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Effects of Sleep on Intrusive Symptoms and Emotional Reactivity in a Laboratory-Based Film Analog Study

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Abstract

Posttraumatic stress disorder (PTSD) is characterized by four symptom clusters. Recently, research highlights the need to focus on the impact of intrusive symptoms as a possible risk factor for the development and maintenance of PTSD. Cognitive and sleep models contribute to further understanding of intrusive symptoms. Recent work also highlights disgust as an emotion closely associated with the emergence of posttraumatic stress symptomology following traumatic events. This study used a film eliciting disgust in order to examine the effects of sleep on the intensity of intrusion symptoms and emotion reactivity. The sample consisted of 49 college students randomly assigned to either sleep or sleep deprivation conditions. It was hypothesized that, relative to a control group, participants randomly assigned to a night of sleep deprivation would evidence increased intrusion symptoms and emotional reactivity. Findings were partially consistent with hypotheses. There were no group or interaction effects on intrusive symptoms or self-reported arousal, although participants across both groups reported significant decreases in negative valence, arousal, and intrusion symptoms across the study. There also was a significant interaction effect between sleep group and self-reported negative valence, specifically, individuals in the acute sleep deprivation group reported higher negative valence compared to the sleep as usual group. Methodological considerations are addressed as potential explanations for the observed findings, and specific suggestions for conducting future work in this important area are provided.

Table of Contents

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Posttraumatic stress disorder (PTSD) is described as a disorder of recovery and is the only disorder in the *Diagnostic and Statistical Manual – 5th Edition* (DSM-5) that requires an external traumatic event to meet diagnostic criteria (American Psychiatric Association [APA], 2013). Epidemiological studies suggest an estimated lifetime prevalence of PTSD of 7.8 % with 60% of men and 50% of women to have PTSD at some point in their lives (Kessler et al., 1995; Tolin & Foa, 2006). Although symptoms typically decrease as time goes on, effective identification of which symptoms predict risk for chronic PTSD warrants further examination (Powers et al., 2014).

Intrusive Symptoms and Emotional Reactivity in PTSD

Recent research both broadened the study of different reactions to a traumatic event and identified intrusive symptoms and emotional reactivity as a possible risk factor for PTSD (Badour & Feldner, 2018; Ehlers & Steil, 1995; Rizvi et al., 2008). Lang and Bradley (1994) define emotion as valenced (positive or negative) with varying degrees of arousal. For example, if an individual were excited about an event, this emotion of excitement would be positively valenced with high arousal. Previous literature demonstrated that individuals with PTSD have higher activation in brain regions known for their association with arousal and emotional reactivity (Lanius et al., 2002; McTeague et al., 2010). These negatively valenced, high arousal emotions associated with flashbacks of a traumatic event are thought to lead to chronic negative alterations in affect, hyperarousal, and avoidant symptoms of PTSD (Brewin et al., 1996).

Intrusive thoughts and memories, otherwise known as intrusive symptoms, are also believed to contribute to the development and maintenance of PTSD. Intrusive symptoms are

described as spontaneous, unwanted memories of the traumatic event, such as images, sounds, or words (Salkovskis & Campbell, 1994). Additionally, intrusive symptoms can also include emotional distress after exposure to the traumatic reminder or physical reactivity after exposure to the traumatic reminder (American Psychiatric Association [APA], 2013). Dalgleish and Power (2004) also proposed that information about a traumatic event becomes intrusive and repeated because cognitive integration of the memories into pre-existing schema fails. This failure of integration results in chronic processing of the traumatic event-related information, and as a result, intrusive symptoms, specifically intrusive thoughts and memories.

Emotional reactivity and intrusive symptoms likely interact to contribute to the development of PTSD. The proposed etiology of PTSD is complex and multidimensional (Nemeroff et al., 2006). One focus of research is understanding cognitive processes involved in a reaction to traumatic event exposure. When a traumatic event occurs, a stress response syndrome is triggered that includes integration of memories of the traumatic event into pre-existing schemas via assimilation and/or accommodation (Horowitz, 1976; Resick & Schnicke, 1992). Researchers hypothesize that this process is driven by consciously and subconsciously remembering the event until complete integration of the memory occurs. Failure of information integration contributes to the assimilation and/or accommodation process halting. Ultimately, this results in chronic intrusive symptoms that would linger well after the event had taken place.

The *Schematic Propositional Analogical Associative Representation System* (SPAARS) model has outlined an integrated theoretical approach to understanding the development of intrusive thoughts and related emotion dysregulation (Dalgeish & Power, 2004). The SPAARS model was built upon schema-theories by integrating research on poor emotion regulation in conjunction with intrusive memories. The SPAARS model hypothesizes that shock, horror, and

negatively valenced emotions originate from, and eventually lead to, the maintenance of intrusive symptoms (Dalgleish & Power, 2004). This model posits that there are four levels of mental representational systems that contribute to the negative appraisal of the traumatic event and the associative learning that results in generalization of threatening cues that can lead to trauma-related symptoms.

The first level is the schematic system of the individual that includes the overall schemas or worldviews of the individual. The second level is the propositional system which includes information that can be verbally expressed by an individual and the third level is the analogue system, which is conceptualized as an image-based memory system that includes different sensory systems. The associative representation system is thought to be the "bridges" or connections that individuals use to connect the image-based and verbally expressed information and assimilate or accommodate this information into their schematic system.

According to Dalgleish and Power (2004), when a traumatic event occurs, these 4 systems will work simultaneously to encode the memory of the traumatic event into the overall schema of an individual. If the process becomes interrupted or if there is difficulty integrating this trauma memory into the network, the network begins to overcompensate for this by consciously and subconsciously bringing up the memory of the traumatic event, subsequently leading to intrusive symptoms.

Sleep Loss is Common Among People with PTSD

Sleep disturbances often are associated with, and may even be a core feature of, PTSD (Ross et al., 1989; Spoormaker & Montgomery, 2008). Epidemiological research on the relation between sleep and PTSD notes that at least 70% - 91% of individuals with PTSD have difficulty falling or staying asleep. Furthermore, people with PTSD report more nightmares, higher rates of

sleep-disordered breathing, and sleep-movement disorders than the general population (Maher et al., 2006). Interestingly, improved sleep quality can lead to reductions in trauma-related depressive symptoms and arousal symptoms (Rusch et al., 2015). In combination, this work has led researchers to consider classifying trauma-related sleep disturbances as a distinct disorder (Mysliwiec et al., 2018). Furthermore, studies have shown that individuals who have PTSD also have an increase in awakenings, higher adrenocorticotropic hormones, and higher activation of the sympathetic nervous system during sleep (van Liempt et al., 2013). While many PTSD symptoms are categorized into negative cognitions, negative impact, and hyperarousal, trauma-related sleep disturbances are also often a significant aspect of posttraumatic symptomology.

Sleep Loss Likely Exacerbates Intrusive Symptoms and Emotional Reactivity

Sleep disturbances may contribute to PTSD development by exacerbating intrusive symptoms, particularly intrusive memories. Sleep plays a large role in many cognitive processes that include, but are not limited to, both emotion regulation and consolidation of memory (Pilcher & Huffcutt, 1996; Stickgold, 2005; Yoo et al., 2007). The role of sleep in memory has typically been characterized as involving two different types of memory: before learning (encoding) and after learning (long-term consolidation; Marshall & Born, 2007; Walker & Stickgold, 2004). Memory of emotional stimuli has been shown to be consistently better than neutral stimuli (Bradley et al., 1992, Buchanan & Lovallo, 2001; Heuer & Reisberg 1990). The encoding of arousing and negatively valenced memories is hypothesized to be influenced by hormone levels during sleep and particular brain structures (McGaugh, 2004; Adolphs et al., 1997). In fact, when individuals are sleep-deprived they retain more negatively valenced memories while individuals in sleep conditions will demonstrate higher retention of positive or

neutral stimuli (Payne & Kensinger, 2010; Walker & van Der Helm, 2009). However, there have been few tests of sleep loss as a contributing factor to intrusive symptoms.

