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Neuroticism, rumination, negative affect, and sleep: Examining between- and within-person associations

Danica C. Slavish, Ph.D.[1], **Martin J. Sliwinski, Ph.D.**[2], **Joshua M. Smyth, Ph.D.**[3], **David M. Almeida, Ph.D.**[2], **Richard B. Lipton, M.D.**[4], **Mindy J. Katz, M.P.H.**[4], and **Jennifer E. Graham-Engeland, Ph.D.**[3]

[1]Department of Psychology, University of North Texas, 1155 Union Circle #311280, Denton, TX 76203, U.S.A

[2]The Department of Human Development and Family Studies, The Pennsylvania State University, University Park, PA, 16802, U.S.A

[3]The Department of Biobehavioral Health, The Pennsylvania State University, University Park, PA, 16802, U.S.A

[4]The Albert Einstein College of Medicine, Bronx, NY, 10461, U.S.A

1. Introduction

Neuroticism is a personality trait characterized by a tendency to perceive one's environment as threatening and difficult to manage. It is strongly implicated in elevated risk for poor health outcomes, including cardiovascular disease, depression, anxiety, and in particular, disturbed sleep and insomnia (Gurtman, McNicol, & McGillivray, 2014; Lahey, 2009; van de Laar, Verbeek, Pevernagie, Aldenkamp, & Overeem, 2010). The connection between neuroticism and disturbed sleep seems intuitive yet needs further exploration. In cross-sectional and experimental sleep deprivation studies, neuroticism and cognitive-emotional hyperarousal have been shown to be some of the strongest vulnerability factors for poor or insufficient sleep (Calkins, Hearon, Capozzoli, & Otto, 2013; Duggan, Friedman, McDevitt, & Mednick, 2014; Gurtman et al., 2014; Mastin, Peszka, Poling, Phillips, & Duke, 2005). However, it is unclear if neuroticism is a direct predictor of sleep, and/or if it moderates associations between related psychological processes (e.g., cognition and emotion) and sleep. Moreover, because most previous work has been cross-sectional, the daily, within-person psychological processes related to neuroticism and impaired sleep remain relatively unexplored. Daily psychological processes are important to investigate as they may be a proximal disruption to nightly sleep and may represent modifiable intervention targets. In the current research, we focus on the construct of neuroticism as both a direct predictor of

Corresponding author: Jennifer E. Graham-Engeland, jeg32@psu.edu, phone: (814) 863-1840; address: 219 Biobehavioral Health Building; The Pennsylvania State University, University Park, PA, 16802, U.S.A.

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reported sleep and as a potential moderator of daily associations between cognitive-emotional processes (i.e., rumination and negative affect) and reported sleep.

Rumination, or repetitive thinking about the causes and consequences of one's problems, and negative affect (NA), or emotions like anger, fear, and sadness, may each relate to impaired sleep in daily life. According to the response styles theory (Nolen-Hoeksema, 1991), when individuals fixate on their response to a stressful event as well as the causes and effects of this response (e.g., "Why do I get distressed when others don't?"), this can prolong and heighten distress. Elevated distress can lead to hyperarousal, which makes the act of falling and staying asleep more difficult (Brosschot, Gerin, & Thayer, 2006; Guastella & Moulds, 2007). Cross-sectionally, both NA and rumination have been associated with poorer subjective sleep quality (Brummett et al., 2006; Norlander, Johansson, & Bood, 2005; Zawadzki, Graham, & Gerin, 2013). In studies in daily life, when examined separately, daily NA and rumination have been shown to predict impaired subjective and objective (i.e., actigraphy-determined) sleep quality (McCrae et al., 2008; Pillai, Steenburg, Ciesla, Roth, & Drake, 2014; Winzeler et al., 2014).

Despite some evidence of neuroticism, rumination, and NA each predicting impaired sleep, no studies have examined associations between these constructs simultaneously in daily life. Although they are likely related, neuroticism is a trait that is relatively stable over time (Lahey, 2009), whereas rumination and NA have been shown to fluctuate from day-to-day and moment-to-moment (Eid & Diener, 1999; Takano & Tanno, 2011). Neuroticism, rumination, and NA may each be unique predictors of sleep and/or may interact in daily life to predict sleep. For example, individuals higher in neuroticism may be particularly likely to suffer from the consequences of daily rumination and NA on impaired sleep. Neuroticism has been shown to moderate the link between daily stressors and NA reactivity (Bolger & Zuckerman, 1995), as well as the link between negative cognitions and depressive symptoms (Hankin, Fraley, & Abela, 2005); individuals higher in neuroticism exhibit stronger positive associations between these variables compared to those lower in neuroticism. Similarly, hostility, a trait with some overlap with neuroticism, exacerbated a connection between daily NA and subjective sleep quality (Brissette & Cohen, 2002). These studies suggest that neuroticism and related traits may predict stronger associations between negative psychological states and poor health behaviors. However, no studies have examined neuroticism as a moderator of the relationships between rumination, NA, and impaired sleep quality in daily life.

