Ruminative self-focus and negative affect: An experience sampling study

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Abstract

We conducted an experience sampling study to investigate the relationship between momentary ruminative self-focus and negative affect. Ninety-three adults recorded these variables at quasi-random intervals eight times daily for one week. Scores on questionnaire measures of dispositional rumination were associated with mean levels of momentary ruminative self-focus over the experience sampling week. Concurrently, momentary ruminative self-focus was positively associated with negative affect. Cross-lagged analyses revealed that ruminative self-focus predicted negative affect at a subsequent occasion, while negative affect predicted ruminative self-focus at a subsequent occasion. Decomposition of the dispositional rumination measure suggested that brooding, but not reflective pondering, was associated with higher mean levels of negative affect. Though broadly consistent with Nolen-Hoeksema's (1991) response styles theory, these results suggest that a reciprocal relationship exists between ruminative self-focus and negative affect.

Keywords: depression, rumination, self-focus, experience sampling, affect

The response styles theory (RST; Nolen-Hoeksema, 1991, 2000) posits that rumination is an important vulnerability factor for the onset and maintenance of depression. Nolen-Hoeksema (1991, p. 569) defines rumination as a response style characterised by "repetitively focusing on the fact that one is depressed; on one's symptoms of depression; and on the causes, meanings, and consequences of depressive symptoms". Within RST, the tendency to adopt a ruminative style in response to depressed mood is proposed to be an individual difference that is stable across time.

Consistent with the hypothesis that rumination contributes to the onset and maintenance of depression, longitudinal prospective studies have found that, controlling for initial levels of depression, a ruminative response style predicts the onset of a subsequent major depressive episode among non–depressed students (Just & Alloy, 1997; Spasojević & Alloy, 2001) and community adults (Nolen-Hoeksema, 2000), as well as the severity of ongoing depression in people diagnosed with depression (Kuehner & Weber, 1999; Nolen-Hoeksema, 2000). Furthermore, experimental studies have found that rumination plays a causal role in the exacerbation of negative mood and negative cognition. Compared to distraction, rumination exacerbates dysphoric mood, increases negative thinking and impairs social problem solving, although this effect is only found for participants already in a dysphoric mood prior to the rumination manipulation (e.g., Lyubomirsky & Nolen-Hoeksema, 1995; Lyubomirsky, Tucker, Caldwell, & Berg, 1999; Nolen-Hoeksema & Morrow, 1993).

Consistent with the hypothesis that rumination is a stable, trait-like characteristic, Roberts, Gilboa, and Gotlib (1998) found that previously dysphoric students had higher levels of rumination than never-dysphoric students, suggesting that rumination is not merely a concomitant of depressed mood. Furthermore, test-retest correlations for the Response Styles Questionnaire (RSQ), the principal self-report measure of the ruminative response style, in

adult samples over periods up to one year are typically greater than .60 (Nolen-Hoeksema, 2000; Nolen-Hoeksema & Davis, 1999; Nolen-Hoeksema, Parker, & Larson, 1994), indicating a reasonable degree of stability. However, not all studies have found such good test-retest reliability. Studies utilising clinically depressed samples tend to find moderate to poor stability (e.g., .50 across one year for students experiencing major depressive episodes, Just & Alloy, 1997; .36 across six months for depressed students, Kasch, Klein, & Lara, 2001). Additionally, Kasch et al. (2001) found that participants who recovered from the depressive episode showed significant reductions in rumination.

Furthermore, there are several important limitations of prospective studies that use test-retest assessment of the RSQ questionnaire to assess the stability of rumination. First, Fraley and Roberts (2005) warn that test-retest reliability coefficients are not sufficient indicators of the trait-like properties of a construct because they cannot assess dynamic change over time. Thus, a high test-retest coefficient for a rumination measure over two assessments is uninformative about the extent to which rumination fluctuates over time *between* the two assessments. Moreover, although RST proposes that a *tendency* to ruminate is a stable personality characteristic, one would expect *actual engagement* in ruminative thinking to exhibit variability from moment to moment over the day.

Second, a particular limitation of the RSQ is that it requires participants to make retrospective reports on their responses to depressed mood. Such retrospective assessment is known to be vulnerable to bias and distortion (Stone, Schwarz, Neale, et al., 1998).

