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Sleep problems may mediate associations between rumination and PTSD and depressive symptoms among OIF/OEF veterans

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Abstract

Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans have high rates of posttraumatic stress disorder (PTSD), depression, and sleep problems. Identifying potential contributing factors to these mental health problems is crucial for improving treatments in this population. Rumination, or repeated thoughts about negative experiences, is associated with worse PTSD, depression, and sleep problems in non-veterans. Therefore, we hypothesized that rumination would be associated with worse sleep problems, PTSD, and depressive symptoms in OIF/OEF veterans. Additionally, we proposed a novel hypothesis that sleep problems are a mechanism by which rumination contributes to depressive and PTSD symptoms. In this cross-sectional study, 89 OIF/OEF veterans completed measures of trait rumination, sleep problems, and PTSD and depressive symptoms. Analyses confirmed that greater rumination was associated with worse functioning on all mental health measures. Moreover, greater global sleep problems statistically mediated the association between higher rumination and more PTSD and depressive symptoms. Specifically, sleep disturbance and daytime somnolence but not sleep quantity emerged as significant mediators. Although it is impossible with the current non-experimental data to test causal mediation, these results support the idea that rumination could contribute to impaired sleep, which in turn could contribute to psychological symptoms. We suggest that interventions targeting both rumination and sleep problems may be an effective way to treat OIF/OEF veterans with PTSD or depressive symptoms.

Keywords: Rumination, Sleep Problems, PTSD, Depression, Veterans

Introduction

Mental health problems are common after military deployment. Approximately 22% of Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans entering Veterans Affairs (VA) health care are diagnosed with Posttraumatic Stress Disorder (PTSD), and 17.4% have depression (Seal, Metzler, Gima, Bertenthal, Maguen, & Marmar, 2009). The factors that lead some veterans to develop these symptoms are poorly understood. Identifying potential contributing factors is critical to improving treatments for this vulnerable population.

We propose that one contributing factor to the development and maintenance of poor mental health in OIF/OEF veterans is rumination, or repetitive thought about negative feelings and problems (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Rather than effectively tackling problems, ruminators unproductively relive past experiences and brood about questions such as “What does it mean that I feel this way?” and “What if I don’t snap out of this quickly?” This form of repetitive thought is associated with worse mental health symptoms across a wide range of psychopathologies in non-veterans (for a review, see Nolen-Hoeksema et al., 2008). The few studies with veterans found that rumination is associated with increased emotional distress among Vietnam and World War II veterans (Holman & Silver, 1998; Kraaij & Garnefski, 2006) and with PTSD and depressive symptoms in a sample of mostly OIF/OEF veterans (Borders et al., 2012). However, researchers have not explored how rumination increases psychological distress among veterans. We propose that sleep problems constitute one pathway by which rumination is associated with depressive and PTSD symptoms. Sleep problems are a common complaint of OEF/OIF veterans, affecting up to 41% of this population (McLay et al., 2010). Rumination worsens sleep problem in civilian populations (e.g., Guastella & Moulds, 2007), although this association has not been examined in veterans. In the current study, we explored whether rumination is a contributing factor to sleep problems and mental

health symptoms in exclusively OIF/OEF veterans. We also tested whether sleep problems mediate the associations between rumination and depressive and PTSD symptoms. Below, we review the literatures linking rumination with depression, PTSD, and sleep problems in non-veterans. We then draw on relevant theories to hypothesize that impaired sleep is one mechanism by which rumination contributes to mental health symptoms. Because the studies reviewed below measure a range of sleep domains, we will use sleep problems to refer to the larger construct of impaired sleep.

Rumination in Non-Veterans

A robust literature suggests that rumination maintains and exacerbates depressive symptoms. Nolen-Hoeksema and colleagues (2008) propose that responding to a sad mood with ruminative thinking prolongs and intensifies depressive feelings and thoughts. Prospective studies show that distressed individuals who engage in rumination are more likely to develop depressive disorders and have prolonged periods of depression (e.g., Nolen-Hoeksema, 2000). Moreover, dysphoric and depressed individuals induced to ruminate report increased sad mood, retrieve more negative memories, and think more negatively about themselves and current issues in their lives (for a review, see Nolen-Hoeksema et al., 2008).

Rumination is also associated with PTSD symptoms. Ehlers and Clark (2000) argue that traumatized individuals often ruminate about the trauma and its consequences. This perseverative thinking typically involves evaluative and “what if” thinking, such as how the trauma could have been prevented, how the trauma has ruined one’s life, or how justice can be achieved.

Rumination differs from the re-experiencing symptoms of PTSD, which involve sensory memories rather than cognitive appraisals (Ehring, Frank, & Ehlers, 2008). Studies have found that rumination is associated with worse concurrent PTSD symptoms in victims of both assault

and traffic accidents (Ehring et al., 2008; Michael, Ehlers, Halligan, & Clark, 2005). Moreover, rumination following these traumas predicted PTSD symptom severity four to six months later.

An emerging literature suggests that rumination is associated with a range of sleep problems. In experimental research, high-trait ruminators who went through a rumination induction reported more disrupted sleep the night after a midterm exam than did low-trait ruminators (Guastella & Moulds, 2007). Using an objective measure of sleep onset, Zoccola and colleagues (2009) found that greater trait and state rumination predicted longer time to fall asleep (sleep onset latency) the night after a laboratory stressor. Moreover, survey studies (Carney, Edinger, Meyer, Lindman, & Istre, 2006; Hall et al., 2000; Stoia-Caraballo, Rye, Pan, Kirschman, Lutz-Zois, & Lyons, 2008; Takano, Iijima, & Yanno, 2012) have consistently found that higher rumination correlates with worse “sleep quality,” a global construct that includes aspects of sleep quantity, sleep onset latency, number of awakenings during the night, number of sources of impaired sleep (e.g., snoring, breathing problems), difficulty staying awake during the day (daytime somnolence), and subjective judgments of sleep quality (Buysse et al., 1989).

