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Intolerance of uncertainty and responsibility for harm predict nocturnal panic attacks

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ABSTRACT

Nocturnal panic involves waking suddenly from sleep in a state of panic, with no apparent cause, and affects more than half of patients with panic disorder. The *Fear of Loss of Vigilance* theory is the only proposed model for nocturnal panic, suggesting nocturnal panickers fear states in which they are unable to react to danger or protect themselves from threats. Prior work using a self-report questionnaire designed to test the theory (i.e., Fear of Loss of Vigilance Questionnaire; FLOVQ) was unsuccessful at differentiating nocturnal from daytime panickers. This study tested the theory using alternative measures to the FLOVQ. We predicted nocturnal panickers would show elevated responses to measures assessing fears of being unable to respond to or protect themselves from threats. A diverse community sample ($N = 218$) completed self-report measures related to panic attacks, intolerance of uncertainty, responsibility for harm, and anxiety sensitivity dimensions. Nocturnal panickers endorsed greater inhibitory intolerance of uncertainty and responsibility for harm, but not prospective intolerance of uncertainty, or anxiety sensitivity physical or cognitive concerns. This study provides support for the fear of loss of vigilance theory and suggests intolerance of uncertainty and responsibility for harm reduction be targeted in treatment for nocturnal panic attacks.

1. Introduction

Many who suffer from panic disorder experience panic attacks during sleeping states (i.e., *nocturnal panic*) in addition to wakeful states (i.e., *daytime panic*; Craske et al., 2001). Nocturnal panic begins while one is sleeping and results in awaking to a panic attack (Craske and Rowe, 1997). Nocturnal panic attacks comprise the same symptoms as daytime panic attacks, but occur during the transition from light to deep sleep. Nocturnal panic attacks are not associated with dreams or nightmares and occur outside of other sleep disorders (Craske and Rowe, 1997). Nocturnal panic attacks can occur in various psychological diagnoses (e.g. PTSD), but the nature of nocturnal panic is not well documented outside of panic disorder (Craske and Tsao, 2005). For those who suffer from nocturnal panic, the financial and psychological burden of panic symptoms is worsened by the additional sleep loss (Craske and Tsao, 2005). Returning to sleep following a nocturnal panic attack is typically difficult and often nocturnal panickers fear sleep due to the risk of waking in a panic state (Craske and Rowe, 1997). Nocturnal panickers commonly try to avoid sleep in order to avoid the panic attacks, which leads to sleep deprivation and insomnia (Craske and Tsao, 2005). Chronic sleep loss then contributes to poorer mental and physical health, poorer work performance, and more accidents (Barnes and Drake, 2015).

There are multiple theories of panic that attempt to explain daytime panic attacks, but much less theoretical work has addressed nocturnal panic attacks (see Bouton et al., 2001 for a review). Craske and colleagues (Craske et al., 2001, 2005; Freed et al., 1999; Tsao and Craske, 2003a, 2003b) have been the exception, and have completed several studies examining and developing a conceptual model of nocturnal panic. Individuals with panic disorder who experience nocturnal panic attacks do not seem to differ from those who panic only while awake on respiratory or heart rate variability during sleep, body movement while sleeping, panic disorder symptom severity, anxiety symptoms, depressive symptoms, or other sleep disorders (Craske and Tsao, 2005). In addition, nocturnal panickers are not more aware of or more afraid of anxiety symptoms than daytime panickers (Craske et al., 2001).

Individuals who experience nocturnal panic do, however, have increased anxiety and panic responses to meditative relaxation and report more discomfort associated with attempting to relax (Craske et al., 2001). Tsao and Craske (2003a) suggest that individuals who experience nocturnal panic are "particularly fearful of states associated with loss of vigilance, including sleep, relaxation, and hypnosis." The fear of

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loss of vigilance theory proposes that nocturnal panickers fear being unable to respond properly to threats and fear being unable to protect themselves because of decreased vigilance (Tsao and Craske, 2003a). An individual with elevated fear of loss of vigilance, for example, may attempt to avoid sleep for fear of having a heart attack while sleeping because their ability to get medical help would be diminished (Tsao and Craske, 2003b).