This lack of research examining both individual and daily predictors of sleep across time represents an important gap in the literature. It is helpful to understand what it means for a person to vary from day-to-day on repeated measures of sleep over time (i.e., within-person effects), in addition to what it means for some people to be higher or lower overall, relative to other people, on these same measures (i.e., between-person effects; Mroczek, Spiro, & Almeida, 2003; see Smyth & Heron, 2014 for a general discussion). Both approaches are useful, but answer very different questions: Between-person analyses can identify individuals at greatest risk for adverse sleep outcomes (e.g., those higher in trait neuroticism), whereas within-person analyses can identify specific daily processes related to sleep (e.g., days characterized by more rumination or NA than average). The separation of

between- and within-person effects helps avoid the ecological fallacy, where inferences about associations at one level of analysis (e.g., day-level characteristics) are conflated with associations at another level of analysis (e.g., person-level characteristics; Kramer, 1983; Zawadzki, Smyth, Sliwinski, Ruiz, & Gerin, 2017).

To address gaps in the literature, we investigated associations between neuroticism, rumination, NA, and sleep across a 14-day repeated-measures study. At the between-person level, we examined neuroticism as a predictor of reported sleep, with the expectation that neuroticism would be associated with more impaired sleep quality and greater difficulty falling asleep across the 14 days. At the within-person level, we examined associations between daily rumination and NA with reported sleep; we hypothesized that on days when individuals reported relatively greater (i.e., higher than their person-mean) rumination and NA, they also would report more impaired sleep quality and greater difficulty falling asleep that night. Finally, we tested neuroticism as a moderator of the associations between daily rumination, NA, nightly sleep quality, and difficulty falling asleep, with the expectation that these associations would be stronger for those higher in neuroticism.

2. Method

2.1. Overview

Data were drawn from the first burst of data collection from a longitudinal burst study. Participants were recruited from a housing development in the Bronx, New York using systematic probability sampling. Eligible participants were 25 to 65 years old, ambulatory, fluent in English. Exclusion criteria included inability to answer smartphone surveys throughout the day due to visual impairment or work requirements. Within each burst, participants completed a baseline assessment of neuroticism. Upon completion of a training session, participants completed two weeks of daily surveys in the morning and before bedtime via a customized smartphone interface (see below for more details). Informed consent was obtained from all participants.

2.2. Participants

The larger study consisted of 337 participants, but only participants who completed the baseline assessment at least one daily diary survey from the first burst of data collection were included in analyses. The final sample thus was comprised of 242 adults (M_{age} = 46.8 ± 10.9 years; 66.5% female; 62.4% African-American, 18.2% White Hispanic/Latino, 6.2% Black Hispanic/Latino, 9.1% Caucasian). There were no demographic differences between those who only completed the baseline survey and those who completed both the baseline survey and at least one daily survey.

2.3. Daily survey procedure

Participants first completed a training session for instruction on how to complete the surveys on the smartphone they were given to use as part of the study. Participants then completed a 2-day daily diary practice phase. For the actual 14-day daily diary protocol, each day participants completed two reports: one upon waking, in which they reported on their

previous night's sleep, and another within an hour before bedtime, in which they reported their thoughts and emotions over the course of that day.

2.4. Measures

2.4.1. Neuroticism—Neuroticism was assessed at baseline using a 24-item scale derived from the International Personality Inventory Pool (DeYoung, Quilty, & Peterson, 2007; Goldberg et al., 2006; Johnson, 2011). This 24-item scale consists of six subscales that each demonstrate high internal consistency (α's = 0.77 to 0.88). The 24-item subscale also demonstrates good convergent validity with the Revised NEO-Personality Inventory (r = 0.87; Johnson, 2011). Participants rated how accurately each statement described themselves on a scale of 1 (very inaccurate) to 5 (very accurate). Example items included "Worry about things" and "Get irritated easily." Items were added together to create a composite measure. Possible scores ranged from 24-120, with higher scores indicating greater levels of neuroticism.

2.4.2. Daily negative affect—Daily negative affect (NA) was assessed in the evening survey. Participants rated how much they felt five NA items (tense, frustrated, angry, depressed, unhappy) over the past day on a scale of 0 (not at all) to 100 (very much). These particular items were chosen in alignment with previous research on daily negative affect (Diener & Emmons, 1984) and were derived from the Profile of Mood States, which has shown to be a reliable and valid measure of affect (McNair, Lorr, & Dropelman, 1981). Items were averaged to create a composite measure of NA. Possible scores ranged from 0-100, with higher scores indicating greater daily NA. (For psychometric quality, between and within-person variances were computed for all waking and bedtime repeated measures; see Table 1.)

