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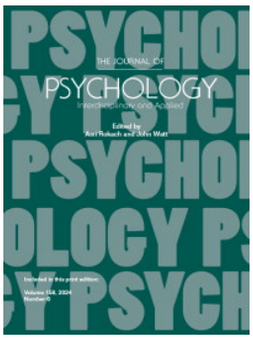

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Interpersonal Loneliness Predicts the Frequency and Intensity of Nightmares: An Examination of Theoretic Mechanisms

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ABSTRACT

The evolutionary theory of loneliness (ETL) argues that human belongingness is essential to survival and failing to meet belongingness needs constitutes a threat to viability. In two separate studies (total $N = 1{,}609$), links between loneliness and nightmares were examined as a test of ETL postulates. As hypothesized, loneliness predicted nightmare frequency (both studies) and nightmare intensity (Study Two only). Although stress mediated the relationship between loneliness and nightmare frequency in Study One, stress was not a significant mediator of this relationship in Study Two. As predicted, in Study Two both hyperarousal and rumination mediated the relationships between loneliness and nightmare frequency and between loneliness and nightmare intensity. Theoretical implications include support for both the aversive signaling and implicit vigilance postulates of ETL.

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Loneliness; nightmares; sleep quality; evolutionary theory of loneliness

Interpersonal relationships are a fundamental human need (Allen et al., 2022). Indeed, having strong social and personal relationships contributes to multiple forms of physical and mental health and well-being (Floyd, 2019; Holt-Lunstad, 2018). Because humans have a strong need to belong (Baumeister & Leary, 1995), they suffer physically (Quadt et al., 2020), mentally (Beutel et al., 2017), and socially (Freak-Poli et al., 2022) when that need goes unmet. Much as hunger denotes a lack of attention to caloric needs or fatigue signals a lack of attention to sleep needs, loneliness has evolved to alert individuals that their needs for interpersonal connection are being neglected (Cacioppo & Cacioppo, 2018).

As detailed below, loneliness is such a distressing state that it is associated with a vast and varied range of mental, physical, and social detriments, including impairments in the duration and quality of sleep for both lonely individuals (Griffin et al., 2020) and their romantic partners (Segrin & Burke, 2015). One characteristic of disturbed sleep that researchers are beginning to investigate in relation to loneliness is the frequency and intensity of nightmares, which are vivid and often horrifying dreams that frequently interrupt restorative sleep. Although some studies have documented correlations between loneliness and the frequency and intensity of nightmares, however, little is known about the mechanisms that account for variance in those associations.

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Working from Cacioppo and Cacioppo's (2018) evolutionary theory of loneliness, the present studies explore how the stress, rumination, and hyperarousal associated with loneliness may exacerbate the experiences of nightmares.

This review begins with a description of loneliness and its comorbidities. We then describe nightmares and hypothesize on the basis of Cacioppo and Cacioppo's (2018) theory that loneliness is directly associated with both the frequency and the intensity of nightmares and that stress, rumination, and hyperarousal mediate these associations. Two studies are then described that test these predictions, one a secondary analysis of existing data and the other an original study.

Loneliness

Loneliness is a distressing psychological state that occurs when individuals feel that their social needs are not adequately met within their interpersonal relationships (Cacioppo et al., 2006). Although loneliness can impact people of all age groups, certain demographics are more vulnerable than others. Research consistently reveals that adolescents and young adults (Qualter et al., 2015; Victor & Yang, 2012), as well as the elderly (Cudjoe et al., 2020; Perissinotto et al., 2012), are the most affected. According to a 2022 meta-analysis by Surkalim et al. (2022), the global prevalence rates for loneliness range from 9.2% to 14.4% for adolescents and reach up to 24.2% for adults.

Whereas episodic loneliness affects individuals during specific life stages or transitions (such as during a move to a new city; Hawkley & Cacioppo, 2010), loneliness can also be conceptualized as a trait characterized by subjective thoughts, feelings, and perceptions related to social isolation (Cacioppo & Cacioppo, 2018). Notably, lonely individuals exhibit higher levels of depression (Alpass & Neville, 2003) and stress (Richardson et al., 2017), and diminished psychological resilience (Gerino et al., 2017), relative to non-lonely counterparts. Additionally, loneliness is associated with increased pain (Jaremka et al., 2013) and elevated risks of cardiovascular disease (Paul et al., 2021), coronary heart disease (Thurston & Kubzansky, 2009), and Alzheimer disease-like dementia in later life (Wilson et al., 2007). Loneliness is also a significant risk factor for suicide ideation (Goldsmith et al., 2002) and attempted suicide (Stickley & Koyanagi, 2016), as well as for all-cause mortality (Holt-Lunstad et al., 2015; Wang et al., 2023). Understandably, loneliness has been recognized a public health crisis, not only in the United States (Gerst-Emerson & Jayawardhana, 2015; National Academies of Sciences, Engineering, and Medicine, 2020) but also in other parts of the world (Dahl, 2020; DiJulio et al., 2018).

Loneliness also impairs the quality of sleep (Matthews et al., 2017). A 2020 meta-analysis by Griffin et al. ($N = 45{,}177$) reported that loneliness had a significant association ($r = .28$) with self-reported sleep disturbance, although not with sleep duration. Segrin & Burke (2015) even found that loneliness is related to disturbed sleep not only for oneself but also for one's romantic partner. Whereas sleep disturbance often comprises difficulty falling asleep and/or difficulty staying asleep (see Zhang et al., 2020), sleep impairment can also manifest in the form of nightmares, as we discuss subsequently.