The *Sleep to Remember, Sleep to Forget* model (Walker, 2010) hypothesizes that sleep provides the necessary neurochemical environment and cognitive activation to regulate highly emotional memories. Walker (2010) states that individuals are provided an opportunity for inhibitory learning through sleep-related processes. The *Sleep to Remember, Sleep to Forget* model proposes that highly emotional memories are regulated through cognitive processes involved while emotional memories are processed during sleep, which is a time when a person is in a state of low physical arousal. Studies of the neurochemical environment during different sleep stages supports Walker's idea that a type of inhibitory learning occurs during sleep (McGaugh, 2004; Adolphs et al., 1997; Wagner et al., 2001). For example, late-night REM sleep has been hypothesized to be critical to emotional memory consolidation (Wagner et al., 2001). During REM, the hormones responsible for bringing the body into homeostasis will peak, while hormones responsible for arousal will dip. This further emphasizes the role of sleep in reducing emotional reactivity towards what was previously a highly arousing memory of a traumatic event.

Disgust, Traumatic Event Exposure, and Intrusive Memories

Other studies further highlight the role of sleep in emotion regulation (Payne & Kensinger, 2010). Recent literature has broadened the spectrum of negatively valenced emotions associated with PTSD and has suggested that disgust may predict a higher frequency of intrusive memories related to a traumatic event (Bomyea & Amir, 2012; McNally, 2003). Disgust and mental contamination are increasingly being linked to posttraumatic stress symptomology (Badour & Feldner, 2018; Badour & Feldner, 2013). Specific aspects of traumatic event

exposure often include experiencing or witnessing events that elicit disgust (Dalgeish & Power, 2004; McNally, 2003). Research has also shown that some individuals will primarily experience disgust during a trauma (Hathaway, et al., 2010). Posttraumatic symptoms and intrusive memories are becoming increasingly connected to disgust and the experience of traumatic events. From the hypothesized connection, exploration into additional factors affecting intrusive memories of disgusting events may offer preliminary insight into the development of intrusive symptoms after traumatic events.

The Current Study

The aim of this study was to look at the relation between sleep loss and the development of intrusive symptoms. Based on the research reviewed above, it is likely there is a relationship between acute sleep deprivation and frequency of intrusive symptoms related to a disgusting film clip; a paradigm shown to elicit disgust and mimic trauma-related symptoms (Arnoudova & Hagenaars, 2017). The first hypothesis was that acute sleep deprivation would be associated with a higher frequency of intrusive symptoms compared to a sleep-as-usual control condition. The second hypothesis was that acute sleep deprivation would result in greater emotional reactivity to negative stimuli related to the film compared to a sleep-as-usual control condition. More specifically, it was predicted that, compared to the sleep-as-usual group, the sleep-deprived group would show greater increases in negative valence and emotional arousal in response to the film-related stimuli.

Method

Participants

A total of 51 undergraduate students (35 female, M_{age} = 19.2 years, SD_{age} = 1.68, range 18 – 26 years) enrolled in the study; 49 completed study procedures ($M_{control\ age}$ = 19.5, $SD_{control}$

$_{age}$ = 1.98). Participants were 67.35% Caucasian/White, 16.33% Black, African American, African, 2.04 % Asian, and 14.23% Multiracial. Out of the sample, 8.1% reported their ethnicity was Latino or Latina (see Table 1 for demographic data). Students were recruited from the General Psychology Research Participation Pool via Sona Systems and were all undergraduate students at the University of Arkansas.

Inclusion and exclusion criteria. To be eligible for the study, participants had to be at least 18 years old at the time of the study, able to provide written informed consent, willing to stay awake overnight, and consent to not drive to their appointment the following morning if they were placed in the sleep deprivation condition.

With regard to exclusion criteria, participants were screened for the presence of psychological disorders in the past month that could affect sleep and overall mental health concerns. This included past month suicidal intent, major depressive disorder, psychosis, bipolar disorder, general anxiety disorder, panic attacks, panic disorder, trauma and stressor-related disorders, and other neurocognitive/neurodevelopmental disorders, which can also affect sleep. Participants also were excluded for 1) insomnia symptoms occurring at least three times per week during the past month, 2) trauma and stressor-related symptoms that were present at least three times per week during the past month and 3) taking medication for sleep or had medical conditions that were contraindicative for sleep deprivation.

Measures and Materials

Screening measures. Individuals were administered a phone screen containing questions about their mental health and psychological/psychiatric history in the past month as a preliminary screen for exclusion criteria. Upon arrival to the laboratory, potential participants were given the Mini-International Neuropsychiatric Interview (MINI; Lecrubier et al., 1997;

Sheehan et al., 1997, 1998) as a more thorough screening for participants in order to identify any mental health exclusion criteria.

Baseline questionnaires. A series of questionnaires were administered to measure participant baseline characteristics to allow for manipulation and random assignment checks. Questionnaires included a demographics questionnaire, the Pittsburg Sleep Quality Index (PSQI; Carpenter & Andrykowski, 1998), the Stanford Sleepiness Scale (SSS; Hoddes et al., 1973), the Mood and Anxiety Symptom Questionnaire (MASQ; Watson & Clark, 1991), the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), and the Difficulties with Emotion Regulation Scale (DERS**;** Gratz & Roemer, 2004). The PSQI is normed over a variety of samples and measures sleep quality and disturbance retrospectively over a 1-month period using self-report. This index demonstrates high internal reliability and construct validity (Carpenter & Andrykowski, 1998). Additionally, the one-item SSS has been shown to be sensitive to sleepiness induced by sleep deprivation and has been shown to have high internal reliability and construct validity (Hoddes et al., 1973). The MASQ was constructed to test key aspects of depression and anxiety proposed by Clark and Watson and has been demonstrated to be highly reliable and have high correlations with other commonly used anxiety and depression measures, suggesting adequate convergent validity (Watson et al., 1995). The PANAS is widely validated cross-cultural and also fulfills the criteria for cross-cultural reliability (von Humboldt, et al., 2017). The DERS was developed to measure how frequently and intensely adults experience an array of clinically relevant emotion regulation problems, and the original study demonstrated acceptable validity and reliability in adult populations and adolescent populations (Gratz & Roemer, 2004). Descriptive statistics for these measures from the current study can be found in Table 2.

Self-Assessment Manikin (SAM). This image-based measure presented a series of five figures depicting values along each of three dimensions that represented the major dimensions of emotional reactions (Bradley & Lang, 1994). Participants were instructed to rate each dimension of their emotional state, including valence (SAM-V) and arousal (SAM-A). Ratings were made by placing an "X" on or between any of the figures, resulting in three 0 to 5 scales (Bynion & Feldner, 2017). Emotional reactivity was operationalized using the SAM-V and SAM-A scales. Specifically, mean SAM ratings for post-film stimuli on Day 1 were utilized as the baseline indices and mean SAM ratings for post-film stimuli on Day 2 were used as outcome variables. The alphas for SAM-V was $\alpha_{Day\ 1} = 0.96$ and $\alpha_{Day\ 2} = 0.96$. The alphas for SAM-A was $\alpha_{Day\ 1} = 0.93$ and $\alpha_{Day\ 2} = 0.97$. For ease of scoring and interpretation, SAM-A values were reverse coded.

