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The Role of Traumatic Experiences in Developing Nocturnal Panic Attacks

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THE ROLE OF TRAUMATIC EXPERIENCES IN DEVELOPING NOCTURNAL PANIC ATTACKS

by

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ABSTRACT

Nocturnal panic attacks refer to panic attacks that occur out of a sleeping state with no obvious cause, resulting in awakening at the peak of a panic attack. Nocturnal panic affects roughly half of patients with panic disorder as well as individuals with other psychological disorders such as PTSD. Prior research has suggested that experiencing a traumatic event may lead to the development of nocturnal panic attacks. The current study sought to expand upon the extant literature related to the role of trauma in nocturnal panic by collecting a comprehensive trauma and panic history in order to establish a timeline of events. Individuals who experience nocturnal panic attacks were expected to report more lifetime traumatic events, with interpersonal traumas and childhood traumas being reported more frequently compared to individuals who panic only while awake or do not experience panic attacks. An online community sample (Nocturnal Panic N = 73; Daytime Panic N = 80; Without Panic N = 63) completed self-report measures about panic attack history, trauma history, current PTSD symptoms, fear of sleep, dissociation, and intolerance of uncertainty. Results showed that the daytime panic group reported more lifetime, interpersonal, and childhood traumas than the nocturnal and without panic groups. Further, only half of the nocturnal panic group reported experiencing a traumatic event prior to their first nocturnal panic attack. Latent profile analysis revealed a three-profile solution illustrating different reactions to trauma in terms of the number of traumas reported and current symptomatology. Finally, discriminant analysis using the latent profile results, demographic variables, and self-report measures was moderately successful in predicting panic group membership. These results demonstrate that the

number, type, and timing of traumatic events is insufficient to explain differences between nocturnal and daytime panic groups, highlighting the need for further research.

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I would like to thank my advisor, Dr. Daniel Capron, for his support throughout the course of this project. Without his guidance and encouragement, I may not have pursued this niche area of research that has become my primary focus. I would also like to thank committee member Dr. Nora Charles for the guidance and direction she provided as I drew from unfamiliar research to inform the study design. Finally, I would like to thank committee members Dr, Randolph Arnau and Dr. Richard Mohn for their direction as I attempted new and exciting statistical analyses to answer this project's questions.

DEDICATION

I would like to dedicate this dissertation to my family for their support throughout the extensive and sometimes confusing road to my doctorate. I didn't always know exactly where I was headed, but you always had faith I could get there. I would also like to thank my research family, who helped to guide and cheer me on through the most stressful years of my life. I am immensely proud of each of you and humbled by the love you have shown me over the years. Finally, I would like to thank my husband Brad for being my place of calm in the storm. You followed me across the country to support my career. You made sure I took care of myself when I didn't make time to eat or sleep. You believed in me, especially when I doubted myself. Most importantly, you reminded me that life can be fun. I can't thank you enough for that.

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LIST OF ABBREVIATIONS

PTSD	Post-Traumatic Stress Disorder
REM	Rapid Eye Movement
APA	American Psychiatric Association
BTT	Betrayal Trauma Theory
DP	Daytime Panic
NP	Nocturnal Panic
WP	Without Panic
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, 5th edition
PCL-5	PTSD Checklist for DSM-5
LEC-5	Life Events Checklist for DSM-5
FoSI-SF	Fear of Sleep Inventory-Short Form
DES-II	Dissociative Experiences Scale-II
IUS-12	Intolerance of Uncertainty Scale-12 Item
SPSS	Statistical Package for the Social Sciences
LPA	Latent Profile Analysis
BIC	Bayesian Information Criterion
AIC	Akaike's Information Criteria
BLRT	Bootstrap Likelihood Ratio Test
ANOVA	Analysis of Variance
HSD	Honestly Significant Difference
AFM	Army Field Manual

CHAPTER I - INTRODUCTION

Nocturnal Panic Attacks

Nocturnal panic attacks are panic attacks that occur during a sleeping state, resulting in awakening mid-panic (Freed, Craske, & Greher, 1999). Nocturnal panic attacks share many of the characteristics of uncued or unexpected panic attacks that occur while awake (daytime panic) in that they comprise the same symptoms and occur without any obvious trigger (Craske & Rowe, 1997). That is, awakening due to environmental stimuli (e.g., thunder, loud noises), nightmares, or night terrors would not constitute a nocturnal panic attack (Craske & Tsao, 2005). Nocturnal panic does not occur during the same sleep stages as other types of sleep disturbances, but rather during the transition from light to deep sleep in late stage II sleep to early stage III sleep (Mellman & Uhde, 1989a). Nightmares occur during REM sleep and night terrors occur during stage IV sleep, much later in the sleep cycle than nocturnal panic (Craske & Rowe, 1997). Those who experience nocturnal panic attacks often have difficulty returning to sleep after a panic attack and report more insomnia than individuals who only panic while awake (Mellman & Uhde, 1989b). Chronic nocturnal panic leads to a fear of sleep, with individuals attempting to delay sleep onset for as long as possible in order to avoid the panic attacks (Craske & Tsao, 2005). Prolonged periods of insufficient sleep result in poorer mental and physical health (Barnes & Drake, 2015).

Nearly one-half of individuals with Panic Disorder regularly experience nocturnal panic attacks (Craske et al., 2001) and nearly three quarters of those with Panic Disorder have experienced at least one nocturnal panic attack in their lifetime (Freed et al., 1999). Some, however, never experience nocturnal panic. It is unclear why some individuals

develop nocturnal panic whereas others do not. Those who experience nocturnal panic do not differ from those who experience only daytime panic on respiratory (Craske & Barlow, 1990) or cardiac (Craske et al, 2005) fluctuations during sleep, movements while sleeping (Uhde, 1994), panic symptom severity, anxiety symptoms more generally (Craske et al., 2002), or comorbid sleep disorders (Craske & Tsao, 2005). Differences between individuals who experience nocturnal panic compared to those who experience daytime-only panic have been demonstrated in reactivity to states of decreased vigilance (Craske et al., 2005).

Studies have shown that those who experience nocturnal panic respond to meditative relaxation exercises (Craske et al., 2001) and hypnosis (Tsao & Craske, 2003b) with exacerbated anxiety symptoms and panic attacks. Those who experienced nocturnal panic attacks reported feeling uncomfortable with trying to relax or "letting go" (Craske et al., 2001). Tsao and Craske (2003a) have suggested that a fear of loss of vigilance separates individuals who experience nocturnal panic from those who experience daytime-only panic. The theory suggests that individuals who experience nocturnal panic have a fear of being unable to respond appropriately to threats or protect themselves from danger during states of lessened vigilance (Tsao & Craske, 2003a). Individuals with Panic Disorder commonly fear potential negative consequences of panic attacks (e.g., dying from a heart attack, being unable to catch one's breath) during daytime panic attacks (APA, 2013). Similarly, an individual who experiences nocturnal panic attacks may fear dying in their sleep as a result of being unable to respond to a heart attack or protect themselves from an intruder. It has not yet been established,

however, what causes the fear of loss of vigilance and nocturnal panic to occur in some, but not all, individuals who experience panic attacks.

Existing theories indicate that fear of loss of vigilance leads to the development of nocturnal panic. Craske & Tsao (2005) proposed that fear of loss of vigilance leads to a conditioned panic response associated with the shift from light sleep to deep sleep. For these individuals, the fear associated with "letting go" and shifting into a non-vigilant state is repeatedly coupled with the internal physiological cues that occur as one shifts into deep sleep (Craske & Tsao, 2005). This association between fear and specific internal stimuli result in nocturnal panic attacks during the transition between stage II and stage III of sleep. According to this theory, a precipitating event (or events) would be required to create the fear of loss of vigilance, which then leads to the eventual development of nocturnal panic attacks through conditioning.Below are examples to illustrate the formatting of each style, all of these styles are accessible using the style ribbon in Word (in the Home section).

Trauma and Nocturnal Panic

A history of traumatic experiences may serve as a catalyst for fear of loss of vigilance if the individual perceives their traumatic experience as potentially preventable had they been more alert and aware of their surroundings. Indeed, there are many similarities between individuals with Post-Traumatic Stress Disorder (PTSD) and those who experience nocturnal panic (Freed et al., 1999). Both groups experience insomnia, reduced sleep efficiency, and abrupt awakenings from sleep (Freed et al., 1999). Although awakenings due to nightmares are common to individuals with PTSD, Mellman and colleagues (1995) found both through self-report and in laboratory-recorded sleep

studies that a substantial portion of awakenings occur with no obvious internal or external triggers. Prior research has demonstrated an association between PTSD symptoms and exaggerated threat expectation (Engelhard et al, 2009; Kimble et al., 2012; Zuj et al, 2017). For those who associate increased threat expectation with a diminished capacity to protect oneself during non-vigilant states, such as sleep, a fear of loss of vigilance may develop (Freed et al., 1999). Fear of sleep, for example, is common to both individuals who experience nocturnal panic and to individuals with PTSD (Smith & Capron, 2021; Pruiksma et al., 2014; DeViva et al., 2004).

A small number of studies to date have examined traumatic experiences as a potential precursor to the development of nocturnal panic. Freed and colleagues (1999) were the first to establish that individuals who experience nocturnal panic were more likely to report traumatic experiences than those who experienced only daytime panic. Their findings also demonstrated that nocturnal panic onset was preceded by a traumatic event in 96% of cases. Those who experienced nocturnal panic were more likely to report certain types of traumatic events, including earthquakes, witnessing gore, witnessing accidents, experiencing accidents themselves, nonsexual assaults in adulthood, as well as childhood physical and sexual abuse compared to those who panic only while awake (Freed et al., 1999). Individuals who were physically or sexually abused as children have also been shown to report more fear of sleep onset and fear associated with waking abruptly in the middle of the night (Chu, Dill, & Murphy, 2000). These participants described a “dread of losing conscious control” when falling asleep. This study did not separate awakenings due to nocturnal panic from awakenings due to nightmares, although many participants reported awakening with a feeling of intense anxiety not due to

nightmares. Based on these studies, childhood traumatic events, particularly abuse, may represent a pathway by which fear of loss of vigilance and nocturnal panic may develop.