In sum, the links between rumination and poor mental health among non-veterans are well established. Given the high prevalence of depression, PTSD, and sleep problems among OIF/OEF veterans, it seems important to explore whether rumination contributes to these outcomes in this population. There are reasons to expect that rumination may be a common strategy employed by OIF/OEF veterans. First, rumination is more likely in individuals who have experienced extreme stressors or trauma (e.g., Baer, Peters, Eisenlohr, Geiger, & Sauer, 2012), and approximately 50% of OEF/OIF veterans report some type of combat trauma (Tanielian & Jaycox, 2008). Second, rumination is associated with cognitive inflexibility and impaired inhibition (Nolen-Hoeksema et al., 2008), cognitive deficits that are common

consequences of traumatic brain injury (Frencham, Fox, & Maybery, 2005), which approximately 19% of OIF/OEF veterans sustain during deployment (Tanielian & Jaycox, 2008). Thus, many OIF/OEF veterans have experienced events that increase their likelihood of engaging in rumination.

A Proposed Mediation Model

In addition to exploring the bivariate associations between rumination, psychological distress, and sleep problems in OIF/OEF veterans, we were interested in examining whether sleep problems may constitute a mechanism by which rumination contributes to depressive and PTSD symptoms. Our rationale for this proposed mediation model comes from several different theories.

In their perseverative cognition hypothesis, Brosschot, Gerin, and Thayer (2006) argue that rumination is maladaptive because it produces sustained activation of cognitive and physiological systems. Specifically, as individuals engage in sustained and unproductive attempts at mental problem solving, they are in a state of prolonged cognitive activation, which is in turn associated with elevated activation of autonomic and cardiovascular systems. Thus, individuals who ruminate as a general disposition will show chronically elevated physiological arousal. In support of this theory, rumination is associated with elevated cortisol levels (e.g., Zoccola Dickerson, & Zaldivar, 2008), as well as higher heart rate and blood pressure and slower heart rate recovery (for a review, see Brosschot et al., 2006), all of which are indicative of increased sympathetic nervous system activation. Brosschot and colleagues (2006) focus on particular health implications of perseverative cognition, such as cardiovascular disease and immune functioning. However, another likely consequence of elevated cognitive and physiological arousal is impaired sleep.

Sleep theorists suggest that perseverative cognition and concomitant hyperarousal contribute to sleep problems. For example, Harvey's (2002) model of insomnia proposes that excessive repetitive thought before bed triggers autonomic arousal and emotional distress. This state of heightened arousal and distress contributes to perceptions of inadequate sleep as well as actual sleep deficits. In support of this theory, several studies found that people with insomnia have heightened autonomic arousal during the night (for a review, see Harvey, 2002).

Rumination is also associated with increased beta activity (active brain waves) during sleep, suggesting that repetitive thought during the day contributes to hyperarousal during sleep (Hall et al., 2000). Although Harvey (2002) focused on worry particularly about getting enough sleep in the future, studies indicate that general rumination as defined above is uniquely associated with a range of sleep problems (Carney, Harris, Moss, & Edinger, 2010; Takano et al., 2012).

Finally, theory and research suggest that poor sleep contributes to worse PTSD and depressive symptoms. In their "sleep to forget" hypothesis, Walker and van der Helm (2009) argue that sleep enables the brain to emotionally process significant life events. Specifically, sleep allows for the decoupling of memories from their associated affect, so that memories of negative life events do not trigger the same emotional responses over time. Conversely, lack of sleep contributes to memories retaining the same magnitude of affective charge, resulting in emotional and autonomic hyper-reactivity and subsequent chronic depression and/or anxiety. Of course, sleep problems are diagnostic criteria of both PTSD and depression (American Psychiatric Association, 2000). Therefore, it is not surprising that individuals with PTSD and depression report many types of sleep problems (Lavie, Hefez, Halperin, & Enoch, 1979; Palesh et al., 2007). However, prospective evidence suggests that sleep problems predict the onset and severity of depressive and PTSD symptoms. For example, insomnia and somnolence within one

month of a trauma predict the subsequent development of PTSD (Koren, Arnon, Lavie, & Klein, 2002). Similarly, reviews conclude that insomnia constitutes an independent predictor of new depressive episodes at least one year later (e.g., Baglioni et al., 2011). In longitudinal studies of veterans, insomnia post-deployment predicted later depressive and PTSD symptoms, but symptoms did not predict later insomnia (McLay et al., 2010; Wright et al., 2011).

In sum, we propose that heightened rumination leads to greater sleep problems, and that these sleep problems in turn contribute to both depression and PTSD symptoms. If veterans ruminate about past combat experiences or current life difficulties, they may experience prolonged cognitive and physiological activation, which would contribute to disrupted sleep. If this happens repeatedly, their impaired sleep may prevent emotional processing of negative memories, which would contribute to worse PTSD and depressive symptoms. We are not aware of this particular mediational model being previously examined.

The current study

In this study, we measured rumination tendencies, sleep problems, and PTSD and depressive symptoms concurrently in a sample of OIF/OEF veterans seeking treatment at a tertiary care clinic. In line with the research and theory reviewed above, we hypothesized that: (1) Greater rumination would be associated with more sleep problems, depressive symptoms, and PTSD symptoms in OIF/OEF veterans; and (2) Worse sleep problems would mediate the associations between rumination and depressive and PTSD symptoms.

Method

Procedure and Participants

Veterans were recruited from the Department of Veterans Affairs New Jersey War Related Illness and Injury Study Center (NJ WRIISC), a tertiary care specialty clinic that provides care for veterans with deployment-related health concerns. From 2004 to 2010,

approximately 1200 veterans participated in comprehensive clinical evaluations at the NJ WRIISC. All evaluated veterans were invited to participate in this follow-up study. Of these, 324 consented and were mailed a follow-up questionnaire packet. All research was approved by VA New Jersey Institutional Review Board and appropriate research committees.