Intrusive symptom measures. The Impact of Event Scale (IES; Horowitz et al., 1979) was used to measure the frequency and mean of reported intrusive symptoms or avoidant symptoms. This measure can be used repeatedly over time and has been shown to have high reliability and validity in measuring intrusive symptoms (Horowitz et al.,1979). The IES was administered at 9 PM the same day of the first lab session and was given at 9 AM the next morning during the second lab session. The instructions were modified to ask the individual to report on their experiences during the past two hours. This measure is split into two subscales; the intrusive scale (IES-I) and avoidance (IES-A) scale. These two scales were summed for a total score. Intrusive symptoms were operationalized by using the difference in the IES-I scale from Day 1 to Day 2. The measure was presented on computers via Qualtrics surveys. The alphas for the first day for intrusive and avoidance symptoms respectively were $\alpha = 0.85$ and

0.77. The alphas for the second day for intrusive and avoidance symptoms were $\alpha = 0.81$ and 0.86.

Film Paradigm. Based on Arnoudova and Hagenaars' (2017) study on intrusive symptom formation from specifically themed film clips, this study employed a brief series of film clips curated from the Saw Films, all depicting scenes meant to elicit disgust. Research indicates that disgust reactions are not only elicited by food related stimuli, but also occur in response to non-food related stimuli such as animals, body envelope violations and death (Olatunji et al., 2007e). Thus, a series of clips from the Saw Film franchise that included animals being shredded, body envelope violations, and needles were used to induce studies to induce high arousal and negatively valenced emotion. The researchers collected 10 still images from the film and 20 still images similar to the film and presented these images to participants to gauge their emotional reactivity in response to these still images.

Falling Blocks Task. A well-known computer game, Tetris, was used as a neutral distractor test that required participants to attend to a screen for 10 minutes and respond to the stimulus of falling blocks by orienting them to form straight lines along the bottom of the screen. The Falling Blocks task was given during the session as a distractor task to ensure that the participant was not actively rehearsing the content of the film. This task was used in previous studies to ensure that participants would not try to actively rehearse the film content in preparation of the memory task (Iyadurai et al., 2018).

Procedure

Figure 1 presents a visual flowchart of the procedures. Broadly, participants completed a screening procedure, a baseline laboratory session on day 1, was randomly assigned to either a

sleep deprivation or sleep-as-usual condition, and then completed a second laboratory session on day 2.

Informed Consent and Screening. Participants completed an informed consent procedure with a trained research assistant or primary researcher. During the informed consent process, participants were told that they will be watching a distressing and graphic film that is known to elicit disgust. Additionally, participants were told that they may have to undergo a sleep deprivation task and consent to not driving to or from the day 2 laboratory session because of the effects that sleep can have on executive functioning. Finally, participants were informed of credit allocation if they were to leave the study voluntarily. In order to decrease risk for attrition and balance individuals' voluntary participation in the study, participants were provided 2 credits for completing the in-lab session on Day 1. If they were assigned to the sleep as usual condition, they were informed that they would receive 6 credits for the next in-lab session on Day 2, resulting in a total of 8 credits. If individuals were assigned to the sleep deprivation condition, they were provided 2 credits for Day 1 and 0.5 credits for every phone call they made into the lab to ensure adherence to the sleep deprivation protocol. Additionally, this would permit the participants to receive compensation for every hour they remained awake without penalizing them for dropping out of the study early due to tiredness or safety concerns. If individuals were able to remain awake all night and came into the lab the next morning to complete the rest of the surveys, they received the remaining 1.5 credits, resulting in a total of 8 credits.

Individuals completed the MINI with the primary researcher or a trained research assistant. Eligible participants were then given time to complete the baseline questionnaires during a 20-minute adaptation period while the experimenter was available in the same room to

answer questions for the participant. These questionnaires included a demographics form, sleep log, PSQI, SSS, MASQ, the PANAS, and the DERS.

Laboratory session: Day 1. Participants was shown the film clip after completing the informed consent and the baseline questionnaires. Participants viewed the film while seated in front of a computer screen in a dark room and completed each laboratory session individually. Before the film was shown, instructions from Gross and Levenson (1993) were given as follows: "We will now be showing you a short film clip. It is important to us that you watch the film clip carefully, but if you find the film too distressing, just say 'stop'."

The experimenter also emphasized that participants must engage with the entire film by keep their eyes on the screen for as long as possible and try to picture themselves as if they were in the room with the characters in the film. Participants filled out a SAM before the film and after the film. After completion of the post-film SAM, participants were asked to engage in a neutral filler task, the Falling Blocks Task, for 10 minutes. The task stimuli was presented on a computer screen. Participants were then shown emotional images from the film and asked to rate their emotional reaction using the SAM after each image.

Randomization. Participants were then randomly assigned to either a sleep ($N = 25$) or no-sleep ($N = 24$) condition using a coin flip. This was done at the end of day 1 in order to keep the researcher blinded for as long as possible to the participant's group condition. Participants assigned to the normal sleep condition were asked to go about their day as planned and attempt to go to sleep at 10pm. Those in the sleep deprivation condition were asked to stay awake all night and call in every hour between 10 PM and 6 AM. During the waking hours, both groups of participants were asked to not ingest alcohol, caffeine, or other substances that could affect their sleep/wake cycle.

Both groups were instructed to fill out the IES between 9PM – 9:30 PM on Day 1 and again from 9 AM - 9: 30 AM on Day 2. The experimenter checked to see if the IES was completed by 9:00 PM for each participant via Qualtrics. If a participant did not complete the IES during the evening period, the experimenter prompted the participant by emails every 5 minutes until 9:30 PM. If the participant did not complete the IES at the evening timepoint after reminder emails they were excluded from the study.

Laboratory Session: Day 2. Participants returned to the lab at 9 AM the following morning and completed an IES upon entering the lab. They also completed questionnaires that included the SSS, the MASQ, the PANAS, and the DERS. Participants completed the 10-minute Falling Blocks task and was then asked to view images from the film with novel images similar to the film (foils). With each presentation of stimuli, participants were asked if they recognized previously presented stimuli viewed from Day 1. Participants were debriefed by the researcher once they had completed the recognition task.

Data Analytic Approach

A power analysis was performed for sample size estimation. Based on data from previously published studies examining the relation between sleep deprivation and emotional reactivity and cognitive processes, the effect sizes were $\eta^2 = 0.065$ and $d = -0.564$, respectively (Franzen et al., 2008; Lim & Dinges, 2010). These effect sizes were considered medium to large according to Cohen's criteria (1988). As a conservative approach, I used small to medium sized effects ($d = 0.25$) with the α set at 0.05 and the power value set to 0.80 in a power analysis conducted using the G*Power software (Faul et al., 2009). Based on this analysis, the projected sample size needed to detect an effect with a repeated measures within-subject ANOVA with two repeated measures was 54. Due to the onset of a global pandemic, only 51 participants were

recruited. Similar studies conducted by Porcheret et al. and Lau-Zhu et al. (2018, 2019) had sample sizes of 42 and 51, which provided precedence to suspend data collection earlier than anticipated due to health safety reasons.

The data were first cleaned and examined to ensure statistical assumptions were met. Two participants skipped the IES-I. After determining that this was a systemic error, both participants were excluded. Linearity, homoscedasticity, skewness, and kurtosis were confirmed using visual inspections of scatterplots, evaluation of Cook's D values, and studentized residuals. IES-I, SAM-V, and SAM-A did not meet assumptions. Outliers were determined if they demonstrated studentized residuals 3 or more standard deviations away from the mean. This resulted in removal of one outlier from the IES-I analysis and SAM-V analyses. Additionally, two outliers were removed from the SAM-A analysis. Assumptions were re-examined after the removal of further outliers. The variables of interest all met assumptions for linearity, homoscedasticity, skewness, and kurtosis. Sphericity was determined via Mauchly's test of sphericity. Levene's test confirmed homogeneity of variance for both variables of interest.

Next, descriptive statistics were computed. The adequacy of random assignment was checked by comparing groups in terms of demographic (i.e., sex, age) and psychological (i.e., symptoms of anxious arousal, anhedonic depression, and general distress on the MASQ; sleep quality on the PSQI) factors. T-tests were conducted comparing group differences at baseline for psychological factors and demographic factors. Manipulation checks using SUDs ratings for the film paradigm, and SSS scores for the sleep groups, were conducted to ensure that the film effectively increased negative affectivity and to ensure the sleep deprivation group reported higher levels of sleepiness than the control group. The General Linear Model was used to compute significance of changes in negative affectivity and sleepiness. SUDs ratings pre-film

were regressed on SUDs ratings post-film. Additionally, SSS ratings on day 2 were regressed on condition.