Several studies provide evidence consistent with the fear of loss of vigilance theory. Craske and colleagues have measured responses to hypnotic imagery (Tsao and Craske, 2003b) and meditative relaxation exercises (Craske et al., 2001). Nocturnal panickers responded with more panic symptoms during hypnosis and meditation exercises than did individuals who experienced only daytime panic attacks and non-anxious controls (Craske et al., 2001; Tsao and Craske, 2003b). Indirect evidence for the theory is the noted similarities between those who experience nocturnal panic and those with PTSD such as insomnia and awakening in a heightened state of arousal (Freed et al., 1999). Freed and colleagues suggest that traumatic experiences increase expectation of future threats, resulting in hypervigilance. States during which vigilance and self-protection are lessened, such as sleep, produce more anxiety and distress in response to the perceived danger, resulting in frequent awakenings. Indeed, nocturnal panickers were more likely to report traumatic experiences than daytime panickers and those experiences preceded nocturnal panic onset (Freed et al., 1999). The studies described have provided initial evidence that nocturnal panickers are more fearful of decreased vigilance than daytime panickers.

As its name implies, the Fear of Loss of Vigilance Questionnaire (FLOVQ) was explicitly designed to test the fear of loss of vigilance theory (Tsao and Craske, 2003a). The measure asks participants to rate the amount of fear and anxiety associated with fourteen different states of decreased vigilance (e.g., fatigue, daydreaming) on a scale from 0 (no fear or anxiety) to 8 (extreme fear or anxiety). Higher FLOVQ scores indicate more fear and anxiety associated with states of decreased vigilance (Tsao and Craske, 2003a). Unfortunately, the FLOVQ failed to significantly differentiate between nocturnal and daytime panickers (Tsao and Craske, 2003a). Possibly, the questionnaire did not differentiate the groups because the items asked about experiences of decreased vigilance (e.g., fatigue, drowsiness), but not complete loss of vigilance (e.g. sleep) or more considerable losses of vigilance (e.g. meditation and hypnosis). Conceivably, the types of experiences referenced in the questionnaire do not involve enough loss of vigilance to trigger fears of being unable to respond to or protect one-self from harm. For example, the fatigue item assesses fear of a state of decreased vigilance, but the individual may still feel able to respond to danger when experiencing fatigue. Conversely, that individual may feel unable to respond to threats while sleeping and may actually prefer fatigue compared to the risk of harm associated with sleep. Measures that address experiences of more complete loss of vigilance, general feelings of vulnerability, or an inability to act during non-vigilant states may better differentiate nocturnal panickers from daytime panickers. Therefore, if fear of loss of vigilance does differentiate between daytime and nocturnal panic, it may need to be measured more broadly.

One construct that may be related to the fear of loss of vigilance theory is intolerance of uncertainty. Intolerance of uncertainty "is an individual's dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty." (Carleton, 2016a). Individuals with elevated intolerance of uncertainty experience uncertain situations as stressful, unfair, difficult or impossible to respond to, as well as something that should be avoided (Buhr and Dugas, 2002). For nocturnal panickers, there may be excessive worry about the consequences of unforeseen events such as heart attacks or suffocation during sleep. Worry about cardiac and respiratory disaster is common in panic disorder (Craske et al., 2001), and sleep is a state in which it is more difficult to call for help or get to safety. In addition to worry about internal threats, nocturnal panickers may also worry about external threats such as natural disasters or home invasions (especially for those suffering from PTSD). In such cases, individuals may also fear being harmed or killed before they are able to wake up. Attempts to increase or maintain vigilance may be a way for nocturnal panickers to feel in control of their surroundings, allowing them to prepare for a panic attack and temporarily reduce worry about unforeseen events. Loss of vigilance, then, would also mean loss of that sense of control. In sum, because sleep limits the capacity to deal with unexpected threats and lessens feelings of control over one's surroundings, elevated intolerance of uncertainty may exacerbate sleep-related fear thereby contributing to nocturnal panic.

Another construct that is likely related to fear of loss of vigilance is responsibility for harm. Responsibility for harm refers to doubts about causing harm through actions or failing to prevent harm through inaction (Wheaton et al., 2012). For example, someone who feels strong responsibility for harm might be excessively preoccupied with worry about whether or not they left the stove on, potentially causing a fire (Wheaton et al., 2012). Doubtful thought patterns related to causing harm are commonly seen in individuals with obsessive-compulsive disorder (OCD) and can be accompanied by repeatedly checking for potential dangers (Abramowitz et al., 2010). Likewise, nocturnal panickers engage in nighttime vigilance behaviors such as delaying sleep onset and sleeping with the lights on (Craske and Tsao, 2005). Nocturnal panickers may feel that they are failing to prevent harm by allowing themselves to sleep rather than taking steps to protect themselves. Nocturnal panickers may also worry that they have forgotten to do something to protect themselves in the event of a threat (e.g. plugging in their cellular phone in case they need to call for help or locking all of the doors and windows to prevent against intruders). For nocturnal panickers, sleep may represent a context in which they are missing an opportunity to protect against an unforeseen internal or external danger.