Third, a general limitation of this approach is that it cannot investigate how ruminative thinking occurs moment by moment in real-life, real-time settings. Because ruminative thought is an ongoing dynamic process that fluctuates over time, it is critical to examine how it is manifest in everyday contexts and settings, most particularly in response to real emotional experiences as they happen. Retrospective reports are unlikely to be informative

about the time course of a ruminative episode and its temporal relationship to mood fluctuations. Such real-world, real-time sampling is also necessary in order to assess whether the association between ruminative thinking and negative mood reported in prospective and experimental studies can be replicated in more ecologically valid settings.

Only a few studies have attempted to track the relationship between ruminative thought and mood over multiple time points. A diary study by Nolen-Hoeksema, Morrow, & Fredrickson (1993) in which students recorded their responses to depressed moods using a daily checklist found that 83% of participants were consistent in the strategies used when experiencing depressed mood. Ruminative responding was associated with longer periods of depressed mood and was highly correlated with RSQ score. Using the same daily checklist, Young and Azam (2003) reported that the extent to which persons with seasonal affective disorder ruminated on sad mood during the fall predicted the severity of their depressed mood in the following winter, controlling for prior depressive severity. Finally, Wood, Saltzberg, Neale, Stone, and Rachmiel (1990) asked men to report daily on their negative mood and the extent to which they ruminated about the 'most bothersome' event of that day. Rumination was positively correlated with negative mood, at both the within-person and between-person levels. These results are broadly consistent with RST.

Although a methodological improvement on test-retest questionnaire studies because response styles were assessed on multiple occasions, these diary studies have a number of limitations. First, they only assessed rumination daily, typically at the end of the day, rather than randomly sampling in real-time at the occasion-level throughout the day. This means that the assessment involved retrospective reporting of rumination and mood, and was therefore still prone to retrospective reporting biases (Stone et al., 1998). Second, this assessment method cannot detect contingencies between events of which participants are unaware, nor

allow for analysis of the time course and interrelationship of mood and rumination across time and across different contexts.

Thus, as suggested by Roberts, Gilboa, and Gotlib (1998), research on ruminative thinking would benefit from the use of a more naturalistic method that enables individuals to report their thoughts and feelings as they occur. Experience sampling methodology (ESM; Csikszentmihalyi & Larson, 1987), also known as ecological momentary assessment (Stone & Schiffman, 1994), asks persons to report on subjective (and objective) states as they occur at various times over the day and circumvents many of the pitfalls of retrospective reports.

Silk, Steinberg, and Morris (2003) used an ESM design to examine the mood regulation strategies of adolescents. Participants were sampled 48 times over one week and asked to rate their most negative experience over the last hour, the mood regulation strategies they used, and their current affect. Hierarchical linear modeling revealed that involuntary engagement (defined as *either* rumination *or* impulsive, involuntary action following negative events) was associated with greater sadness and anger at the subsequent assessment. Greater use of involuntary engagement strategies over the week was also associated with more depressive symptomatology. However, conclusions from this study are limited by the fact that rumination was not a *necessary* component of involuntary engagement and because the reporting of rumination was largely retrospective.

Therefore, in the current study, we took advantage of an ESM design to explicitly examine ruminative self-focus with the aim of building on and extending the previous research on rumination. Our objectives were to examine (a) the extent to which ruminative thought varies over time for individuals across a broad range of everyday situations, and (b) the concurrent and prospective relationship between occasion-level ruminative self-focus and negative affect. A unique strength of our design was that it minimized retrospective bias by asking participants to rate their ruminative self-focus and affect in real-time at a randomly

chosen particular moment, rather than over a longer duration. This assessment permits a more precise and immediate analysis of the relationship between ruminative self-focus and negative affect. Unlike most previous studies, we assessed ruminative self-focus independently of concurrent affect, thereby measuring its variability across a broad range of settings. This allowed us to investigate whether individuals reporting a dispositional ruminative response style have *generally* higher levels of ruminative self-focus in everyday life. It is important to note the distinction between a ruminative response style as a *stable tendency* and ruminative self-focus as a *momentary behavior* that varies from one time to another. Thus, although ruminators may report higher *average* levels of ruminative self-focus than non-ruminators, individuals are likely to show considerable variability from one moment to another.

