The Relationship between PTSD, Hypervigilance, and Disordered Sleep

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**Abstract**

Our research focused on the link between post-traumatic stress disorder (PTSD) and disordered sleep. Specifically, our research investigated hypervigilance, one of the three symptom clusters in a PTSD diagnosis, as the prominent underlying mechanism in this link. Furthermore, our research investigated whether hypervigilance affects dream content and themes in individuals with PTSD. We recruited three groups of participants: individuals diagnosed with PTSD with prominent hypervigilance symptoms ($n = 7$); individuals diagnosed with PTSD without prominent hypervigilance symptoms ($n = 7$); and healthy controls ($n = 8$). Each individual spent 1 night in our sleep laboratory, and we measured sleep latency, awakenings, time spent awake after sleep onset, and sleep efficiency. We also obtained self-reports of sleep quality, as well as two dream reports. Our hypotheses regarding disordered sleep in PTSD with hypervigilance were confirmed: Objective measures of sleep quality tended toward between-groups significance, while subjective measures revealed statistically significant between-group differences. Our hypotheses regarding dream content and theme were not confirmed, however. Possible factors influencing the results are discussed.

The Relationship between PTSD, Hypervigilance, and Disordered Sleep

Post-traumatic stress disorder (PTSD) is a highly prevalent anxiety disorder in South Africa. This high prevalence may be due to individuals being exposed to gender inequality, criminal violence (including rape), and extreme poverty (Stein et al., 2008). PTSD is likely to be a psychiatric consequence of potentially traumatising events for a significant portion of the at-risk population (Edwards, 2005).

Results from the South Africa Stress and Health (SASH) study showed that anxiety disorders, including PTSD, are the most prevalent disorder in individuals with low socio-economic status (SES). The SASH study also found that PTSD and other anxiety disorders were diagnosed in15.8% of individuals with low SES. The SASH study confirmed data from smaller-scale epidemiological studies in South Africa: For instance, Carey, Stein, Zungu-Dirwayi, and Seedat (2003) found that PTSD was diagnosed in 20% of individuals presenting at a township primary healthcare clinic.

Furthermore, the SASH study showed anxiety disorders were more prevalent in South African women than men. Other South African studies have further supported, through the use of discriminate function analysis, the proposition that being female and having a history of sexual violence is significantly associated with risk for developing PTSD (Olley, Zeier, Seedat, & Stein, 2005). This association between sex and the likelihood of being diagnosed with an anxiety disorder is consistent with epidemiological data from other countries (Grice, Brady, Dustan, Malcolm, & Kilpatrick, 1995; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995).

According to the American Psychiatric Association (2000), PTSD is defined as a psychopathological reaction to a traumatic event in which a person experienced or witnessed actual or threatened death, serious injury, or a threat to the physical integrity of self or others. The individual's response may include fear, helplessness, or horror. The formal diagnostic criteria for PTSD, as established by the text revision of the fourth edition of the Diagnostic and Statistical Manual (DSM-IV-TR; American Psychiatric Association [APA], 2000) are presented in Appendix A. As can be seen, criteria for the formal diagnosis indicate that the symptoms of PTSD are grouped into three major clusters: re-experiencing symptoms, avoidance symptoms, and hyperarousal symptoms.

The re-experiencing symptom cluster (cluster A), involves distressing images, thoughts, or perceptions related to the traumatic event. This includes feeling as if the traumatic event is reoccurring in the form of hallucinations or illusions, for example. Extreme psychological distress or physiological reactivity to internal or external cues that remind the individual of the event may possibly be present.

The hyperarousal symptom cluster (cluster B) is defined by difficulty falling or staying asleep, irritability or outbursts of anger, difficulty concentrating, accentuated startle response, and hypervigilance that was not present before the experienced trauma.

The avoidance symptom cluster (cluster C), includes numbing of general responsiveness not present before the trauma, and is related to symptoms that include efforts to avoid thoughts, feelings, or conversations associated with the trauma.

A major feature of the clinical presentation of PTSD is disordered sleep. The reported relationship between the experience of trauma and fluctuations in sleep architecture suggest that sleep disturbances constitute a normal initial reaction to traumatic experiences (Ohayon and Shapiro, 2000). If these disturbances become entrenched, however, a psychopathological stress-related disorder may develop (Harvey, Jones, & Schmidt, 2003).

In general, the term "disordered sleep" refers to a broad range of disrupted sleep behaviours occurring on a regular basis (Roth, 2007). These behaviours include sleep disruption during rapid eye movement (REM) sleep stage, disrupted sleep efficiency, disrupted sleep latency, and recurrent awakenings during the night. As such, sleep in individuals diagnosed with PTSD is often characterised by clinicians as being much more fragmented and less restorative than sleep in healthy individuals.

Empirical studies support this clinical impression, suggesting that PTSD patients experience decreased sleep efficiency, increased sleep latency, increased frequency of nighttime awakenings, and accentuated levels of arousal (Fuller, Water, & Scott, 1994). For instance, Neylan et al. (1998) showed that up to 91% of combat veterans with PTSD indicated that they had trouble maintaining sleep, compared to 63% of veterans without PTSD. Other studies have found 47% of PTSD participants experience disrupted sleep caused by frequent awakenings, compared to 18% of participants without PTSD (Ohayon & Shapiro, 2000).

Our research focused on this relationship between PTSD and disordered sleep. As is clear from the preceding review, this association is fairly well established in the literature and in clinical lore. The mechanisms linking PTSD and disordered sleep have not been researched fully, however. We investigated the possibility that hypervigilance symptoms, which are

related to the physiological state of hyperarousal, are a key mechanism underlying the relationship between PTSD and disordered sleep.

A foundational proposition in our investigation is that, in order to investigate the relationship between PTSD and disordered sleep properly, one must take into account physiological processes at work during and after trauma exposure (Mellman, Knorr, Pigeon, Leiter, & Akay, 2004). The occurrence of an environmental stressor has prominent consequences at the physiological level. The cognitive assessment of a real or imagined threat orchestrates the physiological and behavioral responses to this potential threat. The brain plays an especially important role as it releases certain hormones and neurotransmitters in an attempt to adapt to the stressful circumstances (Vanitallie, 2002).

Specific brain structures are implicated in this process of adaptation; these include the sympathoadrenal system (SAS) and the hypothalamic-pituitary-adrenocortical (HPA) axis. In the face of danger, an acute activation of the SAS occurs, which results in increased production of epinephrine and norepinephrine in the adrenal medulla. Acute activation of the HPA axis results in the increased secretion of corticotropin-releasing hormone (CRH) and arginine vasopressin (AVP). This secretion suppresses urine production, influences cardiovascular function, and elevates mood, memory, and selective attention. CRH also stimulates the secretion of adrenocorticopic hormone (ACTH), which in turn stimulates the adrenal cortex to release glucocorticoids (Kim and Gorman, 2005).

Glucocorticoids are important for modulating the stress response in the hippocampus, which in turn modulates activity in the HPA axis. The effects of long-term stress on the hippocampus can lead to the structure atrophying, with consequent effects on the HPA axis (Kim & Gorman, 2005).

The hippocampus is not the only brain region affected by the experience of an environmental stressor: The amygdala is also affected by the neuroendocrine abnormalities that occur during and after the experience of trauma (Yehuda, 2002). Functionally, the amygdala plays a critical role in regulating stress, anxiety, and the fear response. It also plays a prominent role in emotional processing and memory consolidation. The excessive release of norepinephrine that accompanies a traumatic experience interferes with amygdalar functioning, thus compromising all of the abovementioned functions (Mellman, Kulick-Bell, Ashlock, & Nolan, 1995).

The development of PTSD is facilitated by an inability to contain the physiological stress response outlined above. This defective stress response is mediated by the increased workings of the SAS, HPA axis, and the damaged hippocampus and amygdala. The

combined effects of these systems, in particular impaired amygdalar processing, lead to a state of hypervigilance in an individual with PTSD (Kim & Gorman, 2005).

Hypervigilance in the context of PTSD refers to two related physiological conditions: an exaggerated fear response and the state of hyperarousal (Harvey et al., 2003; Pillar, Malhotra, & Lavie, 2000). The former is associated with the previously mentioned functions of the amygdala relating to the regulation of stress and anxiety. When this structure is damaged, for example by the presence of intense chronic psychological stress as in the case of PTSD, the threshold of activation for the startle response is decreased. This decreased threshold leads to a situation where perpetual fear of benign stimuli can become cognitively conditioned, resulting in the physiological state of hyperarousal (Kim & Gorman, 2005). This state features higher-than-normal respiratory rates, tachycardia, increased movement, and heightened muscle tension (Fuller et al., 1994).