Only one study to date has examined events that occurred in temporal proximity to the development of Panic Disorder. Albert and colleagues (2005) found that nocturnal and daytime panic groups did not differ in the frequency, severity, or nature of stressful life events that occurred within a year of Panic Disorder onset. This study, however, did not report on the onset of nocturnal panic attacks in relation to the stressful life events. Rather, it was assumed that for the nocturnal panic group the first nocturnal panic attack occurred at the time of Panic Disorder onset. Therefore, if a traumatic event occurred which led to the development of nocturnal panic attacks and the individual did not meet diagnostic criteria for Panic Disorder within the next year, the event would not have been included in the study. Similarly, if an individual met criteria for Panic Disorder and then experienced a stressful life event that lead to the development of nocturnal panic attacks (in addition to daytime panic attacks) then the event would also not have been included in the study. Therefore, Albert and colleagues (2005) were unable to construct the complete timeline of events necessary to determine if a given traumatic event led to the development of nocturnal panic as opposed to the development of Panic Disorder more generally.

Trauma Memories

The validity of the extant studies linking nocturnal panic with a history of traumatic events necessarily depends on the confidence that can be attributed to the accuracy of participants' recall for those events. Theories that extreme emotional reactions can impair memory of traumatic events, especially events that occur during

childhood, have existed for at least 125 years (Breuer & Freud, 1895). Theories related to the complete repression of traumatic memories, however, have achieved little to no empirical support (Pope et al., 1998). Rather, the evidence for deficits in traumatic memories have been linked to reduced memory specificity, defined as having reported fewer sensory details (Hyman & Byrne, 1999), impaired association of a specific memory with a cue word (Kleim & Ehlers, 2008), and difficulty identifying the date an event occurred (Moore & Zoellner, 2007). Furthermore, many studies of memory repression or "dissociative amnesia" have been criticized for severe methodological limitations (Pope et al., 1998). For example, one study included responses such as "if I remembered, I would feel terrible, so I pushed it out" and "I didn't want to think about it" in the category of "could not remember" even though none of their participants selected the response, "I simply had no memory of it ever happening" (Melchert & Parker, 1997). Clearly, these responses indicate that participants could remember the traumatic event but took steps to avoid the memory. Another study included a subset of participants whose traumatic experiences occurred prior to age 4, when the participants were neurologically incapable of forming long-term memories (events occurred between 10 months of age and 12 years of age; Williams, 1994). Therefore, the types of events that will be reported in the proposed study (i.e., the type of events that occurred and approximate age at which the events occurred) would not be affected by reduced memory specificity for details. The study data will, however, be subject to the same limitations that affect all self-report studies (e.g., biased recall, purposeful nondisclosure). The proposed study will follow the recommendations of Pope and colleagues (1998) by including only traumatic events that are reported at age 6 or older (to ensure the participant was old enough to form long-term

memories) and by asking about specific types of traumatic experiences which will serve as cues to aid recall.

Nature of Traumatic Events

In addition to the stage of life in which traumatic events occur, the nature of the traumatic events may affect the development of psychological symptoms. Vrana and Lauterbach (1994), for example found that college students reporting multiple lifetime traumatic experiences frequently identified deeply personal traumatic events such as rape, child abuse, and sudden death of a loved one as the most traumatic whereas events such as natural disasters, fires, and being in life-threatening accidents were rarely identified as the most traumatic. Similarly, interpersonal traumatic events such as rape, assault, and being threatened with a weapon have been associated with increased risk of a subsequent suicide attempt compared to non-interpersonal events such as natural disasters, life-threatening accidents, and witnessing the serious injury of another person (Belik et al., 2007). Weinberg and Gil (2016) also demonstrated that factors such as proximity to the traumatic event, dissociation, and certain personality traits were related to increased risk for developing PTSD symptoms. Together, these results suggest that the nature of a traumatic event affects resulting symptomatology and interpretations about the impact of the event on the individual's life.

Specific types of traumatic events, such as interpersonal traumas and traumatic childhood experiences, may be more likely to lead to a fear of loss of vigilance. Interpersonal traumas such as sexual assault have been shown to increase expectation of future threats (Foa et al., 1995). With respect to the fear of loss of vigilance theory, sleep represents a state in which threats to one's personal safety are at greatest risk due to an

inability to protect oneself from danger (Freed et al., 1999). Therefore, individuals who have experienced an interpersonal trauma may develop a fear of being unable to protect themselves in a world that they now perceive as dangerous and threatening. The response to this fear would be to attempt to remain vigilant to any potential threat and avoid situations in which vigilance is not possible.

Freed and colleagues (1999) also suggested that traumatic events that occurred at night or in connection with sleep or a bed might constitute the type of conditioning event that could lead to developing nocturnal panic if the fear is generalized to include all sleep related contexts. It is also possible that being in a state of diminished vigilance at the time of the traumatic event may lead to developing a fear of loss of vigilance, especially if the individual believes that they may have prevented the event had they been more vigilant. Traumatic experiences such as the sexual assault of an intoxicated person or a nighttime home invasion could potentially lead to the belief that the victim could have prevented the event had they been in a more alert state at the time.

Trauma Reactions

Dissociation is one example of a non-vigilant state that often occurs during traumatic experiences and differs based on the type of trauma and the age of the individual during the experience. Betrayal Trauma Theory (BTT; Freyd, 1994; 1996) states that psychological reactions to traumatic events depend on (1) the amount of social betrayal involved and (2) the amount of fear the individual feels. BTT predicts that traumas high in betrayal (interpersonal trauma perpetrated by a trusted individual such as a friend or family member) should lead to dissociation (Freyd, 1996). Dissociation is believed to be a protective reaction when the relationship with the perpetrator of the

trauma is necessary to the victim (Bernstein et al., 2015). Recent studies, however, have indicated that the age of the individual at the time of the traumatic experience also influences their psychological response (Bernstein et al., 2015). Traumatic events high in betrayal that occurred during childhood were highly associated with dissociation. Traumatic events high in betrayal that occurred during adulthood, however, were associated with hypervigilance and not associated with dissociation. For those individuals who experienced betrayal traumas in childhood and responded with dissociation, that state of non-vigilance may become associated with the traumatic memory (or memories), thereby creating a conditioned panic response to the transition into a non-vigilant state, as is thought to occur in nocturnal panic. Individuals who experience nocturnal panic, especially those with a history of childhood trauma and dissociation, may include dissociative experiences in their fear of loss of vigilance and may attempt to avoid them.

The way in which an individual interprets a traumatic event may also impact the development of a fear of loss of vigilance. Intolerance of uncertainty is one construct that may impact the way that a traumatic event is interpreted. Intolerance of uncertainty refers to the fear of the consequences of uncertain situations as well as the perceived inability to react to uncertain situations (Carleton et al., 2007). Especially following a traumatic event, individuals who are intolerant of uncertainty may respond with hypervigilance to be continually guarded against unexpected threats. Indeed, the extant literature has established that intolerance of uncertainty is related to the avoidant, hyperarousal, and emotional numbing symptom clusters of PTSD (Fetzner et al., 2013) and the association remains even after accounting for related constructs such as anxiety sensitivity and negative affect (Oglesby et al., 2017). The avoidant and hyperarousal symptom clusters

are particularly related to a fear of loss of vigilance, which involves avoiding non-vigilant states as much as possible and responding to non-vigilance with anxiety and panic (Tsao & Craske, 2003a). Prior research has established a relationship between intolerance of uncertainty and nocturnal panic but thus far, none have included traumatic experiences in the theoretical framework (Smith et al., 2019).

Aims and Hypotheses

The current study aims to clarify the nature of traumatic experiences as a precipitating factor for the development of fear of loss of vigilance and nocturnal panic attacks. I hypothesize the following:

1. Individuals who experience nocturnal panic attacks will differ from those who experience only daytime panic and those who do not experience panic in terms of trauma history as follows:
    a. Individuals who experience nocturnal panic attacks will be more likely to report a past traumatic event compared to individuals who experience only daytime panic and those who do not experience panic attacks.
    b. Those who experience nocturnal panic will report more interpersonal traumas compared to those who experience only daytime panic and those who do not experience panic.
    c. Individuals who experience nocturnal panic will report more childhood traumatic events compared to those who experience only daytime panic and those who do not experience panic.

2. The reported traumatic experiences will precede nocturnal panic onset in nearly all cases, but daytime panic onset will be unrelated to traumatic experiences.
3. Fear of sleep will be related to experiencing an interpersonal traumatic event, as prior literature indicates interpersonal trauma impacts feelings of personal safety.
4. Those who experience nocturnal panic attacks will report fewer recent dissociative experiences compared to those who experience only daytime panic and those who do not experience panic.
5. Individuals who experience nocturnal panic will report higher intolerance of uncertainty than individuals who experience only daytime panic and those who do not experience panic attacks.

Taken together, these results will provide information about a potential pathway by which traumatic experiences may lead to the development of nocturnal panic through fear of loss of vigilance.

CHAPTER II – METHODS

Participants

Participants (*N* = 216) were adults recruited online to participate in a research study about anxiety and stressful experiences. Participants were sorted into groups based on self-report of panic attack history via the Daytime Panic Screen and Nocturnal Panic Screen (Craske & Tsao, 2005). Participants in the Daytime Panic (DP) and Nocturnal Panic (NP) groups were excluded if they endorsed a history of panic attacks but denied experiencing four or more symptoms at one time (*N* = 95), or if they failed a panic definition check (*N* = 419). Participants were excluded, regardless of group, if they failed to answer more than two items for any one or more outcome measures (*N* = 333) or if they failed more than three of the 13 validation questions (*N* = 364). Refer to Figure 1 for recruitment flow.