2.4.3. Daily rumination—Daily rumination was assessed in the evening survey. Questions were: "Today, how often did you think about personal problems and worries?"; "Today, how often did you experience a train of thought that was difficult to get out of your head?"; "Today, how often were you preoccupied with thoughts about the future?" and "Today, how often did you think about situations that upset you?" Items were derived from previous pilot work on daily rumination. The items were rated on a scale of 0 (not at all) to 100 (very often) and were averaged together to create a composite measure of rumination. Possible scores ranged from 0-100, with higher scores indicating greater daily rumination.

2.4.4. Nightly sleep—Nightly sleep quality and difficulty falling asleep each were assessed in the morning recall survey using measures derived from the Patient-Reported Outcomes Measurement Information System® (PROMIS) short-form sleep disturbances scale (Yu et al., 2012), adapted for daily measurement (i.e., changing time frame from "over the past 7 days" to "last night"). Participants rated their sleep quality and difficulty falling asleep the previous night, each on a scale of 0 (very poor) to 100 (very good). Higher scores indicated better sleep quality and increased difficulty falling asleep. Although the PROMIS® sleep disturbances scale has not been validated for daily usage, previous work has demonstrated that self-reported sleep quality is sensitive to change over short periods of time (McCrae et al., 2008; Sin et al., 2017). The original 8-item short-form sleep disturbances

scale demonstrates good convergent validity with the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale (Yu et al., 2012).

2.4.5. Covariates—Age, gender (male = 1, female = 2), and reported annual household income (below $39,999 = 0, greater than or equal to $40,000 = 1) were included as covariates, as age and gender differences exist in sleep (Krishnan & Collop, 2006; Reyner, Horne, & Reyner, 1995), and income may be a proxy for conditions related to sleep (e.g., neighborhood conditions or access to health care; Hale et al., 2013). Weekday versus weekend was included as a time-varying covariate (Friday and Saturday = 1, all other days = 0), as sleep patterns can vary on weekdays versus weekends (Hale, 2005).

2.5. Analytic plan

2.5.1. Data preparation—Analyses were conducted in SAS software, version 9.4. (SAS Institute, 2008) using PROC MIXED for multilevel modeling (MLM). Data were nested as days (level 1) within people (level 2). In these models, between-person refers to person-level effects and within-person refers to day-level effects. Because evening reports were used to predict next morning reports, morning reports were lagged minus one day, and the first day's morning and last day's evening reports were deleted. Level 1 predictors were centered around the individual's mean across the 14 days (i.e., to reflect within-person effects), and continuous level 2 predictors were centered around the sample mean across all participants (i.e., to reflect between-person effects). Restricted maximum likelihood (REML) was used for model estimation and random effects were allowed to be correlated. REML adjusts for uncertainty of fixed effects, producing less biased variance and covariance estimates than maximum likelihood techniques (Raudenbush & Bryk, 1992).

2.5.2. Analyses—Descriptives and correlations first were examined. For aim 1, we examined neuroticism as a predictor of the random-intercepts of sleep quality and difficulty falling asleep. For aim 2, we examined daily fluctuations in (i.e., within-person centered) rumination and NA as predictors of the random-intercepts of sleep quality and difficulty falling asleep. (Predictors for aims 1 and 2 were examined simultaneously, but each sleep outcome was examined separately.) For aim 3, we included neuroticism as a between-person moderator of the relationships assessed in aim 2. For an approximation of total model effect sizes, pseudo-R^2 values were calculated by using a ratio to compare the level 1 and level 2 variance in the intercept-only model to the residual variance after all predictors in each aim were added. To assess the degree of multicollinearity between rumination, NA, and neuroticism, variance inflation factors (VIF; i.e., an index of how much the variance of each coefficient is increased because of collinearity), were examined by entering all predictors simultaneously to predict each outcome using SAS PROC REG (as VIFs cannot be calculated in SAS PROC MIXED). VIFs >=10 were considered evidence of serious multicollinearity requiring correction, whereas VIFs <10 were considered acceptable (Belsley, Kuh, & Welsch, 1980).

3. Results

3.1. Descriptive and correlational results

The sample was diverse in education and income levels (e.g., 55.8% completed at least some college; 48.2% reported an annual household income below $39,999). Participants completed an average of 25 out of 28 total daily surveys (i.e., the sum of the 14 morning and 14 evening surveys) for an average compliance rate of 89%. The daily diary design captured substantial variability in rumination, NA, sleep quality, and difficulty falling asleep, both between participants and within the same participant across days (*ps* < .001; see Table 1). At the between-person level, neuroticism was associated with rumination, NA, sleep quality, and difficulty falling asleep (*ps* < .01; see Table 2). Rumination was associated with NA at both the between-person ($r = 0.73$, $p < .001$) and the within-person level ($r = 0.53$, $p < .001$; see Table 2).