In summary, then, the hypervigilance symptoms that are part of the diagnostic criteria for PTSD (e.g., irritability, angry outbursts, problems with concentration, and an augmented startle response (DSM-IV-TR; APA, 2000)) can be traced fairly directly to the physiological processes outlined above, and in particular to the physiological state of hyperarousal.

Hypervigilance symptoms, and the physiological mechanisms underlying them, have a clear influence on sleep. Specifically, hypervigilance involves the inability to adjust arousal levels, which may result in difficulty falling asleep as well as recurrent awakenings (Fuller et al., 1994). A proposed underlying mechanism for this inability to adjust arousal levels relates to the previously mentioned process of the excessive release of norepinephrine that accompanies the experience of a traumatic event. This release results in a hypervigilant state when the individual is both awake and asleep, and therefore disrupts sleep architecture, particularly during REM sleep stages (Kim & Gorman, 2005).

The chronic release of norepinephrine, which results in impaired amygdalar functioning, could therefore be a causative factor in disrupted REM sleep (Kim and Hamann, 2007). REM sleep is the sleep stage in which the majority of dreams occur (Mellman, David, Bustamante, Torres, & Fins, 2001). With emotional processing being disrupted during REM sleep due to a damaged amygdala, dreaming in PTSD individuals might also be affected (Bryant, Marosszeky, Crooks, & Gurka, 2000). In support of this proposition, neuroimaging studies point to the presence of increased amygdalar activity and increases in emotional memory formation during REM sleep (Maquet et al., 1996). Increased levels of norepinephrine can also lead to the over-consolidation of memories during REM sleep, which allows the traumatic event experienced by PTSD individuals to be replayed repeatedly during

dreaming (Southwick et al., 1999). This over-consolidation of memories can result in persistent flashbacks and repetitive nightmares, for example. A positive feedback loop[1] may be established from the repetition of the traumatic event and the simultaneous release of norepinephrine. The over-consolidation of memories and emotionally-disrupted dreaming that occurs during REM sleep is specifically linked to the previously mentioned neurobiological structures and neurotransmitters. This can lead to an increase in dreaming and especially an increased occurrence of nightmares.

Nightmares, in general, are defined as dreams of a terrifying nature that are accompanied by threats to survival, safety, or self-worth, and that often result in awakenings. Such dreams frequently produce feelings of anxiety, anger, and grief (Spoormaker, Schredl, & Van den Bout, 2005). The diagnostic criteria for PTSD state that nightmares are a mechanism of intrusion where the traumatic event is played out (APA, 2000). Re-experiencing a traumatic event through nightmares is considered to be one of the main components of PTSD (Pillar et al., 2000). Empirical studies report that nightmares are experienced by 60% of individuals diagnosed with PTSD, and that nightmares are a component of disrupted sleep in PTSD (Fuller et al., 1994; Harvey et al., 2003; Pillar et al., 2000.)

When studying dreams (and, more specifically, nightmares) in individuals diagnosed with PTSD, an interesting question is whether dream content is related to the previously-experienced traumatic event. Studies have found that almost 50% of remembered dreams are about events related to the trauma; in many cases, dreams are exact replications of the traumatic event (Schreuder, Kleijn, & Rooijmans, 2000; van der Kolk, Blitz, Burr, Sherry, & Hartmann, 1984). In terms of themes in dreams, previous research suggests that themes of a threatening nature predominate in dreams reported by PTSD individuals, as opposed to themes that are exact replications of previously experienced trauma (Dow, Kelsoe, & Gillin, 1996; Mellman et al., 2001).

Time since trauma has also been speculated to influence dream content. Trauma-related dreams seem to occur less frequently in the chronic stage of PTSD, or in the first year following exposure to trauma (Esposito, Benitez, & Mellman, 1999; Kramer, Schoen, & Kinney, 1984; Mellman et al., 2001). Hence, individuals who have recently experienced trauma should show less traumatic dream material. In support of this proposition, Dow et al.

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[1] The term 'positive feedback loop' in a physiological context refers to "a response mechanism that results in the amplification of an initial change. Positive feedback results in avalanche-like effects, as occurs in the formation of a blood" clot (Fox, p. 6, 2009).

(1996) found that Vietnam War veterans who had been diagnosed with PTSD for over 20 years experience more nightmares than individuals in the chronic stages of PTSD.

The evidence presented above suggests that hypervigilance is highly influential in producing disrupted sleep in individuals diagnosed with PTSD. The underlying cause for the multiple sleep disruptions seen in PTSD patients, such as nightmares and a deepening of sleep, relates to the impaired functioning of the amygdala and the state of neuroendocrinological imbalance that accompanies the experience of a traumatic event and that persists in its aftermath. In particular, the extant literature suggests, at least tentatively, that there are associations between traumatic stress, hypervigilance, disrupted sleep architecture, the amygdala, and norepinephrine.

In summary, although a relationship between PTSD and disordered sleep has been established, one of the major questions facing the field is what mechanism(s) support this relationship. We investigated hypervigilance as a key factor supporting this relationship. Our research first investigated whether PTSD patients with prominent hypervigilance symptoms experience more disordered sleep than PTSD patients without such symptoms and healthy controls. Secondly, we examined whether PTSD patients with prominent hypervigilance symptoms experience more negative dream themes, and more negative dream content, than PTSD patients without such symptoms and healthy controls. Finally, we investigated whether time since trauma in PTSD patients affects their dream content when compared to healthy controls.

**Methods**

**Design and Setting**

Our research was of a quasi-experimental cross-sectional design and was nested within a larger research project evaluating memory and sleep architecture in PTSD. The study procedures obtained ethical approval from the University of Cape Town (UCT) Faculty of Health Sciences Research Ethics Committee (REF REC 363/2009) and the UCT Department of Psychology Research Ethics Committee.

Phase 1 of the study (the *screening phase*) was set at the UCT Department of Psychology and at the UCT Department of Psychiatry and Mental Health at Groote Schuur Hospital. Phase 2 (the *sleep testing night*) was set at the sleep laboratory at Vincent Pallotti Hospital.

**Participants**

Participants were recruited into three groups: the PTSD+H group ($n$ = 7) included individuals diagnosed with PTSD, or experiencing sub-clinical PTSD, marked by prominent hypervigilance symptoms; the PTSD-H group ($n$ = 7) included individuals diagnosed with PTSD, or experiencing sub-clinical PTSD, but without prominent hypervigilance symptoms; and the CON group ($n$ = 8) included healthy individuals with no past or current psychiatric diagnoses.

All participants were recruited from organisations focused on treating trauma-related disorders (e.g., Rape Crisis Centre and the Trauma Centre) and from surrounding communities. Advertisements were placed in newspapers and posters were placed in community police stations, trauma treatment organisations, and clinics. Recruitment for this study and the larger study within which it was nested began in February 2010, and testing commenced in June 2010.

For this study, we only recruited females between the ages of 20 and 40 years. Because the base rate of PTSD in South Africa is higher in females than in males, we decided to focus our recruitment efforts on females so as to ease our path and to ensure homogenous groups of participants. We employed a restricted age range in our recruiting because (a) aging is linked to a change in sleep cycles (Landolt, Dijk, Achermann, & Borbély, 1996), and (b) the sleep cycles of adolescents display different properties than those of adults (Kales et al., 1970).

We also decided to recruit only women who had experienced trauma related to inter-personal violence, again due to the fact that we wanted to strive for homogeneity in our study groups: most of our potential patient participants reported such events as being the source of their PTSD. Furthermore, we ensured that participants in the two patient groups had experienced their trauma between 1 to 5 years prior to enrollment in the study. This inclusion criterion was implemented because time since trauma experience is influential in determining sleeping patterns; that is to say, the immediate manifestations of PTSD in sleep may differ from later manifestations. Immediate responses to trauma, for example recurrent awakenings, might decline over time (Engdahl, Eberly, Hurwitz, Mahowald, & Blake, 2000). In addition, dream content is suggested to differ in the chronic stages of PTSD (i.e., within 1 year of the traumatic experience).

Table 1 presents the demographic characteristics of participants in the three study groups, as well as the group average scores on the Beck Depression Inventory – Second

Edition (BDI-II; Beck, Steer, & Brown, 1996). In addition to these characteristics, all participants reported Xhosa to be their first language.

The table shows that groups were matched on age and SES, with the analysis revealing no significant difference between the groups. There were, however, statistically significant between-group differences with regard to BDI-II scores. Post-hoc comparisons of these data revealed significant differences between the CON group and the PTSD+H group ($p$ = .001) and between the CON group and the PTSD-H group ($p$ = .013), but no significant difference between the PTSD+H group and the PTSD-H group ($p$ = .470). This pattern of differences in depression was expected due to the high comorbidity of PTSD and depression (Krakow et al., 2000). Moreover, the depression factor is important because, if there are differences in sleep architecture between the two PTSD groups, those differences cannot be attributed to depression because there are similar rates of depression in the patient groups.