Anxiety sensitivity is a third construct potentially related to fear of loss of vigilance. "Anxiety sensitivity is the fear of arousal-related sensations, arising from beliefs that the sensations have adverse consequences such as death, insanity, or social rejection" (Taylor et al., 2007). Prior research has linked anxiety sensitivity with body vigilance, the conscious attention to internal bodily sensations (Schmidt et al., 1997). The body vigilance model suggests that individuals with panic disorder, who have elevated anxiety sensitivity, pay more attention to internal sensations in order to detect potentially dangerous physiological fluctuations compared to individuals with other anxiety disorders or the population in general (Schmidt et al., 1997). Nocturnal panickers may be particularly fearful of their inability to consciously monitor bodily fluctuations during sleep and other non-vigilant states. Several studies have examined the relationship between anxiety sensitivity and nocturnal panic (Craske and Krueger, 1990; O'Mahony and Ward, 2003; Tsao and Craske, 2003a). Findings have been mixed, with some studies supporting higher anxiety sensitivity in nocturnal panic groups compared to daytime panic groups (Craske and Krueger, 1990; O'Mahony and Ward, 2003), whereas others failed to find such differences (Tsao and Craske, 2003a).

Each of the previous studies examining relations between anxiety sensitivity and nocturnal panic used the original Anxiety Sensitivity Index (ASI; Reiss et al., 1986), which was not designed to equally assess the three lower order dimensions of anxiety sensitivity (e.g., physical, cognitive, social), but rather focused primarily on physical concerns. No study has yet attempted to replicate these findings using the revised Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2007) to determine how the three lower order anxiety sensitivity dimensions relate to nocturnal panic. One possibility is that nocturnal panickers may report higher cognitive concerns even compared to the already elevated cognitive concerns of daytime panickers because they are additionally fearful of the consequences of mental incapacitation. Physical (e.g., racing heart) and social (e.g., blushing) anxiety sensitivity symptoms, conversely, would likely not be relevant during sleep. The relationship

between nocturnal panic and anxiety sensitivity may be clarified by examining each lower order dimension separately rather than focusing on global anxiety sensitivity. For example, previous work in other areas (e.g., suicide) has shown that using the ASI-3 versus the ASI has revealed that the previously undermeasured cognitive and social anxiety sensitivity subfactors may be driving the relationship between overall anxiety sensitivity and other constructs (Capron et al., 2012, 2016)

This study was the first, to our knowledge, to test the fear of loss of vigilance theory of nocturnal panic in a diverse community sample with high levels of psychopathology. Previous studies have utilized samples of patients with panic disorder (Craske et al., 2001, 2005; Freed et al., 1999; Tsao and Craske, 2003b) or undergraduate students (Tsao and Craske, 2003a). This study is also the first to test the fear of loss of vigilance theory using related constructs such as intolerance of uncertainty, responsibility for harm, and the three lower order anxiety sensitivity dimensions. We predicted that nocturnal panickers would show greater intolerance of uncertainty and responsibility for harm compared to daytime panickers and controls who do not experience panic attacks (non-panickers). Due to the mixed findings in previous literature, we also tested the hypothesis that anxiety sensitivity subfactors would be differentially elevated in nocturnal panickers compared to daytime panickers or non-panickers. We predicted that due to the similarity between mental incapacitation and fear of loss of vigilance, nocturnal panickers would score more highly on the cognitive concerns subscale of the ASI-3, but not the physical concerns or social concerns subscales compared to daytime panickers or non-panickers. Lastly, based on Craske et al. (2001), we predicted that all panic group differences would remain even after accounting for demographic differences including gender, race, and number of psychological diagnoses.

2. Methods

2.1. Participants

Participants (n = 218) were adult community outpatients recruited to participate in a larger study (n = 304) examining the effects of an anxiety-based and mood-based treatment on suicide (ClinicalTrials.gov Identifier NCT00387049; a description of the anxiety-based intervention can be found in Schmidt et al., 2014). Inclusion criteria for the parent study required participants be at least 18 years of age, demonstrate elevations of at least 1.5 SD above the community mean on one of several risk factors for suicidality (i.e., thwarted belongingness, perceived burdensomeness; Van Orden et al., 2010), including anxiety sensitivity cognitive concerns (Taylor et al., 2007). Participants were also required to be proficient in English. Exclusion criteria included current or past psychotic spectrum disorders, un-medicated bipolar spectrum disorders, serious medical conditions that would preclude participation in the intervention (e.g., respiratory disorder, cardiovascular disease), or significant suicidal intent requiring immediate hospitalization.

