, so it is unclear how many were experiencing chronic poor sleep and were thus more likely to endorse SRCs. Longer-term studies with resources to thoroughly assess the onset, course, and duration of sleep with respect to fluctuations in suicide risk are warranted.

Another limitation is the relative homogeneity of the sample. The participants were predominantly White, non-Latino/a, heterosexual, and college-educated. As research has identified varying suicide risk levels for based on race, ethnicity, sexuality, and educational status, the findings of the current study should not be generalized to the broader population.

The study also used self-report measures of sleep and emotional distress. As such, participants may have overreported or underreported their symptoms or affective states. The previously discussed acute effects of sleep deprivation on executive functioning shown by experimental manipulations of normal sleep patterns (Drummond et al., 2006; Nilsson et al., 2005) were likely masked by perceived chronic sleep difficulties, which may not show similar effects in general populations. Additionally, research demonstrates differential impacts of objectively measured and perceived difficulties with sleep on mood and cognition (Bernert et al., 2014; Bernstein et al., 2019; Klumpp et al., 2017; Williams et al., 2013). Therefore, future research should build upon the current findings using objective measures (e.g., actigraphy, polysomnography), clinical interviews, and ecological momentary assessment (EMA) to better explore the fluid nature of suicide risk. The latter is particularly relevant for assessing SRCs as suicide risk is inherently fluid and fluctuates throughout the day (Rudd, 2006). The current study assessed SRCs broadly as an overall average of cognitions experienced across multiple days. EMA would enable researchers to capture the nuances of these complex relationships as suicide risk varies.

Concluding Remarks

Despite these limitations, the current study makes an important contribution to the field of suicide risk assessment, prevention, and postvention as it explores the impaired disengagement framework of the sleep-suicide relationship with a focus on cognitive strategies to cope with a distressing event rather than the typical focus of strategies to cope with a distressing emotion. These findings can inform treatment for individuals at a higher risk of suicide by identifying which patients may find more benefit from sleep-focused or cognitive compensation treatment targets. Similarly, improving sleep and identifying strategies to compensate for lower executive functioning, specifically the set shifting facet, can prevent the development of emotional distress by allowing for a more efficient use of limited attentional resources. While future research is necessary to continue exploring the mixed findings explaining the sleep-suicide relationship, the current study provided a necessary step to move the field of suicidology forward toward the goal of reversing the decades-long trend of increasing suicides across the country.

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