We operationalized occasion-level ruminative self-focus using a composite measure comprising two distinct but related items. Consistent with the RST conceptualisation of rumination as involving focus on symptoms and feelings (Nolen-Hoeksema, 1991), one item asked participants to rate the extent to which they were focusing on their feelings. Consistent with discrepancy-reduction accounts that implicate rumination as a response to unresolved goals and problems (Carver & Scheier, 1998; Martin & Tesser, 1996), a second item asked participants to rate the extent to which they were focusing on their problems. This second item is also consistent with Nolen-Hoeksema's (1991) definition, given that past and current problems are a likely cause of depressed mood. Think aloud protocols reveal that rumination inductions result in increased problem-related thought for dysphoric students (Lyubomirsky et al., 1999). We called our two-item composite 'ruminative self-focus' because it addressed momentary self-focus regardless of current mood, allowing us to examine the relationship between ruminative thinking and negative affect over a broad range of contexts and situations. An advantage of our items derived from their simplicity: Participants reported on their focus

of attention rather than making the more complicated metacognitive judgments required by other rumination measures.

We operationalized negative affect using a simple three-item measure asking participants to report their feelings of sadness, anxiety, and irritation, each of which has been associated with rumination. For example, longitudinal studies indicate that ruminative responses predict anxiety as well as depression (Nolen-Hoeksema, 2000; Schwarz and Koenig, 1998), while laboratory studies have found that rumination inductions exacerbate anxiety (Blagden & Craske, 1996) and anger (Rusting & Nolen-Hoeksema, 1998). By using face valid, readily comprehensible items (cf. Marco & Suls, 1993; Silk et al., 2003), we hoped to reduce participant burden during the sampling period.

Finally, by using multilevel modelling (Snijders & Bosker, 1999), we investigated whether person-level measures of depressive symptomatology (BDI) and dispositional rumination (RSQ) were associated with mean levels of negative affect and ruminative self-focus. This method also allowed us to investigate possible interactions between person-level and momentary variables, for example, whether momentary ruminative self-focus was more strongly associated with negative affect for individuals scoring highly on the BDI, as suggested by RST. We examined the full Ruminative Response Scale, including its brooding and reflective pondering subscales, as person-level variables, given the evidence that only the brooding subscale is prospectively associated with depressed mood (Treynor, Gonzalez, & Nolen-Hoeksema, 2003).

We tested four hypotheses derived from RST (Nolen-Hoeksema, 1991). First, consistent with the notion of rumination as a personality trait, we predicted that there would be some consistency in ruminative self-focus across occasions. However, this consistency was not expected to be large because of the variability with which this tendency is expressed in momentary behavior. Second, because the RSQ predicts ruminative thinking on a day-to-day

basis (Nolen-Hoeksema et al., 1993), we hypothesised that the RSQ (and its brooding and reflection subscales) would predict mean levels of momentary ruminative self-focus, independently of depressive symptomatology. Third, given that rumination and negative affect are typically correlated (Nolen-Hoeksema et al., 1994) and that rumination is associated with negative affect on a day-to-day basis (Wood et al., 1990), we hypothesised that momentary ruminative self-focus would be associated with higher levels of concurrent negative affect. Fourth, because RST proposes that ruminative thinking prolongs and exacerbates negative affect, we hypothesised that ruminative self-focus would predict negative affect at a subsequent sampling occasion after controlling for initial levels of negative affect. By testing the final hypothesis using a cross-lagged analysis, we could simultaneously also investigate whether negative affect predicts ruminative self-focus at a subsequent sampling occasion after controlling for initial levels of ruminative self-focus. Although few studies have investigated this pathway, one longitudinal study of community adults revealed that depressive symptoms predicted increased rumination one year later after controlling for initial levels of rumination (Nolen-Hoeksema, Grayson, & Larson, 1999).

Method

Participants

Participants were recruited from the University of Exeter and the local area using e-mails and newspaper advertisements. Each advertisement described the study procedure and requested volunteers both who were and were not prone to sad moods and depression. We recruited participants with a wide range of depressive symptomatology, providing greater power to investigate the role of ruminative self-focus for individuals reporting high versus low levels of depressive symptoms. All respondents were invited to take part regardless of their BDI score. This approach resulted in a final analyzed sample with a range of scores on the Beck Depression Inventory-II ($M = 13.4$, $SD = 9.2$, range 0-41; symptom ranges: minimal

depression, $n = 54$; mild depression, $n = 21$; moderate depression, $n = 9$; severe depression, $n = 9$). One hundred and eight persons (76 women) consented to take part (age range = 18-67 years, $M = 26.3$ years old, $SD = 13.3$)[1]. Participants were paid £10 (US$20) for completing the ESM week and received a report summarising their personal results some weeks later.