Table 1
*Demographic and Clinical Characteristics of the Sample*

| | Study Group | | | | | |
| | PTSD+H | PTSD-H | CON | | | |
| Variable | *(n = 7)* | *(n = 7)* | *(n = 8)* | *F* | *p* | ESE |
|---|---|---|---|---|---|---|
| Age (years) | 24.71 (4.11) | 26.57 (5.80) | 24.50 (4.31) | 0.411 | .67 | 0.041 |
| SES | R1000-2499 | R1000-2499 | R2500-5499 | 0.455 | .64 | 0.046 |
| BDI-II score | 27.86 (13.13) | 21.86 (8.3) | 6.5(5.5) | 10.57 | < .001*** | 0.527 |
| Time since trauma | 23.14 (8.51) | 17.29 (5.25) | | 15.50 | .257 | |

*Note.* ESE = effect size estimate; in this case, Cohen's *d*. SES = socioeconomic status, as indicated by income per month (range). BDI = Beck Depression Inventory - Second Edition. ***$p$ < .001. Time since trauma is represented in months. CON group did not experience trauma, therefore, no value is reported. ESE is not reported for time since trauma because non parametric tests were used.

***Exclusion criteria.*** The major eligibility criteria for inclusion in the study have already been documented. Individuals with any of the following characteristics were also excluded from participation:

1. Evidence of a psychotic disorder.
2. Evidence of a history of alcohol or substance abuse. Alcohol and substance abuse were controlled for because recent studies have found significant differences in the sleep architecture of participants with excessive alcohol consumption. The findings include prolonged sleep latency, decreased delta sleep, and shorter REM latency (Irwin, Miller, Gillan, Demodena, & Ehlers, 2000).

3.  Evidence of the use of sleeping pills to treat disordered sleep.

4.  Evidence of receiving any form of pharmacotherapy or psychotherapy for less than 3 months. Participants needed to not be familiar with treatment or to have been stable on treatment for a minimum of 3 months.

5.  Evidence of not being able to speak, read, or comprehend English efficiently.

6.  Pregnancy after 6 months. Sleep architecture of pregnant women differs from that of non-pregnant women (Lee, 1998).

The strict application of all of these eligibility criteria led to many of the originally recruited participants being excluded from participation. Others withdrew for various idiosyncratic reasons. Figure 1 is a flowchart detailing recruitment, selection, and withdrawals from the larger study. Of the eventual total of 24 PTSD participants and 10 control participants recruited into the larger study, 14 PTSD participants and 8 controls were also recruited into this study.

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┌─────────────────────────────────────────┐
│       n = 73 participants recruited      │
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                    │
┌─────────────────────────────────────────┐
│       n = 7: No data were collected      │
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│      n = 5: Part of the larger study only │
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                    │
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│       n = 61 remaining participants      │
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          ╱                       ╲
┌───────────────────────┐   ┌───────────────────────┐
│ n = 49 PTSD participants│  │ n = 12 healthy controls│
└───────────────────────┘   └───────────────────────┘
          │                           │
┌───────────────────────┐   ┌───────────────────────┐
│    n = 2 language       │  │    n = 1 withdrew       │
└───────────────────────┘   └───────────────────────┘
          │                           │
┌───────────────────────┐   ┌───────────────────────┐
│ n = 9 trauma occurred in│  │  n = 1 substance abuse  │
│     exclusion period    │  │                         │
└───────────────────────┘   └───────────────────────┘
          │                           │
┌───────────────────────┐   ┌───────────────────────┐
│    n = 2 withdrew       │  │ n = 10 healthy controls │
└───────────────────────┘   └───────────────────────┘
          │
┌───────────────────────┐
│  n = 6 substance abuse  │
└───────────────────────┘
          │
┌───────────────────────┐
│    n = 2 comorbid       │
│    psychopathology      │
└───────────────────────┘
          │
┌───────────────────────┐
│     n = 3 pregnancy     │
└───────────────────────┘
          │
┌───────────────────────┐
│       n = 1 male        │
└───────────────────────┘
          │
┌───────────────────────┐
│ n = 24 PTSD participants│
└───────────────────────┘
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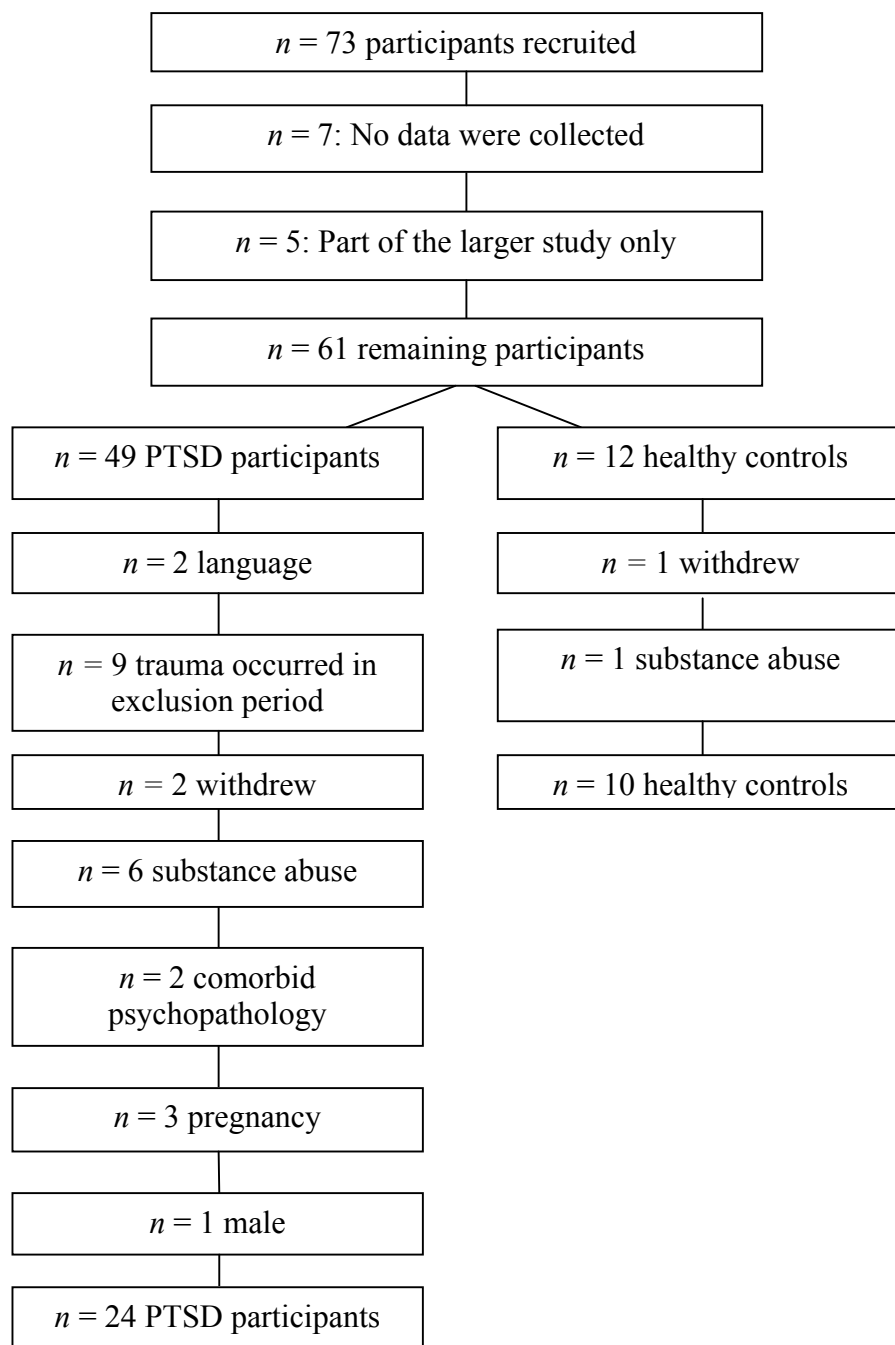
Figure 1. Participant flow chart starting with all individuals that responded to recruitment efforts for this study and the larger study. Using objective measurements and established exclusion criteria, potential participants were excluded accordingly. All eligible participants were not used because measurements for this study were not established until 4 months into the recruitment process.