The subset of participants used in the present analyses was selected based on responses to self-report questions regarding panic attacks occurring within the past month. Fifty-one participants did not complete the questionnaires regarding panic attack occurrence and were excluded from the present study because their panic attack experience over the preceding month was unknown. No differences were found in age, sex, race, or ethnicity when comparing those included and excluded from the present study. All data were collected during the baseline appointment of the parent study, prior to treatment randomization.

The relevant item from the Panic Attack Questionnaire (PAQ; *In the past four weeks how many panic attacks have you had?*) was used to determine the occurrence of daytime panic attacks within the past month. An item from the Pittsburgh Sleep Quality Index (PSQI; *During the past month, how often have you had trouble sleeping because you had severe anxiety or panic, not related to traumatic memories?*) was used to determine the occurrence of nocturnal panic within the past month. Individuals who reported both nocturnal and daytime panic attacks belonged to the nocturnal panic group (NP), those who reported only daytime panic attacks belonged to the daytime panic group (DP), and those who reported no panic attacks belonged to the without panic group (WP). The wording of the PAQ and PSQI items closely resembles that used in Tsao and Craske (2003a) to create similar groups. Participants were excluded if they endorsed nocturnal panic attacks within the past month while also reporting that they had not experienced any panic attacks during that period (n = 35), following the practice of Tsao and Craske (2003a). Tsao and Craske (2003a) contacted participants who endorsed nocturnal panic attacks, but also reported that they had not experienced any panic attacks during the same time period and found that the majority of these participants reported waking up due to nightmares, loud noises, etc. but not from true nocturnal panic attacks. Participants in the current study were not directly contacted, but were excluded due to inconsistent reporting.

Participants used for the current analyses ranged in age from 18–79 (M = 36.25, SD = 16.32), and were fairly evenly split among genders (n = 126 female; 57.8%). Approximately one-third (29.8%) of the sample reported a history of military service but no participants were active duty. Most participants identified their race/ethnicity as White/Caucasian (59.2%), with the rest of the sample made up of African American/Black (28.9%), Asian (2.8%), American Indian/Native American (0.5%), or 'Other' (e.g., bi-racial; 8.7%).

2.2. Procedure

Individuals who met initial eligibility criteria completed self-report questionnaires and a semi-structured diagnostic interview. All study procedures were approved by the university's Institutional Review Board, and informed consent was obtained from all participants prior to data collection.

2.3. Self-report measures

2.3.1. Intolerance of uncertainty scale (IUS-12)

The IUS (Carleton et al., 2007) is a 12-item measure used to assess an individual's ability to tolerate the uncertainty of ambiguous situations, including prospective (i.e., worry about the consequences of future uncertainty) and inhibitory (i.e., behavioral symptoms in response to uncertainty) intolerance of uncertainty. Participants are asked to indicate the extent to which each item is characteristic of their typical experience (e.g., *When it's time to act, uncertainty paralyses me)* on a 5-point Likert scale ranging from *not at all characteristic of me* to *entirely characteristic of me*. Previous research has demonstrated strong psychometrics for the IUS total score as well as the Prospective and Inhibitory subscales (Carleton et al., 2007). In the current study, the IUS Prospective and Inhibitory subscale scores demonstrated good to excellent internal consistency (α = 0.90 and α = 0.89 respectively).

2.3.2. Dimensional obsessive-compulsive scale (DOCS) responsibility for harm subscale

The DOCS (Abramowitz et al., 2010) is a 20-item measure assessing the four dimensions of OCD symptoms most reliably replicated in structural research on OCD: contamination, responsibility for harm, unacceptable thoughts, and symmetry/completeness. Participants are asked to respond to each item with regard to their experience in the past month using a 5-point Likert scale ranging from 0 to 4 (e.g., *When you think about the possibility of harm or disasters, or if you cannot check or get reassurance about these things, how distressed or anxious did you become?*). The DOCS has demonstrated good psychometric properties in prior research, including test-retest reliability, validity, and diagnostic sensitivity (Abramowitz et al., 2010). In the present sample, only the responsibility for harm subscale was used, which demonstrated

excellent internal consistency ($\alpha = 0.90$).