Procedure

We used ESM (Csikszentmihalyi & Larson, 1987) to assess negative affect and ruminative self-focus eight times daily in naturalistic settings over seven days, using a signal-contingent method whereby participants rated their moods and thinking styles when signalled by an alarm from a wrist-worn actiwatch (Cambridge Neurotechnology Ltd., Cambridge, UK). A time-stratified random sampling strategy was adopted so that, for each participant, each day was divided into eight equal periods with one alarm occurring at a random time within each period, with the constraint that successive alarms could not occur within 15 min. This resulted in a 12-hour daily sampling period with one alarm occurring within each of eight 90 min periods (e.g., 10:00 to 22:00). Times were individually randomised for each participant to fit in with his or her typical waking hours (actual range: 07:00-23:59).

During a briefing session, informed consent was obtained and baseline measures of dispositional rumination and depressive symptoms were administered. The ESM procedure was then explained and practised. The experimenter gave the actiwatch to the participant, explained the meaning of each prompt, and demonstrated how each rating could be made in response to a hypothetical beep. It was stressed that all ratings should be made with reference to *the moment just before* the actiwatch beeped. When the participant indicated that they fully understood the procedure, they specified their preferred 12-hour sampling period, which was used to configure the actiwatch. Finally, the participant was given the actiwatch and a card on which the prompts and their corresponding questions were printed. Participants were told to carry this card on their person for reference while wearing the actiwatch.

At each beep, a flashing letter on an LED display prompted participants to enter a rating about their mood or ruminative self-focus in the moment just before the beep, by pressing a button on the actiwatch to cycle through ratings from 1 to 7. After each rating was entered, the next letter was displayed, prompting the participant for the next rating. The actiwatch only accepted entries within 20 s of the alarm, ensuring that all data was entered promptly and preventing the possibility of retrospective ratings. The items rated at each beep (prompt letter in parentheses) were sadness (S), anxiety (N), irritation (I), focus on feelings (F); and focus on problems (P). Participants rated themselves on each of these items using a 7-point rating scale from 1 (*not at all*) to 7 (*very much*).

Completion rates were generally good. Eleven participants withdrew from the study during the week of experience sampling ($n = 7$, ESM was too time-consuming; $n = 2$, actiwatch malfunctioned; $n = 1$, family emergency; $n = 1$, experienced ESM as upsetting). In accordance with standard guidelines (Delespaul, 1995), a further four participants who responded to less than one-third of the signals were considered non-completers and excluded from the analysis. Non-completers did not differ from completers on the BDI or the RSQ.

Ninety-three participants (67 women) were included in the analysis (age range = 18-67 years, $M = 26.2$ years, $SD = 13.5$). Four occasions when responses of 1 were entered for every rating were identified as multivariate outliers and deleted from the dataset on the assumption that they represented occasions when participants had pressed the button to stop the alarm.

The mean response rate to the watch signals was 77% ($SD = 13\%$), representing good responding for studies using electronic recording devices (Christensen, Barrett, Bliss-Moreau, Lebo, & Kaschub, 2003). Only three participants responded to fewer than half of the actiwatch beeps. Across participants, ratings for 3,992 occasions were recorded.

We calculated a composite measure of occasion-level negative affect by standardising each of the sad, anxious, and irritated ESM ratings across beeps and persons before summing

the resulting *z*-scores (α = .71). Similarly, we calculated a composite measure of occasion-level ruminative self-focus by standardising each of the focus on feelings and focus on problems ESM ratings across beeps and persons before summing the *z*-scores (α = .66).

Thus, for both the negative affect and the ruminative self-focus composite, each constituent item was weighted equally while preserving between-person variability.

Measures

Beck Depression Inventory–II (BDI-II; Beck, Brown & Steer, 1996). The BDI assesses levels of depressive symptomatology with 21 items that are rated on a scale from 0 to 3, with higher scores reflecting more depressive symptoms (range 0-63). Cronbach's alpha in our sample was .91.

Response Styles Questionnaire–Ruminative Responses Scale (RSQ; Nolen-Hoeksema & Morrow, 1991; Treynor et al., 2003). Ruminative response style was measured using the Ruminative Responses Scale of Nolen-Hoeksema & Morrow's (1991) Response Styles Questionnaire. The RSQ measures the extent to which individuals respond to depressed mood by focusing on self, symptoms and on the causes and consequences of their mood, with 22-items rated on a 4-point frequency scale. Cronbach's alpha in our sample was .92. Because we were interested in aspects of the RSQ that were less confounded with depressive symptoms, we also calculated scores on the separate brooding (α = .76) and reflection (α = .76) subscales identified by Treynor et al. (2003).