Approximately 29% of the veterans we contacted completed the questionnaires. This low response rate likely reflects the fact that for some participants, questionnaires were sent years after initial consent. Thus, we may have not retained current contact information, and/or individuals may no longer have been interested in participating. Despite the low response rate, the sample of veterans used in this study did not differ in initial PTSD symptoms, age, education, or marital status from the baseline sample. Moreover, the prevalence of probable PTSD in our sample (53%) is similar to the 45% reported in an earlier study that reviewed charts at the same clinic between 2004 and 2006 (Helmer et al., 2007). Therefore, the current sample likely represents veterans who have been treated at the NJ WRIISC.

We excluded 4 veterans of other conflicts. Thus, our final sample consisted of 89 OIF/OEF veterans (87% male). Their mean age was 38.92 (SD = 11.08, range = 21-61). Approximately 39% identified as White, 30% Latino/Latina, 18% Black, 2.5% Asian, 2.5% American Indian, and 8% "other." Average years of education was 14 (SD=2.0, range = 11-18).

Measures

Rumination. The 12-item Rumination subscale of the Rumination and Reflection Questionnaire (Trapnell & Campbell, 1999) assesses the general tendency to engage in self-focused repetitive thinking about threats or losses (e.g., "Long after an argument is over with, my thoughts keep going back to what had happened"). Participants indicate level of agreement on a 5-point Likert scale. Higher summed scores indicate more rumination ($\alpha = .94$). This measure

correlates highly with other measures of rumination (Siegle, Moore, & Thase, 2004). The average score on this measure in university samples was 41.52 (Trapnell & Campbell, 1999).

Sleep problems. The 12-item sleep scale of the Medical Outcomes Study (Hays & Stewart, 1992) assesses six dimensions of sleep problems: sleep disturbance (trouble falling asleep, how long to fall asleep, sleep was not quiet, awaken and have trouble falling asleep again), subjective sleep adequacy (get enough sleep to feel rested, get amount of sleep needed), daytime somnolence (drowsy during day, trouble staying awake during the day, take naps), snoring (one item), sleep awakening due to shortness of breath or headache (one item), and quantity of sleep (one item: average hours of sleep per night). Participants respond to questions on a 6-point scale from *none of the time* to *all of the time* in relation to the past four weeks. Based on recommended scoring procedures (Spritzer & Hays, 2003), we converted each item to a 0 to 100 range (e.g., 1 became 0, 2 became 20, ...5 became 100), so that recoded scores represented the achieved percentage of the total possible score. In addition to the six scales mentioned above, the measure yields a 9-item global sleep problems index that averages all items except the snoring item, one somnolence item (taking naps during the day), and the sleep quantity item. This index is similar to the total score on the Pittsburgh Sleep Quality Index (Buysse et al., 1989), a common measure of sleep quality, and correlates with other measures of sleep quality (e.g., Canafax, Bhanegaonkar, Bharmal, & Calloway, 2011).

Because past research suggests that rumination impacts many aspects of sleep, we examined several sleep scales. Specifically, we used the global sleep problems index ($\alpha = .89$), the sleep disturbance ($\alpha = .91$), daytime somnolence ($\alpha = .67$), and the single-item sleep quantity subscales. The internal consistency of the two-item sleep adequacy scale was too low in this sample ($\alpha = .35$) to use in analyses. Reported norms in the general population on these subscales

are as follows (Hayes, Martin, Sesti, & Spritzer, 2005): global sleep problems index (25.79), sleep disturbance (24.47), sleep quantity (6.79), and daytime somnolence (21.89).

PTSD Symptoms. The 17-item PTSD Checklist (Weathers, Litz, Herman, Huska & Keane, 1993) assesses the presence and frequency of PTSD symptoms over the past month. Participants respond on a 5-point scale from *not at all* to *extremely*. Because we did not know the degree of participants' exposure to combat, we used the civilian version of the PCL, which asks about PTSD symptoms in response to a past "stressful experience." This measure correlates highly with the Clinician Administered PTSD scale (Blanchard et al., 1996). Summed scores at or above 50 suggest a probable PTSD diagnosis, and approximately 53% of the current sample scored above this cut-off. To decrease inflated shared variance between measures in our primary analyses, we excluded one item that assesses "trouble falling or staying asleep." Therefore, the scores reported below included 16 items and could range from 17 to 81 ($\alpha = .97$). We also ran the analyses with a) the full scale and b) omitting the item assessing "repeated disturbing dreams" and found the same pattern of results (not reported).

Depressive Symptoms. The 8-item Patient Health Questionnaire (Kroenke, Strine, Spitzer, Williams, Berry, & Mokdad, 2009) assesses the presence and frequency of depressive symptoms over the past two weeks, omitting suicidal ideation for research purposes. We included the additional item that assesses degree of functional impairment. Participants respond on a 4-point scale from *not at all* to *nearly every day*. Research supports the construct validity of this measure as both a screening and diagnostic tool (Kroenke et al., 2009). Approximately 54% of our sample obtained a summed score of 10 or above, which is the recommended cut-off score for estimating diagnosable depression. For our analyses, we again excluded one item that assesses sleep problems ("trouble falling or staying asleep, or sleeping too much"). The scores

reported below therefore included seven items and could range from 0 to 21 ($\alpha = .92$). We also ran the analyses with the full scale and found the same pattern of results (not reported).

Data analysis

We tested our first hypothesis about the bivariate associations between rumination and mental health outcomes using zero-order correlations. To test our second hypothesis, we ran separate regression analyses to examine the total effect of the independent variable (IV; rumination) on each dependent variable (DV; PTSD and depressive symptoms). We then added the mediator (sleep scales) to the regression equations (see Figure 1). Mediation was examined by calculating indirect effects, which are defined as the product of the coefficients for the (a) IV to the mediator and the (b) mediator to the DV after controlling for the IV (Preacher & Hayes, 2008). We examined the significance of indirect effects by calculating the bootstrap estimates and bias-corrected confidence intervals for each indirect effect (Preacher & Hayes, 2008). To reduce the chance of inflated Type 1 error due to multiple analyses, we calculated 99% confidence intervals. An indirect effect that is significantly different from zero suggests that the mediator accounts for a significant proportion of the variance between the IV and DV.