3.2. Model results

3.2.1. Aim 1: Neuroticism as a predictor of sleep—Across the two-week study period, controlling for day of the week, age, income, and gender, neuroticism was associated with poorer sleep quality ($\beta = -0.21$, $SE = 0.09$, $p < .01$) and greater difficulty falling asleep ($\beta = 0.25$, $SE = 0.09$, $p < .01$; not shown in tables). However, after additionally controlling for between-person levels of rumination and NA and within-person centered rumination and NA, neuroticism no longer independently was associated with sleep quality ($\beta = -0.07$, $SE = 0.09$, $p = 0.43$) or greater average difficulty falling asleep ($\beta = 0.06$, $SE = 0.09$, $p = 0.48$; see Table 3).

3.2.2. Aim 2: Daily rumination and negative affect as predictors of sleep—On days when individuals reported more NA than their individual average, they also reported poorer sleep quality ($\beta = -0.10$, $SE = 0.04$, $p < .01$) and greater difficulty falling asleep that night ($\beta = 0.11$, $SE = 0.05$, $p < .05$; see Table 3), controlling for day of the week, age, income, gender, between-person levels of rumination and NA, within-person centered rumination, and between-person centered neuroticism. In the same model, with the same covariates, daily rumination was not associated with either sleep quality ($\beta = -0.03$, $SE = 0.03$, $p = 0.37$) or difficulty falling asleep ($\beta = 0.05$, $SE = 0.04$, $p = 0.23$; see Table 3).

3.2.3. Aim 3: Neuroticism as a moderator of daily associations between rumination, negative affect, and sleep—Neuroticism did not moderate associations between daily rumination and sleep quality or difficulty falling asleep, or associations between daily NA and sleep quality or difficulty falling asleep, controlling for day of the week, age, income, gender, between-person levels of rumination/NA, daily rumination/NA, and between-person centered neuroticism (see Table 4).

4. Discussion

This was the first naturalistic study to examine between- and within-person associations linking neuroticism, rumination, NA, and self-reported measures of sleep quality. Results provided support for some of our hypotheses but not others. Our first hypothesis was that

neuroticism would be associated with poorer sleep quality and greater difficulty falling asleep after controlling for daily rumination and NA. This prediction was not fully supported. Although neuroticism predicted sleep quality and difficulty falling asleep before controlling for rumination and NA, it was not independently associated with sleep after accounting for these daily-level variables. This finding is partially in contrast with cross-sectional studies demonstrating that higher neuroticism relates to more impaired sleep (Calkins et al., 2013; Vincent, Cox, & Clara, 2009); however, these studies did not examine daily fluctuations in rumination and NA, which appear to be more independent predictors of sleep than person-level characteristics such as neuroticism. Our findings extend research by examining these constructs simultaneously in daily life, allowing examination of both between-person and within-person effects. Our novel examination of within-person effects helps characterize which types of days, relative to an individual's typical type of day, may be most detrimental sleep (e.g., days with greater NA than average), even after accounting for personality traits and average tendencies (e.g., typical levels of NA). These potentially modifiable daily processes may be important to investigate in future research seeking to identify non-pharmacological targets for improving sleep.

Our second hypothesis was that on days when individuals reported greater rumination and NA than their individual average, the next morning they would also report worse sleep quality and greater difficulty falling asleep during the previous night. This prediction was partially supported: only NA independently predicted impaired sleep quality and difficulty falling asleep. Other studies have shown cross-sectional associations between NA and impaired sleep quality (for a review, see Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010), and daily diary studies have shown that days with more NA than an individual's average are associated with nights with poorer sleep quality in a sample of older adults (McCrae et al., 2008).

In contrast to this previous research, a strength of the present work was that we were able to assess both daily rumination and NA simultaneously in relation to nightly self-reported sleep quality in a more representative and diverse sample of adults. In our sample, we found that only daily NA remained a significant independent predictor of the self-reported sleep outcomes. This finding is in contrast with studies showing cognitive arousal plays a larger role in psychophysiological impairment than does affective arousal (Lichstein & Rosenthal, 1980; Munoz, Sliwinski, Smyth, Almeida, & King, 2013). However, there are some potential explanations for our finding. First, both of these previous studies were cross-sectional, and therefore, were unable to examine the influence of both between- and within-person effects. Average levels of rumination and NA may be differentially related to each other and to sleep than are daily fluctuations in rumination and NA. Second, it may be that daily NA is more toxic for sleep than rumination, perhaps particularly for certain populations. Rumination also may exert its effects by promoting and sustaining negative mood, a supposition which is supported by previous literature (Watkins, 2008). Future studies may benefit from examining the temporal and dynamic interactions between NA and rumination, or by examining directional pathways between NA, rumination, and sleep.