## Materials and Apparatus

*Diagnostic and screening instruments.* The *Mini International Neuropsychiatric Interview* English version 5.0.0 (MINI; Sheehan et al., 1998), a structured diagnostic

interview, was used to screen for the presence of major DSM-IV Axis I psychiatric disorders. According to the MINI's developer's, the tool has good psychometric properties and can be administered within approximately 15 minutes by a clinician or by a layperson who has undergone appropriate training. The MINI has demonstrated good psychometric properties when used with South African populations (Olley et al., 2005). Here, the MINI served not only to confirm diagnoses of PTSD but also to confirm the absence of other Axis I psychiatric disorders (including alcohol and other substance abuse).

The *BDI-II* (Beck et al., 1996) consists of 21 standardised self-report questionnaire items that evaluate the severity of depression in adults. The instrument's developers report that it has good psychometric properties and can be implemented in a clinical setting as a research tool. The instrument has been used successfully in South African PTSD research (see, e.g., Seedat, Nyamai, Njenga, Vythilingum, & Stein, 2004). In this study, the BDI-II was used to compare severity of depressive symptoms across groups. This was important to the study in order to determine if differences in sleep architecture between groups may have been influenced by depression.

The *Clinician Administered PTSD Scale* (CAPS; Blake et al., 1995) is a structured interview developed for the assessment of the main and associated symptoms of PTSD. This interview seeks to determine the frequency and intensity of PTSD symptoms by asking standard questions and providing an explicit, behaviourally accurate rating scale. According to the developers, this scale is a good detector of PTSD severity and displays good psychometric properties (Blake et al., 1995). The CAPS has been used successfully in previous South African research (see, e.g., Martenyi, Brown, Zhang, Koke, & Prakash, 2002). In this study, the CAPS was used to confirm a PTSD or PTSD sub-clinical diagnosis and to measure the extent of hypervigilance as a cluster of symptoms within this diagnosis.

The CAPS criteria are comprised of 17 core symptoms that are found in a PTSD diagnosis (APA, 2000). In this study, the interviewer administered questions regarding these core symptoms in relation to how the individual has been feeling over the past month. PTSD symptoms were rated on two separate dimensions of symptom severity: frequency and intensity. These dimensions are rated on separate 5-point (0-4) scales, and so can be summed to create a 9-point (0-8) severity score for each symptom. Total scores were used to diagnose the severity of PTSD, so that a score of 0-19 marked asymptomatic/few symptoms; 20-39 mild PTSD symptomatology; 40-59 moderate PTSD symptomatology; 60-79 severe PTSD symptomatology; and > 80 extreme PTSD symptomatology. With regards to this study, any score between of 45 and 20 was considered to be subclinical (Blake et al., 1995).

In relation to symptom-cluster scoring, no specific rules have been established within the CAPS (Blake et al., 1995). We used a score of 20 or above to qualify as prominent hypervigilance symptoms, while a score of below 20 was classified as not prominent hypervigilance. This criterion was established because 20 was the mean hypervigilance score collected from PTSD participants.

The *Michigan Alcoholism Screening Test* (MAST; Selzer, 1971) is a 25-item structured interview used to detect alcoholism and substance abuse. The questionnaire demonstrates good reliability and validity (Gibbs, 1983). We screened for alcohol and other drug abuse, as a possible cause of disordered sleep, using this instrument. Any participant scoring greater than 5 on the MAST (which has a possible range of scores from 0 to 25) was excluded. The MAST has proven to be a useful screening instrument in South African research studies (see, e.g., Bekker & van Velden, 2003).

***Self-report measures of sleep and dreaming.*** The *Pittsburgh Sleep Quality Index* (*PSQI*; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) is a self-rated questionnaire used to evaluate an individual's sleep quality and sleep disturbances over the past month. A total score is produced that represents subjective sleep latency, sleep efficiency, awakenings, and time spent awake in the night. In this study, the total score was used to represent participants' subjective sleep quality. The PSQI has both psychometric and clinical properties that make it well suited for use in clinical practice and in research activities (Germain, Hall, Krakow, Shear, & Buysse, 2005). The PSQI has been administered successfully to South African populations (Rockwood, Mintzer, Truyen, Wessel, & Wilkinson, 2001).

Participants were asked to complete a *Most Recent Dream* form (Domhoff & Schneider, 1998) that included the date, setting, time of day, and location of recollection (see Appendix B). They were asked to describe the content of a dream in as much detail and as accurately as possible. This report was used to measure dream content and dream theme. Dream forms, filled out immediately upon waking or when dreams are remembered, have been suggested as a reliable way to further uncover dream content. Dream reports can be collected outside the laboratory, and they have shown small or no content differences depending on varying personality and cognitive variables found amongst participants (Domhoff, 2000).

***Sleep laboratory equipment.*** Objective measures of sleep quality were obtained using a polysomnograph (PSG) that categorizes sleep into stages and charts sleep architecture.

The Vincent Pallotti Hospital sleep laboratory was selected because it provided all of the necessary equipment and facilities needed to conduct sleep research, including a PSG. A

PSG consists of electroencephalographic (EEG) equipment specially modified for sleep research. The equipment contains EEG electrodes that measure brain activity, electrooculograph (EOG) electrodes that monitor eye movement, and electromyograph (EMG) electrodes that monitor muscle tone. In the current study, the standard measurements of the EEG, EOG, and EMG in terms of sleep stages were classified according to the delineation of the American Academy of Sleep Medicine (Kushida et al., 2005).

**Procedure**

At the beginning of the *screening phase*, the participant signed a consent form and was briefed on the procedure to follow. The diagnostic and screening measures were then administered. If the participant was considered to be an eligible candidate, she was assigned, on the basis of the diagnostic and screening measures, to one of the three study groups. At the conclusion of the screening session, the experimenter scheduled an appointment for the sleep testing night. That testing session took place within 1 week of screening.

In the second phase of the study, *the sleep testing night,* the participant arrived at the sleep lab at 20h00. The experimenter then prepared the participant for a night's sleep. Participants were attached continuously throughout the night to a PSG to monitor sleep architecture. The instrument also measured brain activity through EEG electrodes, eye movements through EOG, and muscle tone through EMG. Participants were woken up 7-8 hours after going to bed. They were then asked to complete the Most Recent Dream form one more time after completing the first form at the screening. The participant was also asked to complete the PSQI. A full debriefing occurred after all questionnaires were administered and the study procedure was complete. At this time the participant was compensated with R150.

Participants only spent one night in the sleep lab. The "first-night effect," which refers to abnormal readings on the PSG due to the unfamiliarity of the laboratory environment, was once a major concern in sleep research. Recent literature suggests, however, that this effect does not significantly affect PSG results. For instance, Ross et al. (1999) found no significant PSG differences from the first night of testing to subsequent nights. Fuller et al. (1994) reported similar results in PTSD individuals, with no significant changes in sleep architecture occurring over a 3-night period. Overall, then, we have some assurances that the first-night effect does not account for significant disruptions in the sleep patterns of people with PTSD who are tested in a sleep laboratory.

**Statistical Analysis**

Data were analysed using the statistical software package SPSS, version 18.0. The independent variable was *group condition*, and it had three levels: PTSD+H; PTSD-H; and CON. The threshold for statistical significance ($\alpha$) was set at .05 for all statistical decisions.

The dependent variables included four *objectively-measured characteristics of sleep quality* (sleep latency (time spent falling asleep, measured minutes); number of awakenings from sleep; time spent being awake after sleep onset (measured in minutes); and sleep efficiency[2]), one *subjective measure of sleep quality* (PSQI total score), and dream report content and theme scores. The objective measures of sleep quality were obtained via the PSG, and we analysed those data with assistance from trained professionals. All analyses of the PSG were scored based on criteria provided by the American Academy of Sleep Medicine (Kushida et al., 2005).

A feature of this study is that we obtained both objective (via the PSG) and subjective (via structured self-report questionnaire) measures of sleep quality. Very few extant studies in this field have attempted to obtain convergent data from two independent sources, and so we are confident that we gained an accurate depiction of disordered sleep in PTSD.

Data analysis proceeded over several steps. First, we compared sleep quality, as reported subjectively and as measured objectively, across the three groups using a series of one-way ANOVAs and pairwise comparisons based on a priori predictions about the relative sleep quality of participants in the three groups.