Statistical Model

Our data exhibited a nested structure: Occasions (Level 1) were nested within days (Level 2), which were nested within persons (Level 3). For this reason, we used hierarchical linear modeling to investigate the relationships between negative affect, rumination and the dispositional variables. Hierarchical linear modeling is an extension of the regression approach in which multiple error terms are used to partition variance between each level of

structure in the data (Snijders & Bosker, 1999). In this way, relationships both within and between each level of structure can be analysed without violating standard assumptions of independence. Multilevel models are fitted to the data using maximum likelihood (ML) estimation, an iterative procedure that is more efficient than ordinary-least-squares (OLS) regression. A further benefit of a hierarchical linear modelling approach is that it copes well with missing and unbalanced data. For our analyses, we used the software package MLwiN v.2.02 (Rasbash, Steele, Browne, & Prosser, 2005) with iterative generalized least squares (IGLS) estimation.

We constructed random coefficient models for which the general regression equation can be expressed as follows:

$$(Outcome)_{ijt} = b_{0ij} + \sum_{q=1}^{Q} b_q x_{qijt} \sum_{r=1}^{R} b_r x_{ri} + e_{ijt}$$

where $(Outcome)_{ijt}$ is the ruminative self-focus or negative affect score for participant i at beep t on day j. The intercept is denoted by b_{0ij}, while x_{qijt} is an entry of momentary variable x_q with corresponding coefficient b_q, x_{ri} is an entry of person-level variable x_r with corresponding coefficient b_r, and e_{ijt} is an error term. The intercept (b_{0ij}) was specified as randomly varying at both the day and person levels, accounting for the fact that observations tend to be more similar if they are (a) taken on the same day, and (b) taken from the same person. The coefficients b_q and b_r can be considered equivalent to unstandardized regression coefficients in standard multiple regression. However, when entered as predictors in our analysis, momentary ruminative self-focus and negative affect were each modeled with a coefficient that was randomly varying at the person level. This specification allowed the relationship

between each variable and the outcome measure to differ between individuals. Autocorrelation between subsequent observations may be a problem in experience sampling data because it can downwardly bias the standard errors of coefficients. However, inspection of the occasion-level residuals for each of our models revealed that the average within-person serial correlation was of a magnitude ($\leq |.05|$) low enough to have a negligible impact on the standard errors (F. Steele, personal communication, February 12, 2007). For this reason, we did not model an autoregressive error structure.

The BDI-II score distribution was positively skewed and we therefore applied a square-root transform to normalize this variable. For ease of interpretation, person-level measures (BDI-II, RSQ) and momentary ratings of negative affect and ruminative self-focus were each entered as continuous explanatory variables centered on their grand mean. Time of day was converted to fractional days and centred on the mean sampling time (15:06) and day of study was centred on day 4. For each analysis, we constructed parallel models using (a) the full RSQ score, and (b) the RSQ brooding and reflection subscale scores.

Results

Consistency of Ruminative Self-Focus

We used multilevel modelling to test our first hypothesis that the composite measure of ruminative self-focus would be reasonably consistent across situations. In an empty multilevel model (i.e., one that partitions the variance at each level without including explanatory variables), the intra-class correlation (ICC) between persons is equivalent to the mean correlation between ratings at two randomly chosen occasions for a particular person (Snijders & Bosker, 1999). For our data, this provides an index of the level of consistency of ruminative self-focus within persons. The intra-class correlation between persons was 0.34 for the ruminative self-focus measure, indicating modest levels of consistency over time. The

majority of the variance in ruminative self-focus was within-persons and within-days (ICC = 0.57), with a small proportion of variance between days within persons (ICC = 0.09).

Next, we expanded the model to explore whether ruminative self-focus was associated with time of day or with day of the study. We modelled ruminative self-focus with an intercept, a linear and quadratic time coefficient, a linear day coefficient, and random error. There was a significant quadratic effect of time ($B = 2.282$, $SE = 0.830$, $p < .01$) and a significant linear effect of day ($B = -0.057$, $SE = 0.015$, $p < .001$). This indicated that ruminative self-focus tended to be higher in the mornings and evenings than in mid-afternoon and that ruminative self-focus decreased slightly from day to day as the week progressed. In combination, the inclusion of the time and day coefficients significantly improved the model fit, reduction in log-likelihood $\chi^2(3) = 24.89$, $p < .001$.