2.3.3. Anxiety sensitivity index-3 (ASI-3)

The ASI-3 (Taylor et al., 2007) is an 18-item self-report measure developed to improve the psychometric properties of the original ASI (Reiss and McNally, 1985) and is used to index individual differences in the tendency to interpret benign, anxiety-related arousal symptoms as potentially dangerous. Participants are asked to rate how much they agree with each statement (e.g., *When I cannot keep my mind on a task, I worry that I might be going crazy*) using a 5-point Likert scale ranging from *very little* to *very much*. The ASI-3 is composed of a total score and three lower-order subscales: anxiety sensitivity cognitive concerns, anxiety sensitivity physical concerns, and anxiety sensitivity social concerns. The ASI-3 has exhibited strong psychometric properties, including internal consistency, factor stability, and divergent validity (Chavarria et al., 2015; Farris et al., 2015; Taylor et al., 2007). In the current study, the ASI-3 cognitive, physical, and social scores demonstrated good to excellent internal reliability (α's = 0.92, 0.82, and 0.85, respectively).

2.4. Clinician administered measure

2.4.1. Structured clinical interview for DSM-V, research version (SCID-5-RV; First et al., 2015)

All psychiatric diagnoses were determined using the SCID-5-RV, which was administered by highly trained doctoral level therapists with extensive training in SCID-5-RV administration and scoring, including reviewing training tapes, observing live administrations, and conducting practice interviews with other trained therapists. In addition, all SCID-5-RV results were reviewed by a licensed clinical psychologist to ensure accurate diagnoses. Prior studies in our lab using the same procedures have demonstrated excellent interrater reliability (κ = 0.77–0.86; Keough and Schmidt, 2012; Schmidt et al., 2014, 2017). In the current study a subsample of participants was used for reliability coding which yielded excellent interrater reliability (κ = 0.86).

2.5. Data analytic plan

Participants were classified into nocturnal panic (n = 94), daytime panic (n = 50), and without panic (n = 74) groups based on their reports of panic attacks within the past month on the PSQI and PAQ. Data analysis began with group comparisons to ensure any group differences that emerged were not driven by group differences in demographic (e.g., age, biological sex) and psychopathology-related variables. Next, group differences in IUS Prospective, IUS Inhibitory, DOCS-Responsibility for Harm, and ASI-3 subscales were examined to determine if individuals reporting nocturnal panic differed from those reporting no panic or daytime-only panic.

3. Results

3.1. Group comparisons on demographic and psychopathology variables

Nocturnal Panic (NP), Daytime Panic (DP), and Without Panic (WP) groups were compared on demographic and psychopathology-related variables. Descriptive data are shown in Table 1. Chi-square analyses revealed significant group differences in gender and race, but no significant group difference in ethnicity. The NP and DP groups each had more female participants and more Caucasian participants than the WP group. Therefore, gender and race were included as covariates in subsequent analyses. The number of psychological diagnoses was also assessed for group differences to control for the effect of overall psychopathology. A preliminary ANOVA revealed a significant main effect, $F(2, 215) = 34.55$, $p < 0.001$. Planned contrasts revealed that the NP group had significantly more diagnoses than the DP group ($p < 0.001$) and the DP group had significantly more diagnoses than the WP group ($p < 0.001$). Number of psychological diagnoses was also included as a covariate in subsequent analyses.

Table 1
Descriptive statistics for measures by group.

	Without panic		Daytime panic		Nocturnal panic	
	Mean	SD	Mean	SD	Mean	SD
IUS – prospective	17.86	5.73	20.70	6.94	24.03	7.37
IUS – inhibitory	9.50	3.91	11.44	5.21	14.51	5.38
DOCS-category 2	3.03	3.31	3.60	3.82	6.47	4.72
ASI-3 physical	7.49	6.42	8.80	5.81	11.71	6.09
ASI-3 cognitive	6.19	5.84	9.28	6.83	13.02	7.03
ASI-3 social	9.39	6.09	11.38	5.73	15.15	5.49
Number of diagnoses	1.32	1.09	1.86	1.18	3.04	1.63

	Percentage	Percentage	Percentage	χ^2
Gender				
Female	39%	66%	68%	> 0.001
Ethnicity				
Hispanic	8%	16%	9%	0.29
Race				
Caucasian	42%	68%	68%	>0.001

Without panic, n = 74. Daytime Panic, n = 50. Nocturnal Panic, n = 94. IUS, intolerance of uncertainty scale; DOCS, dimensional obsessive-compulsive scale; ASI-3, anxiety sensitivity index-3.