Nightmares

Nightmares are "vivid and terrifying nocturnal episodes" in which a dreamer is often awakened from REM sleep and experiences difficulty returning to sleep (Pagel, 2000, p. 2037). Approximately 18.3% of the population reports having nightmares (Ohayon et al., 1997). In North America at least, undergraduate students report between 6 and 26 nightmares per year (Wood & Bootzin, 1990; Zadra & Donderi, 2000), with one study reporting a mean of 3.66 nightmares in a 21-night period (Levin & Fireman, 2002). A 2010 study by Li et al. (2010) found similar prevalence among Hong Kong adults.

Nightmares can be either *posttraumatic* or *idiopathic*. The former either represent direct replications of trauma or depict traumatic emotion or content (Wang et al., 2019). In contrast, although the latter can manifest from disturbing experiences in early life, they do not necessarily reflect a previous traumatic event and are thus considered idiopathic, or arising spontaneously (Nielsen et al., 2019). Research indicates that posttraumatic nightmares present as more stressful and cause more significant sleep disturbances than idiopathic nightmares (Germain & Nielsen, 2003). Some nightmares are also *recurrent,* meaning depicting identical content with relative frequency, such as a recurring nightmare about being trapped in the basement of a burning house (see McNamara et al., 2015).

Although the presence of nightmares is not pathological in and of itself, *nightmare disorder*—also called dream anxiety disorder—is a pathology characterized by recurrent episodes of extended, well recalled, and extremely dysphoric dreams that usually depict efforts to avoid threats to security, survival, or physical integrity (American Psychiatric Association, 2022). Nightmare disorder results from nightmares that are not attributable to the physiological effects of medications or drugs, nor to comorbid medical or mental health conditions (American Academy of Sleep Medicine, 2014). Approximately 2 to 5% of the general population experiences nightmare disorder (Schredl, 2010), whereas Swart et al. (2013) documented a prevalence of 29.9% among psychiatric patients.

Both nightmares and nightmare disorder are significantly more common in women than in men (Schredl, 2014; Wang et al., 2021). A 2011 meta-analysis by Schredl & Reinhard (2011) found that females experienced more nightmares than males among adolescents, young adults, and middle-aged adults, with effect sizes ranging from .15 to .26 (effect sizes for the gender difference among children and among the elderly were not significantly different from zero). Nielsen et al. (2006) also reported that nightmare frequency increases as a function of age for women between the ages of 10 and 39, then decreases to age 59, whereas frequency is stable for men until the age of 39, then decreases to age 59.

Nightmares as a Function of Loneliness

Why would loneliness be associated with the prevalence of nightmares? Cacioppo and Cacioppo's (2018) evolutionary theory of loneliness (ETL) posits that human belongingness is so essential to survival that a failure to meet belongingness needs (see Baumeister & Leary, 1995) constitutes a threat to human viability. According to ETL, loneliness is an evolved adaptive mechanism that alerts humans to the presence of

social isolation and the absence of meaningful social connections. Cacioppo and Cacioppo argued that such an adaptation evolved to promote social bonding and cooperation, ultimately increasing the odds of both survival and reproduction.

ETL postulates multiple effects of loneliness, and two postulates are particularly relevant with respect to nightmares. First, the *aversive signal postulate* claims that loneliness has evolved to be a physically and psychologically aversive experience. In the same way that an aversion to physical pain motivates humans to attend to, and correct, the source of their pain, an aversion to the experience of loneliness motivates humans to attend to threats to their social well-being. Second, the *implicit vigilance postulate* explains that loneliness signals a relative lack of resources in one's environment, creating the perception that one is in a tenuous, vulnerable state and prompting vigilance for and avoidance of social threats.

Reasoning from these two postulates, specifically, one could surmise that loneliness contributes to psychological states that have a high likelihood of manifesting in the form of nightmares. For one, loneliness contributes to psychological stress as part of its aversive signaling function, and psychological stress has been shown to increase both the frequency and intensity of nightmares (see Blagrove et al., 2004). Second, loneliness creates a state of hyperarousal as part of its implicit vigilance function. This heightened state of alertness may make it difficult to attain deep, restorative sleep, and when sleep is shallow or disrupted, nightmares can become more frequent (Gieselmann et al., 2019). Finally, as a function of both aversive signaling and implicit vigilance, loneliness can manifest in worry and rumination, which can infiltrate dreams, manifesting as unsettling nightmares (Rek et al., 2017).

Few studies have documented zero-order correlations between loneliness and nightmare frequency. Palmer et al. (2022) found an association of $r = .12$ between loneliness and nightmare frequency in a sample of U.S. American adolescents 13 to 18 years of age. Similarly, Costa et al. (2022) reported an association of $r = .24$ between loneliness and nightmare frequency in a sample of Italian office workers. In both studies, nightmare frequency and loneliness were each assessed with single-item measures.