The second stage of data analysis involved a series of multiple regression models. On average, participants in both PTSD groups self-reported experiencing moderately high depressive symptomatology, whereas participants in the CON group self-reported experiencing minimal such symptomatology (see Table 1). Hence, multiple regression analyses sought to detect the separate contributions of two independent variables (group condition and BDI-II scores) to change in the same objective and subjective measures of sleep quality in PTSD participants. In particular, partial correlation coefficients were used to evaluate to what degree group status (PTSD+H versus PTSD-H) was associated with the dependent variable under consideration when the BDI scores were controlled for. The third stage of data analysis dealt with data from the dream reports. With regards to these reports (i.e., textual data on the Most Recent Dream Forms), they were randomized by an

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[2]Sleep efficiency is described conventionally as the total time spent asleep when all other sleep variables are taken into consideration. Formally, then, the variable is determined by: total sleep time x 100/time spent in bed with lights out (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992).

independent individual as a first step in establishing a blind rating system. The individual gave each report a number and recorded that number, along with the participant's name on a master reference sheet. The participant's name was then removed from the report. Each report was then typed and a copy was given to two raters. The raters separately scored the reports for content and theme. Specifically, each rater read the dream report in its entirety, and then classified the overall theme as negative, neutral, or positive. The rater then scored dream content on a scale ranging from -10, indicating highly negative content, to +10, indicating highly positive content (Domhoff, 2000). Appendix C shows the instructions raters followed through this scoring procedure. Interrater reliability was established for content and theme prior to inferential statistical tests being conducted.

All scored reports were entered into a spreadsheet using the recorded number as the participant's identity. The averaged theme and content scores across each person's two dream reports was used for further analysis. These analyses were (a) bivariate correlations to test the strength of the association between dream content and theme, (b) ANOVA to detect the presence of any between-group differences in dream content or theme (i.e., to determine if participants in the PTSD+H group experienced more negative dream content and dream themes compared to those in the PTSD-H and CON groups), and (c) whether the time since trauma exerts an influence on dream content and theme.

## Results

**Objective and Subjective Measures of Sleep Quality**

To the knowledge of the authors, previous studies investigating sleep quality and PTSD has predominantly relied on self-report data. Very few studies in this field have utilised a polysomnography or other objective measures to gather sleep data. Our research is unique in terms of its design, in that we use objective sleep quality measures in conjunction with subjective sleep quality measures.

Table 2 presents the results of a series of one-way ANOVAs comparing objective and subjective measures of sleep quality across the three groups. The data upheld all the assumptions for ANOVA successfully.

Table 2
*Sleep quality: Between-group comparisons*

| | Group | | | | | |
| | PTSD+H | PTSD-H | CON | | | |
| Variable | ($n = 7$) | ($n = 7$) | ($n = 8$) | $F$ | $p$ | $\eta^2$ |
|---|---|---|---|---|---|---|
| PSG measure | | | | | | |
|     Sleep latency | 15.79 (7.23) | 16.36 (6.16) | 13.56 (12.09) | 0.20 | .820 | .02 |
|     Awakenings | 5.29 (2.87) | 5.29 (3.81) | 2.13 (1.64) | 3.10 | .07 | .25 |
|     Awake after onset[a] | 42.79 (31.23) | 35.43 (23.68) | 15.13 (16.24) | 2.68 | .095 | .29 |
|     Sleep efficiency | 90.85 (6.91) | 92.64 (4.87) | 96.87 (3.38) | 2.70 | .093 | .22 |
| | | | | | | |
| PSQI total score[b] | 12.86 (2.48) | 7.57 (3.70) | 4.38 (2.56) | 10.57 | .001*** | .63 |

*Note.* Degrees of freedom were (2, 21) for all PSG measures, and (2, 19) for the PSQI total score.
[a]Time spent awake after sleep onset. [b]Higher scores indicate poorer overall sleep quality.
***$p < .001$.

Table 2 reveals reasonable effect sizes, which is considered to be a medium effect. However, apart from sleep latency, all variables are approaching statistical significance. This may indicate that with a bigger sample size significant results in this analysis could be obtained.

With regard to the PSG data, although no statistically significant between-group differences were apparent on the one-way ANOVA, we conducted a series of pairwise comparisons because we had *a priori* predictions about the relative sleep quality of participants in each group. The fact that we had such predictions means that protection from a statistically significant omnibus *F* is not necessary to conduct pairwise comparisons (Rosenthal, Rosnow, & Rubin, 2000). These pairwise comparisons, detailed in Table 3, showed several statistically significant differences between the PTSD+H group and the CON group, as predicted by our *a priori* hypotheses.

The hypotheses are confirmed even more strongly by the PSQI data, which show that participants in the PTSD+H group reported experiencing significantly worse sleep quality than those in the both the PTSD-H and CON groups. Interestingly, those in the PTSD-H group also reported experiencing significantly worse sleep quality than those in the CON group. The comparisons between groups are seen in Table 3.

Table 3
*Sleep Quality: Multiple pairwise comparisons*

|  | Comparison | | |
| Variable | CON vs. PTSD+H | CON vs. PTSD-H | PTSD+H vs. PTSD-H |
| --- | --- | --- | --- |
| PSG measure | | | |
| Sleep latency | .642 | .559 | .908 |
| Awakenings | .046* | .046* | 1.00 |
| Awake after onset[b] | .039* | .120 | .575 |
| Sleep efficiency | .037* | .131 | .524 |
|  | | | |
| PSQI total score | < .001*** | .049* | .003** |

*Note.* Data presented are *p* values.
[a]The test statistic for all of these comparison was Fisher's Least Significant Difference (LSD).
[b]Time spent awake after sleep onset. [c]The test statistic for this comparison was Tukey's Honestly Significant Difference (HSD).
*p < .05; **p < .01; ***p < .001

## Controlling for the Effects of Depression on Sleep Quality: Multiple regression analyses

Five separate hierarchical multiple regression analyses were run to evaluate the effect of two predictors (group status and BDI-II score) on the four PSG sleep quality variables and PSQI total. For each model, BDI-II score was entered at the first step and group status (PTSD+H versus PTSD-H) was entered at the second step. All of the models met the assumptions underlying regression analysis (Field, 2009), but only one (the PSQI model) proved to be a statistically significant good fit for the data. Table 4 in Appendix D presents a full description of each of the five models.

Briefly, the results obtained from the series of multiple regression models are these: For PSG-measured sleep latency, $R^2 = .15$ at step 1 and $\Delta R^2 = .15$ from step 1 to step 2. The partial correlation of sleep latency with group status, while controlling for BDI-II score, was very small and non-significant, $r_{xy.z} = -.08$.

For PSG-measured awakenings, $R^2 = .01$ at step 1 and $\Delta R^2 < .001$ from step 1 to step 2. The partial correlation of awakenings with group status, while controlling for BDI-II score, was very small and non-significant, $r_{xy.z} = -.03$.

For PSG-measured time awake after sleep onset, $R^2 = .01$ at step 1 and $\Delta R^2 = .032$ from step 1 to step 2. The partial correlation of time awake after sleep onset with group status, while controlling for BDI-II score, was small and non-significant, $r_{xy.z} = -.18$.

For PSG-measured sleep efficiency, $R^2 = .01$ at step 1 and $\Delta R^2 = .04$ from step 1 to step 2. The partial correlation of sleep efficiency with group status, while controlling for BDI-II score, was small and non-significant, $r_{xy.z} = .20$.

For PSQI total score, the model was significant at step 1, $p = .014$, $R^2 = .41$, and at step 2, $p = .013$, $\Delta R^2 = .263$). The partial correlation of PSQI total score with group status, while controlling for BDI-II score, was large and significant, $r_{xy.z} = -.67$.

**Dream Content and Theme**

Pearson's correlation showed that there was a statistically significant and positive relationship between dream content and dream theme, $r = .77$, $p$ (two-tailed) < .001. This relationship is to be expected, given that negative dream themes would ordinarily be associated with negative content, and vice-versa.

One-way ANOVA examined the effect of the group condition on dream content and theme. There were no statistically significant between-group differences with regard to either dream content or dream themes, $F(2, 21) = 1.21$, $p = .321$, $\eta^2 = .14$, and $F(2, 21) = 0.83$, $p = .453$, $\eta^2 = .08$, respectively. Although there were no statistically significant differences, it should be noted that the expected trends of dream content in relation to group membership is evident in Figure 2.
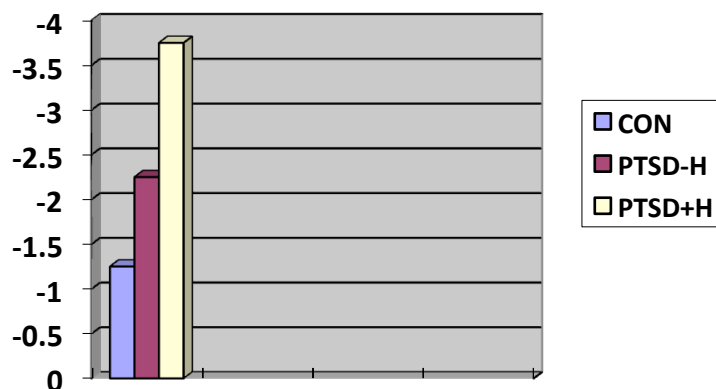


*Figure 2.* Although no significant differences were found in relation to dream hypotheses, the predicted finding of PTSD+H individuals showing the more negative dream content in comparison to the other groups can be seen through mean trends.

