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# Rumination and Anxiety Mediate the Effect of Loneliness on Depressed Mood and Sleep Quality in College Students

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**Objective:** We examined the mechanisms that underlie the observed relationships between loneliness and depressed mood and poor sleep quality in college students. This study was the first to investigate whether rumination and trait anxiety are psychological mechanisms that mediate this relationship. **Methods:** In Study 1 ( $n = 1,244$ ), using factor analysis with cross-sectional data, we established that loneliness and rumination are distinct constructs. We then collected survey data in two cross-sectional samples ( $n_s = 300$  and  $218$ ) and one prospective ( $n = 334$ ) sample to test whether rumination and anxiety were mediators of the relationship between loneliness and depressed mood and poor sleep quality. Structural equation modeling was used to test the proposed relationships. Participants completed self-report measures of loneliness, rumination, trait anxiety, depressed mood, and sleep quality. In addition, measures of hostility, neuroticism, negative affect, and tobacco use were also assessed and tested as mediators, while social support was assessed and tested as a moderator. **Results:** Consistent across the three studies, we found that rumination and trait anxiety fully mediated the associations between loneliness and depressed mood as well as poor sleep quality; these relationships held after testing all other factors. **Conclusion:** This study helps explain how loneliness dynamics relate to poor health and suggests specific points of departure for the development of interventions.

**Keywords:** anxiety, depressed mood, loneliness, rumination, sleep quality

Loneliness is associated with poor health outcomes, including depressed mood (McGaha & Fitzpatrick, 2005), sleep quality (Cacioppo et al., 2002), heart disease (Sorkin, Rook, & Lu, 2002), and all-cause mortality (Tilvis, Kähönen-Väre, Jolkkonen, Pitkala, & Strandberg, 2004). However, the mechanisms underlying these associations are unclear. In this article, we examine rumination and anxiety as potential psychological mediators of the effect of loneliness on depressed mood and poor sleep quality.

## Loneliness, Depressed Mood, and Poor Sleep Quality

Loneliness is the perception that one is not achieving a desired level of social interaction (Peplau & Perlman, 1982), and is a source of considerable psychological distress (Bell & Daly, 1985). College students report high levels of loneliness (Ernst & Cacioppo, 1999; Wei, Russell, & Zakalik, 2005), which is stable over one's life span (Boomsma, Willemsen, Dolan, Hawkey, & Cacioppo, 2005). Given the linkage between stress and health, it is

unsurprising that loneliness pejoratively affects health, including depressed mood (Wei et al., 2005) and poor sleep quality (Cacioppo et al., 2002).

Both depressed mood and sleep are relevant outcomes to study among college students. Prevalence of depressed mood in college students ranges from 10–25% (e.g., Mackenzie et al., 2011), with many students experiencing their first bout of depression while in college (Mowbray et al., 2006). Depression is related to a variety of poor health outcomes, including mortality (Murberg, Bru, Svebak, Tveteras, & Aarsland, 1999), and has a high rate of relapse (Gopinath, Katon, Russo, & Ludman, 2007). Turning to sleep, as few as 11% of college students meet the criteria for good sleep quality (Jensen, 2003), with problems including trouble falling asleep, insomnia, and waking too early (Buboltz, Brown, & Soper, 2001). Poor sleep increases the use of health care services and the chance for injury, illness, and mortality (Krueger & Friedman, 2009). Finally, sleep problems early in life set the stage for reoccurrence of existing health issues and the emergence of chronic health problems (Worthman & Brown, 2007).

The reasons for the associations of loneliness with depressed mood and poor sleep quality are not well known. Researchers have found that lonely individuals engage in more risk-related behaviors (Cacioppo & Hawkey, 2003), including smoking (Lauder, Mummery, Jones, & Caperchione, 2006). These habits then result in greater health complications, such as poor cardiovascular function and poor sleep. However, these effects are cumulative over time; indeed, the wear-and-tear effects of loneliness on health have been likened to general effects of aging (Hawkey & Cacioppo, 2007). Thus, a behavioral model may be of limited utility in explaining more immediate health effects of loneliness.

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Another possibility is that lonely individuals have negative cognitive and emotional self-regulatory strategies, especially with hostile thoughts. Cacioppo and Patrick (2008) suggest that lonely individuals enter a downward spiral of negative thoughts and behaviors that can become “dramatically corrosive” (p. 14). These thoughts lead to trusting others less (Wittenberg & Reis, 1986), and may explain why lonely individuals score higher on measures of trait hostility than nonlonely individuals (Ernst & Cacioppo, 1999). In turn, hostility is related to both depressed mood (Doering, Moser, & Dracup, 2000) and poor sleep quality (Brissette & Cohen, 2002); however, the mechanisms explaining these linkages are unclear. For example, it is not apparent how mistrust in others would lead to an overall self-evaluation of worthlessness, which is a central characteristic of depression (Cacioppo et al., 2006). We suggest that associations between loneliness, depression, and sleep are due more specifically to individual differences in tendencies to engage in persistently negative thoughts (i.e., rumination) and experience anxiety.

### Rumination and Anxiety as Mediators

Rumination is defined as thoughts and behaviors that focus a person’s attention on negative moods, the causes and consequences of those moods, and self-evaluations related to them (Nolen-Hoeksema & Morrow, 1991). Anxiety is conceptualized as an emotional state that includes apprehension, nervousness, and worry, along with physiological arousal (Spielberger & Sydeman, 1994). We hypothesize that: (1) Loneliness influences the extent to which (a) one’s attention is focused on negative thoughts resulting from past provocations and stressors, and (b) one experiences anxiety; (2) rumination and anxiety covary; and (3) this attentional-affective bias toward rumination and anxiety affects depressed mood and sleep quality.