Slightly more evidence exists with respect to loneliness and nightmare severity. In a sample of U.S. American undergraduates, using an *ad hoc* measure of loneliness, Hom et al. (2017) found a moderate association ($r = .22$) between loneliness and the Disturbing Dreams and Nightmare Severity Index (DDNSI; Krakow, 2006), an assessment of nightmare frequency and severity that can indicate the presence of a nightmare disorder. Moreover, a meta-analysis of research on loneliness and sleep disturbances by Hom et al. (2020) identified five studies assessing nightmares, specifically, and reported an average association of $r = .19$ between loneliness and nightmare severity (Golding et al., 2015; Nadorff et al., 2013; Rogers & Joiner, 2017; Suh et al., 2016). Each of those studies used DDNSI to measure nightmares and measured loneliness using the thwarted belongingness subscale of the Interpersonal Needs Questionnaire (Van Orden et al., 2012).

Existing evidence is therefore relatively sparse as to whether loneliness is associated with the frequency or intensity of nightmares, and some such evidence relies on assessments of unknown psychometric adequacy. Further, no previous studies have adjudicated the potential mediators of the association between loneliness and nightmares that Cacioppo and Cacioppo's (2018) ETL identify.

Hypotheses

Reasoning from Cacioppo and Cacioppo's ETL leads first to the general hypotheses that *loneliness is directly related to nightmare frequency* (H1) and *loneliness is directly related to nightmare intensity* (H2). The aversive signal and implicit vigilance postulates also suggest that *the associations between loneliness and nightmare frequency and intensity are mediated by stress* (H3a, b); *hyperarousal* (H4a, b); *and rumination* (H5a, b).

Two studies report direct tests of these hypotheses. Study One offers secondary analyses of data reported in Hesse et al. (2023) that test H1 and H3a only, as that study collected data relevant to those hypotheses only. Study Two, designed and conducted specifically for this paper, re-tests H1 and H3a as well as testing the remaining predictions.

Study One

Participants

Participants ($N = 827$) were U.S. American adults. Participants ranged in age from 18 to 81 years ($M = 44.63$ years, $SD = 16.07$). Most identified as either female (421, 51.2%) or male (397, 48.2%), whereas four participants (0.5%) identified as non-binary, and the remainder chose not to answer. With respect to racial identity, 75.1% identified as White, 14.3% as Black/African American, 7.6% as Asian, 5.8% as Latino/a, 2.1% as Native American or Aleut, 0.8% as Middle Eastern/North African, and 1.1% reported another racial identity.[1] Most (93.1%) reported a non-Hispanic ethnicity, whereas 6.9% identified as Hispanic. An *a priori* power analysis (Faul et al., 2007) indicated that a sample size ≥158 would provide 95% power to detect a small (.10) effect size, assuming $\alpha = .05$.

Procedure

Participants were recruited on the online portal Prolific Academic. Prospective participants were eligible for the study if they were 18 years old or older, lived in the United States, and could read and write in English. Participants completed and submitted an online questionnaire in exchange for $2.10US, which equated to an average per-hour rate of $14.56US. The sample was Census-matched to the United States adult population with respect to gender, age, and racial categories.

Participants completed a questionnaire hosted on Qualtrics and submitted their responses electronically. The study was IRB approved and some portions of the method are also reported in Hesse et al. (2023). Data for both studies are posted to Open Science Framework.[2]

Measures

Loneliness was measured with the 3-item UCLA Loneliness Scale Short Form (Steptoe et al., 2013). Participants are asked how often they experience various feelings on a 7-point scale anchored at 1 (*hardly ever*) and 7 (*often*). Sample questions are "How often do you feel that you lack companionship?" and "How often do you feel left out?" ($\omega = .91$).

Frequency of nightmares was measured with the 4-item Nightmare Experience Scale (Kelly & Mathe, 2019). Participants are asked their level of agreement with statements about nightmares on a 5-point scale anchored at 1 (*disagree*) and 5 (*agree*). Sample items are "I have nightmares often" and "Intense nightmares are a problem for me" (ω = .93).

Stress was measured with the 10-item Perceived Stress Scale (Cohen et al., 1983), which asks participants how often over the past month they have felt various ways. Responses were on a 7-point scale anchored at 1 (*never*) and 7 (*very often*). Sample items are "Been upset because of something that happened unexpectedly" and "Found that you could not cope with all the things you had to do" (ω = .92).

Descriptive statistics and intercorrelations appear in Table 1.

Ethics Statement

The study was approved by the Institutional Review Board at the University of Arizona (approval number 00000839). To maintain participants' confidentiality, participants were informed that filling out and submitting the online questionnaire would signify their consent to participate. All participants were adults.

Data Analysis

H1 was tested using a hierarchical multiple regression in SPSS version 29.0.1.0, whereas H3a was tested using Model 4 of Hayes's (2022) PROCESS macro for mediation and moderation.

Results

Prior to testing the hypotheses, age and gender were explored as potential control variables. Age was inversely related to nightmare frequency, r (825) = −0.17, $p < .001$ (two-tailed). With respect to gender, the nine cases reporting a gender other than male or female were temporarily suppressed due to their small cell sizes. As is commonly reported, women reported higher nightmare frequencies ($M = 1.74$, $SD = 1.07$) than did men ($M = 1.58$, $SD = 0.98$), Welch's t (815.075) = −2.22, $p = .027$ (two-tailed). Age and gender were therefore included as covariates in the tests of the hypotheses.