A series of repeated-measures ANOVAs were conducted to evaluate the primary study hypotheses. First, between-subjects effects (sleep deprivation versus control condition), within-subjects effects (from baseline to post-manipulation), and the interaction of these factors on IES scores were examined. To evaluate the second hypothesis, between-subjects effects (sleep deprivation versus control condition), within-subjects effects (from baseline to post-manipulation), and the interaction of these factors on SAM-V and SAM-A scores were examined.

Results

Preliminary Data Analyses

Descriptive Statistics

Descriptive statistics for study variables are reported in Table 2 and 3. Table 4 includes correlations among continuous study variables. Observed IES-Intrusive score means were compared to IES means in published work ($M_{Intrusion}$ = 8.11 [SD = 5.61]; $M_{Avoidance}$ = 6.29 [SD = 3.76]; Mairean & Livia, 2019). Previous literature reported similar IES-Intrusive scores; however, scores for this current study were somewhat higher than reported means in previous literature. Although Porcheret's (2019) study methods resembled the current study's methods the most, there were differences in IES calculations and time of administration. Thus, it was more appropriate to compare the observed IES-Intrusion score means to the Mairean and Livia (2019) study rather than the Porcheret study (2019) due to scoring methods and administration time.

Randomization Check.

Groups did not differ based on demographic factors of sex and age and did not demonstrate significant differences in psychological factors, such as anxious arousal or general distress, emotion regulation, and sleep quality. This indicated that random assignment was successful. Therefore, no covariates were included in the primary hypothesis and randomization was considered adequate. For ease of interpretation, the condition was coded using contrast coding where the sleep as usual (control) condition was -0.5 and the sleep deprivation (experimental) condition was 0.5. A summary of the randomization checks are depicted in Table 5. Higher scores on the SAM-V and SAM-A indicated more negative valence and higher arousal.

Manipulation Check.

SUDs ratings increased for anxiety, disgust, and sadness from pre- ($M_{anxiety}$ = 10.6, $SD_{anxiety}$ = 14.5; $M_{disgust}$ = 2.29, $SD_{disgust}$ = 8.22; $M_{sadness}$ = 4.84, $SD_{sadness}$ = 10.7) to post- ($M_{anxiety}$ = 16.2, $SD_{anxiety}$ = 16.6, $M_{disgust}$ = 5.90, $SD_{disgust}$ = 10.6, $M_{sadness}$ = 6.16, $SD_{sadness}$ = 11.9) film manipulation, suggesting the film paradigm manipulation induced anxiety, disgust, and sadness. These were confirmed via linear regression (see Table 5). Data also suggested that the sleep deprivation manipulation was successful. Specifically, individuals in the sleep deprivation group demonstrated a 1.69 unit increase in their sleepiness scores compared to the sleep as usual group (See Table 5). Finally, participants were asked whether or not they had viewed or were familiar with all three film clips pulled at random from the Saw franchise films to rule out the possibility of confounds. Only 3 individuals noted specifically that they viewed all three film clips; however, this did not impact the overall SUDs ratings post-film.

Primary Analyses

Findings for the primary analyses are depicted in Table 6. One further participant was excluded due to endorsing responses 6 SD away from the mean. With regard to the first hypothesis, there was no significant main effect of condition on intrusive symptoms ($F(1, 47) = 1.76$, $p = 0.192$). There was a significant main effect of time indicating decreases in intrusive symptoms from baseline to post-manipulation ($F(1, 47) = 10.30$, $p < 0.01$). There was no significant interaction effects between group and time ($F(1, 47) = 1.346$, $p = 0.252$). Findings are depicted in Figure 2.

In order to perform analyses on the second hypothesis, an average of the SAM-V ratings for day 1 and day 2 were calculated (separately). Specifically, stills from the film were displayed to participants and participants were asked to provide a SAM-V rating after every image. These ratings were averaged as the overall valence for Day 1 and Day 2, respectively. There was no significant main effect of group on SAM-V scores ($F(1, 46) = 0.025$, $p < 0.876$). However, there was a significant main effect of time ($F(1, 46) = 23.806$, $p < 0.001$), the data pattern suggests SAM-V ratings decreased across time regardless of group. Additionally, there was a significant interaction effect with time and group. Individuals in the sleep deprivation group reported significantly higher negative valence in response to film stimuli compared to the control group ($F(1, 48) = 7.869$, $p < 0.01$) (See Figure 3). Post-hoc analyses with a Bonferroni adjustment revealed that all pairwise differences, between groups, were statistically different ($t(2, 23) = -2.92$, $p_{adj} < 0.01$).

Finally, with regard to the third hypothesis, there was no main effect of arousal as a function of group. However, there was a significant effect of time, with SAM-A scores

decreasing day 1 to day 2 regardless of condition ($F(1, 45) = 24.960$, $p < 0.001$). There were no significant interaction effects *(*$F(1, 45) = 0.798$, $p = 0.377$*).* Findings are depicted in Figure 4.

Discussion

Recent research highlights the need to focus on the contribution of cognitive processes, and specifically the impact of intrusive memories, in terms of better understanding PTSD. Sleep problems are a common characteristic of PTSD. These two domains, cognition and sleep, may be integrated to understand the role of intrusive thoughts. Prominent theoretical models suggest a relation between sleep and memory formation as a factor in the development of intrusive memories and subsequent emotion dysregulation (Walker, 2010, Dalgeish & Power, 2004). As an initial test of this idea, this study utilized the trauma-film paradigm to examine the effects of acute sleep deprivation on the frequency of intrusive symptoms and emotional reactivity. Findings were only partially consistent with hypotheses.

First, with regard to intrusive symptoms, both groups demonstrated a significant decrease in intrusion symptoms across a 24-hour period, regardless of condition (sleep as usual vs acute sleep deprivation), but there were no significant differences between experimental groups, nor was evidence for the hypothesized interaction obtained. These data suggest sleep deprivation does not impact intrusive symptoms, at least as measured in the current study. Pulling this pattern apart somewhat, the overall decline in intrusive symptoms is intriguing and potentially reflects the natural progression of most individuals after witnessing a traumatic event (Sinclair et al., 2020). Indeed, studies of intrusive symptoms in non-clinical samples indicate decreases over time (Elhai et al., 2012). Secondly, the particular trauma film utilized in the current study may have impacted findings. Trauma films are commonly used in the literature; however, in a recent study by Arnoudova and Hagenaars (2017), the authors concluded that films eliciting disgust

were more likely to trigger higher *frequency* of intrusive memories rather than the intensity of intrusive symptoms over time. This conclusion was based on a method in which participants were asked to both fill out the IES and a diary documenting number of intrusive memories/thoughts a day. In the current study, there were methodological challenges to requesting participants to complete a diary over the span of 48 hours due to the type of sample recruited (i.e. students who were compensated with credit may struggle with filling out an intensive log). Therefore, the IES was used instead. Furthermore, the film used by Arnoudova and Hagenaars was unavailable, so short film clips from various *Saw* films were utilized instead. Although *Saw* films are used to examine "torture porn" and themes of torture (Kerner, 2015), it may not have served as an appropriate cue to elicit trauma-relevant symptoms, despite some areas of the literature describing similar emotional and behavioral reactions individuals have to horror films with traumatic stress symptoms over a period of time (Cantor, 2004). Although Cantor (2004) documented 93 students classifying watching horror films (including the *Saw* films) as disturbing events in their lives, it may be that the intensity of intrusion symptoms following a viewing of a known horror franchise film is blunted. Indeed, the film stimulus in Arnoudova and Hagenaars' (2017) study, which depicted a individual consuming their own vomit, was both potently disgusting and not well-known (cf., the *Saw* franchise); it is possible that familiarity with the stimuli used in the present study also influenced effects on intrusive symptoms.