Results

Descriptive statistics and zero-order correlations for all study variables are presented in Table 1. All variables met assumptions of normality. Greater rumination was correlated with more global sleep problems, sleep disturbance, daytime somnolence, and fewer hours of sleep, as well as worse PTSD and depressive symptoms. The sleep scales, PTSD symptoms, and depressive symptoms were positively intercorrelated. This sample did not score significantly higher or lower than the norms provided above on the rumination measure, $t(88) = 1.55, ns$. However, participants did report significantly higher scores on all sleep scales, compared with norms from a nationally representative sample (all t 's $> 7.00, p$'s $< .01$).

Total effect regression analyses indicated that rumination significantly predicted both PTSD ($\beta = .72, p < .0001$) and depressive symptoms ($\beta = .65, p < .0001$). We then included the global sleep problems index as a mediator in each regression equation. Rumination predicted global sleep problems, and sleep problems in turn predicted each DV (see Table 2). Moreover, the coefficients from rumination to each DV decreased when sleep problems was added to the equation. Finally, the 99% bootstrap confidence intervals did not include zero for either dependent variable. Thus, global sleep problems significantly mediated the associations between rumination and PTSD and depressive symptoms. We repeated the same mediational analyses with each of the remaining sleep scales. As seen in Table 2, sleep disturbance and daytime somnolence significantly mediated the associations between rumination and both DVs. Sleep quantity was not a significant mediator for either DV.

Discussion

This correlational study examined the associations between rumination, sleep problems, and PTSD and depressive symptoms in a sample of exclusively OIF/OEF veterans. This was the first study to explore whether rumination is associated with sleep problems in veterans. We also tested the novel hypothesis that rumination may contribute to increased PTSD and depressive symptoms through disrupted sleep. Several interesting findings emerged.

First, rumination was associated with worse sleep problems, PTSD, and depressive symptoms in OIF/OEF veterans. These findings accord with previous studies showing that rumination correlates with psychological distress in veterans of other conflicts. Moreover, although research with non-veterans suggests that rumination contributes to a range of sleep problems, this is the first study to find an association between rumination and impaired sleep in veterans. Specifically, rumination was associated with global sleep problems, sleep disturbance,

daytime somnolence, and fewer hours of actual sleep. These results add to the limited past research suggesting that rumination predicts mental health functioning in OIF/OEF veterans.

Our second hypothesis was that sleep problems would statistically mediate the association between rumination and psychiatric symptoms. Drawing on several theories, we proposed that because rumination prolongs cognitive and physiological activation, it likely contributes to disrupted sleep. This impaired sleep may in turn prevent the emotional processing of negative memories, which could contribute to PTSD and depressive symptoms. Although non-experimental data cannot confirm causal mediation, our pattern of results is consistent with this proposed model. Specifically, we found that global sleep problems, sleep disturbance, and daytime somnolence mediated the associations between rumination and both PTSD and depressive symptoms. By contrast, sleep quantity (typical hours of sleep per night) did not emerge as a significant mediator and was less strongly associated with PTSD and depressive symptoms. The global sleep problems index is similar to measures of sleep quality, or subjective global sleep complaints (Buysse et al., 1989). Previous research also suggests that perceived sleep quality is a better predictor of health and well-being than is sleep quantity (Pilcher, Ginter, & Sadowsky, 1997). Because the global sleep problems index included the other sleep subscales we analyzed, we will focus our discussion on those two subscales.

The sleep disturbance subscale assessed perceived trouble falling and staying asleep, which are hallmark symptoms of insomnia. Thus, our results accord with past findings that rumination predicts more disrupted sleep and longer time to fall asleep (e.g., Carney et al., 2010), and that insomnia symptoms predict future PTSD and depression (e.g., Wright et al., 2011). Moreover, the theories we reviewed above focus on insomnia symptoms. The cognitive and physiological arousal that occurs with frequent rumination likely contributes directly to difficulty

falling and staying asleep (Harvey, 2002). Interestingly, insomnia is associated with unstable rapid-eye movement (REM) sleep, which is characterized by fragmented sleep or frequent micro-arousals (Riemann et al., 2012). Moreover, in their “sleep to forget” hypothesis, Walker and van der Helm (2009) propose that REM sleep in particular is responsible for the emotional processing of negative life events. Thus, unstable REM sleep may constitute an objective measure of the disrupted sleep that mediates the association between rumination and PTSD and depressive symptoms. Clearly, research is needed to examine this speculative hypothesis.

Daytime somnolence also mediated the associations between rumination and psychiatric symptoms. One previous study found links between rumination and excessive daytime sleepiness (Stoia-Caraballo et al., 2008). Given the strong correlation between sleep disturbance and daytime somnolence in our sample, participants’ trouble falling and staying asleep could have contributed to their perceived daytime sleepiness. Unfortunately, our sleep measure did not differentiate between moderate somnolence symptoms such as low daytime energy or subjective sleepiness and more extreme symptoms such as an inability to stay awake during the day. Sleep disorders like obstructive sleep apnea and narcolepsy are common causes of more extreme daytime somnolence (Chellappa, Schröder, & Cajochen, 2009). However, the cognitive and physiological arousal associated with frequent rumination might wear people out and contribute to more moderate somnolence symptoms. Daytime somnolence is associated with motor vehicle and work-related incidents, as well as depression and PTSD (Chellappa et al. 2009; Koren et al., 2002). Future research might examine whether people feel fatigued or sleepy from frequent rumination, and whether this fatigue is in turn related to work performance and accidents.

This study had some important limitations. First, because our data were cross-sectional, we cannot confirm the direction of association between variables. Existing PTSD and depressive

symptoms may contribute to sleep problems and rumination. Similarly, veterans' sleep problems could contribute to their rumination tendencies. Specifically, persistent sleep problems may trigger repetitive thinking about future sleep problems (Harvey, 2002). There is also evidence that sleep deprivation impairs executive attention and the ability to inhibit responses to negative stimuli (e.g., Lim & Dinges, 2010), both of which are implicated in rumination (Nolen-Hoeksema et al., 2008). Thus, in addition to repetitive thought impairing sleep, sleep problems may in turn contribute to increased repetitive thought. A better understanding of the temporal associations between our variables requires a longitudinal or experimental design.