Our third hypothesis was that individuals higher in trait neuroticism would exhibit stronger associations between daily rumination, NA, nightly sleep quality, and difficulty falling

asleep. This prediction was not supported: There was no evidence that neuroticism moderated the associations between daily rumination or daily NA on that night's reported sleep quality or difficulty falling asleep. To our knowledge, this is the first research to examine neuroticism as a potential moderator of these relationships at the daily level. Despite cross-sectional research suggesting that neuroticism exacerbates associations between emotion, cognition, and/or sleep, the present research examining daily associations demonstrated that days with more impaired emotional functioning than average appear to be most detrimental for sleep, regardless of an individual's level of neuroticism and typical emotional patterns. Overall, our results suggest that the examination of within-person processes, particularly daily affective processes, may be better predictors of reported sleep than between-person personality characteristics. Future work should continue to examine associations between other daily psychological processes (e.g., positive affect, mindfulness, or social interactions) and sleep.

Despite the unique strengths of the current study, there are some methodological limitations that warrant further investigation. First, we only measured self-reported sleep quality and difficulty falling asleep (which were selected on the theoretical basis that these facets of sleep would be most related to cognitive-emotional processes); however, there may be other dimensions of sleep that are also related to neuroticism, rumination, and/or NA (e.g., sleep timing, sleep duration, or wake after sleep onset). We also relied exclusively on self-report measures of sleep; future research should employ more objective measures (e.g., actigraphy) to ascertain whether individuals high in neuroticism are more likely to report as well as experience sleep-related impairment (an important issue given the relation of neuroticism to self-report bias). Finally, and perhaps most importantly, although the reporting structure imposed temporality (i.e., daily reports of NA and rumination precede those of sleep), data were correlational and cannot determine causality. To strengthen causal inference and better inform intervention efforts, experience sampling designs must be supplemented with experimental designs.

In summary, this study demonstrated that neuroticism is not associated with sleep quality and difficulty falling asleep after accounting for daily fluctuations in rumination and negative affect. Days when individuals report greater negative affect than their individual average appear detrimental for sleep that night; these effects were independent of their daily levels of rumination and their levels of trait neuroticism. Results highlight the importance of utilizing repeated measures designs and conducting multilevel analyses, where between- and within-person effects can be examined simultaneously and in interaction with each other. Together, our results help better identify daily risk factors for poor reported sleep and underscore the importance of assessing within-person predictors of sleep in future research.

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References

Baglioni C, Spiegelhalder K, Lombardo C, Riemann D. Sleep and emotions: A focus on insomnia. Sleep Medicine Reviews. 2010; 14:227–238. doi: http://dx.doi.org/10.1016/j.smrv.2009.10.007. [PubMed: 20137989]

Belsley, DA., Kuh, E., Welsch, RE. Regression Diagnostics: Identifying Influential Data and Sources of Collinearity. Hoboken, NJ: John Wiley & Sons, Inc; 1980.

Bolger N, Zuckerman A. A framework for studying personality in the stress process. Journal of Personality and Social Psychology. 1995; 69:890–902. doi: http://dx.doi.org/10.1037/0022-3514.69.5.890. [PubMed: 7473036]

Brissette I, Cohen S. The contribution of individual differences in hostility to the associations between daily interpersonal conflict, affect, and sleep. Personality and Social Psychology Bulletin. 2002; 28:1265–1274. doi: http://dx.doi.org/10.1177/01461672022812011.

Brosschot JF, Gerin W, Thayer JF. The perseverative cognition hypothesis: A review of worry, prolonged stress-related physiological activation, and health. Journal of Psychosomatic Research. 2006; 60:113–124. doi: http://dx.doi.org/10.1016/j.jpsychores.2005.06.074. [PubMed: 16439263]

Brummett BH, Babyak MA, Siegler IC, Vitaliano PP, Ballard EL, Gwyther LP, Williams RB. Associations among perceptions of social support, negative affect, and quality of sleep in caregivers and noncaregivers. Health Psychology. 2006; 25:220–225. doi: http://dx.doi.org/10.1037/0278-6133.25.2.220. [PubMed: 16569114]

Calkins AW, Hearon BA, Capozzoli MC, Otto MW. Psychosocial predictors of sleep dysfunction: The role of anxiety sensitivity, dysfunctional beliefs, and neuroticism. Behavioral Sleep Medicine. 2013; 11:133–143. doi: http://dx.doi.org/10.1080/15402002.2011.643968. [PubMed: 23136825]

DeYoung CG, Quilty LC, Peterson JB. Between facets and domains: 10 aspects of the Big Five. Journal of Personality and Social Psychology. 2007; 93:880–896. doi: http://dx.doi.org/10.1037/0022-3514.93.5.880. [PubMed: 17983306]

Diener E, Emmons RA. The independence of positive and negative affect. Journal of Personality and Social Psychology. 1984; 47:1105–1117. doi: http://dx.doi.org/10.1037/0022-3514.47.5.1105. [PubMed: 6520704]

Duggan KA, Friedman HS, McDevitt EA, Mednick SC. Personality and healthy sleep: The importance of conscientiousness and neuroticism. PLoS ONE. 2014; 9:e90628. doi: http://dx.doi.org/10.1371/journal.pone.0090628. [PubMed: 24651274]

Eid M, Diener E. Intraindividual variability in affect: Reliability, validity, and personality correlates. Journal of Personality and Social Psychology. 1999; 76:662. doi: http://dx.doi.org/10.1037//0022-3514.76.4.662.