With regard to the null effects of condition, it is possible that sleep loss does not impact intrusive memories as predicted, but several other factors may explain the pattern of results. The first factor pertains to the operationalization of intrusive symptoms over time. The window of assessment for intrusive symptoms in the current study may not have provided a sufficient

window for significant level of intrusion symptoms to occur. Participants were only asked to assess their symptoms over a span of 24 hours and within those 24 hours they were only asked to think about their intrusion symptoms over a total of four hours. However, intrusive symptoms are typically thought to be clinically significant or informative when occurring over a longer period of time (at least one month; Michael et al., 2005). Future work could improve upon this approach by monitoring intrusive symptoms every hour using a brief assessment tool, or measuring intrusive symptoms over the span of a month as a way to evaluate the natural progression of intrusive symptoms over a longer period of time. Second, it is plausible that the effects of sleep deprivation on intrusive memories are constrained to clinical samples, with more overall robust intrusive symptom presentations. Clinical samples, particularly those where PTSD is prominent, evidence elevated sleep deprivation and intrusive symptoms relative to non-clinical samples. As these factors likely have bi-directional effects on one another, a single night's sleep deprivation may have a more prominent effect on intrusive symptoms elicited by the current manipulation. Furthermore, clinical samples of participants with PTSD would allow for the use of ideographic trauma cues (cf., a standardized, disgust-relevant cue as utilized here), which would likely produce elevated intrusive symptoms. Third, the IES is commonly used with non-clinical sample; however, other studies indicate that the IES may not be the ideal measure when utilizing trauma paradigms with non-clinical samples (Reynolds & Brewin, 1998; Rombold et al., 2016; Thatcher & Krikorian, 2005). These considerations could collectively be addressed by utilizing other (non-IES) assessments of intrusive symptoms, studying clinical samples, and utilizing alternative trauma films as the manipulation. Studies that include more idiographic and salient trauma cues (e.g., script driven imagery procedures) would provide a particularly important extension to the literature.

With regard to self-reported valence, the expected interaction was observed; participants in the sleep deprivation condition evidenced significantly higher negative valence post-manipulation, compared to the control group. These data suggest that acute sleep deprivation does have an effect on the emotional reactivity in response to disgust-relevant stimuli despite possible habituation effects as evidenced by declining SAM-V ratings over time for both groups. This is consistent with literature describing sleep disturbances as a contributing factor to elevated emotional reactivity when exposed to trauma cues (Pilcher & Huffcutt, 1996; Stickgold, 2005; Yoo et al., 2007). Also consistent with the current findings, improved sleep quality over time is associated with reductions in trauma-related negative affectivity and arousal symptoms (Rusch et al., 2015). Finally, a factor that may further explicate the impact of acute sleep deprivation on self-reported negative valence may lie with particular (higher-order) emotion regulation strategies, such as cognitive reappraisal. Often, these strategies are mediated by structures in the prefrontal cortex that are linked to sleep processes (Parvaz et al., 2012). More specifically, individuals who experience acute sleep deprivation are more affected when asked to perform certain emotion regulation strategies, such as attempting to reinterpret an emotion-eliciting situation in a way that alters the meaning of the situation and changes the emotional impact of the situation (i.e., cognitive reappraisal; Lazarus, 1991; Gross & John, 2003). Cognitive reappraisal requires more complex cognitive skills (e.g., imagining and reinterpreting future events) compared to less sophisticated strategies, such as behavioral avoidance, and is negatively impacted by acute sleep deprivation (Kusztor et al., 2019; Zhang et al., 2019). Although participants in the current study were not specifically asked to perform cognitive reappraisal strategies, these emotion regulation processes may be more accessible or more readily utilized in individuals that have a full night of sleep. This may be explain why participants in the control

condition reported lower negative valence compared to those in the acute sleep deprivation group. Future studies may evaluate this possibility this finding by asking participants directly to reappraise the disgust-relevant stimuli prior to presentation on Day Two.

Finally, with regard to self-reported arousal, only a main effect of time was observed, indicating participants reported declining arousal between Days 1 and 2, regardless of condition. The divergence between valence and arousal findings is conceptually interesting and merits further consideration. Those in the sleep-as-usual-group may have had the benefit of the neurochemical processes during different sleep phases hypothesized to reduce the level of physiological reactivity to memories of traumatic events (McGaugh, 2004; Wagner, et al, 2001; Walker, 2010). Hence the observed reduction in arousal over time. However, at the same time, sleep deprivation may also have blunted physiological arousal in the experimental group. Fatigue and sleepiness are associated with blunted physiological responses, vigilant attention, and reaction time (Riley, et al., 2019; Wilson et al., 2003). In other words, sleep deprivation in the current study may have decreased, rather than increased, physiological arousal. In addition, there is mixed evidence in the sleep literature on whether or not hyperarousal results from chronic, partial sleep loss (e.g. insomnia) or if chronic, partial sleep loss is a product of chronic low-level physiological arousal (Gunn, et al., 2014; Vargas et al., 2020). Future studies may benefit from the examination of chronic fatigue over time on physiological arousal in response to trauma-relevant cues using a partial sleep loss manipulation.

In addition to those discussed above, a number of other limitation merit discussion. First, the unexpected null effects in the current study may be attributable to a lack of power to detect effects if present. *A priori* analyses indicated that a sample size of 54 would be ideal to detect the effects, based upon effect sizes observed in prior work. Due to the onset of a global

pandemic, data acquisition was halted at $N = 51$, in order to protect the safety of both researchers and participants. A post-hoc power analysis suggested that a sample size of 70 may actually have been more appropriate for the particular stimuli used in the current study. Future studies utilizing larger samples will be necessary to draw confident inferences regarding the effects of acute sleep deprivation on intrusive symptoms and emotional reactivity to disgust-relevant trauma film cues. Internal validity was prioritized over external validity in the present study; the control afforded by the laboratory-based setting was deemed critical in addressing study hypotheses. However, findings may not generalize to more naturalistic settings. Recruitment of a more diverse population would also benefit the generalizability and external validity of this study.

Conclusion

Despite the aforementioned limitations, this study has important implications as an extension of literature. Results suggest that acute sleep deprivation worsens negatively valenced reactivity to disgust-relevant cues. No evidence was found for hypothesized effects on intrusive symptoms or arousal, which may be due to methodological factors. Future work can address these challenges by using a larger sample size, idiographic trauma cues, and by recruiting a clinical sample. Such work would build on the current study and provide more information about the role of acute sleep deprivation on key factors (intrusive symptoms and emotional reactivity) related to PTSD.

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Appendix

Appendix 1: IRB Memorandum of Approval

UNIVERSITY OF ARKANSAS

To:	Annamarie T. Nguyen BELL 4188
From:	Douglas J Adams, Chair IRB Expedited Review
Date:	04/01/2021
Action:	**Expedited Approval**
Action Date:	08/21/2020
Protocol #:	1907204837A004
Study Title:	Effects of Sleep on Intrusive Memories and Emotion Regulation in a Laboratory-Based Film Analog Study
Expiration Date:	08/20/2021
Last Approval Date:	08/21/2020

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution's IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

Protocols are approved for a maximum period of one year. You may not continue any research activity beyond the expiration date without Committee approval. Please submit continuation requests early enough to allow sufficient time for review. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study closure.

Adverse Events: Any serious or unexpected adverse event must be reported to the IRB Committee within 48 hours. All other adverse events should be reported within 10 working days.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, study personnel, or number of participants, please submit an amendment to the IRB. All changes must be approved by the IRB Committee before they can be initiated.

You must maintain a research file for at least 3 years after completion of the study. This file should include all correspondence with the IRB Committee, original signed consent forms, and study data.

cc: Becca Campbell, Investigator
Ellen W Leen-Feldner, Investigator
Abigail Hope Vance, Key Personnel

Table 1.