Finally, we conducted a correlational analysis to investigate whether time since trauma is associated with changes in dream theme and content. There was no statistically significant association between time since trauma and dream theme, or between time since trauma and dream content, $r = .09$, $p$ (two-tailed) = .765, and $r = -.28$, $p$ (two-tailed) = .354, respectively.

**Discussion**

Previous research has described a clear relationship between posttraumatic stress disorder and disrupted sleep. For example, Ohayon and Shaprio (2000) found 47% of PTSD participants experience disrupted sleep caused by frequent awakenings, compared to 18% of participants without PTSD. In addition, empirical studies report that nightmares are experienced by 60% of individuals diagnosed with PTSD, and that nightmares are a component of disrupted sleep in PTSD (Fuller et al., 1994; Harvey et al., 2003; Pillar et al., 2000.). One of the major questions facing the field, however, is what mechanism(s) support this relationship. Based on well-established knowledge about the neurobiology of the stress response and of post-trauma physiology, we proposed that hypervigilance might be a key factor supporting this relationship. To test this proposal, we investigated whether PTSD patients with prominent hypervigilance symptoms experienced more disordered sleep than PTSD patients without such symptoms and than healthy controls. Secondly, we examined whether PTSD patients with prominent hypervigilance symptoms experienced more negative dream themes, and more negative dream content, than PTSD patients without such symptoms and than healthy controls.

Previous research into sleep quality in PTSD has, overwhelming, relied on self-report data. Very few, if any, studies in this field have used a polysomnograph, or other sophisticated sleep laboratory equipment, to gather data. Our research is thus unique not only in its aims but in its execution.

With more specific regard to the investigation of specific characteristics of sleep quality that we investigated using PSG data, firstly, sleep latency has not been thoroughly researched in individuals diagnosed with PTSD with prominent hypervigilance symptoms, and so we investigated whether PTSD+H individuals do in fact take longer to fall asleep than PTSD-H and CON individuals. Secondly, awakenings in PTSD-H individuals have been compared to healthy controls, but no between-group differences have been found (Neylan et al., 1998). We aimed to determine whether the PTSD+H group would show more awakenings when compared to the PTSD-H and CON groups. Thirdly, time spent awake after sleep onset has not been thoroughly researched with regards to individuals diagnosed with PTSD with prominent hypervigilance symptoms, and so we investigated whether PTSD+H individuals spent more time awake after sleep onset when compared to PTSD-H and CON individuals. Finally, considering the lack of previous research regarding PTSD+H individuals, we investigated the sleep efficiency of the PTSD+H group compared to PTSD-H and CON groups in order to understand overall sleep quality.

Using the PSG, the main hypothesis of this study (i.e., that individuals diagnosed with PTSD and with prominent hypervigilance symptoms would display poorer sleep quality than individuals diagnosed with PTSD but without prominent hypervigilance symptoms, and that healthy controls) was at least partially confirmed, after a series of post-hoc pairwise tests, for three of the four measured sleep variables. Specifically, the sleep architecture produced by the PSG showed that, as predicted, participants in the PTSD+H group experienced more disrupted sleep efficiency, had more nighttime awakenings, and spent more time awake after sleep onset, when compared to participants in the CON group. With regards to time spent awake after sleep onset and sleep efficiency, these findings were further strengthened by the result of multiple regression analyses, which aimed to evaluate the effect of two predictors (group status and BDI-II score) on the four PSG sleep quality variables and PSQI total. However, the current PSG data also suggest, however, that there were no statistically significant differences in sleep quality between the two PTSD groups. These non-significant results may be attributed to several factors, one of which is the fact that levels of depression were similar (and at moderate-to-high severity) in the two PTSD groups. Depression, by itself, disrupts sleep architecture (Krakow et al., 2000). Other factors that may have affected the results yielded by the PSG include artifact in recordings and the change of environment that was experienced by the participants. The change of environment included the hospital providing a more secure, comfortable sleeping environment. Each of these factors is discussed in more detail below.

The sleep quality data derived from the objective source (i.e., the PSG measures of sleep architecture) were only partially consistent with sleep quality data derived from the subjective self-report measure (i.e., the PSQI). The PSQI data were, in fact, more strongly supportive of the *a priori* predictions. Specifically, PSQI data suggested that participants in the PTSD+H group had significantly worse sleep quality than not only healthy controls but also participants in the PTSD-H group. Those in the CON group reported the best sleep quality, followed by those in the PTSD-H group, with the PTSD+H group reporting the worst sleep quality.

A major discrepancy between objective and subjective measures, with regards to hypotheses surrounding sleep quality, was on the sleep latency variable. PSG data showed that participants in the PTSD+H had sleep latencies equivalent to those in the other two groups. PSQI data, in contrast, showed that participants in the PTSD+H group reported longer sleep latencies than participants in both of the other groups. Later in this discussion,

we use this discrepancy to consider how self-report biases need to be considered when undertaking research in this field.

With regard to our hypotheses surrounding dream content and dream themes, we found no statistically significant between-group differences. Below we consider whether the tendency of PTSD individuals to avoid traumatic thoughts or reminders of their trauma might be a contributing factor to this finding (Caldwell and Redeker, 2005).

**Objective Measure of Sleep Quality: The polysomnography**

Polysomnographic equipment used to categorise sleep into stages and to measure sleep architecture is considered the most reliable and ideal way to gather sleep data (Harvey et al., 2003). To our knowledge, no previous studies in this field have a PSG to investigate the sleep architecture of individuals diagnosed with PTSD and with prominent hypervigilance symptoms; all have relied upon self-report data. Even without the hypervigilance element that was included in this study, previous research into sleep and PTSD has rarely used a PSG to investigate sleep architecture. The fact that this study used this objective measure in conjunction with subjective reports of sleep quality is a considerable contributing factor to more accurate overall measurement.

Although participants in the PTSD+H group were significantly different from those in the CON group on three of the four sleep quality variables, there were no statistically significant differences between the two PTSD groups. The quality of the PSG recording (and particularly whether it is sensitive to small but significant differences in the measured variables) might be a contributing factor to this non-significant finding. Because previous research has rarely used a PSG to study the sleep disturbances found in PTSD, the effect of artifact has not been determined when analysing sleep architecture recordings in this regard.

The empirical fact remains that PSG sleep scoring is not perfectly reliable (Tryon, 2004). This is particularly important when considering artifact, or obstructions to sleep architecture recordings. Eye movements, eye blinks, muscle noise, and heart signals are all possible factors contributing to artifact (Jung et al., 2000). Artifact makes PSG recordings difficult to read, and therefore, harder to interpret. In the case of hypervigilant participants, their elevated physiologically hyperaroused state may have affected PSG recordings more so than in the case of other participants.

So, although this hyperaroused state is suggested to be a contributing factor to the disrupted sleep architecture of PTSD+H individuals (Nofzinger et al., 2004), their heightened responses may have caused greater artifact in sleep architecture recordings (Fedoroff &

Taylor, 2000). For example, excessive movement and restlessness could have been mistaken for awakenings, when in fact it was evidence of an artifact. Although professionals aided the researchers in the scoring of PSG recordings, these recordings are, as mentioned previously, not perfectly reliable. Therefore, the non-significant differences between PTSD groups may have been influenced by imperfect recordings disrupted by artifact, and the resulting difficulty differentiating between artifact and the sleep tendencies of PTSD+H individuals.

The change in environment (i.e., a change from normal sleeping environment to sleeping in the sleep laboratory) might also have affected the PSG results all three groups. Many of the current participants lived in relatively unsafe areas, townships such as. These areas were reported by participants to be unsafe due to high rates of crime and violence; they also often described that their living conditions as being less than ideal. For example, some participants claimed their sleep is often disturbed because they are affected by bedrooms that are too cold, the lack of comfortable beds, and being exposed to high levels of noise. The hospital sleep lab, in contrast, provided participants with a safe, warm, noise-free sleeping environment. Most participants ($n = 20$) reported in the morning that they slept better than normal because of these factors.

In summary, because participants typically slept better on the night of testing, PSG recordings may have shown better-than-normal sleep architecture. This may have narrowed the sleep differences seen in the PTSD groups, and thereby influenced the results of the study.