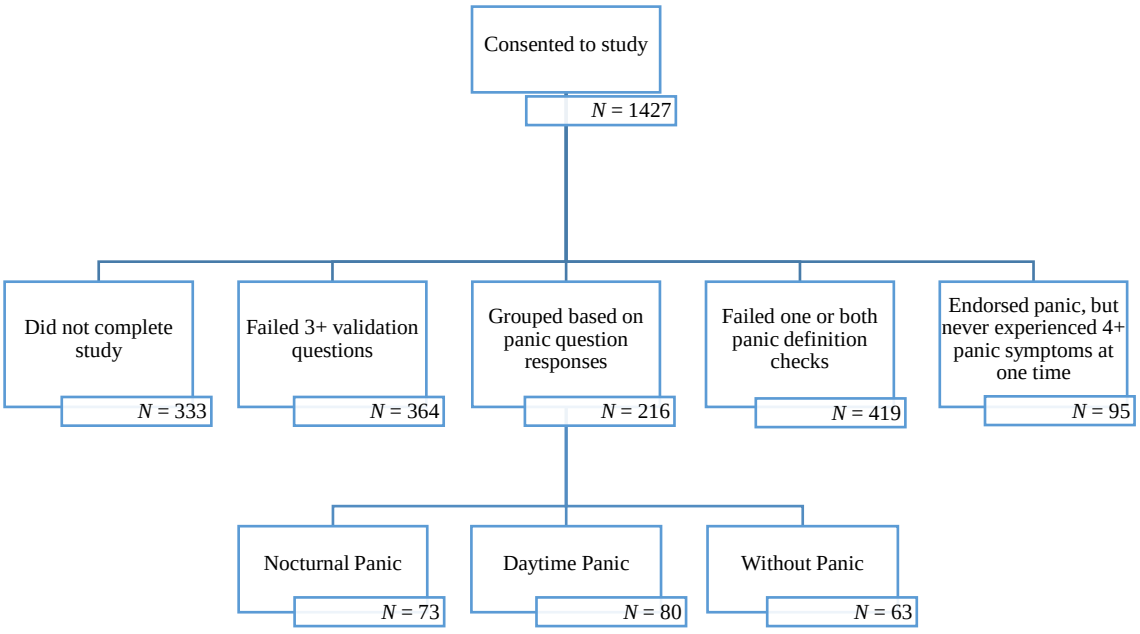

Figure 1. Recruitment Flow Chart.

Participant ages ranged from 18 to 75 years (M = 31.5, SD = 10.0) and were mostly female (N = 157, 73.4%). Most participants racially identified as White (80.1%), with the rest of the sample identifying as Asian/Asian American (7.0%), Multiracial/Mixed Race (4.2%), Latinx (3.2%), Native American/American Indian (2.3%), and Black/African American (1.9%). Twelve percent of the sample identified as Hispanic. See Table 1 for additional demographic information.

Table 1 *Demographic Data by Group*

	Nocturnal Panic Percentage	Daytime Panic Percentage	Without Panic Percentage	χ^2
Biological Sex				
Female	65.8%	89.9%	61.3%	>.001**
Transgender	5.5%	2.5%	1.6%	.395
Sexual Orientation				
Heterosexual	71.2%	68.8%	85.7%	.050
Race				
White	78.1%	80.0%	82.5%	.810
Multiracial	1.4%	8.8%	1.6%	.035*
Asian	5.5%	6.3%	9.5%	.622
Black	2.7%	0.0%	3.2%	.296
Latinx	6.8%	1.3%	1.6%	.101
Native American	5.5%	1.3%	0.0%	.077
Other	0.0%	2.5%	0.0%	.180
Ethnicity				
Hispanic	27.4%	5.0%	3.2%	>.001**
Marital Status				
Never Married	42.5%	57.5%	69.8%	.006**
Education				
Some College	95.9%	95.0%	95.2%	.965
Employment Status				
Employed Full-Time	75.3%	71.3%	52.4%	.011*
Past or Current Military	17.8%	2.5%	4.8%	.001**
Disability	12.3%	13.8%	1.6%	.033*
Age in years				ANOVA
Mean (SD)	30.0 (7.44)	30.5 (8.25)	34.5 (13.42)	.014*

Note. Nocturnal Panic N = 73. Daytime Panic N = 80. Without Panic N = 63. **p < .01. *p < .05.

Procedure

Eligible participants completed self-report measures online using the Qualtrics survey program (https://www.qualtrics.com). Participants who endorsed a history of panic attacks but did not meet symptom criteria or failed a panic definition check were directed to the end of the survey and informed that they do not qualify for the study. After completing the questionnaires, participants were invited to provide their email address to be entered into a drawing to win one of ten $25 Amazon gift cards as compensation for participation. The university's Institutional Review Board approved all study procedures prior to data collection. All participants provided informed consent prior to advancing to study questionnaires.

Measures

Nocturnal Panic Screen.

The Nocturnal Panic Screen (Craske & Tsao, 2005) is a 24-item measure used to record the timeline, frequency, symptom severity, and behaviors associated with nocturnal panic attacks (e.g., *When was your most recent panic attack out of a sleeping state for no apparent reason?*). The screener includes a detailed description of nocturnal panic attacks that is visible throughout the screener so that participants can distinguish nocturnal panic from awakenings due to nightmares or loud noises. Participants also provide severity ratings for the 14 panic symptoms listed in the DSM-5 on a 5-point Likert scale ranging from *Not at all* (0) to *Extreme* (4) to characterize their typical nocturnal panic experience. The Nocturnal Panic Screen was designed to be administered in person but was adapted for a digital administration and has been used in previous

studies (Smith & Capron, 2021; Smith et al., 2020). In the current sample, the symptom severity ratings demonstrated good internal consistency ($\alpha = .82$).

Daytime Panic Screen.

The Daytime Panic Screen (adapted from Craske & Tsao, 2005) was created by this author based on the structure of the Nocturnal Panic Screen. The Daytime Panic Screen is a 25-item measure used to record the timeline, frequency, symptom severity, and behavioral responses to panic attacks that occur while awake (e.g., *How old were you when you first experienced a panic attack while awake?*). The screener displays a detailed description of daytime panic attacks that is visible throughout the screener so that participants can distinguish daytime panic attacks from other forms of anxiety. The Daytime Panic Screen is identical to the Nocturnal Panic Screen except that it refers to panic attacks while awake rather than out of a sleeping state and includes a separate item about panic attacks that occur out of the blue. Nocturnal panic attacks, by definition, occur with no apparent cause so the item differentiating cued from uncued panic attacks is necessary only for the Daytime Panic Screen. In this study, the symptom severity ratings demonstrated acceptable internal consistency ($\alpha = .77$).

PTSD Checklist for DSM-5 with Life Events Checklist for DSM-5 and Criterion A (PCL-5 with LEC-5 and Criterion A).

The PCL-5 (Weathers et al., 2013) is a 20-item measure of PTSD symptom severity. Participants rate how much they have been bothered by twenty PTSD symptoms from the DSM-5 on a 5-point Likert scale ranging from *Not at all* (0) to *Extremely* (4). Item scores are summed to create a total score. The LEC-5 contains 17 traumatic life events that may fit the criteria for PTSD Criterion A according to the DSM-5. For each

type of event (e.g., *Natural disaster, Physical assault, Combat*) participants indicate whether it happened to them personally, they witnessed the event happening to someone else, they learned about the event happening to a close family member or close friend, they were exposed to the event as part of their job, they are unsure if an event fits the type of event listed, or the type of event does not apply to them. If participants indicate " any other very stressful event or experience" they are asked to briefly describe the event in a free text response. The Criterion A portion of the questionnaire typically asks participants to identify one event as the "worst event" or the one that is currently bothering them the most. The participant then answers eight follow up questions related to that event (*How long ago did it happen?*) in order to determine whether or not the event meets Criterion A. For the present study, because I am interested in establishing a timeline of events, participants will be asked to answer the follow up questions for each event that is not marked "Doesn't apply" instead of providing additional details only for the event determined to be the "worst" that they have experienced. The PCL-5 has demonstrated strong psychometric properties including internal consistency, test-retest reliability, convergent validity, and divergent validity in trauma-exposed college samples (Blevins et al., 2015) and veterans (Bovin et al., 2016). In this sample, the PCL-5 demonstrated excellent internal consistency ($\alpha = .97$).

Fear of Sleep Inventory-Short Form (FoSI-SF).

The FoSI-SF (Pruiksma et al., 2014) is a 13-item measure of "fear of loss of control, and fear of darkness," two facets that make up fear of sleep. Participants rate the frequency with which they experienced various thoughts and behaviors related to sleep throughout the past month (e.g., *I felt that it was dangerous to fall asleep*) on a 5-point

Likert scale that ranges from *Not at all* (0) to *Nearly every night* (4). Item scores are summed to create a total score. Two items from the FoSI-SF reference bad dreams and nightmares. For the present study, two new items were created, replacing "bad dream" and "nightmare" with "panic attack" (e.g., *I avoided going to sleep because I thought I would have bad dreams* was revised to *I avoided going to sleep because I thought I would have panic attacks*). The original items and the panic items are included in this study such that there were 15 total items instead of 13. The 15-item revised version of the FoSI-SF that includes nocturnal panic items has been used in previous research (Smith & Capron, 2021). The FoSI-SF has demonstrated strong psychometric properties in prior research, including internal consistency, convergent validity and discriminant validity (Pruiksma et al., 2014). In the current study, the FoSI-SF demonstrated excellent internal consistency ($\alpha = .95$).

Dissociative Experiences Scale – II (DES-II).