Association between Dispositional Rumination and Momentary Ruminative Self-Focus

In the next step, we tested our second hypothesis that participants' dispositional ruminative style (RSQ) would predict mean levels of ruminative self-focus, independently of depressive symptoms. Thus, the person-level variables of RSQ score and BDI-II score were entered together to explain variability in mean levels of ruminative self-focus[2]. Table 1 presents the results of this model. Higher scores on the RSQ (but not the BDI-II) were associated with greater ruminative self-focus and the inclusion of these person-level variables significantly improved the model fit, reduction in log-likelihood $\chi^2(2) = 26.76$, $p < .001$.

When the RSQ brooding and reflection subscales were entered instead of the full RSQ scale, both BDI-II and brooding (but not reflection) were positively associated with mean levels of ruminative self-focus (see Table 1). The inclusion of RSQ brooding, RSQ reflection, and BDI-II resulted in a significantly improved model fit, reduction in log-likelihood $\chi^2(3) = 30.71$, $p < .001$.

Thus, as hypothesized, participants' mean levels of momentary ruminative self-focus were positively associated with a questionnaire-based measure of dispositional rumination (particularly brooding), even after controlling for depressive symptoms.

Momentary Ruminative Self-focus and Concurrent Negative Affect

Our third hypothesis was that momentary ruminative self-focus would be concurrently associated with negative affect after controlling for depressive symptomatology. To test this prediction, we constructed multilevel models predicting momentary negative affect from depressive symptomatology, dispositional rumination, and momentary ruminative self-focus. We also explored whether the relationship between ruminative self-focus and negative affect would differ for persons reporting high versus low levels of depressive symptomatology by testing a cross-level interaction between these variables. As in the previous analysis, we modeled linear and quadratic effects of time and linear effects of day.

Are depressive symptomatology, dispositional rumination and momentary ruminative self-focus associated with momentary negative affect? To examine the relative associations of the dispositional and momentary variables with mean levels of negative affect, we conducted a sequential multilevel regression in which BDI-II and RSQ scores were entered simultaneously as person-level variables in the first step, before momentary ruminative self-focus was entered in the second step.

Both BDI-II ($B = 0.594$, $SE = 0.123$, $p < .001$) and RSQ ($B = 0.036$, $SE = 0.012$, p < .01) significantly predicted mean levels of negative affect, resulting in a significantly improved model fit, reduction in log-likelihood $\chi^2(2) = 53.52$, $p < .001$. In the second step, momentary ruminative self-focus was a significant predictor ($B = 0.495$, $SE = 0.029$, $p < .001$) of negative affect and its inclusion significantly improved the model fit, reduction in log-likelihood $\chi^2(3) = 890.04$, $p < .001$. RSQ remained a significant predictor in the model, although the magnitude of its coefficient was reduced ($B = 0.023$, $SE = 0.010$, $p < .05$).

In the first step of the analysis using RSQ subscales, brooding significantly predicted mean levels of negative affect ($B = 0.186$, $SE = 0.048$, $p < .001$), as did BDI-II ($B = 0.613$, $SE = 0.112$, $p < .001$), but reflection did not ($B = –0.065$, $SE = 0.042$, ns). The inclusion of these variables resulted in a significantly improved model fit, reduction in log-likelihood $\chi^2(3) = 58.71$, $p < .001$. In the second step, ruminative self-focus ($B = 0.495$, $SE = 0.029$, $p < .001$) significantly predicted negative affect, resulting in a significantly improved model fit, reduction in log-likelihood $\chi^2(3) = 889.16$, $p < .001$. Brooding remained a significant predictor in the model, although the magnitude of its coefficient was reduced ($B = 0.126$, $SE = 0.040$, $p < .01$).