We suggest that rumination and anxiety create a reciprocally determinative cycle in which each tends to promote and prolong the other. Such a model assumes that the stress experience does not end when the stressful situation ends, but can continue on in one’s thoughts and affect. Thus, it is not only the exposure to the stressor itself, but exposure to the recurring representation of that event in the individual’s mind that is responsible for loneliness’ effects on depressed mood and sleep. This mental representation has been shown to affect cardiovascular recovery as much as the original stressor (Gerin, Davidson, Christenfeld, Goyal, & Schwartz, 2006). Increased physiological activation because of rumination and anxiety could prevent sleep. Furthermore, the continued reliving of perceived isolation and other stressors may result in the belief that one’s needs cannot be met, fostering feelings of worthlessness and depressed mood.

Previous work has tested several aspects of the proposed model. Loneliness correlates with anxiety (Heinrich & Gullone, 2006). While the relationship between loneliness and rumination has not been tested, it has been hinted at in prior work. For example, individuals ruminate more when they feel unhappy (McIntosh & Martin, 1992) and anxious (Nolen-Hoeksema, 2000). Rumination has been linked to depression (Nolen-Hoeksema & Morrow, 1991) and poor sleep quality (Guastella & Molds, 2007). Anxiety is a well-known component of depression (Thapar, Kerr, & Harold, 2009) and has been associated with poor sleep quality (Kecklund & Akerstedt, 2004). However, neither rumination nor anxiety have

been previously tested as mediators of the relationship of loneliness to depressed mood and sleep quality.

### The Present Research

We examine whether rumination and anxiety mediate the effect of loneliness on depressed mood and sleep quality across four independent samples of college students, using both cross-sectional and longitudinal designs. Furthermore, we test whether smoking behaviors (Studies 2 and 3), hostility (Studies 2 and 3), neuroticism (Study 2), and negative affect (Study 3) function as core explanatory factors (alternative models), and whether social support (Studies 3 and 4) moderates the observed effects. It is important to note that we examine statistical mediation, but do not have the means to test causality in the present research. The overall purpose of the present research is to understand what variables are implicated in the links between loneliness, depression, and poor sleep quality and to suggest how they may function. It is possible that some of the proposed relationships described herein are bidirectional.

### Study 1

Study 1 was conducted to measure the previous untested association between loneliness and rumination, and to examine whether loneliness and rumination represent distinct constructs.

### Method

**Participants.** As part of a larger study, 1,244 undergraduates (705 women, 529 men, 10 unidentified) from an introduction to psychology subject pool responded to a series of questionnaires in exchange for course credit.

**Materials and procedure.** Participants filled out the following questionnaires online. (1) The Ruminative Response Scale (RRS; 22 items), which is a subscale of the Response Styles Questionnaire (Nolen-Hoeksema & Morrow, 1991), measures ruminative coping responses to negative mood. (2) The UCLA Loneliness Scale (ULS; 20 items) measures the frequency and intensity of aspects of the lonely experience (Russell, 1996). Participants responded to both scales using a 1 (*never*) to 4 (*always*) Likert-type scale. Composite scores were computed by averaging the items of each scale after reverse coding when appropriate, such that higher numbers indicate greater rumination ( $\alpha = .95$ ) and loneliness ( $\alpha = .93$ ).

### Results

Rumination and loneliness were strongly correlated,  $r(1231) = .65, p < .001$ . Because of this moderate to high correlation, we tested whether rumination and loneliness were unique constructs by performing a principal axis factor analysis on the RRS and ULS items, using a promax rotation to allow for correlations between the factors (a varimax rotation produced similar results). A three-factor solution emerged, as determined by eigenvalues greater than 1, accounting for 50.93% of the variance (Factor 1: Eigenvalue = 16.26, 38.72%; Factor 2: Eigenvalue = 3.78, 8.99%; Factor 3: Eigenvalue = 1.35, 3.21%). Factor 1 comprised 19 of the 22 items from the RRS (the three remaining items failed to have a factor loading of .4 or higher on any factor), with loadings ranging from

.40 to .87. Factors 2 and 3 comprised the 20 items from the ULS, with the 11 negatively valenced items clustered in Factor 2 having loadings of .47 to .77, and the 9 positively valenced items clustered in Factor 3 having loadings of .58 to .81. Further supporting a three factor structure, no item on a factor had a cross-loading on another factor of greater than .15. Looking at the correlation between the factors, Factor 1 (the RRS factor) was correlated highly with Factors 2 and 3 (the ULS factors) ( $r = .76, p < .001$  and  $r = -.41, p < .001$ , respectively); Factors 2 and 3 were also correlated ( $r = -.61, p < .001$ ). In summary, while rumination and loneliness are related, they also represent distinct constructs.

## Study 2

Study 2 tests the roles of rumination and anxiety as mediators of the association between loneliness and depressed mood. In addition, we examine whether including smoking, hostility, or neuroticism as mediators adds to the variance accounted for in depressed mood. As discussed earlier, the effects of smoking behaviors (Lauder et al., 2006) and hostility (Ernst & Cacioppo, 1999) on loneliness may be best understood cumulatively over the course of one's life; however, the relationships between smoking and negative health outcomes appear to emerge in young adulthood and have been observed in college students for both depressed mood (Morrell, Cohen, & McChargue, 2010) and poor sleep quality (Phillips & Danner, 1995).

## Method

**Participants.** In exchange for course credit, an independent sample of 300 undergraduates from introductory biobehavioral health classes participated in the study ( $M_{\text{age}} = 20.3$  years; 216 women, 84 men).