The DES-II (Carlson & Putnam, 1993) is a 28-item questionnaire that measures the frequency of dissociative experiences (e.g., derealization, depersonalization, amnesia). Participants rate how often various dissociative experiences happen to them on an 11-point Likert scale ranging from *0%* (0) to *100%* (10). The total score is calculated by summing the item scores (with values 0-10), multiplying the total by 10 and then dividing by 28 (the number of items). The total score represents an average percentage of time that the individual reports dissociative experiences with higher scores indicating more dissociate experiences. The DES-II has demonstrated good internal consistency, factor stability (Zingrone & Alvarado, 2002), test-retest reliability (Carlson & Putnam,

1993), convergent validity, and predictive validity (van Ijzendoorn & Schuengel, 1996). In the current sample, the DES-II demonstrated excellent internal consistency (α = .96).

Intolerance of Uncertainty Scale (IUS-12).

The IUS-12 (Carleton et al., 2007) is a 12-item measure that assesses an individual's reactions to uncertain situations. Two subscales, prospective and inhibitory intolerance of uncertainty, make up the scale. The prospective intolerance of uncertainty subscale measures worry related to the consequences of future uncertainty. The inhibitory intolerance of uncertainty subscale measures behavioral responses to uncertainty. Participants rate how characteristic each item is of them (e.g., *I can't stand being taken by surprise*) on a 5-point Likert scale ranging from *Not at all characteristic of me* (1) to *Entirely characteristic of me* (5). Scores for the prospective (7-item) and inhibitory (5-item) subscales are summed to create subscale scores and all 12 items are summed to create the total score. The IUS-12 total score, prospective subscale, and inhibitory subscale have demonstrated each strong psychometric properties (Carleton et al., 2007). In this sample, the IUS-12 total score, prospective subscale score, and inhibitory subscale score demonstrated good to excellent internal consistency (α = .92, α = .88, α = .87, respectively).

Data Analyses

Data screening.

All data was screened for outliers and missing data. Data points identified as outliers with undue influence on the dataset were transformed prior to analysis. Z scores for continuous variables (i.e., PCL-5, FoSI-SF, DES-II, and IUS-12) were calculated based on the full participant sample. Any data that exceeded a Z score of 2.5 in either the

positive or negative direction (outside the range of 99% of the data) was set to positive or negative 2.5 as a means of maintaining the general shape of the distribution while limiting the influence of extreme data points. Overall, 26 data points were adjusted, all at the upper end of the distribution (set to positive 2.5). For the PCL-5 6 data points were adjusted, for the FoSI-SF 12 data points, for the DES-II 6 data points, and for the IUS-12 two data points. Missing data from continuous variables was estimated using multiple imputation, linear trend at point. Overall, 25 missing data points were imputed. The PCL-5 had 4 missing data points, the FoSI-SF also had 4 missing data points, the DES-II had 8 missing data points, the IUS-12 had 9 missing data points. Participants who did not provide age estimates for traumatic experiences or onset of panic attacks (for the NP and DP groups) were excluded from timeline comparisons due to the inability to establish a complete timeline. Cases with missing data from the Nocturnal and Daytime Panic Screens that are necessary for group determination (described below) were excluded from all analyses. Skewness and kurtosis of continuous variables was examined prior to performing the latent profile analysis and discriminant analysis. Non-normal distributions were adjusted using Blom's formula. Analyses were performed using SPSS version 26 with the exception of the latent profile analysis, which was performed using R version 4.0.2, using the tidyLPA package.

Group determination.

Participants were placed into one of three panic groups based on responses to the Daytime and Nocturnal Panic Screen measures. Individuals who denied ever having a panic attack either while awake or out of a sleeping state were placed in the Without Panic (WP) group. Individuals who endorsed having experienced a panic attack while

awake and denied having ever experienced a panic attack out of a sleeping state were placed in the Daytime Panic (DP) group, provided they endorsed experiencing four or more panic symptoms at one time and correctly identified the definition of a daytime panic attack from a set of distractors. Individuals who endorsed having experienced a panic attack out of sleep, regardless of whether or not they also endorsed panic attacks while awake, were placed in the Nocturnal Panic (NP) group, provided they endorsed experiencing four or more panic symptoms at one time out of a sleeping state and correctly identified the definition of a nocturnal panic attack from a set of distractors. Participants who endorsed both nocturnal and daytime panic attacks were required to pass the symptom count check and definition check for both types of panic attacks in order to be included in the NP group.

Chi-square analyses.

Three chi-square analyses were performed to determine whether panic groups significantly differ with regard to reported traumatic experiences. First, the presence of lifetime traumatic experiences reported was compared based on panic group. Second, presence of lifetime interpersonal traumatic experiences were compared based on panic group. Traumatic experiences were independently classified as interpersonal or non-interpersonal by four undergraduate research assistants as well as by the first author. All but three types of traumatic events were classified with complete agreement (see Table 2 for classifications).

Table 2 *Classifications of Traumatic Events from the Life Events Checklist*

Interpersonal Events	Non-Interpersonal Events
Physical assault	Natural disaster
Assault with a weapon	Fire or explosion
Sexual assault	Transportation accident
Other unwanted or uncomfortable sexual experience	Serious accident at work, home, or during recreational activity
Captivity	Exposure to toxic substance
Sudden violent death	Combat or exposure to a warzone
Serious injury, harm, or death you caused someone else	Life-threatening illness or injury
	Severe human suffering
	Sudden accidental death

Combat or exposure to a warzone, severe human suffering, and sudden accidental death were classified as non-interpersonal events by four out of five raters. These classifications are consistent with previously reported classifications of interpersonal and non-interpersonal traumatic events (Belik et al., 2007; Lilly & Valdez, 2012). Third, presence of childhood traumatic experiences were compared based on panic group. Traumatic experiences reported as occurring prior to age 18 were classified as childhood events and experiences reported as occurring at age 18 or older were classified as adulthood events.

Latent profile analysis.

A latent profile analysis (LPA) was preformed to classify participants based on patterns of responses to continuous variables as well as types of traumatic experiences reported. Continuous variables were standardized into z scores prior to conducting the LPA, allowing for direct comparisons across measures. Three latent profiles were expected, to align with the three panic groups. Therefore, LPA models ranging from 2 to 4 latent profiles were run and fit statistics assessed to determine the best fitting model, as

recommended by Marsh and colleagues (2009). Model fit was assessed based on minimization of the Bayesian Information Criterion (BIC) and Akaike's Information Criteria (AIC), maximization of entropy values, and significant p values for the Bootstrap Likelihood Ratio Test (BLRT) as directed by Nylund, Asparouhov, and Muthen (2007).

Discriminant analysis.

A discriminant analysis was performed to determine the ability of the latent classes indicated in the LPA to discriminate among panic groups. The three panic groups (NP, DP, and WP) were used as the outcome variable. The latent classes determined by the LPA as well as significantly different demographic variables and self-report measures were used as independent variables to predict panic group membership.

CHAPTER III - RESULTS

Group Determination

Responses to the Nocturnal and Daytime Panic Screens as well as the validation questions were assessed as described above. Participants who met the inclusion criteria were sorted into the Nocturnal Panic group (NP; $N = 73$), the Daytime Panic group (DP; $N = 80$), and the Without Panic group (WP; $N = 63$). The groups differed on several demographic characteristics. Participants in the NP group were more likely to be Hispanic and were more likely have served in the military. Participants in the DP group were more likely to be female and were more likely to be multiracial. Participants in the WP group were 4 years older than the NP and DP groups on average. WP participants were also less likely to be married, to be employed full-time, or to report having a disability. Refer to Table 1 for demographic information for each group.

Correlations and Variable Distributions

Overall means, standard deviations and correlations for continuous variables are reported in Table 3.

Table 3 *Means, Standard Deviations, and Intercorrelations for Included Measures*

Measure	Mean	SD	1	2	3	4	5
1. PCL-5	18.88	19.11	-				
2. FoSI-Short Form	6.28	10.55	.675**	-			
3. DES-II	14.88	14.76	.529**	.502**	-		
4. IUS-12	30.56	10.02	.558**	.414**	.227**	-	
5. IUS-Prospective	17.77	6.07	.572**	.433**	.233**	.974**	-
6. IUS-Inhibitory	12.79	4.33	.488**	.350**	.197**	.948**	.850**

Note. $**p < .01$. PCL-5 = PTSD Checklist for DSM-5. FoSI = Fear of Sleep Inventory. DES-II = Dissociative Experiences Scale-II. IUS = Intolerance of Uncertainty Scale.

PCL-5 scores were most strongly correlated with FoSI-SF scores, indicating that individuals with more symptoms of PTSD also reported more fear of sleep. DES-II scores were also highly correlated with PCL-5 and FoSI-SF scores, indicating participants reporting more dissociative experiences also reported more symptoms of PTSD and fear of sleep. As expected, the IUS-12 total score demonstrated a strong correlation with each of its subscales (i.e., Prospective and Inhibitory) and the subscales correlated strongly with one another. The prospective IUS-12 subscale correlated more strongly with the PCL-5, FoSI-SF, and DES-II scores than did the Inhibitory subscale, suggesting that PTSD symptoms, fear of sleep, and dissociation may be more related to fear of future uncertainty than to behavioral responses to uncertainty. Both IUS-12 subscales most strongly correlated with the PCL-5, followed by the FoSI-SF. The IUS-12 subscales demonstrated only a weak correlation with DES-II scores, indicating that negative reactions to uncertainty may be largely unrelated to dissociation.