Does depressive symptomatology interact with momentary ruminative self-focus to predict momentary negative affect? In the next step, we examined whether the association between momentary ruminative self-focus and negative affect would differ for individuals reporting high versus low levels of depressive symptomatology. According to RST, ruminative self-focus is more strongly associated with negative affect for individuals already experiencing depressive mood. Therefore, in a final step, we included the cross-level interaction between ruminative self-focus and depressive symptomatology (BDI-II). This interaction was statistically significant and its inclusion significantly improved fit both for the model using total RSQ score, reduction in log-likelihood $\chi^2(1) = 7.36$, $p < .01$, and for the model using the RSQ subscales, reduction in log-likelihood $\chi^2(1) = 6.84$, $p < .01$. Figure 1 shows the plot of this interaction for the model including total RSQ score. As displayed, the positive relationship between ruminative self-focus and negative affect was stronger for individuals scoring one standard deviation above the mean on depressive symptomatology than it was for individuals scoring one standard deviation below the mean. Parameter estimates for the final models predicting concurrent negative affect are provided in Table 2.

These results indicate that momentary ruminative self-focus was associated with higher levels of concurrent negative affect and that, further supporting RST, ruminative self-focus was associated with greater levels of negative affect for persons reporting more severe depressive symptomatology.[3]

Prospective Analysis

In our final analyses, we tested our fourth hypothesis that ruminative self-focus at one occasion would predict negative affect at a subsequent occasion after controlling for initial level of negative affect. For this analysis, we used the sample of 2,958 occasions for which ESM data were entered on that occasion (T2) and the immediately preceding occasion (T1) within a day, entering the time interval between occasions as a covariate. As in previous analyses, we modeled linear and quadratic effects of time and linear effects of day. In order to account for a possible association between T1 negative mood and T2 ruminative self-focus, we constructed a bivariate cross-lagged multilevel model in which T2 negative affect and T2 ruminative self-focus were each simultaneously regressed on T1 negative affect and T1 ruminative self-focus. In the first step of this model, we simultaneously entered BDI-II score and RSQ score (or its subscales). In the second step, we simultaneously entered T1 negative affect and T1 ruminative self-focus to test the cross-lagged components.

In the first step, both BDI-II ($B = 0.602$, $SE = 0.124$, $p < .001$) and RSQ ($B = 0.037$, $SE = 0.012$, $p < .01$) were significant predictors of mean levels of T2 negative affect. Furthermore, RSQ ($B = 0.029$, $SE = 0.009$, $p < .01$) was a significant predictor of mean levels of T2 ruminative self-focus but BDI-II was not ($B = 0.159$, $SE = 0.094$, *ns*). The simultaneous inclusion of these person-level variables resulted in a significant improvement in the model fit, reduction in log-likelihood $\chi^2(4) = 57.16$, $p < .001$.

In the next step, T2 negative affect and T2 ruminative self-focus were each simultaneously regressed on T1 negative affect and T1 ruminative self-focus with slopes that

varied randomly at the person level. Negative affect at T1 predicted negative affect at T2, while ruminative self-focus at T1 predicted ruminative self-focus at T2. Additionally, each of the cross-lagged paths was statistically significant, indicating that negative affect and ruminative self-focus were reciprocally associated over time. Thus, negative affect at T1 predicted ruminative self-focus at T2 while ruminative self-focus at T1 predicted negative affect at T2. The inclusion of the cross-lagged paths significantly improved the model fit, reduction in log-likelihood $\chi^2(22) = 308.83$, $p < .001$. Parameter estimates for this model are shown in Table 3.

Results were very similar for the model using RSQ subscales. Like BDI, brooding significantly predicted mean levels of T2 negative affect ($B = 0.197$, $SE = 0.049$, $p < .001$) and T2 ruminative self-focus ($B = 0.112$, $SE = 0.037$, $p < .01$). However, reflection predicted neither mean levels of T2 negative affect ($B = –0.067$, $SE = 0.042$, ns), nor mean levels of T2 ruminative self-focus ($B = 0.007$, $SE = 0.032$, ns).[4]

In summary, we found support for our hypothesis that momentary ruminative self-focus on one occasion would predict negative affect on a subsequent occasion, even after controlling for initial levels of negative affect. However, we also found support for the reverse relationship. Negative affect predicted ruminative self-focus on a subsequent occasion after controlling for initial levels of ruminative self-focus, suggesting a bidirectional relationship between these variables over relatively short time intervals.[5]

Discussion

To our knowledge, this is the first explicit study of the relationship between momentary ruminative self-focus and negative affect in everyday life. This relationship was examined both concurrently and prospectively by asking participants to record their affect and thoughts at random time points over one week. The present study tested four hypotheses derived from the RST (Nolen-Hoeksema, 1991). First, momentary ruminative self-focus was

expected to be moderately consistent across occasions. Second, mean levels of momentary ruminative self-focus were expected to be positively associated with dispositional rumination. Third, ruminative self-focus was expected to be positively associated with concurrent negative affect. Fourth, ruminative self-focus was expected to predict negative affect prospectively using a cross-lagged analysis.