Goldberg LR, Johnson JA, Eber HW, Hogan R, Ashton MC, Cloninger CR, Gough HG. The international personality item pool and the future of public-domain personality measures. Journal of Research in Personality. 2006; 40:84–96. doi: http://dx.doi.org/10.1016/j.jrp.2005.08.007.

Guastella AJ, Moulds ML. The impact of rumination on sleep quality following a stressful life event. Personality and Individual Differences. 2007; 42:1151–1162. doi: http://dx.doi.org/10.1016/j.paid.2006.04.028.

Gurtman CG, McNicol R, McGillivray JA. The role of neuroticism in insomnia. Clinical Psychologist. 2014; 18:116–124. doi: http://dx.doi.org/10.1111/cp.12029.

Hale L. Who has time to sleep? Journal of Public Health. 2005; 27:205–211. doi: http://dx.doi.org/10.1093/pubmed/fdi004. [PubMed: 15749721]

Hale L, Hill TD, Friedman E, Nieto FJ, Galvao LW, Engelman CD, Malecki KMC, Peppard PE. Perceived neighborhood quality, sleep quality, and health status: Evidence from the Survey of the Health of Wisconsin. Social Science & Medicine. 2013; 79:16–22. doi: http://dx.doi.org/10.1016/j.socscimed.2012.07.021. [PubMed: 22901794]

Hankin BL, Fraley RC, Abela JRZ. Daily depression and cognitions about stress: Evidence for a traitlike depressogenic cognitive style and the prediction of depressive symptoms in a prospective daily diary study. Journal of Personality and Social Psychology. 2005; 88:673–685. doi: http://dx.doi.org/10.1037/0022-3514.88.4.673. [PubMed: 15796667]

Johnson, JA. Development of a short form of the IPIP-NEO Personality Inventory. Paper presented atthe Association for Research in Personality; Riverside, CA. 2011.

Kramer GH. The ecological fallacy revisited: Aggregate- versus individual-level findings on economics and elections, and sociotropic voting. American Political Science Review. 1983; 77:92–111. doi: http://dx.doi.org/10.2307/1956013.

Krishnan V, Collop NA. Gender differences in sleep disorders. Current Opinion in Pulmonary Medicine. 2006; 12:383–389. doi: http://dx.doi.org/10.1097/01.mcp.0000245705.69440.6a. [PubMed: 17053485]

Lahey BB. Public health significance of neuroticism. The American Psychologist. 2009; 64:241–256. doi: http://dx.doi.org/10.1037/a0015309. [PubMed: 19449983]

Lichstein KL, Rosenthal TL. Insomniacs' perceptions of cognitive versus somatic determinants of sleep disturbance. Journal of Abnormal Psychology. 1980; 89:105–107. doi: http://dx.doi.org/10.1037/0021-843X.89.1.105. [PubMed: 7365114]

Mastin DF, Peszka J, Poling T, Phillips R, Duke J. Personality as a predictor of the objective and subjective impact of sleep deprivation. Personality and Individual Differences. 2005; 39:1471–1482. doi: http://dx.doi.org/10.1016/j.paid.2005.08.007.

McCrae CS, McNamara JP, Rowe MA, Dzierzewski JM, Dirk J, Marsiske M, Craggs JG. Sleep and affect in older adults: Using multilevel modeling to examine daily associations. Journal of Sleep Research. 2008; 17:42–53. doi: http://dx.doi.org/10.1111/j.1365-2869.2008.00621.x. [PubMed: 18275554]

McNair, DM., Lorr, M., Dropelman, LF. Profile of Mood States. San Diego: Educational and Testing Service; 1981.

Mroczek DK, Spiro A, Almeida DM. Between- and within-person variation in affect and personality over days and years: How basic and applied approaches can inform one another. Ageing International. 2003; 28:260–278. doi: http://dx.doi.org/10.1007/s12126-002-1007-z.

Munoz E, Sliwinski MJ, Smyth JM, Almeida DM, King HA. Intrusive thoughts mediate the association between neuroticism and cognitive function. Personality and Individual Differences. 2013; 55:898–903. doi: http://dx.doi.org/10.1016/j.paid.2013.07.019. [PubMed: 24683284]

Nolen-Hoeksema S. Responses to depression and their effects on the duration of depressive episodes. Journal of Abnormal Psychology. 1991; 100:569–582. doi: http://dx.doi.org/10.1037/0021-843X.100.4.569. [PubMed: 1757671]

Norlander T, Johansson Å, Bood SÅ. The affective personality: Its relation to quality of sleep, well-being and stress. Social Behavior and Personality. 2005; 33:709–722. doi: http://dx.doi.org/10.2224/sbp.2005.33.7.709.