The first hypothesis, that loneliness predicts nightmare frequency, was tested using a hierarchical multiple regression. Age and gender were entered in the first step as control variables, and loneliness was entered in the second step, with nightmare fre-

Table 1. Study One: Descriptive Statistics and Intercorrelations for Study Variables ($N = 818$).

Variables	Min	Max	M	SD	1	2
1. Loneliness	1.00	7.00	3.09	1.86	—	
2. Nightmare Frequency	1.00	5.00	1.66	1.03	.27**	—
3. Stress	1.00	7.00	3.33	1.36	.61**	.36**

Notes. Data in this table were calculated after temporarily suppressing those cases in which gender was reported as other than female or male. Loneliness and stress were measured on 1-7 scales, and nightmare frequency on a 1-5 scale, wherein higher numbers reflect larger values of the variable. **$p < .001$ (two-tailed).

quency as the criterion variable.[3] The overall regression model was significant, F (3, 812) = 26.84, p < .001. As hypothesized, with the effects of age and gender controlled, loneliness significantly predicted nightmare frequency, β = .24, p < .001. Full regression results appear in Table 2. The first hypothesis is supported.

Hypothesis 3a, that stress partially mediates the effect of loneliness on nightmare frequency, was tested using Model 4 of Hayes's (2022) PROCESS macro for mediation and moderation. Loneliness was entered as the predictor variable, stress as the mediator, age and gender as covariates, and nightmare frequency as the outcome variable. Loneliness had a significant association with stress, b = .41, t = 20.15, p < .0001, 95% CI = .37, .44. Moreover, stress had a significant effect on nightmare frequency, b = .22, t = 6.70, p < .0001, 95% CI = .15, .28. Finally, the direct path from loneliness to nightmare frequency was significant, b = .05, t = 2.02, p = .04, 95% CI = .001, .09. The mediation model appears in Figure 1. Hypothesis 3a is supported.

Discussion

Although not designed specifically to explore the association between loneliness and nightmares, the first study included measures that allowed for the testing of H1 (loneliness is directly related to nightmare frequency) and H3a (the association between loneliness and nightmare frequency is mediated by stress). Net of the effects of age and gender, loneliness demonstrated a significant association with the frequency of nightmares, in support of H1, and the relationship was partially mediated by stress, in support of H3a.

Table 2. Study One: Multiple Regression Predicting Nightmare Frequency (N = 818).

Variables	Zero-order r	B	SE B	β	ΔR^2
Step 1					.035**
Age	−0.17**	−0.01	.002	−0.17**	
Gender	.08*	.12	.07	.08*	
Step 2					.055**
Age	−0.17**	−0.01	.002	−0.11**	
Gender	.08*	.12	.07	.06	
Loneliness	.27**	.13	.02	.24**	

Notes. Gender was coded as 0 = male, 1 = female. Cells reporting a gender other than female or male were temporarily suppressed. R^2 = .09; adjusted R^2 = .09; F (3, 812) = 26.84, p < .001; *p < .05; **p < .01. Probability estimates for zero-order correlations are two-tailed.

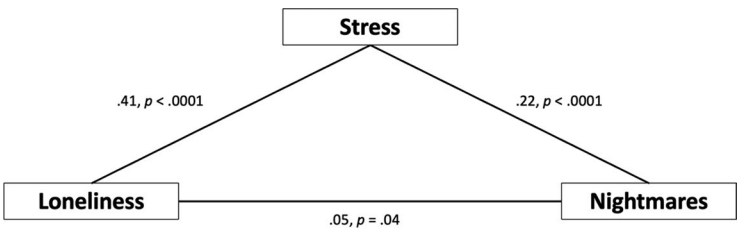

Figure 1. Study one: association between loneliness and nightmare frequency is partially mediated by stress (N = 818).

Even though these were secondary analyses of a study conducted for other purposes, they benefit from the use of published and psychometrically sound measures of loneliness, nightmare frequency, and stress. This is in contradistinction to extant research on the association between loneliness and nightmare frequency, in which the key variables have been assessed with single-item *ad hoc* scales. Nonetheless, the analyses from Study One leave multiple hypotheses untested, prompting the addition of Study Two.

Study Two

The purpose of Study Two was to retest H1 and H3a as well as to test the remaining hypotheses (H2; H3b; H4a, b; and H5a, b).

Participants

Participants ($N = 782$) were U.S. American adults. Participants ranged in age from 18 to 78 years ($M = 42.23$ years, $SD = 14.28$). Most identified as either female (394, 50.4%) or male (383, 49.0%), whereas the remainder chose not to answer. With respect to racial identity, 88.4% identified as White, 2.4% as Black/African American, 7.3% as Asian, 0.5% as Latino/a, 0.4% as Middle Eastern/North African, and 2.0% reported another racial identity. Most (97.6%) reported a non-Hispanic ethnicity, whereas 2.4% identified as Hispanic.

Procedure

Participants were again recruited on the online portal Prolific Academic. Prospective participants were eligible for the study if they were 18 years old or older, lived in the United States, and could read and write in English. Participants completed and submitted an online questionnaire in exchange for $2.50US, which equated to an average per-hour rate of $14.45US. The sample was gender balanced. Participants completed a questionnaire hosted on SurveyMonkey and submitted their responses electronically. The study was IRB approved.