Skewness and kurtosis were assessed for each continuous variable. PCL-5 scores were positively skewed (1.07). This measure was rank-transformed using Blom's formula (transformed values ranged from -1.43 to 2.76; Blom, 1958). FoSI-SF scores were positively skewed (2.28) and leptokurtic (4.84). This measure was also rank-transformed using Blom's formula (transformed values ranged from -.89 to 2.76). DES-II scores were also positively skewed (1.59) and were rank-transformed using Blom's formula (transformed values ranged from -2.76 to 2.76). IUS-12 scores did not violate normality assumptions and were therefore not transformed. Continuous variables were also assessed for outliers. The transformed PCL-5, FoSI-SF, and DES-II scores as well as the raw IUS-12 scores were calculated into z-scores for ease of interpretation in the latent profile

analysis. Any value exceeding 2.5 in either the positive or negative direction was changed to 2.5 or -2.5 (preserving original valence) in order to maintain the shape of the distribution.

Reported Traumatic Events by Panic Group

A series of chi-square analyses were conducted to examine group differences on types of traumatic events reported. Group differences in overall traumatic events reported, interpersonal events, and childhood traumatic events were assessed. Significant chi-square results were followed up with ANOVAs to examine differences in the number of events of each type reported for each group.

Overall traumatic events.

Chi-square analyses revealed a significant difference between NP and DP groups $\chi^2(1, 153) = 5.87$, $p = .02$, with a small effect size (phi coefficient = -.20) based on Cohen's (1988) criteria. The difference between DP and WP groups was also significant $\chi^2(1, 143) = 11.64$, $p = .001$, with a small effect size (phi = -.29). Finally, the difference between NP and WP groups was non-significant $\chi^2(1, 136) = 1.17$, $p = .28$. Individuals who experienced only daytime panic attacks (93.8%) were more likely than the without panic (73.0%) and nocturnal panic (80.8%) groups to report at least one lifetime traumatic event. Nocturnal and without panic groups did not significantly differ in the number of individuals reporting at least one lifetime traumatic event.

Interpersonal traumatic events.

Chi-square analyses revealed a significant difference between NP and DP groups $\chi^2(1, 153) = 18.10$, $p < .001$, with a medium effect size (phi = -.34). The difference between the DP and WP groups was also significant $\chi^2(1, 143) = 29.92$, $p < .001$, with a

medium effect size (phi = -.46). The difference between the NP and WP groups was non-significant $\chi^2(1, 136) = 2.00$, $p = .16$. Like the overall trauma results, the DP group (85.0%) was more likely to report at least one lifetime interpersonal traumatic event than either the NP (53.4%) or the WP group (41.3%), which did not significantly differ from one another.

Childhood traumatic events.

Chi-square analyses reveled a significant difference between the NP and DP groups $\chi^2(1, 153) = 4.53$, $p = .03$, with a small effect size (phi = -.17). The difference between the DP and WP groups was also significant $\chi^2(1, 143) = 18.10$, $p < .001$, with a medium effect size (phi = -.36). The difference between the NP and WP groups was significant as well $\chi^2(1, 136) = 4.89$, $p = .03$, with a small effect size (phi = -.19). The DP group (76.3%) was the most likely to report at least one traumatic event during childhood, followed by the NP group (60.3%), with the WP group (41.3%) least likely.

Number of Traumatic Events Reported by Panic Group

To examine the differences in the number of traumatic events of each type reported between groups, a series of one-way analysis of variance (ANOVA) tests were run. Significant results were followed up with Tukey HSD post hoc comparisons. Analyses met the assumption for homogeneity of variances unless otherwise stated.

Overall traumatic events.

Comparison of the number of lifetime traumatic events of any type revealed a significant difference $F(2, 213) = 11.97$, $p < .001$, with a medium effect size ($\eta^2 = .10$). Post hoc comparisons revealed that the DP group ($M = 3.36$, $SD = 1.72$) reported significantly more traumatic events than either the NP ($M = 2.59$, $SD = 2.16$) or WP ($M =$

1.87, *SD* = 1.69) groups. The NP and WP groups did not significantly differ from one another (*p* = .29).

Interpersonal traumatic events.

Comparison of the number of lifetime interpersonal traumatic events violated the test of homogeneity of variance. The non-parametric alternative, the Kruskal-Wallis test, revealed a significant overall effect H(2, 216) = 36.07, p < .001. Post hoc comparisons revealed that the DP group (M = 1.71, SD = 1.13) reported significantly more interpersonal traumatic events than either the NP (M = 1.05, SD = 1.35) or WP (M = .62, SD = .89) groups. The NP and WP groups did not significantly differ from one another (p = .22).

Childhood traumatic events.

Comparison of the number of childhood traumatic events also violated the test of homogeneity of variance. The Kruskal-Wallis test revealed a significant overall effect *H*(2, 216) = 23.96, *p* < .001. Post hoc comparisons revealed that the DP group (*M* = 1.74, *SD* = 1.52) reported significantly more childhood traumatic events than the NP (*M* = 1.30, *SD* = 1.53) and WP (*M* = .63, *SD* = .94) groups. The NP group reported significantly more childhood traumatic events than the WP group (*p* = .01).

Timelines for Traumatic Events and Panic Onset

Responses to the Life Events Checklist for DSM-5 (LEC-5) were assessed to determine how many participants in the DP and NP groups reported traumatic events prior to nocturnal and daytime panic onset as well as what types of traumatic events (interpersonal vs. non-interpersonal, childhood vs. adulthood) preceded panic onset. The majority of both the NP and DP groups reported traumatic events that occurred prior to

panic onset. Within the NP group, 41 participants (56%) reported experiencing a traumatic event prior to nocturnal panic onset. Six participants (8%) reported only experiencing daytime panic attacks prior to nocturnal panic onset. Nine participants (12%) reported experiencing nocturnal panic onset prior to any traumatic events or daytime panic onset. A subset of the NP group reported never experiencing any traumatic events during their life (N = 17; 23%). Of those who reported traumatic events that occurred prior to nocturnal panic onset, 56% reported interpersonal traumatic events, 76% reported non-interpersonal events, 85% reported childhood events, and 32% reported adulthood events occurring before their first nocturnal panic attack. Participants in the NP group frequently reported multiple traumatic events prior to nocturnal panic onset (N = 22), resulting in multiple types of traumatic events reported for these individuals. Of the traumatic events reported most closely preceding nocturnal panic onset, natural disasters (29.3%) and physical assault (22.0%) were most common.

Within the DP group, 58 participants (73%) reported a traumatic event prior to panic onset. Seventeen (21%) reported experiencing their first panic attack prior to any traumatic events and five (6%) reported never experiencing a traumatic event. Of the participants who reported traumatic events that occurred prior to panic onset, 74% reported interpersonal traumatic events, 69% reported non-interpersonal events, 88% reported childhood events, and 28% reported adulthood events. Participants in this group also frequently reported multiple traumatic events occurring before their first panic attack (N = 38), resulting in multiple types of events being reported for these individuals. Of the traumatic events reported most closely preceding daytime panic onset, other unwanted sexual experiences (32.8%) and transportation accidents (29.3%) were most common.

For comparison to a panic-free control group, 46 participants (73%) in the WP group reported experiencing a traumatic event and never experiencing panic attacks. Of these individuals, 57% reported interpersonal traumatic events, 78% reported non-interpersonal events, 57% reported childhood events, and 70% reported adulthood events. Similar to the panic groups, 35 individuals in the WP group reported experiencing multiple traumatic events in their lifetime. These timelines support the trends identified in the chi-square and ANOVA results reported above in that the NP and WP groups did not greatly differ in terms of interpersonal traumatic events or overall traumas reported. The reported traumatic events were more likely to occur during childhood for the DP and NP groups than for the WP group, however. Therefore, panic attacks may be more likely to develop following a traumatic event during childhood than during adulthood, regardless of whether the event is interpersonal in nature.

Latent Profile Analysis

A latent profile analysis (LPA) was run to assess patterns in responses to continuous variables (i.e., PCL-5, FoSI-SF, DES-II, and IUS-12) across groups. Because the Prospective and Inhibitory IUS subscales correlated strongly and positively with one another as well as with the total IUS-12 score, both subscales were omitted from the LPA to limit redundancy. The number of total lifetime traumatic events, interpersonal lifetime traumatic events, and childhood traumatic events were also included in the model. Continuous variables were standardized prior to analysis for ease of interpretation, resulting in equal variances. Three latent profiles were expected, to coincide with the three panic groups, therefore profile estimates were generated for 2, 3, and 4 latent profiles.

Table 4 *Fit Statistics for Latent Profile Analysis*

Number of Classes	AIC	BIC	Entropy	BLRT (*p*)
2	4170.00	4315.14	.79	.03
3	4109.76	4281.90	.88	.01
4	4085.59	4284.73	.87	.01

Note. AIC = Akaike's Information Criteria. BIC = Bayesian Information Criteria. BLRT = Bootstrap Likelihood Ratio Test.

Table 4 shows the fit indices of the profile solutions. The AIC statistic showed a pattern of minimization from profile 2 through profile 4. After profile 3, however, BIC values begin to increase. Entropy values also begin to decrease at profile 4, suggesting worse fit. The *p* values for the BLRT reached significance for all profiles. Taken together, the observed pattern across the fit statistics supports the 3-profile solution.

For each of the three profiles, the continuous variables (i.e., PCL-5, FoSI-SF, DES-II, and IUS-12) shared the same valency. That is, all were either positive or negative within a given profile. This pattern suggests that PTSD symptoms, fear of sleep, dissociation, and intolerance of uncertainty are related to one another within this sample. The profiles differed in the relationship between traumatic experiences reported and the continuous measure scores. Each profile's average scores on the LPA variables are depicted in Figure 2.