Sample demographics

Baseline Characteristic	Frequency		
	Full Sample	Sleep Deprivation	Control
	n	*n*	*n*
Gender			
Male	15	10	5
Female	34	15	19
Age	M*(SD)*	M*(SD)*	M*(SD)*
	19.1*(1.32)*	19.0 *(1.21)*	10.5 *(1.98)*
	n	*n*	*n*
Race			
White	33	15	18
Black/African American/African	8	5	3
Asian/Pacific Islander	1	1	0
Other (Mixed race)	7	6	1
Ethnicity			
Hispanic	4	3	1
Non-Hispanic	45	22	23
Family Income			
>$100,000	18	11	7
<$100,000	31	14	17
Sexual Orientation			
Homosexual	3	1	2
Heterosexual	44	24	20
Bisexual	1	0	1

Note. $N = 49$ ($n_{control} = 24$).

Table 2.

Psychometric Properties for PSQI, MASQ, PANAS, DERS, IES, and SAM Scales

Scale	*M*	*SD*	Range	Cronbach's α
Age	19.2	1.32	18 - 26	n/a
PSQI	4.55	1.95	1 - 10	0.74
MASQ				
General Distress – Anxious Symptoms	4.16	4.62	0 - 24	0.84
Anxious Arousal	2.74	3.24	0 - 11	0.69
Depressive Symptoms	4.80	5.17	0 - 24	0.88
Anhedonic Depression	52.7	10.4	32 - 75	0.88
DERS				0.76
Non-Acceptance	8.18	3.52	5-17	0.88
Impulse	7.59	2.01	6 - 16	0.79
Awareness	11.4	3.95	5 - 22	0.82
Strategies	12.3	2.80	8 - 20	0.73
Clarity	5.31	1.88	3 - 12	0.71
PANAS				
Positive Affect - Week	24.8	6.55	12 - 39	0.91
Negative Affect - Week	4.41	4.58	0 - 23	0.86
Positive Affect - Current	18.4	8.76	3 – 38	0.93
Negative Affect - Current	1.74	3.39	0 – 18	0.91
IES				
Intrusive Symptoms Day 1	11.9	4.95	0 - 27	0.85
Avoidance Symptoms Day 1	16.9	6.33	1 - 28	0.77
Intrusive Symptoms Day 2	9.69	3.61	8 - 28	0.81
Avoidance Symptoms Day 2	14.8	6.38	8 - 28	0.86
SSS				
SSS Day 1	1.35	0.631	0 - 2	n/a
SSS Day 2	3.43	1.61	1 - 6	n/a

Note: *M* and *SD* represent means and standard deviations of the variables respectively. DERS = Difficulties in Regulation Scale; IES = Impact of Event Scale; MASQ = Mood and Anxiety Symptom Questionnaire; PANAS = Positive and Negative Affect Scale; PSQI = Pittsburg Sleep Quality Index; SSS = Stanford Sleepiness Scale - a single item scale used to measure the overall sleepiness (hence, Cronbach's α not reported)

Table 3.

Variables of Interest Descriptive Statistics

	Full Sample	Sleep Deprivation	Control
	M*(SD)*	M*(SD)*	M*(SD)*
Baseline			
SAM Valence	3.62 *(0.728)*	3.54 *(0.570)*	3.69 *(0.857)*
SAM Arousal	2.94 *(0.671)*	2.84 *(0.690)*	3.00 *(0.659)*
Evening Questionnaire - Post Film and Post-Film Stimuli (images)			
Impact of Event Scale			
Intrusions	11.9 *(4.95)*	11.7 *(4.42)*	12.2 *(5.52)*
Avoidance	16.9 *(6.33)*	16.8 *(6.12)*	17.1 *(6.68)*
Post Manipulation			
SAM Valence	3.34 *(0.613)*	3.00 *(0.570)*	2.25 *(0.847)*
SAM Arousal	2.39 *(0.739)*	2.25 *(0.682)*	2.56 *(0.75)*
Impact of Event Scale			
Intrusions	9.69 *(3.61)*	8.64 *(1.89)*	10.8 *(4.59)*
Avoidance	14.8 *(6.38)*	14.0 *(6.14)*	15.5 *(6.67)*

Note: M and *SD* are used to represent means and standard deviation, respectively. SAM-V = Self-Assessment Manikin-Valence scale; SAM-A = Self-Assessment Manikin-Arousal scale. Higher SAM-V scores reflect greater negative valence. For ease of scoring and interpretation, SAM-A values were reverse coded, such that higher scores reflect greater arousal.

Table 4

Baseline means, standard deviations, and correlations with confidence intervals

Variable	1	2	3	4
1. SAM-V Post-Film				
2. SAM-A Post-Film	.05 [-.23, .32]			
3. SAM-V Post-Film Stimuli	.25 [-.03, .50]	.21 [-.07, .47]		
4. SAM-A Post-Film Stimuli	.11 [-.19, .39]	.37* [.09, .59]	.35* [.06, .58]	
5. IES Intrusion Symptoms	.27 [-.00, .51]	.26 [-.02, .50]	.47** [.21, .66]	.14 [-.15, .42]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$.

Table 5

Randomization and Manipulation Checks

Variable	*B*	*SE*	*t*	*p*	95% CI
Randomization Checks					
MASQ					
Anhedonic Depression → Group	-2.437	2.979	-0.818	0.418	[-8.43, 3.56]
Anxious Symptoms → Group	0.647	1.331	0.486	0.629	[-2.03, 3.32]
Anxious Arousal → Group	0.133	0.937	0.142	0.887	[-1.75, 2.02]
Depression Symptoms → Group	-0.417	1.491	0.279	0.781	[-2.58, 3.42]
PSQI					
PSQI Total → Group	-0.308	0.561	-0.55	0.585	[-1.44, 0.819]
DERS					
DERS Total → Group	-0.177	3.49	-0.051	0.96	[-7.19, 6.94]
PANAS Trait (Past-2 weeks)					
Positive Affect → Group	2.337	1.859	1.257	0.215	[-1.40, 6.08]
Negative Affect → Group	0.555	1.320	0.421	0.676	[-2.10, 3.21]
PANAS State					
Positive Affect → Group	1.698	2.518	0.675	0.503	[-3.37, 6.76]
Negative Affect → Group	0.623	0.973	0.641	0.525	[-1.33, 2.58]
Manipulation Checks					
SUDs					
Disgust Pre-Film → Disgust Post-Film	0.586	0.112	5.212	4.1×10^{-6} ***	[0.36, 0.81]
Anxiety Pre-Film → Anxiety Post-Film	0.390	0.123	3.17	0.003**	[0.143, 0.638]

Table 5 (cont)

Sadness Pre-Film → Sadness Post-Film	0.439	0.128	3.43	0.001**	[0.18, 0.70]

Table 5 (Cont.)

SSS					
Sleepiness Day 2 → Group	1.693	0.394	4.30	8.45×10^{-5} ***	[0.90, 2.48]

Note. CI = confidence interval. * indicates $p < .05$. ** indicates $p < .01$. *** indicates $p < 0.001$

Table 6

Repeated Measures ANOVA Statistics

Variable	Control	Sleep Deprivation	ANOVA				
	M *(SD)*	M *(SD)*	Effect	*F* ratio	*df*	*p*	*d* [CI]
Impact of Event Scale - Intrusion							
Day 1	12.2 *(5.52)*	11.7 *(4.42)*	Time	10.300	46	<0.01**	0.658
Day 2	10.8 *(4.59)*	8.64 *(1.89)*	Group	1.76	46	0.192	[0.24, 1.07]
			Time x Group	1.346		0.252	
Self-Assessment Manikin - Valence							
Day 1	3.69 *(0.857)*	3.54 *(0.570)*	Time	23.806	46	<0.001***	0.487
Day 2	2.25 *(0.847)*	3.00 *(0.913)*	Group	0.025	46	0.876	[0.076, 0.90]
			Time x Group	7.869	46	<0.01**	
Self-Assessment Manikin - Arousal							
Day 1	3.00 *(0.659)*	2.84 *(0.690)*	Time	24.960	45	<0.001***	0.727
Day 2	2.56 *(0.75)*	2.25 *(0.682)*	Group	1.129	45	0.294	[0.308, 1.14]
			Time x Group	0.798	45	0.377	