**Materials and procedure.** Participants completed all study materials online. As with Study 1, participants completed the ULS ( $\alpha = .93$ ) and the RRS ( $\alpha = .95$ ). In addition, as part of a larger study, they completed five other questionnaires. (1) The Spielberger Trait Anxiety Scale (STAS; 20-items) measures the frequency with which respondents generally feel symptoms of anxiety (Spielberger, Gorsuch, & Lushene, 1970). (2) Smoking behavior was assessed using two questions that asked participants how many cigarettes they smoke in a typical day (none; 1–2; 3 to 4; 5 to 10; 11 to 20; and more than 20) and how long they have been smoking (not smoking; less than a year; 1 to 2 years; 3 to 5 years; and more than 5 years). Because the two questions had different scales, scores were standardized before combining. (3) The Cook-Medley Hostility Scale (CMHS; 50-items) measures the cognitive, affective, and behavioral elements associated with hostility (Cook & Medley, 1954). (4) The Beck Depression Inventory (BDI-II; 20-items) measures depressed mood (Beck, Steer, Ball, & Ranieri, 1996). We omitted the item asking about harming oneself or others. (5) The neuroticism subscale of the Big Five Inventory (8-items) measures the tendency to experience negative emotions (John & Srivastava, 1992). Participants responded to the BDI and STAS using a 1 (*Not feeling this way/Not at all*) to 4 (*A lot feeling this way/Very much*) Likert-type scale; to the CMHS using a 1 = True and 2 = False scale; and to the Neuroticism subscale using a 1 (*Disagree strongly*) to 5 (*Agree strongly*) Likert-type scale. Composite scores were computed by averaging the items of each

scale after reverse coding when appropriate so that higher numbers indicated greater trait anxiety ( $\alpha = .93$ ), smoking ( $\alpha = .93$ ), hostility ( $\alpha = .89$ ), depressed mood ( $\alpha = .91$ ), and neuroticism ( $\alpha = .82$ ).

## Results

Table 1 shows that across studies 2–4 approximately a third of participants reported at least mild depression, while over half of participants reported significant sleep problems.

**Rumination and trait anxiety as mediators.** Using structural equation modeling (SEM), we tested our base model positing rumination and anxiety as mediators of the association between loneliness and depressed mood. We entered loneliness as a predictor of rumination and anxiety, allowed these two putative mediators to covary, and tested the effects of rumination and anxiety on depressed mood. AMOS 18.0 was used for all modeling procedures (Arbuckle, 2009).

Our model was an excellent fit to the data, and accounted for 54% of the variance in depressed mood (Table 2, Model A). (1) Loneliness predicted rumination and anxiety. (2) Rumination covaried with trait anxiety, and (3) rumination and trait anxiety predicted depressed mood. Finally, the direct path between loneliness and depressed mood ( $\beta = .56, p < .001$ ) was reduced to nonsignificance when rumination and anxiety were included ( $\beta = .09, p > .10$ ).

**The role of smoking and hostility.** In bivariate analyses, hostility was related to depressed mood ( $r = .43, p < .001$ ), but smoking was not ( $r = .06, p > .28$ ). We modeled smoking and hostility as mediating the relationship between loneliness and depressed mood along with rumination and anxiety, allowing hostility to covary with rumination and anxiety (Table 2, Model B). This model fit the data well, but explained the same amount of variance in depressed mood (54%) as the base model. Smoking was unrelated to all variables. Loneliness was related to hostility, and hostility covaried with rumination and anxiety, but hostility was unrelated to depressed mood. Both rumination and anxiety remained highly predictive of depressed mood.

**Ruling out neuroticism.** In a bivariate analysis, neuroticism was related to depressed mood ( $r = .52, p < .001$ ). We modeled neuroticism as mediating the relationship between loneliness and depressed mood along with rumination, anxiety, smoking, and hostility. We allowed neuroticism to covary with rumination, anxiety, and hostility (Table 2, Model C). Again the model was a strong fit, but explained the same amount of variance in depressed mood (54%) as the base model. Loneliness was related to neuroticism, and neuroticism covaried with rumination, anxiety, and hostility, but neuroticism was unrelated to depressed mood. Both rumination and anxiety remained highly predictive of depressed mood.

## Discussion

Study 2 demonstrated that not only are loneliness and rumination highly related, but that rumination and trait anxiety mediate the effect of loneliness on depressed mood. Notably, rumination and anxiety covaried strongly, yet each still uniquely predicted depressed mood. These results held even when including other possible mechanisms (i.e., smoking, hostility, and neuroticism), as

Table 1  
 Descriptive Statistics for the Variables Tested in Studies 2 Through 4, and Percentages of Participants Suffering From Depression and Sleep Problems

	Study 2	Study 3	Study 4	
			Time 1	Time 2
<b>Outcome variables</b>				
Depression				
Mean ( <i>SD</i> )	1.46 (0.40)	1.39 (0.37)	1.45 (0.48)	1.41 (0.41)
% mild depression	20.3%	16.1%	21.0%	15.0%
% moderate depression	11.7%	11.0%	10.5%	12.0%
% severe depression	3.7%	2.3%	3.6%	4.2%
Poor sleep quality				
Mean ( <i>SD</i> )	—	5.08 (2.68)	5.51 (3.10)	5.40 (3.05)
% with sleep problems	—	53.7%	56.6%	56.6%
<b>Predictor variables</b>				
Loneliness				
Mean ( <i>SD</i> )	1.87 (0.48)	1.81 (0.47)	1.89 (0.49)	1.90 (0.51)
Rumination				
Mean ( <i>SD</i> )	1.81 (0.55)	1.73 (0.52)	1.81 (0.54)	1.79 (0.52)
Anxiety				
Mean ( <i>SD</i> )	1.95 (0.56)	1.93 (0.52)	2.00 (0.55)	2.01 (0.56)
<b>Other mechanisms tested as mediators</b>				
Social Support				
Mean ( <i>SD</i> )	—	1.22 (0.16)	1.23 (0.16)	1.23 (0.17)
Hostility				
Mean ( <i>SD</i> )	1.44 (0.19)	1.40 (0.18)	—	—
Smoking				
% smoke everyday	10.6%	10.1%	—	—

Note. Depression classifications based on criteria outlined by Beck et al. (1996). Sleep problems classifications based on Buysse et al. (1989).

inclusion of these variables in the model did not explain any additional variance in depressed mood over and above rumination and anxiety.