Second, reliance on self-report was limiting for several constructs. It is not clear whether these results would replicate in individuals who have clinician-diagnosed depression and/or PTSD. Similarly, subjective reporting of sleep is not always consistent with objective sleep measures, particularly in depressed individuals (e.g., Jackowska, Dockray, Hendrickx, & Steptoe, 2011). Tang and Harvey (2004) also found that pre-sleep cognitive arousal contributed to distorted perceptions of sleep, suggesting that individuals with high rumination tendencies may provide overestimates of sleep problems. Thus, our obtained associations may be stronger than if we had used objective measures of sleep problems and mental health symptoms. Our use of 99% confidence intervals attempted to prevent Type 1 errors. However, future studies should assess these constructs using non-self-report measures.

Finally, we sampled veterans who sought treatment at a tertiary care VA clinic and who had a low response rate to this survey. The fact that this sample did not differ from the larger baseline sample in terms of demographics or initial PTSD symptoms suggests that our sample represents veterans treated at this particular VA clinic. Nevertheless, this sample exhibits higher rates of PTSD and depressive symptoms compared to other studies of OIF/OEF veterans

(Tanielian & Jaycox, 2008). This is not surprising, as we sampled veterans seeking specialized treatment for war-related injuries. Thus, our results may only generalize to help-seeking OIF/OEF veterans with physical and mental health complaints. Future research should examine whether these results replicate in a non-clinical OIF/OEF veteran population.

Despite these limitations, this study contributes a novel hypothesis and initial supporting evidence for the mediating role of sleep problems in the association between rumination and emotional distress. Clearly, several aspects of the full hypothesis remain untested. Specifically, does cognitive and physiological arousal explain the association between rumination and disrupted sleep? Does impaired emotional processing in turn account for the associations between sleep problems and PTSD and depressive symptoms? Moreover, we do not know whether these associations would replicate in a non-veteran population. For instance, could the extent of past trauma exposure (combat or otherwise) moderate the effect of rumination on cognitive and physiological arousal, sleep, and psychiatric symptoms? Future research will need to address these questions before the hypothesis can be fully supported.

This study also highlights the importance of continued research on the role of rumination in veterans. Rumination is associated with other psychopathologies (e.g., substance abuse) and impulsive behaviors (e.g., aggression, self-harm) in non-veterans that may be particularly relevant for OIF/OEF veterans (Thomsen, Stander, McWhorter, Rabenhorst, & Milner, 2011). One previous study found links between rumination and greater risky behaviors in veterans (Borders et al., 2012), but other potential outcomes of rumination in this population have yet to be explored. We should note that levels of rumination in our sample were not meaningfully different than those reported in civilian samples. Therefore, we cannot conclude that OIF/OEF veterans have greater rumination tendencies than civilians. However, because we assessed only

general tendencies for rumination, we do not know the content of participants' rumination.

OIF/OEF veterans likely have a unique set of stressors (both during and after deployment) about which they might ruminate. Studies with non-veterans suggest that the content of rumination (e.g., depressive, angry) contributes to unique outcomes (e.g., Ciesla, Dickson, Anderson, & Neal, 2011). Future research could explore whether certain types of rumination are more common and problematic in OIF/OEF veterans. Moreover, longitudinal studies should examine whether post-deployment tendencies for rumination primarily reflect pre-deployment traits, or whether experiences during deployment are associated with increased subsequent rumination.

Our results also suggest that treatments targeting *both* rumination and sleep problems may be particularly effective with OIF/OEF veterans suffering from PTSD and depression. Cognitive refocusing treatment for insomnia (Gellis, 2012) attempts to manipulate pre-sleep thought content by teaching clients to think about something that is not cognitively or emotionally engaging. Similarly, cognitive therapy for chronic insomnia (Harvey, 2005) aims to reduce pre-sleep rumination by decreasing attempts at thought suppression and challenging positive beliefs about rumination. Both of these treatments decrease pre-sleep repetitive thinking and improve sleep. Alternatively, training in mindfulness, or intentional and compassionate attention to the present moment, decreases rumination tendencies (Ramel, Goldin, Carmona, & McQuaid, 2004) and improves sleep quality (Carlson & Garland, 2005). Moreover, mindfulness therapy significantly reduced PTSD and depression symptoms in a veteran sample (Kearney, McDermott, Malte, Martinez, & Simpson, 2012). Given these promising treatments, mental health providers who work with OIF/OEF veterans might consider using treatments that target both rumination and sleep problems to decrease depression and PTSD.

References

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.
- Baer, R. A., Peters, J. R., Eisenlohr-Moul, T. A., Geiger, P. J., & Sauer, S. E. (2012). Emotion-related cognitive processes in borderline personality disorder: A review of the empirical literature. *Clinical Psychology Review, 32*(5), 359-369. doi:10.1016/j.cpr.2012.03.002
- Baglioni, C., Battagliese, G., Feige, B., Spiegelhalder, K., Nissen, C., Voderholzer, U., ... & Riemann, D. (2011). Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders, 135*(1), 10-19.
- Blanchard, E. B., Jones-Alexander, J., Buckley, T. C., & Forneris, C. A. (1996). Psychometric properties of the PTSD Checklist (PCL). *Behaviour Research and Therapy, 34*(8), 669-673. doi:10.1016/0005-7967(96)00033-2
- Borders, A., McAndrew, L., Quigley, K. S., & Chandler, H. K. (2012). Rumination moderates the associations between psychiatric symptoms and risky behaviors in Veterans. *Journal of Traumatic Stress, 25*, 583-586.
- Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 193-213. doi:10.1016/0165-1781(89)90047-4
- Canafax, D. M., Bhanegaonkar, A., Bharmal, M., & Calloway, M. (2011). Validation of the post Sleep Questionnaire for assessing subjects with restless legs syndrome: Results from two double-blind, multicenter, placebo-controlled clinical trials. *BMC Neurology, 11*(48), doi:10.1186/1471-2377-11-48
- Carney, C. E., Edinger, J. D., Meyer, B., Lindman, L., & Istre, T. (2006). Symptom-focused rumination and sleep disturbance. *Behavioral Sleep Medicine, 4*(4), 228-241.