On the IUS, each group exceeded the non-clinical means reported in the original normative data for the prospective subscale score, and inhibitory subscale score (M = 16.68 and 9.17 respectively; Carleton et al., 2007). Each group also exceeded the non-clinical means for the DOCS Responsibility for Harm subscale reported in the original normative data (M = 2.86), but no group reached the OCD group mean for the subscale (M = 7.54; Abramowitz et al., 2010). Each ASI-3 subscale exceeded the ASI-3 non-clinical means reported in the original normative data (Cognitive M = 4.2; Physical M = 2.7; Social M = 5.9) for each group (Taylor et al., 2007). See Table 1 for descriptive statistics.

3.2. Correlations

Overall means and correlations for each measure are reported in Table 2. As shown, the scores for each scale were moderately and significantly positively correlated with one another. Thus, the scales used likely measure related, but separate constructs. The IUS subscale scores were most highly correlated with one another, reflecting the close relationship among aspects of intolerance of uncertainty. Similarly, the ASI-3 subscales were highly correlated with one another as well.

3.3. Between group differences

To examine group differences on the scales reported here, a series of one-way ANCOVAs was conducted, each using gender, race, and number of psychological diagnoses as covariates. Correlations were run

Table 2
Means, standard deviations and intercorrelations for included measures.

Measure	M	SD	1	2	3	4	5
1. IUS - prospective	22.88	7.37	–				
2. IUS - inhibitory	13.44	5.37	0.76**	–			
3. DOCS – category 2	4.64	4.38	0.50**	0.47**	–		
4. ASI-3 – physical	9.61	6.40	0.36**	0.44**	0.45**	–	
5. ASI-3 – cognitive	9.84	7.23	0.45**	0.55**	0.53**	0.64**	–
6. ASI-3 – social	12.33	6.27	0.49**	0.49**	0.40**	0.61**	0.64**

** $p < 0.01$. IUS, intolerance of uncertainty scale; DOCS, dimensional obsessive-compulsive scale; ASI-3, anxiety sensitivity index-3.

on the three covariates to test for multicollinearity. No two covariates correlated strongly with one another (all correlations were below 0.23) and so, the multicollinearity assumption was not violated. Refer to Table 1 for group means and standard deviations for each scale. Unless otherwise stated, there were no violations of assumptions in the following analyses.

3.3.1. Intolerance of uncertainty

There was a significant main effect for the IUS Prospective subscale, $F(2212) = 3.37$, $p = 0.04$, with a small effect size (partial eta squared = 0.03). Planned contrasts revealed that, contrary to predictions, the NP group did not differ from the DP group ($p = .28$) and the DP group did not differ from the WP group ($p = 0.16$). The main effect for the Inhibitory subscale was also significant, $F(2212) = 8.07$, $p < 0.001$, with a medium effect size (partial eta squared = 0.07). Levene's test was violated for the Inhibitory subscale analysis ($p = 0.004$), and a Kruskal-Wallis Test was performed to allow for heterogeneity of variance. The Kruskal-Wallis Test was significant ($p < 0.001$), as was the Mann-Whitney U Test used to directly compare the NP and DP groups ($p = 0.001$). The DP and WP groups did not significantly differ ($p = 0.06$) Thus, the IUS Inhibitory subscale successfully differentiated between groups who do and do not experience nocturnal panic attacks, whereas the Prospective subscale did not.

3.3.2. Responsibility for harm and mistakes

There was a significant main effect for the DOCS Responsibility for Harm subscale, $F(2, 212) = 8.01$, $p < 0.001$, with a medium effect size (partial eta squared = 0.07). Planned contrasts revealed that, as predicted, the NP group scored significantly higher than the DP group ($p = 0.003$) and the DP group scored significantly higher than the WP group ($p = 0.01$). Levene's Test was violated ($p < 0.001$) and a Kruskal–Wallis Test was run to allow for heterogeneity of variance. The Kruskal-Wallis Test was significant ($p < 0.001$) as was the Mann-Whitney U Test used to directly compare the NP and DP groups ($p < 0.001$). The DP and WP groups did not significantly differ ($p = 0.59$). Thus, the DOCS Responsibility for Harm subscale successfully differentiated between groups who do and do not experience nocturnal panic attacks.

3.3.3. Anxiety sensitivity index-3 cognitive concerns

There was a significant main effect for the ASI-3 Cognitive Concerns subscale, $F(2, 212) = 6.99$, $p = 0.001$, with a medium effect size (partial eta squared = 0.06). Planned contrasts revealed that, contrary to predictions, the NP group did not significantly differ from the DP group ($p = 0.08$), though the DP group did significantly differ from the WP group ($p = 0.001$). Thus, the ASI-3 Cognitive Concerns subscale successfully differentiated between groups that do and do not experience panic attacks in general, but was unsuccessful in differentiating between groups that do and do not experience nocturnal panic attacks.