### Study 3

Having established that rumination and anxiety mediated the relationship between loneliness and depressed mood, we conducted the next study to examine the following: (1) What role does social support, a factor suggested to buffer the negative effects of a stressor in general (Cohen & Wills, 1985), and to rumination specifically (Puterman, DeLongis, & Pomaki, 2010), play in this process? (2) Are the effects we observed in Study 2 specific to depressed mood or do they apply to other negative health outcomes (i.e., poor sleep quality)? (3) Are these results simply because of a participant's negative affect influencing their responses to the questionnaires? We predicted that even after examining social support as a moderator, rumination and anxiety would continue to mediate the relationship between loneliness and depressed mood for both low and high social support groups, that this effect would extend to poor sleep quality, and that these effects would hold even when negative affect is included as a mediator in the model.

### Method

**Participants.** In exchange for course credit, an independent sample of 218 undergraduates from introductory biobehavioral

health classes and an introduction to psychology class subject pool participated in the study ( $M_{\text{age}} = 20.3$  years; 165 women, 53 men).

**Materials and procedure.** Participants completed all study materials online. Similar to Study 2, participants completed the ULS ( $\alpha = .93$ ), RRS ( $\alpha = .95$ ), STAS ( $\alpha = .93$ ), CMHS ( $\alpha = .91$ ), two smoking questions ( $\alpha = .92$ ), and BDI ( $\alpha = .91$ ). Participants completed three additional questionnaires. (1) The Interpersonal Support Evaluation List (ISEL; 48-items) measures the perceived amount and quality of social support (Cohen, Mermelstein, Kamarck, & Hoberman, 1985). Participants responded to the ISEL using a 1 = True and 2 = False scale. (2) The Pittsburgh Sleep Quality Index (PSQI) measures sleep quality by providing an overall score rating the quality of an individual's sleep (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). (3) To measure negative affect, participants rated the extent to which they felt 22 negative mood terms (e.g., nervous, guilty, tired, angry, sad) using a 1 (*Not at all*) to 5 (*Extremely*) Likert-type scale. Scores were averaged together or totaled such that higher numbers indicated more social support ( $\alpha = .91$ ), poorer sleep quality (scores combined using the instructions outlined by Buysse et al., 1989), and greater negative affect ( $\alpha = .96$ ).

### Results

For ease of interpretation, we examine depressed mood and poor sleep in separate models; mood and sleep were correlated ( $r = .51$ ,  $p < .001$ ), and combining outcomes into a single model produced a similar pattern of results.



Table 2  
Structural Equation Models Testing Rumination, Anxiety, and Other Mechanisms as Mediators of the Relationship Between Loneliness and Depression in Study 2

	Model A	Model B	Model C
Loneliness predicting the mediators			
Rumination	.65***	.65***	.65***
Anxiety	.64***	.64***	.64***
Smoking	—	.06—	.06—
Hostility	—	.41***	.41***
Neuroticism	—	—	.46***
The mediators predicting depression			
Rumination	.42***	.40***	.39***
Anxiety	.38***	.36***	.31***
Smoking	—	.01—	.01—
Hostility	—	.06—	.07—
Neuroticism	—	—	.08—
$\chi^2, df$	2.65, 1	2.40, 4	7.30, 5
<i>p</i> -value	>.10	>.12	>.19
CFI	.997	.996	.998
NFI	.996	.990	.992
RMR	.003	.01	.01
RMSEA	.07	.05	.04
C.I. RMSEA	.00 to .19	.00 to .11	.00 to .10

Note. Model A tests the base model that rumination and anxiety mediate the relationship between loneliness and depression (rumination covaries with anxiety,  $\beta = .51, p < .001$ ). Model B adds smoking and hostility to the base model as mediators of the effect of loneliness on depression (hostility covaries with rumination,  $\beta = .34, p < .001$ , and anxiety,  $\beta = .36, p < .001$ ). Model C adds neuroticism to the Model B as a mediator of the effect of loneliness on depression (neuroticism covaries with rumination,  $\beta = .33, p < .001$ , anxiety,  $\beta = .58, p < .001$ , and hostility,  $\beta = .12, p < .05$ ).

\*\*\*  $p < .001$ .

**Rumination and trait anxiety as mediators.** We replicated and extended the results from Study 2, as the base model was a strong fit to the data and accounted for 57% of the variance in depressed mood (Table 3, Model A) and 25% of the variance in poor sleep quality (Table 4, Model A). Specifically, in both the depressed mood and sleep quality models, (1) loneliness predicted rumination and trait anxiety, (2) rumination covaried with trait anxiety, and (3) rumination and trait anxiety predicted depressed mood and sleep quality. Finally, the direct paths between loneliness and depressed mood ( $\beta = .54, p < .001$ ) and loneliness and poor sleep quality ( $\beta = .39, p < .001$ ) were reduced to nonsignificance ( $\beta$ s = .07 and .09,  $ps > .27$  and .23, respectively) when rumination and anxiety were included as mediators.

**The role of smoking and hostility.** In bivariate analyses, hostility was related to depressed mood and poor sleep quality ( $rs = .27$  and  $.39$ , respectively,  $ps < .001$ ), but smoking was unrelated to both ( $rs = .05$  and  $-.04$ , respectively,  $ps > .49$ ). We modeled smoking and hostility as mediating the relationship between loneliness and depressed mood (Table 3, Model B) and poor sleep quality (Table 4, Model B) along with rumination and anxiety, allowing hostility to covary with rumination and anxiety. The expanded models were strong fits to the data, but explained the same amount of variance in depressed mood (57%) and poor sleep quality (25%) as the base model. Smoking was again unrelated to all variables. Loneliness was related to hostility, and hostility covaried with rumination and anxiety, but hostility was

unrelated to depressed mood and poor sleep quality. Rumination and anxiety remained highly predictive of depressed mood and poor sleep quality.