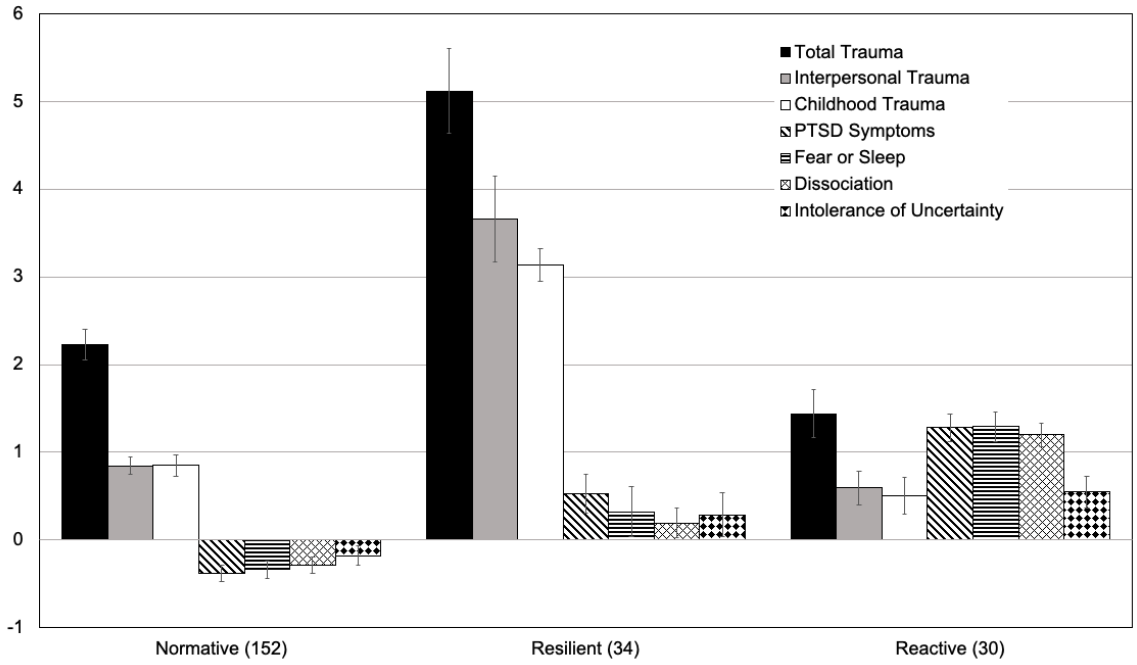

Figure 2. Latent Profile Analysis Three Profile Solution

Note: Means for the three-profile solution. Total, interpersonal, and childhood traumas are displayed as raw counts. PTSD symptoms, Fear of Sleep, Dissociation, and Intolerance of Uncertainty are displayed as standardized scores. Error bars indicate standard error. Numbers in parentheses following each profile name indicate sample size.

Profile 1, which was labelled the normative profile, comprised 152 participants who reported two lifetime traumatic events on average. These individuals reported an average of one interpersonal event and one childhood event. The continuous measures for this group were each below average, suggesting that although these participants have experienced traumatic events, they are not reporting elevated distress in terms of PTSD symptoms, fear of sleep, dissociation, or intolerance of uncertainty. This profile was deemed normative because it comprised the majority of the study sample (70%), which is comparable to the estimated population rate of individuals who will not develop PTSD after exposure to a traumatic experience (Kessler et al., 1995).

Profile 2, labelled the resilient profile, comprised 34 individuals who reported notably more lifetime, interpersonal, and childhood traumatic events and produced relatively low scores on the continuous measures. These individuals produced only mildly positive standardized PTSD symptom, fear of sleep, dissociation, and intolerance of uncertainty scores despite reporting more traumatic experiences than any other profile. The profile represents individuals who reported very little distress after experiencing multiple traumatic events.

Profile 3 was labelled the reactive profile because it includes the highest average PTSD symptoms, fear of sleep, dissociation, and intolerance of uncertainty ratings alongside an average of one or two traumatic events. This profile comprised 30 individuals who reported one or no interpersonal and childhood traumatic events, on average. These individuals produced elevated scores on measures of PTSD symptoms, fear of sleep, and dissociation as well as somewhat elevated scores on intolerance of uncertainty. This profile represents a group of participants who have reported a considerable amount of distress following traumatic experiences. Notably, this profile was made up almost entirely by participants from the NP group. The DP group was split primarily between profiles 1 and 2. The NP group was split primarily between profiles 1 and 3. Finally, the WP group was classified almost entirely into profile 1. See Table 5 for a full crosstabulation of panic groups and LPA profiles.

Table 5 *Panic Group by Latent Profile Crosstabulation*

	Normative Count (% within group)	Resilient Count (% within group)	Reactive Count (% within group)
Nocturnal Panic	35 (47.9%)	11 (15.1%)	27 (37.0%)
Daytime Panic	58 (72.5%)	21 (26.3%)	1 (1.3%)
Without Panic	59 (93.7%)	2 (3.2%)	2 (3.2%)
Total Sample	152 (70.4%)	34 (15.7%)	30 (13.9%)

Note. Nocturnal Panic $N = 73$. Daytime Panic $N = 80$. Without Panic $N = 63$. Total Sample $N = 216$.

Discriminant Analysis

A discriminant analysis was run to determine how well the continuous measures, latent profiles, and demographic information collectively discriminate between panic groups. The four continuous variables (PCL-5, FoSI-SF, DES-II, and IUS-12) as well as the latent profile assignments (normative, resilient, and reactive) were included in the model. Additionally, five demographic variables that were significantly different between panic groups were included. These variables were age, sex, ethnicity, disability status, and military service history. Two individuals declined to answer the biological sex demographic question, one in the DP group and one in the WP group. Both participants were excluded from the model. Transformed values were used for continuous variables that violated normality assumptions as discussed in the data screening section above.

Functions 1 through 2 were significant, X^2 (22, $N = 214$) = 140.28, $p < .001$. Function 2 was also significant, X^2 (10, $N = 214$) = 39.12, $p < .001$. The Eigenvalues for Functions 1 and 2 were .634 and .209, respectively. Canonical correlations revealed that the model explained 46% of the total variability (39% from Function 1 and 7% from Function 2). Standardized canonical discriminant function coefficients revealed that the DES-II had the largest impact on Function 1 (.494) and resilient profile membership had

the largest impact on Function 2 (.494). Standardized canonical discriminant function coefficients for all variables are presented in Table 6.

Table 6 *Standardized Discriminant Function Coefficients*

	Function 1	Function 2
PCL-5	.132	.403
FoSI-Short Form	.397	-.423
DES-II	.494	-.117
IUS-12	-.055	.300
Resilient Profile	-.081	.494
Reactive Profile	.218	.055
Age	.101	-.323
Sex	-.070	.418
Ethnicity	.334	.034
Disability Status	.028	.204
Military Service History	.037	.014

Note. PCL-5 = PTSD Checklist for DSM-5. FoSI = Fear of Sleep Inventory. DES-II = Dissociative Experiences Scale-II. IUS = Intolerance of Uncertainty Scale.

Next, the model was used to predict panic group classification for each participant using the leave-one-out approach. For each participant, the most likely panic group was determined using the discriminant functions based on data from all other participants in this sample. Correct group membership was predicted for 60% of the participants. Classification results organized by panic group are displayed in Table 7.

Table 7 *Leave-One-Out Classification Results*

	Predicted Group Classification		
Actual Group Classification	Nocturnal Panic *N* (%)	Daytime Panic *N* (%)	Without Panic *N* (%)
Nocturnal Panic	41 (56.2%)	21 (28.8%)	11 (15.1%)
Daytime Panic	11 (13.9%)	51 (64.6%)	17 (21.5%)
Without Panic	6 (9.7%)	20 (32.3%)	36 (58.1%)

Note. Each participant's group membership predicted based on functions derived from all other participants in the sample. Nocturnal Panic *N* = 73. Daytime Panic *N* = 79. Without Panic *N* = 62.

CHAPTER IV – DISCUSSION

Previous literature has identified differences between individuals who experience panic attacks out of a sleeping state and those who only panic while awake. Specifically, individuals who experience nocturnal panic attacks report more difficulties with insomnia (Mellman & Uhde, 1989b), fear of sleep (Craske & Tsao, 2005), and anxious reactions to states of loss of vigilance such as meditation (Craske et al., 2001) and hypnosis (Tsao & Craske, 2003b). Individuals who panic out of sleep often report feeling uncomfortable with the idea of "letting go" while relaxing (Craske et al., 2001). Factors that lead to nocturnal panic, however, have not been established. Some have suggested that a traumatic experience may lead to the development of fear of loss of vigilance, which is characteristic of those who panic out of sleep (Mellman et al., 1995; Feed et al., 1999). The literature thus far has been mixed on this topic with some studies finding that those who panic out of sleep are more likely to report experiencing a traumatic event (Freed et al., 1999) whereas others have failed to find such differences (Albert et al., 2005). The purpose of the current study was to improve upon prior study designs to further inform the proposed role of traumatic experiences in the development of nocturnal panic attacks.

Traumatic Events by Panic Group

When examining the number of childhood, interpersonal, and total traumatic events, the DP group reported significantly more traumas than either the NP or WP groups. These results do not support the hypothesis that the NP group would be more likely to report childhood and interpersonal traumatic events. The results differ from Freed and colleagues (1999) who found that those who experience nocturnal panic were more likely to report traumatic experiences than those who panic only while awake. The

current results also differ from Albert and colleagues (2005), who found no differences in reported traumatic experiences between those who panic out of sleep and those who only panic while awake. This discrepancy in results may be the result of differences in study sample. Both the Freed and colleagues (1999) and the Albert and colleagues (2005) samples comprised treatment-seeking participants with a principal diagnosis of panic disorder. The current study, however, used a community sample meeting diagnostic criteria for past panic attacks (NP and DP groups only) but did not require any specific mental health diagnoses to participate. These results suggest that panic attacks may occur as a common response to trauma without necessarily developing into panic disorder.