doi:10.1207/s15402010bsm0404_3

Carlson, L. E., & Garland, S. N. (2005). Impact of Mindfulness-Based Stress Reduction (MBSR) on sleep, mood, stress and fatigue symptoms in cancer outpatients. *International Journal of Behavioral Medicine, 12*(4), 278-285. doi:10.1207/s15327558ijbm1204_9

Chellappa, S., Schröder, C., & Cajochen, C. (2009). Chronobiology, excessive daytime sleepiness and depression: Is there a link?. *Sleep Medicine, 10*(5), 505-514.

doi:10.1016/j.sleep.2008.05.010

Ciesla, J. A., Dickson, K. S., Anderson, N. L., & Neal, D. J. (2011). Negative repetitive thought and college drinking: Angry rumination, depressive rumination, co-rumination, and worry. *Cognitive Therapy and Research, 35*, 142-150. doi:10.1007/s10608-011-9355-1

Ehlers, A., & Clark, D.A. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy, 38*(4), 319-345. doi:10.1016/S0005-7967(99)00123-0

Ehring, T., Frank, S., & Ehlers, A. (2008). The role of rumination and reduced concreteness in the maintenance of posttraumatic stress disorder and depression following trauma. *Cognitive Therapy and Research, 32*(4), 488-506. doi:10.1007/s10608-006-9089-7

Frencham, K. R., Fox, A. M., & Maybery, M. T. (2005). Neuropsychological Studies of Mild Traumatic Brain Injury: A Meta-Analytic Review of Research Since 1995. *Journal Of Clinical And Experimental Neuropsychology, 27*(3), 334-351.

doi:10.1080/13803390490520328

Gellis, L. A. (2012). An investigation of a cognitive refocusing technique to improve sleep. *Psychotherapy, 49*(2), 251-257. doi:10.1037/a0025746

Guastella, A. J., & Moulds, M. L. (2007). The impact of rumination on sleep quality following a stressful life event. *Personality and Individual Differences, 42*(6), 1151-1162.

doi:10.1016/j.paid.2006.04.028

Hall, M., Buysse, D. J., Nowell, P. D., Nofzinger, E. A., Houck, P., Reynolds, C., & Kupfer, D.

J. (2000). Symptoms of stress and depression as correlates of sleep in primary insomnia.

Psychosomatic Medicine, 62(2), 227-230.

Harvey, A.G. (2002). A cognitive model of insomnia. *Behaviour Research and Therapy*, 40(1),

869-893. doi: 10.1016/S0005-7967(01)00061-4

Harvey, A. G. (2005). A cognitive theory of and therapy for chronic insomnia. *Journal of*

Cognitive Psychotherapy. An International Quarterly, 19, 41-60.

doi:10.1891/jcop.19.1.41.66332

Hays, R. D., Martin, S. A., Sesti, A. M., & Spritzer, K. L. (2005). Psychometric properties of the

Medical Outcomes Study Sleep measure. *Sleep Medicine*, 6, 41-44.

doi:10.1016/j.sleep.2004.07.006

Hays, R. D. & Stewart, A. (1992). Sleep measures. *Measuring functioning and well-being: The*

medical outcomes study approach (235-259). Durham, N.C.: Duke University Press.

Helmer, D. A., Rossignol, M., Blatt, M., Agarwal, R., Teichman, R., & Lange, G. (2007).

Health and exposure concerns of veterans deployed to Iraq and Afghanistan. *Journal of*

Occupational and Environmental Medicine, 49(5), 475-480.

doi:10.1097/JOM.0b013e318042d682

Holman, E., & Silver, R. (1998). Getting 'stuck' in the past: Temporal orientation and coping

with trauma. *Journal of Personality and Social Psychology*, 74(5), 1146-1163.

doi:10.1037/0022-3514.74.5.1146

- Jackowska, M., Dockray, S., Hendrickx, H., & Steptoe, A. (2011). Psychosocial factors and sleep efficiency: Discrepancies between subjective and objective evaluations of sleep. *Psychosomatic Medicine, 73*(9), 810-816. doi:10.1097/PSY.0b013e3182359e77
- Kearney, D.J., McDermott, K., Malte, C., Martinez, M., & Simpson, T.L. (2012). Association of participation in a mindfulness program with measures of PTSD, depression and quality of life in a veteran sample. *Journal of Clinical Psychology, 68*(1), 101-116. doi:10.1002/jclp.20853
- Koren, D., Arnon, I., Lavie, P., & Klein, E. (2002). Sleep complaints as early predictors of posttraumatic stress disorder: A 1-Year prospective study of injured survivors of motor vehicle accidents. *The American Journal of Psychiatry, 159*(5), 855-857. doi:10.1176/appi.ajp.159.5.855
- Kraaij, V., & Garnefski, N. (2006). The role of intrusion, avoidance, and cognitive coping strategies more than 50 years after war. *Anxiety, Stress & Coping: An International Journal, 19*(1), 1-14. doi:10.1080/10615800500412449
- Kroenke, K., Strine, T. W., Spitzer, R. L., Williams, J. W., Berry, J. T., & Mokdad, A. H. (2009). The PHQ-8 as a measure of current depression in the general population. *Journal of Affective Disorders, 114*(1-3), 163-173. doi:10.1016/j.jad.2008.06.026
- Lavie, P., Hefez, A., Halperin, G., & Enoch, D. (1979). Long-term effects of traumatic war-related events on sleep. *The American Journal Of Psychiatry, 136*(2), 175-178.
- Lim, J., & Dinges, D. F. (2010). A meta-analysis of the impact of short-term sleep deprivation on cognitive variables. *Psychological Bulletin, 136*(3), 375-389. doi:10.1037/a0018883
- McLay, R. N., Klam, W. P., & Volkert, S. L. (2010). Insomnia is the most commonly reported symptom and predicts other symptoms of post-traumatic stress disorder in U.S. service members returning from military deployments. *Military Medicine, 175*(10), 759-762.

Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/20968266>

- Michael, T. T., Ehlers, A. A., Halligan, S. L., & Clark, D. M. (2005). Unwanted memories of assault: What intrusion characteristics are associated with PTSD? *Behaviour Research and Therapy, 43*(5), 613-628.
- Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology, 109*(3), 504-511.
doi:10.1037/0021-843X.109.3.504
- Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science, 3*(5), 400-424. doi:10.1111/j.1745-6924.2008.00088.x
- Palesh, O. G., Collie, K., Batiuchok, D., Tilston, J., Koopman, C., Perlis, M. L... & Spiegel, D. (2007). A longitudinal study of depression, pain, and stress as predictors of sleep disturbance among women with metastatic breast cancer. *Biological psychology, 75*(1), 37-44.
- Picchioni, D., Cabrera, O. A., McGurk, D., Thomas, J. L., Castro, C. A., Balkin, T. J., & ...Hoge, C. W. (2010). Sleep symptoms as a partial mediator between combat stressors and other mental health symptoms in Iraq war veterans. *Military Psychology, 22*(3), 340-355.
doi:10.1080/08995605.2010.491844
- Pilcher J.J., Ginter D.R., & Sadowsky B. (1997). Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. *Journal of Psychosomatic Research, 42*, 583-596.
- Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879-891. doi:10.3758/BRM.40.3.879
- Ramel, W., Goldin, P. R., Carmona, P. E., & McQuaid, J. R. (2004). The effects of mindfulness

- meditation on cognitive processes and affect in patients with past depression. *Cognitive Therapy and Research*, 28(4), 433-455. doi:10.1023/B:COTR.0000045557.15923.96
- Riemann D., Spiegelhalder K., Nissen C., Hirscher V., Baglioni C., & Feige B. (2012). REM sleep instability – a new pathway for insomnia? *Pharmacopsychiatry*, 45(5), 167-176. doi:10.1055/s-0031-1299721.
- Seal, K. H., Metzler, T. J., Gima, K. S., Bertenthal, D., Maguen, S., & Marmar, C. R. (2009). Trends and risk factors for mental health diagnoses among Iraq and Afghanistan veterans using department of Veterans Affairs health care, 2002-2008. *American Journal of Public Health*, 99(9), 1651-1658. doi:10.2105/AJPH.2008.150284
- Siegle, G.J., Moore, P.M., & Thase, M.E. (2004). Rumination: One construct, many features in healthy individuals, depressed individuals, and individuals with lupus. *Cognitive Therapy and Research*, 28(5), 645-668. doi:10.1023/B:COTR.0000045570.62733.9f
- Spritzer, K. L. & Hays, R. D. (2003, November). *MOS Sleep Scale: A Manual for Use and Scoring, Version 1.0*. Los Angeles, CA.
- Stoia-Caraballo, R., Rye, M. S., Pan, W., Kirschman, K., Lutz-Zois, C., & Lyons, A. M. (2008). Negative affect and anger rumination as mediators between forgiveness and sleep quality. *Journal of Behavioral Medicine*, 31(6), 478-488. doi:10.1007/s10865-008-9172-5
- Takano, K., Iijima, Y., & Tanno, Y. (2012). Repetitive thought and self-reported sleep disturbance. *Behavior Therapy*, 43(4), 779-789. doi:10.1016/j.beth.2012.04.002
- Tanielian, T., & Jaycox, L. H. (Eds.). (2008). *Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery*. Santa Monica, CA: RAND Corporation.
- Tang, N. Y., & Harvey, A. G. (2004). Effects of cognitive arousal and physiological arousal on

- sleep perception. *Sleep: Journal Of Sleep And Sleep Disorders Research*, 27(1), 69-78.
- Thomsen, C.J., Stander, V.A., McWhorter, S.K., Rabenhorst, M.M., & Milner, J.S. (2011). Effects of combat deployment on risky and self-destructive behavior among active duty military personnel. *Journal of Psychiatric Research*, 45, 1321-1331. doi:10.1016/j.jpsychires.2011.04.003.
- Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the five-factor model of personality: Distinguishing rumination from reflection. *Journal of Personality and Social Psychology*, 76(2), 284-304. doi:10.1037/0022-3514.76.2.284
- Walker, M. P., & van der Helm, E. (2009). Overnight therapy? The role of sleep in emotional brain processing. *Psychological Bulletin*, 135(5), 731-748. doi:10.1037/a0016570
- Weathers, F. W., Litz, B. T., Herman, D. S., Huska, J. A. & Keane, T. M. (1993). The PTSD checklist: reliability, validity, & diagnostic utility. Paper presented at the *Annual Meeting of the International Society for Traumatic Stress Studies*, San Antonio, TX, October.
- Wright, K. M., Britt, T. W., Bliese, P. D., Adler, A. B., Picchioni, D., & Moore, D. (2011). Insomnia as predictor versus outcome of PTSD and depression among Iraq combat veterans. *Journal of Clinical Psychology*, 67(12), 1240-1258. doi:10.1002/jclp.20845
- Zoccola, P. M., Dickerson, S. S., & Lam, S. (2009). Rumination predicts longer sleep onset latency after an acute psychosocial stressor. *Psychosomatic Medicine*, 71(7), 771-775. doi:10.1097/PSY.0b013e3181ae58e8
- Zoccola, P. M., Dickerson, S. S., & Zaldivar, F. P. (2008). Rumination and cortisol responses to laboratory stressors. *Psychosomatic Medicine*, 70(6), 661-667. doi:10.1097/PSY.0b013e31817bbc77

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Table 1. *Descriptive statistics and two-tailed correlations*

	Mean (<i>SD</i>)	Range	Skew	1.	2.	3.	4.	5.	6.	7.
1. Rumination	43.35 (11.03)	13-60	-.74	--						
2. Sleep problems index	53.54 (22.72)	9-100	-.11	.67	--					
3. Sleep disturbance	55.55 (30.73)	0-100	-.34	.59	.94	--				
4. Daytime somnolence	39.55 (22.98)	0-100	.66	.54	.75	.61	--			
5. Sleep quantity	5.11 (1.58)	1-10	-.07	-.32*	-.52	-.50	-.33*	--		
6. PTSD symptoms ^a	50.36 (20.06)	17-85	-.19	.72	.78	.75	.57	-.35*	--	
7. Depression symptoms ^a	11.45 (7.21)	0-23	.16	.65	.71	.66	.63	-.35*	.86	--

^a Summed scores excluding one item that assesses “trouble falling or staging asleep.”