3.3.4. Anxiety sensitivity index-3 physical concerns

There was a significant main effect for the ASI-3 Physical Concerns subscale, $F(2, 212) = 3.24$, $p = 0.04$, with a small effect size (partial eta squared = 0.03). Planned contrasts revealed that, consistent with predictions, the NP group did not significantly differ from the DP group ($p = 0.12$) and the DP group marginally significantly differed from the WP group ($p = 0.06$). Thus, the ASI-3 Physical Concerns subscale was unsuccessful at differentiating between groups that do and do not experience nocturnal panic attacks.

3.3.5. Anxiety sensitivity index-3 social concerns

There was a significant main effect for the ASI-3 Social Concerns subscale, $F(2, 212) = 8.09$, $p < 0.001$, with a medium effect size (partial eta squared = 0.07). Planned contrasts revealed that, inconsistent with predictions, the NP group significantly differed from the DP group ($p = 0.007$) and the DP group significantly differed from the WP group ($p = 0.005$). Thus, the ASI-3 Social Concerns subscale successfully differentiated between groups who do and do not experience nocturnal panic attacks.

4. Discussion

Prior conceptual models have suggested that a fear of loss of vigilance, characterized by a fear of the inability to respond to threatening situations and to protect oneself during non-vigilant states, separates individuals who experience nocturnal panic attacks from those who experience panic attacks only while awake (Tsao and Craske, 2003a). Findings from the current study support the fear of loss of vigilance theory, operationalizing intolerance of uncertainty and responsibility for harm as a fear of loss of vigilance. Each construct significantly differentiated between nocturnal panickers and daytime panickers. The nocturnal panic (NP) group reported more inhibitory intolerance of uncertainty, and more feelings of responsibility for harm than did the daytime panic (DP) group. The IUS was used to measure feelings of being unable to react to threatening situations (e.g. during sleeping states) as well as the avoidance of uncertain states (e.g. sleep).

Only the inhibitory subscale of the IUS differentiated the NP and DP groups. The prospective subscale did not, implying that daytime and nocturnal panickers are equally upset by uncertainty and that both groups strive to prepare for uncertainty to the same extent. Nocturnal panickers, however, feel less able to act in the face of uncertainty than do daytime panickers, which may contribute to worry about the ability to react in time to dangers that occur during sleep. The current IUS subscale finding is consistent with previous research that found inhibitory intolerance of uncertainty (but not prospective) to be specifically related to panic symptoms and anxiety sensitivity (Carleton et al., 2013; McEvoy and Mahoney, 2011). Carleton et al. (2014) suggested that the uncertainty inherent to uncued panic attacks maintain inhibitory intolerance of uncertainty, leading to further catastrophizing about future panic attacks. The present findings suggest that nocturnal panickers are either a group with extreme inhibitory intolerance of uncertainty or that the previous findings were driven by nocturnal panickers within the panic disorder group. Future research should examine whether the elevated inhibitory intolerance of uncertainty that has been related to panic symptoms is unique to nocturnal panickers. Carleton (2016b) has indicated that intolerance of uncertainty is necessary for the catastrophic cognitions that characterize anxiety sensitivity and that negative interactions with uncertainty promote hypervigilance, a relationship that may be uniquely important to the development and maintenance of nocturnal panic attacks. Research into the mechanism by which inhibitory intolerance of uncertainty, anxiety sensitivity, and fear of loss of vigilance relate to nocturnal panic symptoms is a promising avenue for future research, but beyond the scope of the current paper.

The DOCS Responsibility for Harm subscale was used to measure feelings of being unable to protect oneself by failing to prevent harmful events (e.g., having a heart attack while asleep). Elevated responsibility for harm may help to explain nighttime vigilance behaviors seen in nocturnal panickers such as sleeping with lights on or checking to make sure doors and windows are locked. Future research should examine the relationship between responsibility for harm and nighttime vigilance behaviors to test this theory directly. Together, the intolerance of uncertainty and responsibility for harm results offer some support for the theory that a fear of loss of vigilance contributes to nocturnal panic attacks.

Contrary to our prediction, the NP group showed significantly higher anxiety sensitivity social concerns than the DP group. Elevated social concerns is a surprising finding as anxiety sensitivity social concerns (e.g., blushing, sweating, trembling in the presence of others) seem unlikely to be activated during sleep. Nocturnal panickers may worry about bed partners noticing and judging them poorly for sleep disturbances, which is likely not a concern for daytime panickers.