The NP and WP groups only differed on reported childhood traumatic events, with the NP group reporting more traumatic events occurring in childhood than the WP group. Once again, these results do not support the study hypothesis that the NP group would be more likely than the DP and WP groups to report interpersonal traumas. The fact that the WP group reported fewer childhood traumatic events than either panic group suggests that panic attacks may be a common reaction to childhood trauma specifically. Adults may be better equipped to process traumatic events without developing panic attacks than children, although the reason for improved trauma processing is beyond the scope of this study. Prior literature has suggested that childhood trauma is associated with taking short-cuts in threat-related information processing Crittenden & Heller, 2017) and these information processing strategies, in turn, have been associated with a wide range of psychopathology in adulthood (McLaughlin et al., 2020). It is possible that adults who experience a traumatic event have already developed more sophisticated threat-related

information processing strategies and are less likely to develop adverse psychological symptoms (e.g., panic attacks).

Timelines for Traumatic Events and Panic

Timeline comparisons for the DP and NP groups produced very similar results. For both groups, the average age of panic onset was roughly 18 years of age. Both groups showed a wide range of latencies between panic onset and the most recent preceding event (DP = 0-19 years; NP = 0-26 years) although the most reported latencies were within 1 year for the DP group and within 2 years for the NP group. Three quarters of the DP group reported a traumatic event that preceded panic onset. Of these individuals, 74% reported preceding interpersonal events and 88% reported preceding childhood events. Timelines for the NP group were somewhat more modest, with only half (56%) reporting a traumatic event that preceded nocturnal panic onset. Of those individuals half reported preceding interpersonal events and 85% reported preceding childhood events.

These results are in contrast with the Freed and colleagues (1999) study, which found that more than three-quarters (78%) of the NP group had reported a traumatic event preceding panic onset compared to only 25% of the DP group. As previously discussed, Freed and colleagues (1999) utilized a treatment-seeking sample in which all participants met criteria for panic disorder, which differs from the present study's community sample meeting criteria for a full-symptom panic attack but not necessarily panic disorder. It is possible that the present study's DP group includes a subset of individuals who would meet criteria for PTSD with panic attacks (who would not have been eligible for Freed et al., 1999). It may also be that nocturnal panic attacks developed following a trauma are more likely to progress into panic disorder. Freed and colleagues (1999) did not establish

a full timeline of events, but they did report that in the NP group, 90% of daytime panic onset and 96% of nocturnal panic onset were preceded by a traumatic event. This demonstrates that most participants did not develop nocturnal panic as a reaction to trauma after already experiencing a pattern of daytime panic.

In the present study, the type of traumatic event most closely preceding panic onset differed between panic groups. Participants in the NP group were most likely to report experiencing a natural disaster or physical assault prior to panic onset whereas participants in the DP group reported other unwanted sexual experiences and transportation accidents most commonly. These results do not support the hypothesis that interpersonal traumatic events would be more likely to precede nocturnal panic onset than non-interpersonal events. Considering panic attacks as an expression of the fight, flight, freeze response helps to conceptualize these results. Responding to the events most endorsed by the NP group often requires action (e.g., fleeing from a natural disaster, fighting or running from a physical assault). Conversely, the optimal response to the events most endorsed by the DP group would often be to freeze. Fighting or fleeing from a transportation accident is typically not as useful as staying in place until the accident is over, and help arrives. Similarly, in an unwanted or uncomfortable sexual experience, a typical response is to freeze until the interaction is over or an opportunity to leave the situation becomes available (Kalaf et al., 2017; Möller et al., 2017). Rizvi and colleagues (2008) compared reactions to physical assault and unwanted sexual experiences specifically and found that the freeze response was strongly related to unwanted sexual experiences but not physical assault. Therefore, traumatic events that require springing into action may be more likely to lead to development of nocturnal panic attacks and

events that are typically met with the freeze response may be more likely to lead to daytime panic, but not nocturnal panic.

Considering the traumatic events that preceded nocturnal panic onset were more likely to require a fight or flight response, and the events preceding daytime panic onset were more likely met with a freeze response may help to explain the development of nocturnal panic attacks rather than (or in addition to) daytime panic. Prior research has demonstrated that individuals who experience nocturnal panic attacks report a fear of "letting go" or letting their guard down, termed fear of loss of vigilance (Craske et al., 2001; Tsao and Craske, 2003a). It is possible that this fear is most likely to develop following traumatic situations that require action (e.g., fight or flight) because failing to act could result in worse outcomes. In this way, individuals who experience nocturnal panic may learn that they must always be ready to respond to potential threats to remain safe. The same would not be true of events requiring a freeze response because increased vigilance would not increase one's ability to freeze effectively.

Latent Profile Analysis

The latent profile analysis produced a three-profile solution, as predicted but the profiles did not map neatly onto the three panic groups as expected. Instead, the profiles highlighted differences in psychological responses to traumatic events. Profile 1, named the normative profile, comprised the majority of the sample and included individuals who had experienced about two lifetime traumatic events but were not reporting clinically elevated symptoms. This group may represent those who experience traumatic events without going on to develop PTSD. It is also possible that these individuals may have exhibited PTSD symptoms in closer proximity to the traumatic event and the symptoms

had resolved (either independently or through formal treatment) by the time of the study. Indeed, an average of 8 years had passed between the most recent trauma and completion of this study for the normative profile. This profile also primarily consisted of individuals who were not currently experiencing panic attacks. Seventy percent of the normative group had not experienced a panic attack of any kind within the past year (including those who had never experienced panic) and very few (13%) had experienced panic in the past month. Therefore, it is likely that this group represents individuals who had already recovered from any anxiety and stress-related symptoms at the time of the study.

Profile 2, named the resilient profile, comprised a smaller subset of participants who reported the greatest number of traumatic experiences. Despite reporting an average of five lifetime traumatic events, this group showed low levels of anxiety and stress-related symptoms. Much like the normative group, an average of 8 years had passed between the most recent trauma and completion of study measures for the resilient group. Unlike the normative group, the resilient group members were more likely to report recent panic attacks, with roughly half experiencing panic within the past year and about one-third of the group experiencing panic within the past month. These individuals reported the most extensive trauma history and were continuing to experience panic attacks, but still reported limited psychological distress. This group may represent participants whose symptoms had resolved (independently or through formal treatment) prior to the study. These individuals may also be primarily experiencing panic-related symptoms. The study measures addressed PTSD symptoms, fear of sleep, dissociation, and intolerance of uncertainty. Measures related to concerns about the consequences of the physiological, cognitive, and social symptoms of panic attacks (i.e., anxiety

sensitivity) and agoraphobic avoidance were not included in the present study. Indeed, the majority of the resilient profile were participants from the daytime panic group (see Table 5 for crosstabulation of profile and panic group counts). This profile may represent individuals who responded to repeated traumas with few persisting psychological symptoms or with primarily panic-related symptoms.

Profile 3, named the reactive profile, also comprised a small subset of participants. This group reported an average of one or two lifetime traumatic experiences with the highest levels of psychological symptoms. The reactive group reported a delay of about 13 years between the most recent traumatic event and completion of study measures. Therefore, this group is not comprised solely of individuals still processing a recent traumatic event. This profile also contained many participants who had recently experienced a panic attack, with roughly two-thirds reporting a panic attack within the past month. Interestingly, this profile was made up almost entirely of participants from the nocturnal panic group. Further, the reactive profile differed from the normative and resilient profile on some demographic factors as well. Individuals in the reactive profile were more likely to be male, non-white, Hispanic, transgender, or to have served in the military. Demographics for the normative and resilient profiles largely resembled one another with the exception that individuals in the resilient profile were more likely than the normative or reactive profiles to identify as having a disability. These patterns highlight the need for future research to investigate differences in how panic attacks (and specifically nocturnal panic) present in minority racial groups, as most panic research is based on heavily White samples. Another potentially fruitful line of research may be to examine nocturnal panic in military samples, given that increased vigilance is explicitly

encouraged in military training (Cameron & Mamon, 2019; Kimble et al., 2013; Army Field Manual, AFM 8-131). Increased knowledge about how nocturnal panic presents in these understudied populations may help to increase overall understanding of the phenomenon.

Discriminant Analysis

The discriminant analysis was run using the continuous measures, latent profiles, and selected demographic data to predict panic group membership was moderately successful. The model explained only 46% of the total variance, indicating an incomplete picture regarding the differences between those who panic out of sleep and those who panic only while awake. Predictions of group membership based on the model exceeded chance levels, with 60% of participants placed in the correct panic group. Chance levels would have been closer to 37% correct placement if all participants were assigned to the largest panic group (DP; naïve model). Function 1 primarily separated the nocturnal panic group from the daytime and without panic groups. Dissociation, measured by the DES-II, had the largest impact on this function. Contrary to my predictions, the nocturnal panic group endorsed more dissociative experiences than either the daytime or without panic groups (see Table 8 for continuous measure scores by panic group).

Table 8 *Descriptive Statistics for Continuous Measures by Group*

	Nocturnal Panic		Daytime Panic		Without Panic	
	Mean	SD	Mean	SD	Mean	SD
PCL-5	30.32	21.91	16.57	15.80	8.57	11.01
FoSI-Short Form	13.15	13.96	3.25	6.63	2.17	4.37
DES-II	26.10	18.20	9.04	6.60	9.28	9.57
IUS-12	33.35	9.22	31.58	9.97	26.04	9.58
IUS-Prospective	19.27	5.88	18.49	5.91	15.13	5.73
IUS-Inhibitory	14.08	3.91	13.09	4.36	10.92	4.19

Note. Nocturnal Panic $N = 73$. Daytime Panic $N = 80$. Without Panic $N = 63$. PCL-5 = PTSD Checklist for DSM-5. FoSI = Fear of Sleep Inventory. DES-II = Dissociative Experiences Scale-II. IUS = Intolerance of Uncertainty Scale.