## Depression and Sleep Architecture

Sleep quality and sleep architecture of both groups of PTSD participants in this study may have been negatively influenced by moderate-to-high levels of depressive symptomatology (as reflected by the BDI-II scores) in those participants. One-way ANOVA results, with appropriate post-hoc pairwise comparisons, revealed that (a) both PTSD groups to have significantly higher depression scores than the CON group, and (b) there was no significant difference in rates of depression between the PTSD groups. Therefore, any differences in sleep architecture or sleep quality between the PTSD and control participants could be attributed to the influence of depression.

The strong association between sleep problems and depression has been previously researched in numerous studies (Berger & Rieman, 1993; Krakow et al., 2000; Tyron, 2004). Sleep disturbances found in depression include abnormalities during REM sleep, such as shortening of REM latency, lengthening of the duration of the first REM period, and

heightening of REM density. Although we did not investigate these specific variables, it is likely that such REM abnormalities were present in our PTSD participants due to their depressive symptomatology.

We conducted multiple regression analyses specifically to consider the question, however, of how much the presence of prominent hypervigilance symptoms adds to what we assume is sleep architecture and sleep quality that is already disrupted by the presence of depression. The results of those analyses provide some support for the notion that the presence of prominent hypervigilance in PTSD makes a small but unique contribution to disrupted sleep patterns in those patients. Multiple regression is deemed a suitable analysis for investigating the effects of depression (BDI-II scores) and the group condition on the dependent variable, even with the small sample size that that were used in this study (Anderson and Lavallee, 2008).

For instance, multiple regression models focused on the outcome variables time spent awake after sleep onset and sleep efficiency showed that, across the two PTSD groups, the presence of prominent hypervigilance symptoms accounts for as much, or even more, sleep disruption than depression. In additional support of the main hypothesis of this study, participants in the PTSD-H group (who, remember, reported levels of depression similar to those in the PTSD+H group) showed no significant differences compared to those in the CON group in relation to time spent awake after sleep onset or sleep efficiency. Those in the PTSD+H group did, however, show significant differences compared to the CON group in relation to these two variables. Despite the sample size used, previous studies have shown that multiple regression was a suitable analysis for this study. (Anderson and Lavallee, 2008).

In summary, we regard the present data as demonstrating that the presence of prominent hypervigilance symptoms is responsible for sleep disruption over and above any such disruption associated with the effects of depression.

**Possible Influence of Self-Report Bias on the Current Data**

A possible self-report bias should be considered when evaluating findings produced by the PSQI. For instance, data from subjective measures might be biased in favor of the respondent's personal perception. In support of this proposal, the median absolute magnitude of over-estimation was estimated to be 27% in a study that evaluated bias when using self-report measurements (Nofzinger et al., 2004). Bias is speculated to vary depending on factors such as age, sex, and intelligence level. Previous studies show that children and adolescents, males, and those with lower levels of intelligence are more biased toward producing self-

aggrandizing reports on personality inventories than are older adults, females, and those with higher levels of intelligence (Herbert et al., 1997). In our study, the variation in such self-report biases was probably reduced because of the homogeneity of our groups with regard to age, sex, and intelligence level.

Furthermore, the levels of self-report bias in our study may also have been reduced because previous studies have shown that, when interviews and questionnaires are completed in person, as was the case in this research design, there are lower tendencies toward self-report bias (Nofzinger et al., 2004). For example, Nederhof (1985) reports that self-report bias can possible be mediated by including the use of force-choiced items, as was the case in this study, and by implementing the self administration of the questionnaire. With specific regards to the two PTSD groups in this study, one must consider the possibility that the discrepant results between PSG and PSQI measurements may be due to a 'sleep-state misperception.

A 'sleep-state misperception' is described as patient's self-report measures revealing more severe levels of disrupted sleep when compared to findings produced by objective measures. With specific regard to PTSD patients, this indicates that perceptual alterations may be associated with the diagnosis (Caldwell & Redeker, 2005). In support of this proposal, previous studies have shown that veterans with PTSD report a greater number of awakenings in addition to rating their sleep as more restless when compared to veterans without PTSD. However, these self-report results were not consistent with PSG measures: the latter reported no significant differences between PTSD individuals and individuals without such a diagnosis (Engdahl et al., 2000).

The discrepancy between self-report and objective measures of sleep latency may, at first glance and for example, be attributed to a sleep state misperception experienced by the PTSD+H individuals. However, the results of our multiple regression analyses provide support that a self-report bias was not an influential factor in the results of this study. The multiple regression results show that results found by the PSQI are not merely a misperception because the regression findings support the results of the PSG, the objective measure. Considering that more disrupted sleep in PTSH+H individuals was supported by a combination of subjective and objective measurements, including a variety of statistical analyses to confirm findings, a self report bias is not an adequate assumption. Perhaps the variable, sleep latency, is not adequately reflected in the PSQI total score of sleep quality provides additional support for this already strong finding by supporting the results that were revealed by the PSG and PSQI measurements.

**Hypotheses Related to Dream Theme and Dream Content**

The statistical analysis revealed no significant differences between the three groups with regard to dream theme and dream content, even when time since trauma was taken into account. One factor that may have contributed to these non-significant findings is the memory impairment that is often experienced by individuals with PTSD (Caldwell & Redeker, 2005).

In several instances, our participants had difficulty remembering recent dreams, or important aspects of their dreams, especially details related to traumatic events. This inability to remember dreams is supported by the fact that memory is impaired in several ways in PTSD individuals relative to healthy controls (see, e.g., Jenkins, Langlais, Delis, & Cohen, 1998; Johnsen & Asbjornsen, 2008; Uddo, Vasterling, Brailey, & Sutker, 1993).

The avoidance symptoms that are a part of the PTSD diagnosis (APA, 2000) may also have had an influence on our dream data. For instance, one could speculate that participants were blocking out disconcerting aspects of a traumatic dream and that is why they did not remember dreams accurately and why their reports contained less severely negative dream content and themes. This proposition is supported by our observations of our participants as they filled out their dream reports: many had clear difficulty remembering their dreams, and some experienced marked distress whilst trying to remember. A case study demonstrates this difficulty and distress.

A participant was asked to complete the first required dream report, at the screening phase of research. The instructions were explained in detail and she said she understood. The participant was given time to reflect on her dream, as all participants were, in order to produce as much detail as possible. After about 10 minutes of the participant not writing anything, the instructions were re-explained and she confirmed that she understood. About 5 minutes after this, the participant started crying hysterically. She asked to leave and said she wasn't sure she could participate in the study. We consoled her and told her to feel free to discuss anything she was feeling with us and reminded her that everything was confidential. She reported that in the past she frequently had distressing dreams that reflected her traumatic experience and she couldn't handle thinking about them or remember them clearly. The participant chose to leave the screening because she was so disturbed by the thought of her dreams. However, she did voluntarily return to the study on another day and was able to eventually provide two dreams reports. This individual case supports the suggestion that

dream data may have been influenced by PTSD participants' active efforts to avoid recalling traumatic information.

**Limitations and Recommendations for Future Research**

One possible limitation of this study relates to the dreaming aspect of it. Participants who were recruited experienced their trauma between 1 and 5 years ago. Results of the dream reports might have been influenced by this long period of time. The research design required that two dream reports be completed; these were dream of the participant's choice, and so we have no way to know whether those dreams were a representative sample of the variety of dreams individuals could potentially have had over the past several years, since the occurrence of their traumatic experience. However, obtaining a representative sample of the variety of dreams that could occur over such a long period would not necessarily be feasible, as it is nearly impossible to calculate the number of dreams that could occur.

Future research should evaluate how many reports are needed to establish a suitable sample. Domhoff (2000) suggests that no less than 100 dreams should be recorded in terms of the sample as a whole. Perhaps a more representative sample could be gathered if a larger sample were recruited, or if participants were asked to keep a dream journal. This would provide the participants with more time to reflect on their dreams, as well as enable researchers to obtain more than two dream reports per participant, in addition to possibly obtaining more detailed accounts of dreams.

A second limitation concerns the language barriers that existed between researchers and participants in this study. The eligibility criteria specifically stated that participants had to be fluent in English, in large part due to the measures we used and the measures used in the larger study within which this one was nested. Although all of the participants were capable of reading and understanding English, none of them were native English-speakers (Xhosa was the home language in all cases). Hence, some language barriers were still present, and may have influenced dream data, in particular.

The dream report required that participants write, in English, the events and feelings associated with their dreams in as much detail as possible. The dream scoring instructions were reliant on examining the key words that were used in the dream reports to establish theme and content scores. Key words were intimately related to the feelings and events that were experienced during the dream. Feelings were a very prominent indicator of the nature of the dream that was experienced. So, the possible limitation of the participant's English vocabulary, when compared to their available vocabulary in their first language, could have

influenced the description that was provided and may have resulted in less detailed and accurate dream reports.