**Ruling out negative affect.** In bivariate analyses, negative affect was related to depressed mood and poor sleep quality ( $rs = .39$  and  $.37$ , respectively,  $ps < .001$ ). We modeled negative affect as mediating the association between loneliness and depressed mood (Table 3, Model C) and poor sleep quality (Table 4, Model C) along with rumination and anxiety, and covaried negative affect with rumination, anxiety, and hostility. Once again this expanded model was a strong fit to the data, but still explained roughly the same amount of variance in depressed mood (57%) and poor sleep quality (27%) as the base model. Loneliness was related to negative affect and social support, and negative affect covaried with rumination, anxiety, and hostility. Negative affect was unrelated to depressed mood, but predicted poor sleep quality. Rumination and anxiety remained as significant predictors of depressed mood and sleep quality.

**Social support as a moderator.** In bivariate analyses, social support was related to depressed mood and poor sleep quality ( $rs = -.45$  and  $-.22$ , respectively,  $ps < .001$ ). Thus, we tested the idea that social support would serve as a buffer or moderator for the observed effects above (Cohen & Wills, 1985). We used a median split to create high and low social support groups, and then performed a multiple groups SEM testing whether the pathways from the full model (Model C) differed for individuals for high and low social support. Both models fit the data well. For depressed mood (Table 3, Model D), rumination and anxiety remained significant predictors regardless of level of social support, with the model explaining roughly the same amount of variance for low (52%) and high (49%) support groups. For sleep quality (Table 4, Model D), while the effect of anxiety remained significant regardless of level of social support, rumination only predicted sleep quality for the low support group, and more of the variance in sleep quality was explained for low social support (31%) than high support (19%).

## Discussion

Study 3 extended Study 2 by showing that rumination and anxiety mediated the effect of loneliness on depressed mood and poor sleep quality. Again rumination and anxiety covaried strongly, yet each uniquely predicted depressed mood and sleep quality. These results held even when cigarette smoking, hostility, and negative affect were included as mediators; as a result, we dropped these variables in the next study. Treating social support as a moderator showed a mixed relationship. The results did not vary between individuals with low and high support for depression, nor did social support influence the effect of anxiety or sleep quality. Social support did moderate the effect of rumination on sleep quality in that rumination was related to poor sleep quality only among participants with low social support. This result makes sense if we consider social support to be a form of distraction, stopping a person from continued rumination and allowing that person to relax enough to fall asleep (Guastella & Molds, 2007).

## Study 4

Study 4 examined the role of rumination and anxiety as mediators of the association between loneliness and depressed mood

Table 3  
Structural Equation Models Testing Rumination, Anxiety, and Other Mechanisms as Mediators of the Relationship Between Loneliness and Depression in Study 3

	Model A	Model B	Model C	Model D	
				High support	Low support
Loneliness predicting the mediators					
Rumination	.61***	.61***	.61***	.58***	.40***
Anxiety	.64***	.64***	.64***	.61***	.31**
Smoking	—	-.02—	-.02—	-.08	.09—
Hostility	—	.47***	.47***	.35***	.36***
Negative Affect	—	—	.33***	.28**	.14
The mediators predicting depression					
Rumination	.29***	.31***	.31***	.22**	.41***
Anxiety	.51***	.53***	.53***	.43***	.50***
Smoking	—	.03—	.03—	.01—	.09—
Hostility	—	-.07—	-.07—	.09—	-.19*
Negative Affect	—	—	.01—	.12—	-.09—
$\chi^2, df$	1.21, 1	2.65, 4	2.70, 5	10.67, 10	
<i>p</i> -value	>.27	>.62	>.74	>.38	
CFI	1.00	.996	1.00	.999	
NFI	.998	.990	.996	.979	
RMR	.002	.01	.01	.02	
RMSEA	.03	.05	.00	.02	
C.I. RMSEA	.00 to .19	.00 to .11	.00 to .07	.00 to .08	

Note. Model A is the base model with rumination and anxiety mediating the relationship between loneliness and depression (rumination covaries with anxiety,  $\beta = .60, p < .001$ ). Model B adds smoking and hostility to the base model as mediators of the effect of loneliness on depression (hostility covaries with rumination,  $\beta = .36, p < .001$ , and anxiety,  $\beta = .36, p < .001$ ). Model C adds negative affect to Model B as a mediator of the effect of loneliness on depression (negative affect covaries with rumination,  $\beta = .41, p < .001$ , anxiety,  $\beta = .38, p < .001$ , and hostility,  $\beta = .29, p < .001$ ). Model D adds social support as a multiple groups analysis, examining the pathways from Model C for participants with low and high social support.

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

and poor sleep quality prospectively over a 3-month period; social support was again examined as a moderator of these relationships. We strategically sampled students at two time points: first, a few weeks after the beginning of an academic semester when they had a chance to begin to acclimate to their new environments, and second, during finals week, a time often associated with high academic stress for some students. Overall, the college experience is perceived as stressful, with many college students reporting becoming overwhelmed with school issues (Buboltz et al., 2001) and reporting poor emotional health (Pryor, Hurtado, DeAngelo, Blake, & Tran, 2010). Taking into account that students vary considerably in the extent to which they can keep emotions under control and maintain confidence in themselves (Fischer, 2007), we predicted that the rates of depressed mood and sleep quality would not necessarily worsen but would vary significantly across our two measurement points. Thus, Study 4 allowed us to replicate our prior findings, and to test the hypothesis that students would have more depressed mood and poorer sleep if they reported increases in trait tendencies to ruminate or experience anxiety over the course of the semester.

## Method

**Participants.** In exchange for course credit, an independent sample of 360 undergraduates from introductory and advanced biobehavioral health classes participated in the Time 1 data collection ( $M_{\text{age}} = 21.2$ ; 275 women, 85 men), and 340 people returned for Time 2 ( $M_{\text{age}} = 20.9$ ; 262 women, 72 men) for a 94.4% response rate. An additional six participants had significant

amounts of missing data. All data analyses were conducted only with participants who completed both Time 1 and 2 data ( $n = 334$ ;  $M_{\text{age}} = 21.2$ ; 258 women, 76 men).