Pillai V, Steenburg LA, Ciesla JA, Roth T, Drake CL. A seven day actigraphy-based study of rumination and sleep disturbance among young adults with depressive symptoms. Journal of Psychosomatic Research. 2014; 77:70–75. doi: http://dx.doi.org/10.1016/j.jpsychores.2014.05.004. [PubMed: 24913345]

Raudenbush, SW., Bryk, AS. Hierarchical linear models: Applications and data analysis methods. Newbury Park, CA: Sage Publications; 1992.

Reyner LA, Horne JA, Reyner A. Gender- and age-related differences in sleep determined by home-recorded sleep logs and actimetry from 400 adults. Sleep. 1995; 18:127–134. doi: http://dx.doi.org/10.1093/sleep/18.2.127. [PubMed: 7792492]

Sin NL, Almeida DM, Crain TL, Kossek EE, Berkman LF, Buxton OM. Bidirectional, temporal associations of sleep with positive events, affect, and stressors in daily life across a week. Annals of Behavioral Medicine. 2017; 51:402–415. doi: http://dx.doi.org/10.1007/s12160-016-9864-y. [PubMed: 28188584]

Smyth, JM., Heron, KE. Ecological Momentary Assessment [EMA] in family research. In: McHale, S.Amato, P., Booth, A., editors. Emerging methods in family research. New York: Springer; 2014.

Takano K, Tanno Y. Diurnal variation in rumination. Emotion. 2011; 11:1046–1058. doi: http://dx.doi.org/10.1037/a0022757. [PubMed: 21517158]

van de Laar M, Verbeek I, Pevernagie D, Aldenkamp A, Overeem S. The role of personality traits in insomnia. Sleep Medicine Reviews. 2010; 14:61–68. doi: http://dx.doi.org/10.1016/j.smrv.2009.07.007. [PubMed: 19897388]

Vincent N, Cox B, Clara I. Are personality dimensions associated with sleep length in a large nationally representative sample? Comprehensive Psychiatry. 2009; 50:158–163. doi: http://dx.doi.org/10.1016/j.comppsych.2008.07.007. [PubMed: 19216893]

Watkins ER. Constructive and unconstructive repetitive thought. Psychological Bulletin. 2008; 134:163–206. doi: http://dx.doi.org/10.1037/0033-2909.134.2.163. [PubMed: 18298268]

Winzeler K, Voellmin A, Schäfer V, Meyer AH, Cajochen C, Wilhelm FH, Bader K. Daily stress, presleep arousal, and sleep in healthy young women: A daily life computerized sleep diary and actigraphy study. Sleep Medicine. 2014; 15:359–366. doi: http://dx.doi.org/10.1016/j.sleep.2013.09.027. [PubMed: 24503474]

Yu L, Buysse DJ, Germain A, Moul DE, Stover A, Dodds NE, Johnston KL, Pilkonis PA. Development of short forms from the PROMIS™ sleep disturbance and sleep-related impairment item banks. Behavioral Sleep Medicine. 2012; 10:624. doi: http://dx.doi.org/10.1080/15402002.2012.636266.

Zawadzki MJ, Graham JE, Gerin W. Rumination and anxiety mediate the effect of loneliness on depressed mood and sleep quality in college students. Health Psychology. 2013; 32:212–222. doi: http://dx.doi.org/10.1037/a0029007. [PubMed: 22823068]

Zawadzki MJ, Smyth JM, Sliwinski MJ, Ruiz JM, Gerin W. Revisiting the lack of association between affect and physiology: Contrasting between-person and within-person analyses. Health Psychology. 2017; 36:811–818. doi: http://dx.doi.org/10.1037/hea0000466. [PubMed: 28277697]

Highlights

- Examines neuroticism, psychological processes, and sleep in daily life
- Uses repeated measures, ecological design in a diverse sample of adults
- Identifies both daily- and individual-level risk factors for poor sleep

Table 1

Variance at Each Level of Analysis for Rumination, Negative Affect, Sleep Quality, and Difficulty Falling Asleep

	Between-person variance	Within-person variance	% of variance between-person	% of variance within-person
Rumination	430.86 (41.08)***	254.18 (7.42)***	62.90%	37.10%
Negative affect	290.70 (28.78)***	234.34 (6.83)***	55.37%	44.63%
Sleep quality	355.45 (35.65)***	399.85 (11.07)***	47.06%	52.94%
Difficulty falling asleep	339.73 (35.99)***	645.87 (17.88)***	34.47%	65.53%

Notes.