Finally, another possible limitation of the present study is that we specifically investigated four sleep variables in PTSD individuals who had experienced only interpersonal violence. Although this strategy fit the broad purposes of our study, future studies should investigate possible differences in sleep architecture amongst people who have experienced different types of trauma. PTSD is a broad phenomenon, and it may be related to diverse events such as war trauma and trauma relating to vehicular accidents, for example. The different manifestations of disrupted sleep for these subgroups have not been clearly demarcated. For example, it has been suggested that war veterans experience longer REM latency and less time sleeping in REM (Ross et al., 1999). In addition, individuals traumatised by motor vehicle accidents reportedly have less slow-wave sleep than healthy individuals (Fuller et al., 1994).

These sleep variables and types of trauma were not investigated by this research. When examining research conducted by other studies, it is clear that differences in sleep disturbances may exist between individuals with different PTSD causes. It is suggested that more comparative studies be conducted in order to elucidate the diverse effects of different traumatic events on a range of different sleep architecture variables.

A final limitation relates to the sample size of this study. Statistical analysis revealed the possibility of obtaining additional significant results when a bigger sample is recruited. The overall statistical trends observed in the analyses of this study, for example the medium effect sizes, serves as an indication that larger sample sizes should be an important consideration in future studies investigating sleep quality and PTSD

**Summary and Conclusion**

This study investigated the influence of hypervigilance as a possible underlying mechanism for disrupted sleep in individuals with PTSD. Objective and subjective measures were implemented to examine the sleep quality of individuals diagnosed with PTSD who showed prominent hypervigilance symptoms in comparison to individuals diagnosed with PTSD but without prominent hypervigilance symptoms and to healthy control individuals. Results suggested that those with prominent hypervigilance symptoms tend to experience poorer sleep quality in comparison to healthy controls, in particular, but that dream content and dream themes were no different across the three groups.

To our knowledge, ours is the first study showing that (a) PTSD individuals with prominent hypervigilance experience more disrupted sleep than matched healthy controls, but that (b) PTSD individuals without prominent hypervigilance symptoms do not experience significantly more disrupted sleep than same control participants. Furthermore, we showed that the presence of hypervigilance symptoms is an added factor, over and above depressive symptomatology, contributing to disrupted sleep in PTSD. Our research thus provides a foundation for further sleep studies to investigate similar, and additional, sleep variables in relation to hypervigilance and PTSD.

In addition, our study has shown that the use of PSG equipment, as an objective measure of sleep architecture and sleep quality, is a valuable and necessary component of research in this field. Where possible, a PSG should be used in conjunction with subjective measures in order to attain a more holistic perspective on sleep architecture and sleep quality. The combined use of these types of measures will, one hopes, yield convergent and reliable data, thus strengthening the conclusions one can draw about the relationship between PTSD and disordered sleep, and about the possible mechanisms underlying that relationship.

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APPENDIX A

DSM-IV-TR criteria for PTSD

In 2000, the American Psychiatric Association revised the PTSD diagnostic criteria in the fourth edition of its Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR). The diagnostic criteria (Criterion A-F) are specified below. Diagnostic criteria for PTSD include a history of exposure to a traumatic event meeting two criteria and symptoms from each of three symptom clusters: intrusive recollections, avoidant/numbing symptoms, and hyper-arousal symptoms. A fifth criterion concerns duration of symptoms and a sixth assesses functioning.

*Criterion A: stressor*

The person has been exposed to a traumatic event in which both of the following have been present:

1. The person has experienced, witnessed, or been confronted with an event or events that involve actual or threatened death or serious injury, or a threat to the physical integrity of oneself or others.

2. The person's response involved intense fear, helplessness, or horror. Note: in children, it may be expressed instead by disorganized or agitated behavior.

*Criterion B: intrusive recollection*

The traumatic event is persistently re-experienced in at least one of the following ways:

1. Recurrent and intrusive distressing recollections of the event, including images, thoughts, or perceptions. Note: in young children, repetitive play may occur in which themes or aspects of the trauma are expressed.

2. Recurrent distressing dreams of the event. Note: in children, there may be frightening dreams without recognizable content.

3. Acting or feeling as if the traumatic event were reoccurring (includes a sense of reliving the experience, illusions, hallucinations, and dissociative flashback episodes, including those that occur upon awakening or when intoxicated). Note: in children, trauma-specific reenactment may occur.

4. Intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event.

5. Physiological reactivity upon exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event.

*Criterion C: avoidant/numbing*

Persistent avoidance of stimuli associated with the trauma and numbing of general responsiveness (not present before the trauma), as indicated by at least three of the following:

1. Efforts to avoid thoughts, feelings or conversation associated with the trauma.

2. Efforts to avoid activities, places or people that arouse recollections of the trauma.

3. Inability to recall an important aspect of the trauma.

4. Markedly diminished interest or participation of significant activities.

5. Feeling of detachment or estrangement from others.

6. Restricted range of affect (e.g., does not expect to have a career, marriage, children or a normal lifespan.

*Criterion D: hyper-arousal*

Persistent symptoms of increasing arousal (not present before the trauma), indicated by at least **two** of the following:

1. Difficulty falling or staying asleep

2. Irritability or outbursts of anger

3. Difficulty concentrating

4. Hypervigilance

5. Exaggerated startle response

*Criterion E: duration*

Duration of the disturbance (symptoms in B, C, and D) is more than one month.

*Criterion F: functional significance*

The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

*Specify if:*

Acute: if duration of symptoms is less than three months.

Chronic: if duration of symptoms is three months or more.

*Specify if:*

With or without delay of onset: Onset of symptoms at least six months after the stressor.

APPENDIX B

Age _____

Gender _____                    **MOST RECENT DREAM**

Date Today _____

We would like you to write down the last dream you remember having, whether it was last night, last month, or last year. But first please tell us the date this dream occurred: _____.

Then tell us what time of day you think you recalled it: _____. Then tell us where you were when you recalled it: _____.

Please describe the dream exactly and as fully as you remember it. Your report should contain, whenever possible: a description of the setting of the dream, whether it was familiar to you or not; a description of the people, their age, sex, and relationship to you; and any animals that appeared in the dream. If possible, describe your feelings during the dream and whether it was pleasant or unpleasant. Be sure to tell exactly what happened during the dream to you and the other characters. Continue your report on the other side and on additional sheets if necessary.

APPENDIX C


DREAM RATING INSTRUCTIONS

Dream reports need to be read carefully and thoroughly for negative, neutral, or positive content. Themes should also be identified in each report. Dream reports should be read at least twice to evaluate content and themes separately. If you feel necessary, you may re-read them.

DREAM THEMES:

Read reports carefully for negative, neutral, or positive themes based on the criteria below:
*Negative content consists of a dream of a threatening nature. For example, violence, aggression, upsetting emotions (e.g. sadness) death, or personal harm of any sort.
*Neutral content consists of a dream of normal occurrences, no extreme emotions of any sort, and nothing harmful or threatening to the individual.
*Positive content consists of a dream of positive emotions or experiences.

CONTENT RATING INSTRUCTIONS:

1. Read reports thoroughly to identify negative, neutral, or positive key words. Tally the amount of positive or negative keywords. In the absence of positive or negative keywords, mark as neutral content. Based on the keywords that are found, give one overall score rating words for positive, negative, or neutral content using the scale below. -10 indicates very negative content and 10 indicates very positive content.
2. Read reports for negative, neutral, or positive content. Use your own discretion to determine how negative, neutral, or positive the overall content of the whole dream is and assign the appropriate number based on the scale below. -10 indicates very negative content and 10 indicates very positive content.
-3 to -10 = negative content
-2 to -2 = neutral
3 to 10 = positive

SCORING:

When the dream reports have been successfully rated, please mark all scores on the back of the report. Clearly stipulate which score belongs with which category.

APPENDIX D

Table 4

Multiple Regression Results for Sleep Variables and PSQI

| Model | $\Delta R^2$ | F | df | p | $r_{xy.z}$ |
|---|---|---|---|---|---|
| Awake time | | | | | |
| BDI | .01 | .13 | 12 | .725 | - |
| Group | .03 | .37 | 11 | .557 | -.18 |
| Efficiency | | | | | |
| BDI | .01 | .13 | 12 | .727 | - |
| Group | .04 | .45 | 11 | .515 | .20 |
| PSQI | | | | | |
| BDI | .41 | 8.25 | 12 | .014* | - |
| Group | .26 | 8.76 | 11 | .013* | -.67 |

*Note.* Awake time = time spent awake after sleep onset. Efficiency = sleep efficiency. A dash was used in place of BDI partial correlation data because the group partial correlation data reflects the influence of the BDI partial correlation.
*p < .05.