Notes: PTSD = Posttraumatic Stress Disorder. * $p < .01$; $p < .001$ for all other correlations.

Table 2. *Mediational Analyses, with Rumination as the Independent Variable*

Mediator and dependent variables	Coefficient between IV and mediator (A)	Coefficient between mediator and DV (B)	Coefficient between IV and DV, with mediator (C')	Indirect effect [99% CI]
Sleep problems index	.67**			
Depressive symptoms		.52**	.30*	.21 [.09 to .34]
PTSD symptoms		.54**	.36**	.63 [.35 to .97]
Sleep disturbance	.59**			
Depressive symptoms		.66**	.39**	.15 [.06 to .28]
PTSD symptoms		.75**	.42**	.52 [.26 to .86]
Daytime somnolence	.52**			
Depressive symptoms		.41**	.43**	.13 [.05 to .23]
PTSD symptoms		.28*	.58**	.24 [.06 to .48]
Sleep quantity	-.32*			
Depressive symptoms		-.17 [^]	.60**	.03 [-.01 to .10]
PTSD symptoms		-.16	.67**	.08 [-.02 to .29]

Notes: PTSD = Posttraumatic Stress Disorder. A, B, and C' refer to paths in Figure 1. Bias-corrected bootstrap confidence intervals

(CIs) that do not include zero indicate a significant indirect effect. [^] $p < .05$, * $p < .01$, ** $p < .001$

RUMINATION AND SLEEP PROBLEMS IN VETERANS

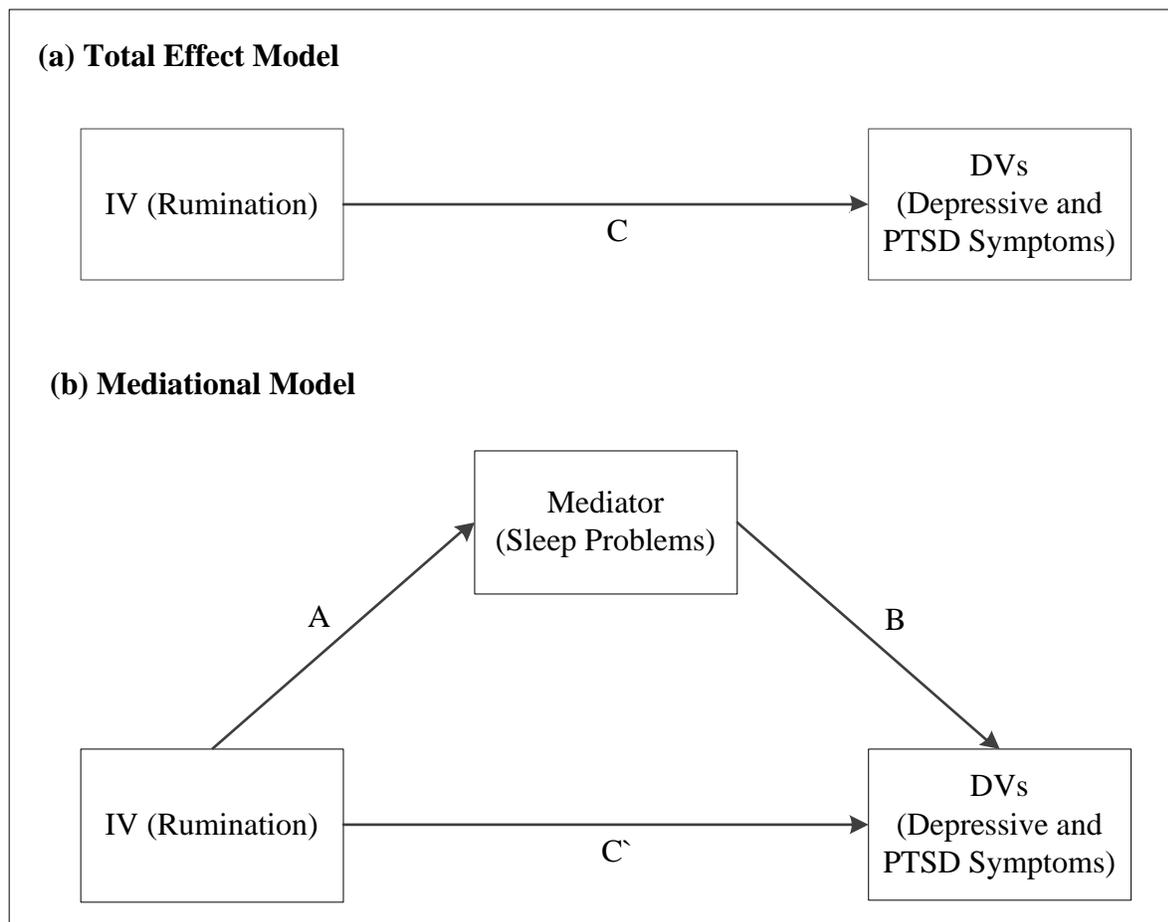


Figure 1. (a) Total effect model of rumination predicting the dependent variables. (b) Mediation model with sleep problems mediating the associations between rumination and the dependent variables. PTSD = Posttraumatic Stress Disorder.