**Materials and procedure.** Participants completed all study materials online. As they did in Study 3, participants at both time points completed the ULS ( $\alpha = .94$ ), RRS ( $\alpha = .94$ ), STAS ( $\alpha = .93$ ), ISEL ( $\alpha = .89$  and  $.91$ ), BDI ( $\alpha = .91$  and  $.93$ ), and PSQI.

## Results

Although the means and percentages in Table 1 suggest some stability across the two time points, as we expected, rates of depressed mood and poor sleep quality greatly varied across the semester. Looking at depressed mood, 36.5% of participants' depression scores worsened, while 50.9% improved. Furthermore, 14.5% of participants' had developed a more severe form of depression at Time 2 (e.g., the participant went from mild to moderate depression), while 15.7% had a less severe depression categorization. Looking at sleep, 37.1% of participants' sleep scores worsened, while 41.4% improved. Furthermore, 11.7% of participants' developed poor sleep quality, while 11.7% no longer had sleep problems.

As with Study 3, we present depressed mood and poor sleep quality in separate models; depressed mood and sleep were correlated at both time points ( $r_s = .53$  and  $.57, p_s < .001$ ), and produced a similar pattern of results when included in a single model.

Table 4

*Structural Equation Models Testing Rumination, Anxiety, and Other Mechanisms as Mediators of the Relationship Between Loneliness and Poor Sleep Quality in Study 3*

	Model A	Model B	Model C	Model D	
				High support	Low support
Loneliness predicting the mediators					
Rumination	.61***	.61***	.61***	.58***	.40***
Anxiety	.64***	.64***	.64***	.61***	.31**
Smoking	—	-.02—	-.02—	-.08—	.09—
Hostility	—	.47***	.47***	.35***	.36***
Negative Affect	—	—	.33***	.28**	.14
The mediators predicting poor sleep quality					
Rumination	.24***	.25***	.20*	.07	.30*
Anxiety	.29***	.31***	.28**	.33**	.23*
Smoking	—	-.05—	-.05—	-.07—	-.03—
Hostility	—	-.03—	-.05—	-.02—	-.08—
Negative Affect	—	—	.15*	.10—	.18†—
$\chi^2, df$	1.41, 1	2.38, 4	2.73, 5	11.92, 10	
<i>p</i> -value	>.22	>.66	>.74	>.29	
CFI	.999	1.00	1.00	.995	
NFI	.996	.995	.995	.971	
RMR	.02	.02	.02	.03	
RMSEA	.04	.00	.00	.03	
C.I. RMSEA	.00 to .19	.00 to .08	.00 to .07	.00 to .08	

*Note.* Model A is the base model with rumination and anxiety mediating the relationship between loneliness and poor sleep quality (rumination covaries with anxiety,  $\beta = .60, p < .001$ ). Model B adds smoking and hostility to the base model as mediators of the effect of loneliness on poor sleep quality (hostility covaries with rumination,  $\beta = .36, p < .001$ , and anxiety,  $\beta = .36, p < .001$ ). Model C adds negative affect to Model B as a mediator of the effect of loneliness on poor sleep quality (negative affect covaries with rumination,  $\beta = .41, p < .001$ , anxiety,  $\beta = .38, p < .001$ , and hostility,  $\beta = .29, p < .001$ ). Model D adds social support as a multiple groups analysis, examining the pathways from Model C for participants with low and high social support.

†  $p < .10$ . \*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

**Rumination and trait anxiety as mediators.** We first included rumination and anxiety (the base model) as mediators of the relationship of loneliness with depressed mood and poor sleep quality at both time points. At Time 1, loneliness predicted rumination ( $\beta = .62, p < .001$ ) and anxiety ( $\beta = .62, p < .001$ ), which covaried with each other ( $\beta = .50, p < .001$ ). In turn, for depression, rumination ( $\beta = .31, p < .001$ ) and anxiety ( $\beta = .57, p < .001$ ) were significant predictors, with a good fitting model that explained 68% of the variance in depression,  $\chi^2(1) = 0.05, p > .82$ ; CFI = 1.00; NFI = 1.00; RMR = .000; RMSEA = .00; C.I. RMSEA = .00 to .09. In addition, for poor sleep quality, rumination ( $\beta = .21, p < .01$ ) and anxiety ( $\beta = .33, p < .001$ ) were significant, with a good fitting model explaining 25% of the variance in sleep,  $\chi^2(1) = 1.12, p > .28$ ; CFI = 1.00; NFI = .998; RMR = .017; RMSEA = .02; C.I. RMSEA = .00 to .15.

At Time 2, loneliness predicted rumination ( $\beta = .64, p < .001$ ) and anxiety ( $\beta = .74, p < .001$ ), which covaried with each other ( $\beta = .48, p < .001$ ). In turn, for depression, rumination ( $\beta = .28, p < .001$ ) and anxiety ( $\beta = .55, p < .001$ ) were significant predictors, with an acceptable fitting model that explained 60% of the variance in depression,  $\chi^2(1) = 3.35, p > .06$ ; CFI = .997; NFI = .996; RMR = .003; RMSEA = .08; C.I. RMSEA = .00 to .19. In addition, for poor sleep quality, while rumination ( $\beta = .10, p = .148$ ) was not related, anxiety ( $\beta = .42, p < .001$ ) was significant, with a good fitting model explaining 24% of the variance in sleep,  $\chi^2(1) = 1.79, p > .18$ ; CFI = .999; NFI = .997; RMR = .020; RMSEA = .05; C.I. RMSEA = .00 to .16.

**Base change model.** We then calculated change scores for each of the variables from Times 1 and 2, and tested the base model as described above. For depressed mood (Figure 1, Panel A), the change in loneliness predicted the change in rumination and anxiety. The changes in these variables then predicted the changes in depressed mood. The model was a strong fit and explained 26% of the variance of the change in depressed mood,  $\chi^2(1) = 0.98, p > .32$ ; CFI = 1.00; NFI = .996; RMR = .001; RMSEA = .00; C.I. RMSEA = .00 to .14). For poor sleep quality (Figure 2, Panel A), only the change in anxiety predicted the change in sleep quality. The model explained 7% of the variance of the change in poor sleep quality ( $\chi^2(1) = 0.85, p > .35$ ; CFI = 1.00; NFI = .995; RMR = .010; RMSEA = .00; C.I. RMSEA = .00 to .14).