Measures

Study Two used the same measures of *loneliness* (ω = .91), *frequency of nightmares* (ω = .91), and *stress* (ω = .64) as Study One. *Intensity of nightmares* was measured with the 9-item Nightmare Distress Questionnaire (Belicki, 1992). Participants are asked how often they have various nightmare experiences on a 7-point scale anchored at 1 (*never or almost never*) and 7 (*always or almost always*). Sample items are "Do nightmares interfere with the quality of your sleep?" and "Are you ever afraid to fall asleep for fear of having nightmares?" (ω = .92).[4]

Hyperarousal was measured with the 26-item Hyperarousal Scale (Hammad et al., 2001), which asks participants their level of agreement with statements related to

arousal. Responses were on a 7-point scale anchored at 1 (*disagree*) and 7 (*agree*). Sample items are "My mind is always going" and "Bright lights, crowds, noise, or traffic bother me" (ω = .88). *Rumination* was assessed with the 22-item Response Styles Theory Rumination Scale (Treynor et al., 2003), which asks participants how often they think or act in ways associated with worry on a 7-point scale anchored at 1 (*never or almost never*) and 7 (*always or almost always*). Sample items are "Think about how hard it is to concentrate" and "Think 'Why can't I get going?'" (ω = .96).

Descriptive statistics and intercorrelations appear in Table 3.

Ethics Statement

The study was approved by the Institutional Review Board at the University of Arizona (approval number 00003396). To maintain participants' confidentiality, participants were informed that filling out and submitting the online questionnaire would signify their consent to participate. All participants were adults.

Data Analysis

H1–2 were tested using a hierarchical multiple regression in SPSS version 29.0.1.0, whereas the remaining hypotheses were tested using a path model run in AMOS v29, which allowed for the examination of six mediation tests simultaneously.

Results

Prior to testing the hypotheses, age and gender were explored as potential control variables. Age was inversely related to nightmare frequency, r (780) = −0.10, p = .007 (two-tailed) and nightmare intensity, r (780) = −0.09, p = .014 (two-tailed). With respect to gender, the cases not reporting a gender were temporarily suppressed due to their small cell sizes. Consistent with Study One, women reported higher nightmare frequencies (M = 1.75, SD = 1.04) than did men (M = 1.60, SD = 0.96), Welch's t (773.294) = −2.02, p = .036 (two-tailed). Women also reported higher nightmare intensities (M = 1.85, SD = 0.86) than did men (M = 1.58, SD = 0.80), Welch's t (773.667) = −4.43, p < .001 (two-tailed). Age and gender were therefore included as covariates in the tests of the hypotheses.

Table 3. Study Two: Descriptive Statistics and Intercorrelations for Study Variables (N = 782).

Variables	Min	Max	*M*	*SD*	1	2	3	4	5
1. Loneliness	1.00	7.00	3.50	1.72	__				
2. Nightmare Frequency	1.00	5.00	1.68	1.00	.27*	__			
3. Nightmare Intensity	1.00	5.00	1.72	0.84	.30*	.86*	__		
4. Stress	1.00	7.00	3.7.	1.23	.61*	.34*	.36*	__	
5. Rumination	1.00	6.90	3.37	1.33	.66*	.37*	.41*	.77*	__
6. Hyperarousal	1.62	6.42	4.22	0.83	.54*	.37*	.41*	.63*	.69*

Notes. Data in this table were calculated after temporarily suppressing those cases in which gender was reported as other than female or male. Loneliness, stress, rumination, and hyperarousal were measured on 1-7 scales, and nightmare frequency and intensity on a 1-5 scale, wherein higher numbers reflect larger values of the variable. *p < .01 (two-tailed).

The first hypothesis, that loneliness predicts nightmare frequency, was tested using a hierarchical multiple regression. Age and gender were entered in the first step as control variables, and loneliness was entered in the second step, with nightmare frequency as the criterion variable.[5] The overall regression model was significant, F (3, 773) = 23.32, $p < .001$. As hypothesized, with the effects of age and gender controlled, loneliness significantly predicted nightmare frequency, β = .27, $p < .001$. Full regression results appear in Table 4. The first hypothesis is supported. The second hypothesis, that loneliness predicts nightmare intensity, was tested in the same manner, with nightmare intensity as the criterion variable. The overall regression model was significant, F (3, 773) = 33.94, $p < .001$. As hypothesized, with the effects of age and gender controlled, loneliness significantly predicted nightmare frequency, β = .29, $p < .001$. Full regression results appear in Table 5. The second hypothesis is supported.

We simultaneously tested the mediating hypotheses (H3a, b; H4a, b; and H5a, b) using a path model run in AMOS v29 (see Figure 2). This allowed us to test six mediation tests at once, limiting possible Type I error rates through the number of statistical tests run with the sample. We ran a bootstrapping model with 500 samples using bias-corrected 95% confidence levels, looking at both the overall indirect effects and the individual pathways. The model showed excellent model fit, χ^2 = 0.132, $df = 2$, p = .94, CFI > .99, TLI > .99, SRMR = .003, RMSEA < .001 (95% CI = .000 to .018). In the full model, loneliness had a positive direct effect on rumination (β = .66, $p < .001$), stress (β = .60, $p < .001$), and hyperarousal (β = .54, $p < .001$). Rumination had a positive direct effect on both nightmare frequency (β = .18, p = .001) and intensity (β = .22, $p < .001$), as did hyperarousal on frequency (β = .19, $p < .001$) and intensity (β = .24, $p < .001$). However, the direct effect of

Table 4. Study Two: Multiple Regression Predicting Nightmare Frequency ($N = 777$).