Individuals who experience nocturnal panic may be more aware of dissociative experiences due to fear of loss of vigilance. If dissociative experiences represent a state of diminished vigilance as proposed in this study, those who fear loss of vigilance may be more likely to scan for states of decreased vigilance. This interpretation would be in line with the body vigilance model of panic disorder (Schmidt et al., 1997), which suggests that individuals with panic disorder scan their bodies for changes in physical sensations and interpret those changes as indicative of dangerous medical events (e.g., heart attack). For those who experience nocturnal panic attacks and have developed a fear of loss of vigilance, dissociative experiences may be interpreted as another warning sign that something dangerous is occurring.

Function 2 had very little influence on the overall model, accounting for 7% of the variance explained. This function primarily separated the daytime and without panic groups from one another, with the nocturnal panic group intermediate between the two. Resilient profile membership had the greatest influence on Function 2, with the daytime panic group having a higher proportion of resilient profile members compared to the without panic group. All panic groups included mostly normative profile members, but

the without panic group comprise almost entirely normative profile member whereas the daytime panic group was split between the normative and resilient profiles and the nocturnal panic group was split among all three profiles.

Conclusions

Taken together, these results indicate that knowledge about the number and types of traumatic events preceding panic onset is insufficient for predicting whether nocturnal panic attacks will develop. The latent profile analysis results revealed a pattern that has not yet been discussed in the nocturnal panic literature. Viewing self-reported symptoms in relation to the number and recency of traumatic events as well as recency of panic attacks demonstrate that individual reactions to traumatic events are likely to play a major role in the development of nocturnal panic. Notably, the reactive profile, though small in relation to the full sample, was made up almost entirely of individuals from the nocturnal panic group who continue to experience nocturnal panic attacks long after a traumatic event. This subgroup provides an avenue for future research to examine reactions to traumatic events in the development of nocturnal panic.

Latent profiles did not, as expected, improve the ability to discriminate panic groups over and above what has been accomplished previously. The discriminant analysis results reported here provided no improvement over those reported by Smith and Capron (2021) using self-report symptom measures and demographic variables. Clearly, there still remains missing constructs to characterize the differences between individuals who panic out of sleep and those who panic only while awake. Future studies may focus on variables related to interpretations surrounding traumatic events as opposed to the types of traumatic events experienced. This is especially important for understanding how a

fear of loss of vigilance may develop following a traumatic event and eventually lead to nocturnal panic.

These results may provide some modest clinical directions for individuals who have experienced traumatic events and those who experience nocturnal panic attacks. Trauma history alone is unlikely to provide much information about the likelihood an individual will develop nocturnal panic attacks. Instead, reactions to traumatic events and interpretations of the individual's response to those events may be more informative. Patients with strong psychological reactions to traumatic events may be more likely to develop nocturnal panic attacks, particularly if they interpret their response to the trauma as being insufficient in some way. These individuals may develop a belief that they must remain vigilant at all times in order to react "correctly" to future threats by springing into action to protect themselves (i.e., fear of loss of vigilance; Tsao & Craske, 2003a). In this way, trauma treatment that addresses feelings of self-blame and hypervigilance may also be effective treatment for reducing nocturnal panic attacks. Future research is needed to ascertain whether directly addressing fear of loss of vigilance leads to fewer nocturnal panic attacks. Interpretation bias modification interventions for anxiety sensitivity have been shown to effectively reduce panic reactions to interoceptive exposures (Capron & Schmidt, 2016; Capron et al., 2017) and suicide risk (Schmidt et al., 2017; Norr et al., 2018). A similar type of intervention may be developed to address fear of loss of vigilance by modifying interpretations that states of decreased vigilance are inherently dangerous.

This study had several limitations worth noting and addressing in future research. First, the study used cross-sectional data, making it impossible to establish causal

mechanisms. Longitudinal studies following individuals after traumatic events to document development of nocturnal and daytime panic attacks would help to clarify many of the gaps still remaining in the literature. Additionally, collecting self-report of symptoms and timeline information through an online survey limited the depth of information it was possible to obtain. Additional studies using clinical interviews would allow for follow-up questions about reactions to traumatic events that preceded panic development as well as symptom course over time. Questions of accuracy related to adult participants reporting traumatic events that occurred during childhood are also relevant. Prior research has demonstrated that complete omission or fabrication of traumatic memories is rare unless specifically induced through study design or leading interview questions (Pope et al., 1998, Loftus & Ketcham, 1996; Loftus & Pickrell, 1995). Studies have shown that memory for details of traumatic events such as sensory details (Hyman & Byrne, 1999) and exact dates the event occurred (Moore & Zoellner, 2007) are likely to be impaired during recall, especially years after the event. Theses impairments are of minimal concern for the present study, as only the type of event and age estimate were required. Future research aimed toward more detailed trauma accounts, however, should consider limitations in long-term recall. Finally, participants were not excluded based on the recency of their last panic attack. Rather, anyone who had experienced a full-symptom daytime and/or nocturnal panic attack were included in the DP and NP groups (respectively). Future studies including only participants who had experienced a panic attack in the last month would help to better characterize results in terms of current panic symptomatology.

The current study also had several strengths. First, although the study used an online survey format, participants were required to complete an extensive panic screening measure before proceeding to the full battery of measures, ensuring that those included were reporting full-symptom panic attacks and that they could correctly differentiate daytime and nocturnal panic attacks from other forms of anxiety. More than 500 individuals were excluded from the study for failing to correctly define daytime and/or nocturnal panic attacks or reporting only limited-symptom panic attacks. Prior studies have classified participants based on a single nocturnal panic question, potentially introducing significant error into the results (Smith et al., 2019; Tsao & Craske, 2003a). This procedure allowed for reliable group assignment without requiring a full diagnostic interview. This study also improved on prior research by using a transdiagnostic community sample. Prior studies have limited participation only to those seeking treatment for panic disorder (Freed et al., 1999; Albert et al., 2005), limiting the generalizability of their results to individuals who experience nocturnal panic attacks in the context of other psychological disorders (e.g., PTSD).

Further, this study improved upon previous research examining nocturnal panic and trauma by establishing timelines to include daytime and nocturnal panic onsets as separate events. Age estimates were also provided for each type of panic onset and for all reported traumatic experiences so that latency between the reported traumas and the development of panic attacks could be examined in more detail. This approach allowed for the possibility that nocturnal panic attacks could develop after an individual had already been experiencing daytime panic attacks for some time and that nocturnal panic could have been preceded by a traumatic event that occurred after daytime panic onset.

Examining daytime and nocturnal panic onset as separate events within the context of traumatic experiences throughout one's life serves to further inform the proposed role of trauma in the development of nocturnal panic attacks.

This study also utilized a novel approach to understanding nocturnal panic through latent profile analysis. Although the profiles did not map directly onto panic groups as expected, the results highlighted new directions for research examining nocturnal panic and trauma. These results revealed the potential importance of interpretations surrounding trauma responses with regard to developing nocturnal panic attacks and demonstrated that the type, number, and timing of traumatic events is likely to be less impactful than anticipated. Future research directed toward examining reactions to traumatic events and addressing maladaptive interpretations are likely to lead to a better understanding of the development of nocturnal panic attacks within the context of trauma.

Existing theories about the development of nocturnal panic attacks suggest that a conditioned fear of loss of vigilance leads to panicked awakenings during the transition from light to deep sleep (Craske & Tsao, 2003a). It is suggested that repeated associations between feelings of danger and states of diminished vigilance (likely starting with states of relaxation while awake) eventually generalize to include the transition from semi-vigilant light sleep stages 1 and 2 into non-vigilant deep sleep states 3 and 4 (Craske et al., 2005). The core of the fear of loss of vigilance is an unwillingness to "let go" or let one's guard down because they would then be unable to escape or get help in the face of threat or danger (Craske et al., 2001). It remains unclear what causes fear of loss of vigilance to develop. These results suggest that a traumatic experience may lead to

developing fear of loss of vigilance, but that interpersonal and childhood traumas are no more likely to lead to nocturnal panic than other types of traumas. Instead, interpretations related to monitoring for future threat or guilt related to inaction during a trauma may lead to fear of loss of vigilance. In such cases, traumatic experiences may represent a pathway to developing nocturnal panic but cognitions surrounding the trauma are likely to be more important to developing nocturnal panic than aspects of the trauma itself. Further, these results showed that not all individuals who panic out of sleep reported a history of trauma prior to panic onset. Thus, fear of loss of vigilance may develop for reasons completely unrelated to the types of traumatic experiences examined in this study. Further research is needed to clarify the origins of fear of loss of vigilance and to detail the progression to developing nocturnal panic attacks.

The results of the current study did not support previous research on the role of traumatic experiences in relation to developing nocturnal panic attacks, highlighting the need for additional studies to fill in the remaining gaps in understanding. The number, type, and timing of traumatic events were insufficient to explain differences between those who panic out of sleep and those who panic only while awake. Timeline analyses, though exploratory in nature, provided direction for understanding fear of loss of vigilance in the context of the fight/flight/freeze response. Latent profile analysis results highlighted the potential for research related to interpretations related to traumatic experiences in the development of daytime versus nocturnal panic attacks. Modest discriminant analysis results demonstrated that much is still missing from our understanding of why some individuals panic out of sleep while others do not. Future

research is warranted, particularly with regard to the ways in which fear of loss of vigilance may develop.

APPENDIX – IRB Approval Letter

Office of
Research Integrity

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NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.
- Face-to-Face data collection may not commence without prior approval from the Vice President for Researches Office.

PROTOCOL NUMBER: IRB-20-413
PROJECT TITLE: Dissertation: The Role of Traumatic Experiences in Developing Nocturnal Panic Attacks
SCHOOL/PROGRAM: School of Psychology, Psychology
RESEARCHER(S): Nicole Smith, Daniel Capron

IRB COMMITTEE ACTION: Approved
CATEGORY: Expedited
7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: October 6, 2020

Donald Sacco Jr.

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

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