**Social support as a moderator.** We created a median split of the change score of social support to use a multiple groups SEM to test whether increases in high and low social support moderated the effects observed in the base change model. For depression, similar to Study 3, rumination and anxiety remained significant predictors regardless of whether the participant had low (Figure 1, Panel B) or high (Figure 1, Panel C) social support. The model was a good fit, explaining 29% of the variance for low social support groups, and 18% for high support,  $\chi^2(2) = 0.73, p > .69$ ; CFI = 1.00; NFI = .996; RMR = .001; RMSEA = .00; C.I. RMSEA = .00 to .08.

For sleep quality, similar to Study 3, while the effect of anxiety remained significant regardless of level of social support, rumina-



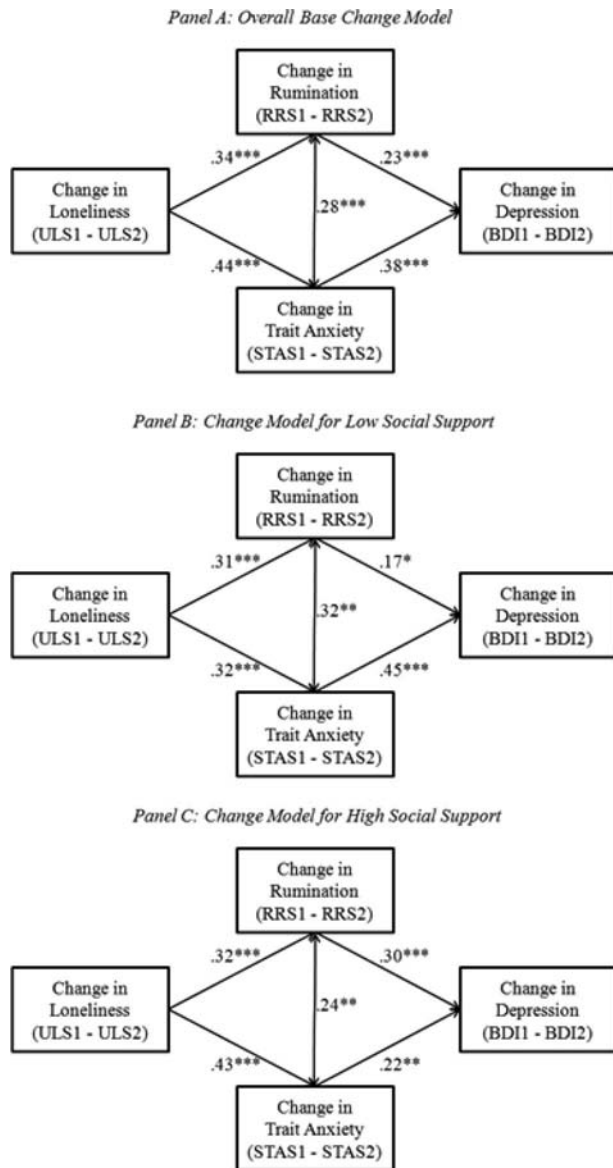


Figure 1. Structural equation models testing rumination and anxiety as mediators of the relationship between loneliness and depression over time in Study 4, with social support as the moderator of this relationship. \*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

tion trended to predict poor sleep quality for the low (Figure 2, Panel B) but not for the high social support group (Figure 2, Panel C). The model was a good fit, explaining 8% of the variance for low support groups, and 6% for high support,  $\chi^2(2) = 0.93$ ,  $p > .62$ ; CFI = 1.00; NFI = .993; RMR = .010; RMSEA = .00; C.I. RMSEA = .00 to .09.

### General Discussion

Although the connection between loneliness and rumination has been suggested by previous research, this is the first study to explicitly show this relationship. Across multiple studies we found that greater loneliness was associated strongly with higher rumi-

nation, and that this tendency toward rumination accounted for the effect of loneliness on both depressed mood and poor sleep quality. Considering the (1) strong correlations demonstrated in all studies ( $r_s = .61-.65$ ) across over 2,100 participants, (2) the results of Study 1 delineating loneliness as a distinct construct from rumination, and (3) the prospective results from Study 4 showing that changes in loneliness were related to changes in rumination, the present research demonstrates that rumination is an important mechanism underlying the relationship between loneliness and negative health outcomes. This suggests that rumination may be an important target for intervention strategies to reduce depressed mood and poor sleep in lonely individuals.