Variables	Zero-order *r*	B	SE B	β	ΔR^2
Step 1					.014**
Age	−0.09**	−0.01	.003	−0.10**	
Gender	.08*	.15	.07	.07*	
Step 2					.069**
Age	−0.09**	−0.01	.002	−0.06	
Gender	.08*	.15	.07	.07*	
Loneliness	.27**	.15	.02	.27**	

Notes. Gender was coded as 0 = male, 1 = female. Cells reporting a gender other than female or male were temporarily suppressed. R^2 = .08; adjusted R^2 = .08; F (3, 773) = 23.32, $p < .001$; *$p < .05$; **$p < .01$. Probability estimates for zero-order correlations are two-tailed.

Table 5. Study Two: Multiple Regression Predicting Nightmare Intensity ($N = 777$).

Variables	Zero-order *r*	B	SE B	β	ΔR^2
Step 1					.031**
Age	−0.09**	−0.01	.002	−0.08*	
Gender	.16**	.26	.06	.16*	
Step 2					.085**
Age	−0.09**	−0.01	.002	−0.04	
Gender	.16**	.26	.06	.16**	
Loneliness	.30**	.14	.02	.29**	

Notes. Gender was coded as 0 = male, 1 = female. Cells reporting a gender other than female or male were temporarily suppressed. R^2 = .12; adjusted R^2 = .01; F (3, 773) = 33.94, $p < .001$; *$p < .05$; **$p < .01$. Probability estimates for zero-order correlations are two-tailed.

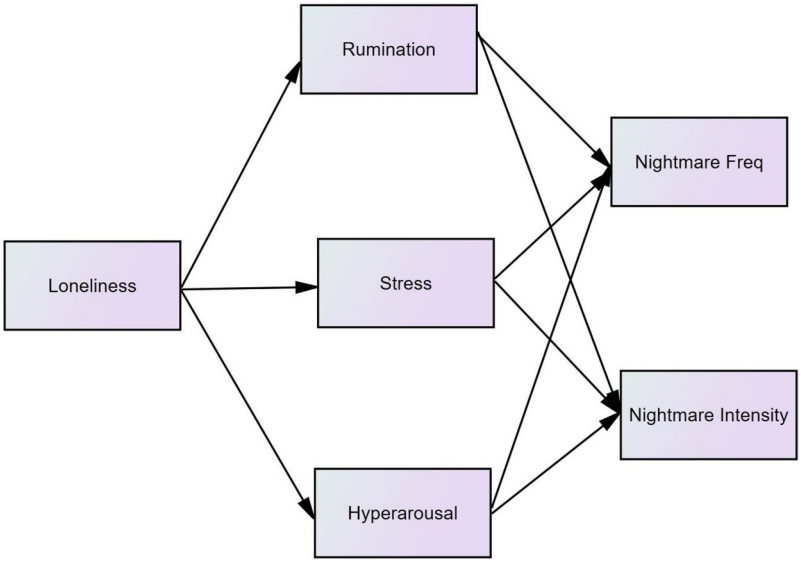

Figure 2. Study two: path analysis of mediators between loneliness and nightmare frequency ($N = 777$).

stress on both frequency (β = .08, p = .11) and intensity (β = .04, p = .44) was nonsignificant. The overall indirect effects for loneliness on both nightmare frequency (β = .27, p = .004) and nightmare intensity (β = .29, p = .004) were significant. We then examined the individual pathways with rumination, stress, and hyperarousal serving as mediators. First, the indirect effects for loneliness through stress on both frequency (β = .03, p = .08) and intensity (β = .01, p = .43) were both nonsignificant. H3a and H3b are not supported. Second, the indirect effects for loneliness through hyperarousal on both frequency (β = .06, p = .004) and intensity (β = .06, p = .004) were both significant. H4a and H4B are supported. Finally, the indirect effects for loneliness through rumination on both frequency (β = .07, p = .004) and intensity (β = .07, p = .005) were both significant. H5a and H5b are supported.

Discussion

This study replicated the main effect of loneliness on nightmare frequency, with nearly the same effect size (β = .24 in Study One, β = .27 in Study Two). In addition, we found that loneliness exerted a main effect on nightmare intensity. These findings support the predictions drawn from Cacioppo and Cacioppo's ETL, illustrating how the distress of loneliness can manifest in sleep disturbances in the form of frequent and intense nightmares.

Perhaps the more important contribution of Study Two was to examine three potential mechanisms deduced from ETL. Whereas Study One had identified a mediating effect of stress on nightmare frequency, this study explored whether stress, hyperarousal, and rumination, in tandem, mediated the association between loneliness and the frequency and intensity of nightmares. When the mediators were considered collectively,

stress did not have a significant mediating effect on either frequency or intensity, contrary to H3a and H3b. Nonetheless, hyperarousal and rumination were significant mediators of the association between loneliness and both the frequency and intensity of nightmares, in support of the remaining predictions. We will speculate about the failure of H3a and H3b subsequently, in the general discussion.