*** $p < 001$.

$N_{persons} = 242$, $N_{\text{person-days}} = 2977$.

Table 2

Means (*SD*), Frequencies (%), and Bivariate Correlations

	M (SD) or n (%)	Age	Income	Gender	Rumination	Negative affect	Sleep quality	Difficulty falling asleep
Neuroticism	60.25 (15.12)	−0.01	−0.12	0.06	0.43***	0.36***	−0.20**	0.23***
Age	46.81 (10.86)	1	−0.04	−0.02	−0.09	−0.08	0.09	−0.06
Income	n = 115 (51.8%) > $40,000/year		1	−0.003	−0.12†	−0.07	0.16*	−0.19**
Gender	n = 161 (66.53%) female			1	0.04	0.01	−0.05	0.07
Rumination	42.37 (21.38)				1	0.73***	−0.33***	0.38***
Negative affect	26.51 (17.74)				0.53***	1	−0.38***	0.45***
Sleep quality	61.94 (19.80)				−0.06**	−0.07***	1	−0.56***
Difficulty falling asleep	31.16 (19.80)				0.07***	0.08***	−0.40***	1

Notes.

† $p < .07$.

* $p < .05$.

** $p < .01$

*** $p < .001$.

$N_{persons}$ = 242, $N_{\text{person-days}}$ = 2977; the top diagonal represents between-person correlations (i.e., daily measures aggregated across the 14-days) and the bottom diagonal represents within-person correlations (i.e., person-mean centered variables), when applicable.

Table 3

Effect Estimates (*SE*) of Neuroticism, Daily Rumination, and Daily Negative Affect on Sleep Quality and Difficulty Falling Asleep

	Sleep quality	Difficulty falling asleep	VIF
Intercept	71.87 (5.26)***	18.20 (5.38)***	–
Neuroticism	−0.07 (0.09)	0.06 (0.09)	1.29
Average rumination	−0.001 (0.09)	0.06 (0.09)	2.60
Average negative affect	−0.43 (0.10)***	0.41 (0.11)***	2.35
Daily rumination	−0.03 (0.04)	0.06 (0.05)	1.38
Daily negative affect	−0.10 (0.04)**	0.11 (0.05)*	1.38
Level 1 residual variance	371.10 (12.23)***	602.34 (20.07)***	–
Level 2 variance in intercept	270.05 (30.18)***	258.29 (31.26)***	–
Level 2 variance in rumination slope	0.05 (0.02)**	0.07 (0.04)*	–
Level 2 variance in negative affect slope	0.01 (0.02)	0.06 (0.04)	–
Level 1 pseudo R^2	0.05	0.02	–
Level 2 pseudo R^2	0.24	0.25	–

Notes.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

$N_{persons}$ = 242, $N_{\text{person-days}}$ = 2977. All analyses control for age, gender, income, weekday vs. weekend (not displayed). VIF = variance inflation factors from SAS PROC REG (VIFs were the same values for both sleep outcomes; therefore only one VIF is displayed per predictor.)

Table 4

Effect Estimates (*SE*) of Neuroticism as a Moderator of the Relationships between Daily Rumination and Negative Affect on Sleep Quality and Difficulty Falling Asleep

	Sleep quality	Difficulty falling asleep	VIF
Intercept	71.84 (5.26)***	18.25 (5.38)***	–
Neuroticism	−0.07 (0.09)	0.06 (0.09)	1.29
Average daily rumination	−0.001 (0.09)	0.05 (0.09)	2.60
Daily rumination	−0.02 (0.04)	0.06 (0.05)	1.42
Average daily negative affect	−0.43 (0.10)***	0.41 (0.11)***	2.35
Daily negative affect	−0.10 (0.04)**	0.13 (0.05)**	1.50
Neuroticism x daily rumination	−0.003 (0.003)	0.002 (0.003)	1.55
Neuroticism x daily negative affect	0.002 (0.002)	−0.005 (0.003)	1.63
Level 1 residual variance	371.12 (12.23)***	601.97 (20.04)***	–
Level 2 variance in intercept	269.88 (30.16)***	257.82 (31.22)***	–
Level 2 variance in rumination slope	0.05 (0.02)**	0.08 (0.04)*	–
Level 2 variance in negative affect slope	0.01 (0.02)	0.06 (0.04)	–
Level 1 pseudo R^2	0.05	0.02	–
Level 2 pseudo R^2	0.24	0.25	–

Notes.

*$p < .05$.

**$p < .01$.

***$p < .001$.

$N_{persons}$ = 242, $N_{person\text{-}days}$ = 2977. All analyses control for age, gender, income, weekday vs. weekend (not displayed). VIF = variance inflation factors from SAS PROC REG (VIFs were the same values for both sleep outcomes; therefore only one VIF is displayed per predictor.)