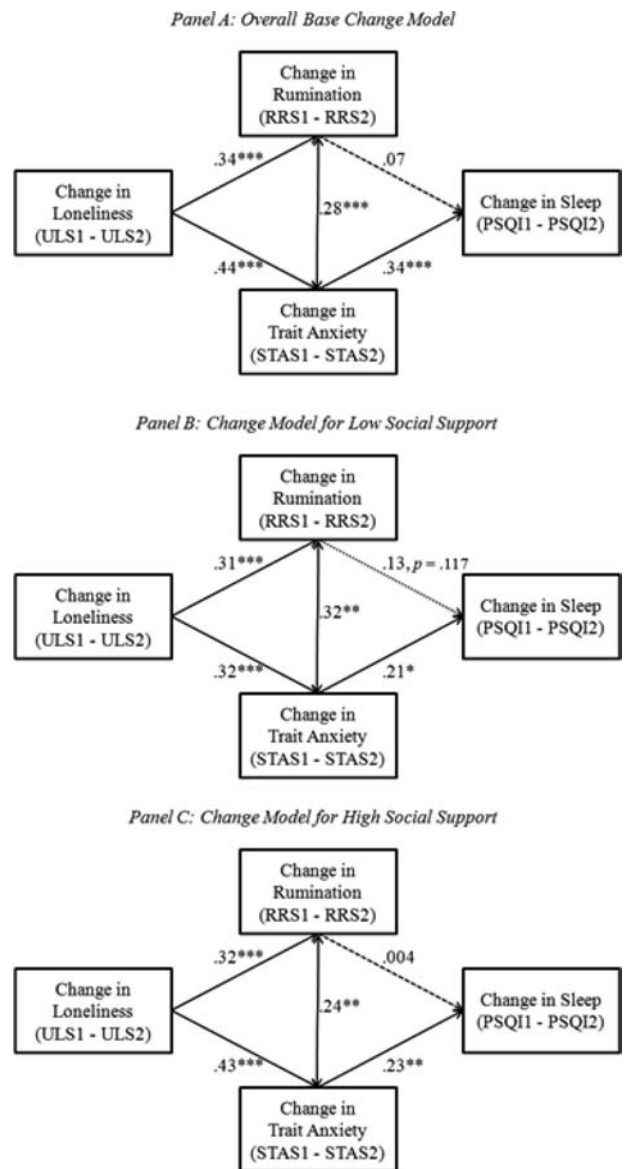


Figure 2. Structural equation models testing rumination and anxiety as mediators of the relationship between loneliness and poor sleep quality over time in Study 4, with social support as the moderator of this relationship. \*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

Interestingly, trait anxiety proved to be as important as rumination. Although both were predicted strongly by loneliness, and rumination and anxiety were related, each uniquely predicted depressed mood and poor sleep quality. These results suggest rumination and trait anxiety act in a reciprocally determinative manner, where each might prolong the other.

Overall, these findings highlight the importance of the cognitive elements of loneliness (Hawkley & Cacioppo, 2010). Loneliness is based on the perception of whether one's relationships are enough to satisfy one's need for social connection. It is possible that loneliness itself serves as a chronic stressor via ruminative processes closely linked with lonely cognitions. For example, when a person perceives that she or he has been excluded or is lacking desired social connections at any given time (an initial acute stressor), she or he may then replay these perceived exclusions over and over (making it a chronic stressor). Furthermore, lonely individuals may be less likely to resolve issues using social relationships (e.g., via conversation), resulting in more rumination and recurrent experiences of stress.

### Other Mechanisms

The other mechanisms tested as mediators added little to the models. Including hostility, smoking behaviors, neuroticism, and negative affect did not improve the explained variance in depressed mood or poor sleep quality above that of rumination and anxiety. Notably, hostility dropped out of the model even though it covaried strongly with rumination and anxiety and independently predicted depressed mood and poor sleep quality. This suggests that rumination, anxiety, and hostility may tap a common latent factor that is related to depressed mood and sleep quality but that rumination and anxiety are stronger predictors of this latent factor.

Findings related to social support were mixed. Social support did not moderate the effects of rumination and anxiety on depression, nor the effects of anxiety on poor sleep quality. It did moderate the effects of rumination on sleep quality, such that only those with low social support had rumination scores related to poor sleep quality. This general null finding is surprising considering the work that has connected social support with depression (e.g., Frasure-Smith et al., 2000) and poor sleep (Brummett et al., 2006). One explanation is that social support shares variance with rumination and anxiety, and does not add any additional explanatory power. A strength of SEM is its power to look at the contribution of key variables to an outcome measure while at the same time specifying how those variables are related to other factors. Another possibility is that social support might be most important in considering how negative patterns of mood and cognition develop to influence physical health outcomes, such as sleep, rather than explaining psychological health outcomes, such as depression.

### Limitations

A limitation of this work is that the data are correlational. While the prospective data can suggest causal relationships, ultimately we cannot make firm conclusions regarding whether loneliness causes rumination and anxiety. In future work, we plan to manipulate loneliness in a laboratory setting and measure the resultant physiological and self-report behaviors.

Furthermore, we sampled college students limiting generalizability. Students are an important sample to study because loneliness is a stable characteristic (Boomsama et al., 2005), and the effects of loneliness on the body tend to be cumulative (Hawkley & Cacioppo, 2007). Importantly, there are strong linkages between loneliness, depressed mood, and suicide (e.g., Furr, Westefeld, McConnell, & Jenkins, 2001), especially in younger adults. However, caution should be exercised in applying the results to older populations. Given that loneliness is quite prevalent, with an estimated 20% of people in the United States reporting loneliness at some point in their lives (Cacioppo & Patrick, 2008), it will be important to assess whether the same mechanisms are at work with different age groups. For example, the physical effects of behavioral choices, such as smoking, are likely to compound over time, suggesting we might see additional pathways predicting depressed mood and poor sleep quality for older adults.

While testing differences between men and women were beyond the scope of this article, we had approximately three times as many women than men, calling into question whether the observed effects are as applicable to college men. We do not believe this to be the case, as a series of *t* tests (unreported) showed that men and women did not consistently differ across the studies on any of the variables measured; this was not surprising, as gender differences in depression and other constructs are often minimized in college populations (Nolen-Hoeksema, 1987). However, further research is warranted to examine possible gender differences in terms of rumination, loneliness, and health connections in research with older populations.

### Conclusions

Although loneliness is associated with depression and poor sleep, how loneliness is connected to these outcomes had heretofore been unclear. We found that as loneliness increases, so does rumination and anxiety. In turn, rumination and anxiety explain why loneliness is related to depressed mood and poor sleep quality. This research sheds new light on understanding loneliness and its cumulative negative effects. Lonely individuals tend not to experience a stressor just once; rather, they often replay a stressor in their minds. This psychological aspect is important to consider as there are currently no established methods for diagnosing and treating loneliness in the mental health field. Our data suggest that loneliness is likely to be comorbid with depression and anxiety and it may also have an effect on those factors. By not recognizing and treating loneliness, interventions designed to alleviate people's depressive or anxious symptoms may fail many individuals. Our findings help explain why lonely individuals are at greater risk for poor health outcomes, and suggest a point of departure for informing future interventions.

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