General Discussion

Loneliness is a pervasive and detrimental condition that significantly impairs wellness. Indeed, when the need to belong is thwarted (Baumeister et al., 2007), humans suffer in a wide variety of ways. Among the many health detriments associated with loneliness is an impairment in sleep quality, including in the experience of nightmares. Whereas some previous research had identified significant main effects of loneliness on the frequency and/or intensity of nightmares, little was known previously about the mechanisms connecting loneliness to the nightmare experience. On the basis of Cacioppo and Cacioppo's ETL, we derived three prospective mediators of the loneliness–nightmare association: stress, rumination, and hyperarousal. Two studies tested the proposed main and mediating effects.

Collectively, the data presented herein confirm that loneliness has moderate associations with the frequency (both studies) and intensity (Study Two) of nightmares. Such findings are obviously cross-sectional and cannot, therefore, establish the causal direction of the relationships. Nonetheless, we would contend that, to the extent that the relationships do have a causal element, it makes greater theoretic sense to surmise that loneliness leads to more frequent and intense nightmares, rather than nightmares leading to loneliness. Insofar as nightmares are associated with experiences of anxiety, trauma, and emotional dysregulation (see Secrist et al., 2019), it is certainly plausible–and consistent with the arguments of Cacioppo and Cacioppo's (2018) ETL–that the psychological distress of loneliness manifests in frequent and intense nightmares. However, longitudinal research has shown that nightmare frequency predicts completed suicide (Sandman et al., 2017), and other research has speculated that nightmare frequency may predict psychiatric disorders, at least in adolescents (Kirov & Brand, 2011), so it is not inconceivable that experiencing nightmares could predict loneliness.

Perhaps the most important contribution of the present studies, however, is the examination of three theoretically derived mechanisms for the loneliness-nightmare association. On the basis of ETL's aversive signaling and implicit vigilance postulates, we hypothesized that stress, hyperarousal, and rumination would mediate the relationship between loneliness and both the frequency and intensity of experienced nightmares. Study One was able to test only the mediating effect of stress, and only on nightmare frequency, and found that stress partially mediated the association between loneliness and frequency. Study Two allowed for all three mediators to be tested with respect to frequency and intensity.

Study Two found that hyperarousal and rumination both partially mediated the associations between loneliness and the frequency and intensity of nightmares, as hypothesized. From the perspective of ETL's aversive signaling and implicit vigilance postulates, the distress of loneliness manifests in experiences of rumination and

hyperarousal, which then give rise to loneliness. Without testing the mediation model longitudinally, we cannot confirm the direction of the causal relationships, of course, but the Hyman-Tate conceptual timing criterion (Tate, 2015) for mediation analysis explains that if the predictor precedes the mediator in time conceptually, and if the mediator precedes the outcome in time conceptually–both of which our theorizing from ETL suggests are true–then it is permissible to make the case that we have identified a true mediation effect despite the cross-sectional design.

When examined by itself in Study One, stress also showed a significant mediating effect between loneliness and nightmare frequency (although intensity was not measured). Nonetheless, when considered simultaneously with the other mediators (hyperarousal and rumination) in Study Two, the mediating effect of stress became nonsignificant. As a post-hoc test, we did run a mediation test in Study Two using only stress as a mediator, and the direct and indirect effects both became significant. Thus, it is possible, both from a statistical and theoretical perspective, that one or both the other two mediators explain more of the variance in terms of nightmares. For example, rumination has been linked to nightmare distress and frequency in multiple studies (e.g., Faccini et al., 2022; Rogers et al., 2017). Another possibility is simply that both rumination and hyperarousal could be manifestations of stress, and thus the model shows how more specific aspects of stress might matter in understanding the link between loneliness and nightmares. Overall, we would caution against dismissing the role of stress, as the study overall shows possible direct and indirect relationships with stress and/or stress factors on both loneliness and nightmares.

Implications and Liabilities

The results of these studies have theoretical implications for ETL in that they provide empirical evidence supporting both the aversive signaling and implicit vigilance postulates of ETL as mechanisms that explain the relationships between loneliness and nightmare frequency and intensity. ETL provides that loneliness is an evolved adaptive mechanism alerting individuals to a lack of meaningful social connections. Its aversive signal postulate argues that loneliness has evolved to be a physically and psychologically aversive experience, whereas its implicit vigilance postulate explains that loneliness generates a perception of vulnerability and prompts vigilance for and avoidance of social threats. We reasoned from these two postulates that loneliness aligns with psychological states—stress, hyperarousal, and rumination—that are likely to manifest in the form of nightmares.

Our studies are the first to our knowledge to apply the ETL as an explanatory mechanism linking loneliness to nightmare frequency and intensity. Our results also offer an explanation for nightmares that is rooted in human evolution as opposed to exclusively being the result of environmental factors such as experiencing trauma (e.g., Wang et al., 2019). Considering the universality of sleep and the prevalence of sleep disturbances in the general population, our results extend the scope of ETL into an important new context.

We believe it would be premature to suggest any implications for intervention or prevention on these correlational results. The associations between loneliness and nightmare frequency and intensity are consistent with the possibility that treating

loneliness would ameliorate the experience of nightmares, but they do not, by themselves, confirm such a possibility, which would have to be addressed in controlled clinical studies. Neither do these correlational results suggest the superiority of any particular clinical approach to treating loneliness, although they may imply that nightmare frequency and intensity could be assessed during therapeutic intake for individuals whose presenting complaint is loneliness itself.