Note. * indicates $p < .05$. ** indicates $p < .01$. *** indicates $p < 0.001$

Figure 1

Experimental Procedure

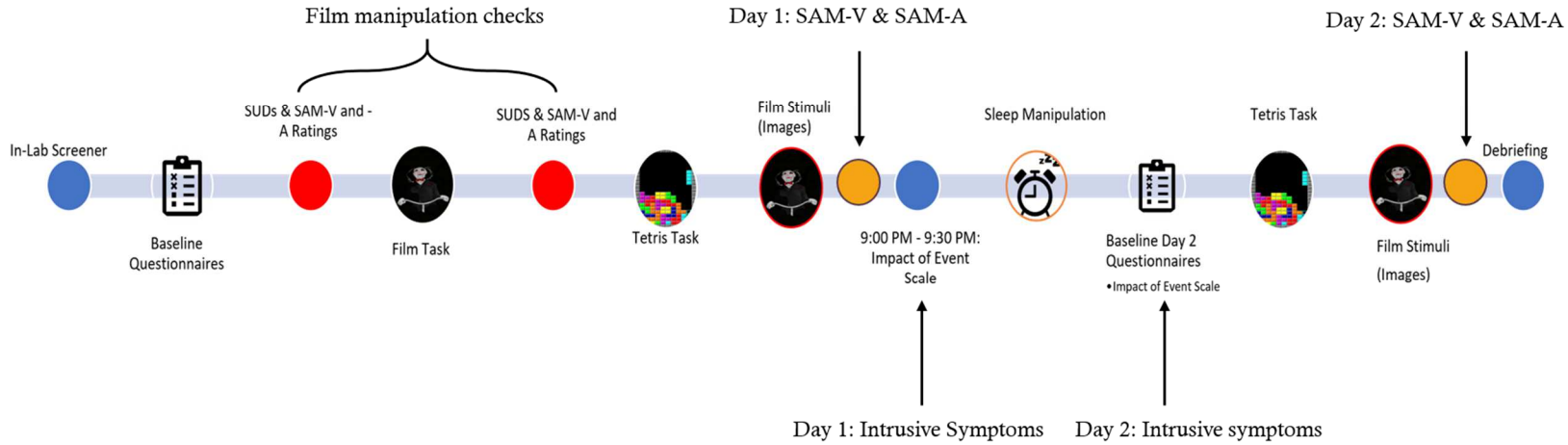

Figure 1. Participants would complete an in-lab screener to ensure eligibility. Once determined eligible, participants completed a set of baseline questionnaires during an adjustment period in the lab. Then participants were asked to complete SUDs and SAM-V and SAM-A ratings before watching a trauma-film paradigm. After watching the film, participants were asked to report SAM-V and SAM-A ratings and complete a tetris task for 10 minutes to prevent rehearsal of the film. Then participants looked at static film stimuli (images), and provided SAM-A and SAM-V ratings for each (the mean was used as the baseline index of emotional reactivity to the images). They were then asked to return home and complete the IES a 9:00 PM. Individuals were assigned to either sleep or stay awake throughout the night. Participants returned to the lab the next day and filled out an IES ~ 12 hours and were then asked to complete another distraction task for 10 minutes and baseline questionnaire to ensure an adjustment period to the lab. SAM-V and SAM-A ratings were taken during Day 2 while participants were shown film stimuli (images). The mean of these ratings wereused as the post-manipulation index of challenge reactivity. Participants were then debriefed and compensated for their time.

Figure 2

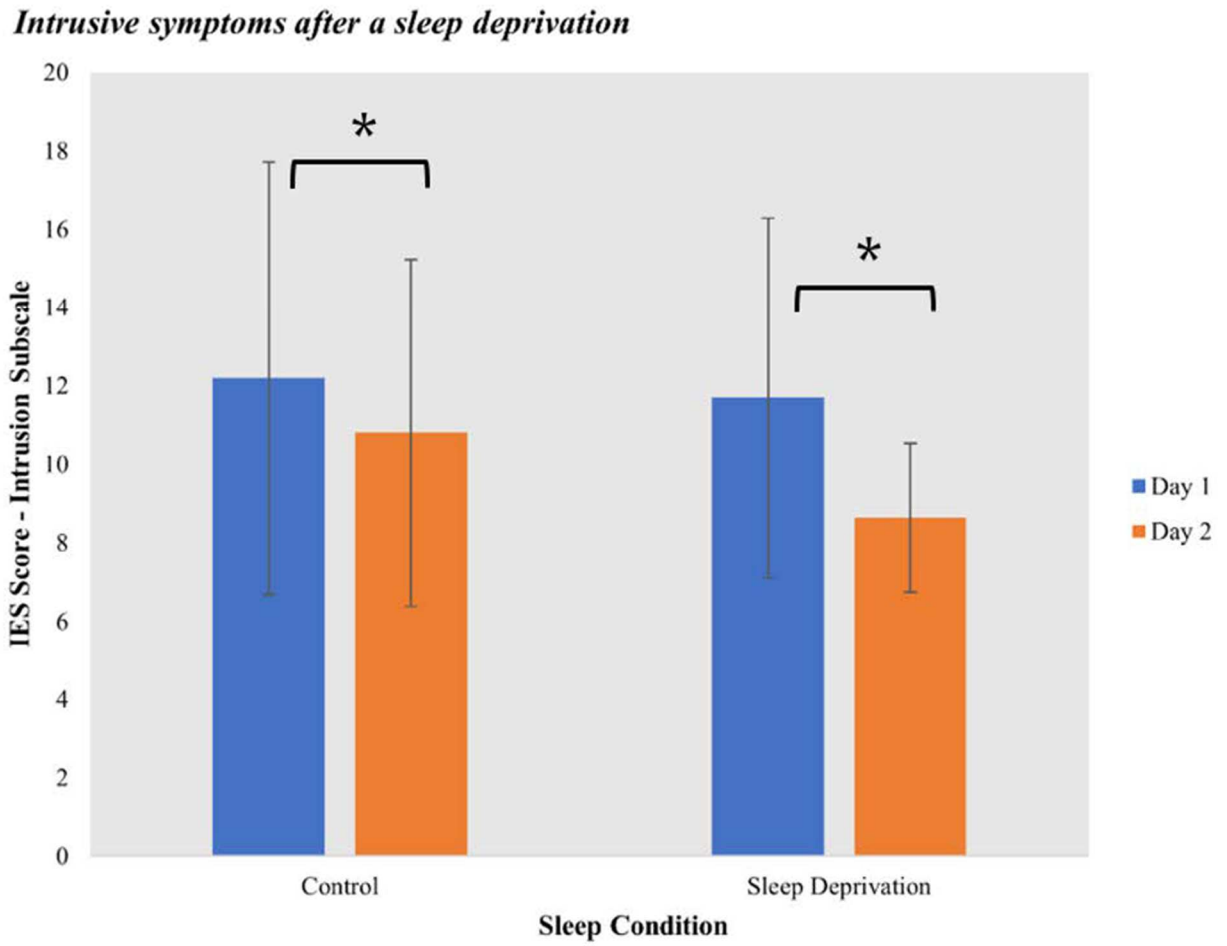

Figure 2. Scores for the IES Intrusion subscale are shown for the sleep deprivation and control group. Scores were calculated as the raw sums of the intrusion subscale in the Impact of Event scale. Error bars show standard deviations.