Hiding a nocturnal panic attack from someone sleeping in the same room is particularly difficult, and may provoke increased fear of being socially rejected or ridiculed by an intimate partner. Another explanation is that an unmeasured third variable, such as social anxiety, may actually be responsible for the elevated social concerns. Individuals with elevated social anxiety engage in greater ruminative post-event processing (Brozovich and Heimburg, 2008). Ruminating about the day's social interactions while falling asleep may lead to greater anxious arousal during sleep. There is no empirical evidence to our knowledge, however, about the relationship between post event processing in social anxiety disorder and sleep. Further work is needed before determining if anxiety sensitivity social concerns are relevant to nocturnal panic.

Cognitive behavioral therapy (CBT) targeted at nocturnal panic has shown some success in reducing the frequency of nocturnal panic attacks, reducing worry about nocturnal panic attacks, and improving general sleep quality (Craske et al., 2005). Specifically, exposure to deep relaxation exercises and sleeping in “hot, stuffy conditions” designed to increase physiological fluctuations were added to the typical CBT procedures used to treat panic disorder (Craske et al., 2005). The resulting nocturnal panic improvements suggest that a conditioned fear of loss of vigilance can be reduced using targeted exposure techniques. Likewise, intolerance of uncertainty has been reduced using targeted CBT (Dugas et al., 1998, 2003; Mahoney and McEvoy, 2012; Robichaud and Dugas, 2006) and computer-based Cognitive Bias Modification (CBM-I; Oglesby et al., 2017). Based on the results of this study, adding intolerance of uncertainty targeted interventions to existing treatments for nocturnal panic may further reduce the fear of sleep as an uncertain and threatening situation, especially if the interventions are able to specifically address fears of being unable to act in uncertain situations.

This study had several limitations. First, assignment to the NP group was based on one item in a questionnaire. While the wording of the item used was similar to wording used in a previous study (Tsao and Craske, 2003a), the use of a nocturnal panic screen like the one used in Craske and Tsao (2005) would have resulted in more reliable group assignment. Second, the measures used in this study were exclusively self-report. A laboratory sleep observation with measurements of physiological arousal leading up to and during sleep would have improved the design. Third, this study used a cross-sectional design, which does not allow causation to be inferred from the relationships reported here. We cannot say with certainty that a fear of loss of vigilance led to the occurrence of nocturnal panic attacks. Repeated occurrence of nocturnal panic attacks may have created a fear of loss of vigilance; however, this would reverse existing conceptual models (Tsao and Craske, 2003a).

Finally, we chose the IUS Prospective subscale, IUS Inhibitory subscale, and DOCS Responsibility for Harm subscale as appropriate measurements of an underlying fear of loss of vigilance. It is possible that intolerance of uncertainty and not a fear of loss of vigilance, for example, differentiates NP and DP groups. Individuals who experience nocturnal panic also experience panic attacks while awake (Craske and Barlow, 1989). Unexpected daytime panic attacks coupled with intolerance of uncertainty may result in increased fear of future panic attacks that extends to sleeping states. Elevated inhibitory intolerance of uncertainty could make the prospect of a panic attack during sleep particularly frightening. The perceived inability to react to unplanned events would be exacerbated during sleep when action on the part of the panicker is required to get help or to defend oneself. Although the IUS and the DOCS Responsibility for Harm subscale were not designed to measure fear of loss of vigilance directly, one possibility is that the combination of these measures may better assess the construct than the FLOVQ, which failed to differentiate nocturnal and daytime panickers (Tsao and Craske, 2003a). Remaining vigilant may allow for some feeling of control over one's surroundings, lessening feelings of uncertainty and allowing the panicker to feel more able to react to threats and prevent potential harm from occurring. A direct comparison, however, is needed in future studies to answer this question more definitively. Further, studies examining the sensitivity and specificity of the IUS and DOCS Responsibility for Harm subscales with regard to nocturnal panic is needed to expand on their predictive ability.

The current study also had a number of important strengths. This study was the first to use a diverse community sample to test the fear of loss of vigilance theory. Previous studies were limited to college undergraduates or individuals diagnosed with panic disorder. The sample used in the current study provides more generalizability to the theory being examined. Additionally, the group differences were present even when important demographic variables such as gender, race, and number of psychological diagnoses were statistically covaried. The results of this study provide additional support for the fear of loss of vigilance theory of nocturnal panic. While further investigation of the fear of loss of vigilance theory is clearly necessary, the current findings suggest that a better understanding of fear of loss of vigilance may lead to a better understanding of nocturnal panic.

Declarations of interest

None.

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