We also acknowledge limitations of the present studies. For one, although the first sample was Census-matched on age, race, and gender, both samples were composed only of U.S. American adults. Recent research has documented that loneliness is a global pandemic and not a uniquely American problem (Sauter et al., 2020). As such, future studies should replicate and extend these findings across samples from different nations and cultures. Given that most social scientific studies rely on samples recruited from Western, democratic, industrialized countries, future research studies endeavors should prioritize recruiting samples from nations and cultures that are typically underrepresented in social scientific research, such as African, Latin American, and Caribbean countries (Pollet & Saxton, 2019).

A second limitation involves the measurement of loneliness and nightmares. Our studies used a 3-item short form version of the UCLA Loneliness Scale, and although this is a commonly used measure of loneliness, it is not the only operational definition. For example, future studies might consider using both the UCLA Loneliness Scale and the De Jong Gierveld Loneliness Scale (De Jong Gierveld & Van Tilburg, 2010), the latter of which provides both a measure of social loneliness and emotional loneliness. Doing so could allow for a more nuanced understanding of what aspects of loneliness relate to nightmare frequency and intensity. Regarding the measurement of nightmares, future studies should consider utilizing a variety of methods to measure this outcome, including established scales such as the Disturbing Dreams and Nightmare Severity Index (DDNSI; Krakow, 2006), physiological measures obtained through devices such as a mattress or wrist actigraphy (Miller et al., 2018) or a headband electroencephalography device (Richards et al., 2023), and daily sleep diaries. The use of sleep diaries, in particular, could provide more detailed and in-depth accounting of the frequency, intensity, and content of participants' nightmares, and this method has been used successfully when measuring other sleep-related outcomes such as insomnia (e.g., Manber et al., 2005).

Questions for Future Research

Quality restorative sleep is critical for cognitive functioning, mood regulation, metabolism, and other forms of well-being (see Luyster et al., 2012), so psychological states that disrupt sleep–including loneliness–warrant empirical attention. Having replicated some earlier studies' main effects of loneliness on the frequency and intensity of nightmares, one question for future research would be whether loneliness is associated with the *content* of nightmares. Few studies have explored nightmare content systematically, but in a thematic analysis of 1,216 recalled nightmares, Schredl & Göritz (2018) found that experiences of failure/helplessness, physical aggression, accidents, being chased, and health-related concerns/death were the five most frequently reported themes. An earlier investigation by Robert & Zadra (2014)

also identified physical aggression, failure/helplessness, and health-related concerns/death among their most frequent themes, but their five most common themes also included interpersonal conflicts and experiences of apprehension or worry, whereas earlier work by Schredl (2010) identified falling, being chased, being paralyzed, being late for an important event, and the death of someone close as the most frequent. Future research might explore whether particular themes are notably common among people with intense loneliness, and whether certain of those themes are more predictive than others of highly concerning loneliness comorbidities such as suicide ideation.

A second question for future investigations is which forms of treatment for loneliness have the most beneficial effects on sleep quality, including the frequency and intensity of nightmares. In a meta-analysis of interventions to reduce loneliness, Masi et al. (2011) identified four primary intervention forms that had received extensive empirical attention: 1) efforts to increase opportunity for social contact between people; 2) interventions design to fortify social support; 3) programs to improve lonely people's social skills; and 4) interventions aimed at identifying and correcting maladaptive social cognitions. It is conceivable that certain interventions might have a more beneficial impact on the frequency and/or intensity of nightmares than others, particularly if stress, rumination, and/or hyperarousal mediate those associations. For instance, it may be the case that correcting maladaptive social cognitions–which Masi and colleagues found to produce the largest effect sizes for loneliness reduction of the four intervention categories–does more to ameliorate stress, reduce rumination, and tamper hyperarousal than, say, increasing a person's social skills. Such a possibility awaits empirical attention, but if future intervention efforts are targeted at improving sleep quality for lonely individuals, specifically, it would be useful to know how existing intervention strategies compare with respect to reducing the frequency or intensity of nightmares or of other sleep detriments.

Conclusion

Interpersonal loneliness is so psychologically distressing, and so predictive of impairments in health and well-being, that it is largely unsurprising to find it associated with disturbed sleep. Few previous studies had examined its effects on nightmares, however, and none had explored the mechanisms of stress, rumination, and hyperarousal that we derived from ETL. As future research adds empirical clarity to these relationships, interventions targeting these mechanisms may be supported to help those suffering from loneliness to improve their sleep quality and reap the associated health rewards.

Notes

1. In both studies, percentages for racial identity sum to >100 because participants could select multiple racial identities.
2. https://osf.io/ukyzp/?view_only=7fb6426a051047308e28ba8287f1a98a.
3. The regression analysis temporarily suppressed nine participants reporting a gender other than male or female.

4. Although Krakow's (2006) DDSNI is frequently employed, we elected to use the Nightmare Distress Questionnaire to assess nightmare intensity so we could replicate the measurement of nightmare frequency used in Study One and keep frequency and intensity as separate measures.
5. The regression analyses temporarily suppressed five participants reporting a gender other than male or female.

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