Figure 3

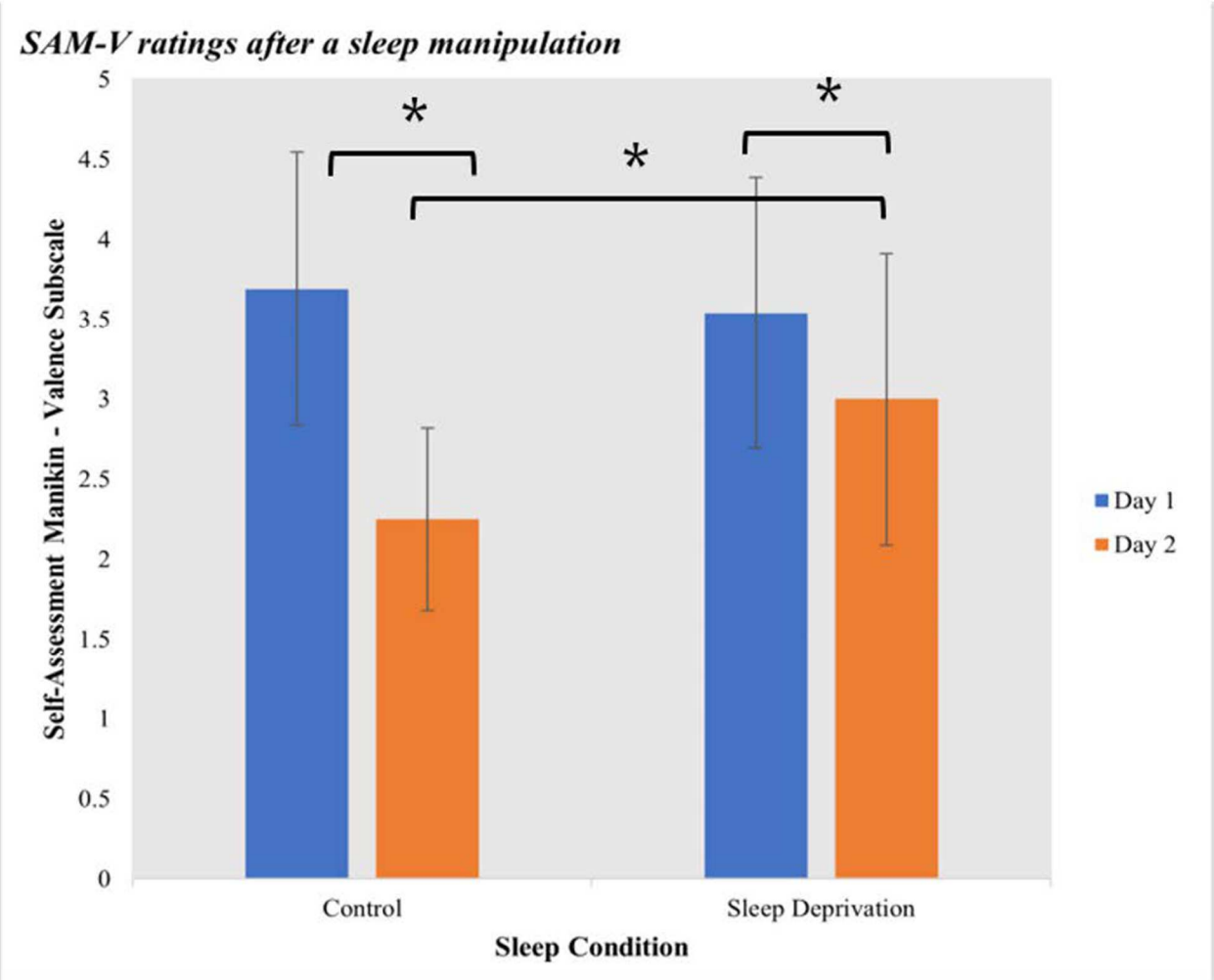

Figure 3. Scores for the Self-Assessment Manikin - Valence Subscale (SAM-V) are shown for the control and sleep deprivation group across days in the lab. Day 1 scores were calculated as the average SAM-V ratings taken while participants looked at film stimuli (images). Day 2 scores were calculated as the average SAM-V ratings while participants looked at the same film stimuli (images).

Figure 4

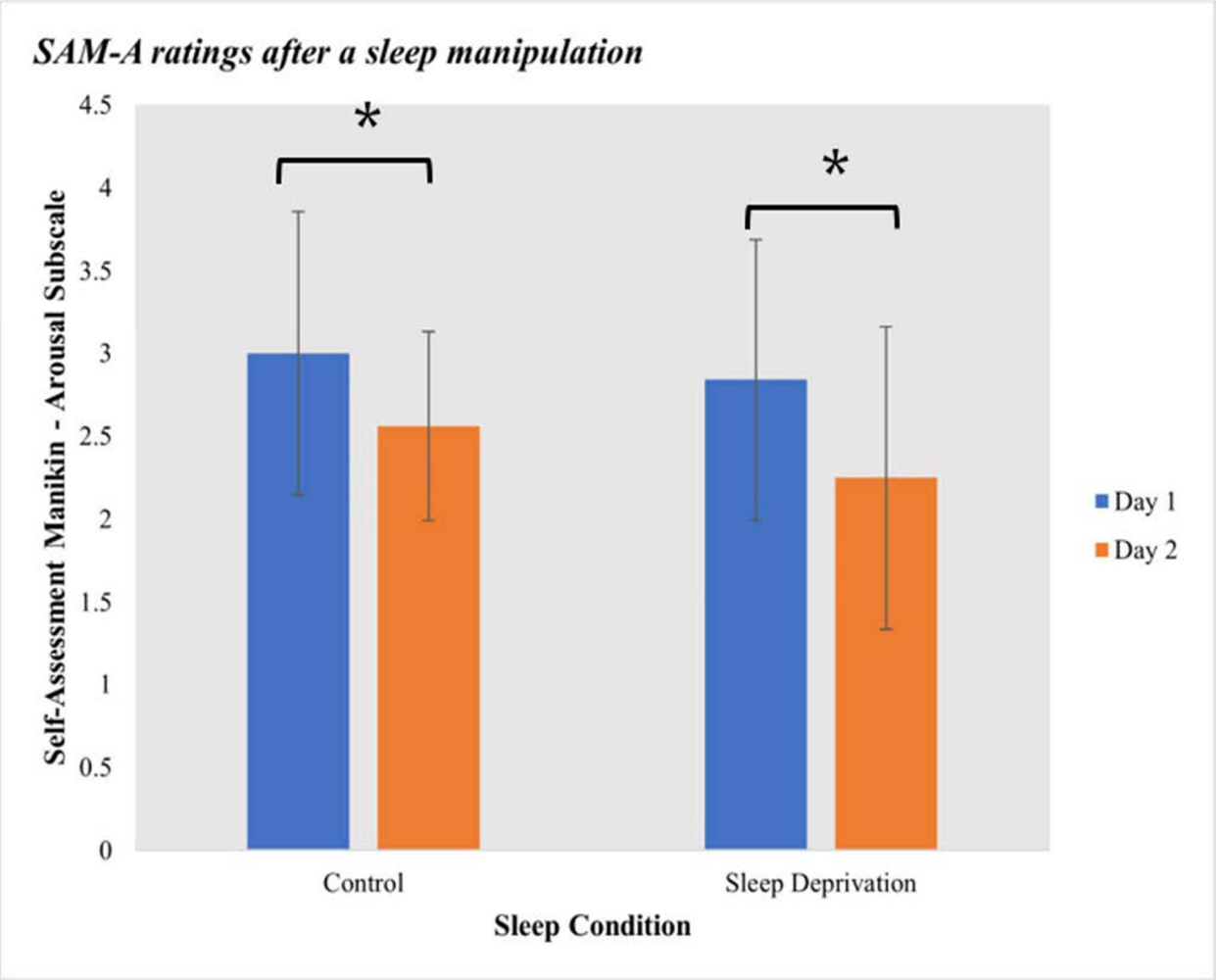

Figure 4. Scores for the Self-Assessment Manikin - Arousal Subscale (SAM-A) are shown for the control and sleep deprivation group across days in the lab. Day 1 scores were calculated as the average SAM-A ratings taken while participants looked at film stimuli (images). Day 2 scores were calculated as the average SAM-A ratings while participants looked at the same film stimuli (images).