As expected, ruminative self-focus exhibited a limited degree of consistency across occasions. For our composite ruminative self-focus variable, the average correlation between any two randomly selected occasions was .34. The finding that there was some consistency in ruminative self-focus is in agreement with RST's assumption that a tendency to adopt a ruminative style is an individual difference variable. Furthermore, as predicted by the RST, our trait measure of ruminative response style (the RSQ) predicted mean levels of ruminative self-focus over the sampling week, controlling for depressive symptoms.

Nonetheless, it is important to recognize that the magnitude of the intra-class correlation between persons was modest and that the within-person variability of the ruminative self-focus composite was greater than its between-person variability. This suggests that momentary ruminative self-focus is influenced by context, increasing as feelings or problems become more salient. It should also be noted that ratings of ruminative self-focus were collected regardless of simultaneous affect and so our measure is not directly analogous to rumination as a response style to sad mood (Nolen-Hoeksema, 1991).

One novel factor that this study revealed to be relevant to ruminative self-focus is time of day. Ruminative self-focus tended to be highest in the morning and in the evening. We speculate that the shift in ruminative self-focus over the day may reflect the nature of activity during a typical daily routine. Individuals may be more likely to tune into their feelings and problems at the beginning and close of the day, in order to anticipate and/or review events. Furthermore, morning and evening tend to be quieter times associated with less distraction

and more scope for introspection and self-focus (e.g., when lying in bed). This interpretation is consistent with our clinical experience in that depressed patients report that their worst bouts of rumination often occur upon waking or going to bed. The effect of time of day on rumination deserves further study in clinical populations.

We offer no simple explanation for our finding that ruminative self-focus decreased slightly over the sampling week. One speculation is that the process of recording *details* of individual instances may be counter-ruminative because it acts to (a) increase awareness of ruminative self-focus, and/or (b) interrupt bouts of ruminative self-focus. Reactivity to ESM procedures is a potentially important issue that has hitherto received little attention (Scollon, Kim-Prieto, & Diener, 2003).

During the everyday lives of our participants, ruminative self-focus was strongly associated with negative affect. Though one cannot draw causal conclusions from this relationship, this is the first study to reveal that ruminative self-focus and negative affect are correlated when they are measured naturalistically in 'real time'. Notably, this was found even though our ruminative self-focus measure did not explicitly refer to negative mood. We also found support for RST in that ruminative self-focus was more strongly associated with negative affect for persons reporting high levels of depressive symptomatology. This is congruent with laboratory studies indicating that rumination inductions are most depressogenic for dysphoric individuals (e.g., Lyubomirsky & Nolen-Hoeksema, 1995; Nolen-Hoeksema & Morrow, 1993).

Using ESM, we were able to construct cross-lagged models in which negative mood and ruminative self-focus were predicted by momentary variables on the preceding occasion. We found a moderate lag for both negative affect and ruminative self-focus, such that each variable on one occasion was correlated with the same variable on a subsequent occasion. Controlling for these relationships, ruminative self-focus predicted

higher levels of negative affect prospectively, consistent with the predictions of RST. The finding that questionnaire-based measures of rumination predict future negative mood and depressive symptoms (Nolen-Hoeksema, 2000) is thus extended to momentary measures of ruminative self-focus and negative mood in everyday settings. However, our cross-lagged analysis also revealed evidence for a reciprocal path between negative mood and ruminative self-focus at the subsequent occasion. This suggests that the two variables may be causally related to one another in a bidirectional manner. Although RST suggests that a ruminative response style is a predisposing factor in negative affect and depression, these results suggest that the micro-level relationships between ruminative thought and negative affect are reciprocal. Earlier research by Wood, Saltzberg, and Goldsamt (1990) showed that a negative mood induction, but not a positive mood induction, resulted in increased self-focused attention among undergraduates (see Sedikides, 1992, for a conceptual replication). As these investigators suggest, negative affect may result in a search for explanatory causes and trigger self-regulatory attempts to repair the negative mood and enact behavioral coping strategies. The cross-lagged relationship revealed here indicates how a downward spiral may ensue in which negative affect and ruminative thinking lead to a progressive worsening of mood.

Our results are consistent with the findings of Treynor et al. (2003), who proposed distinct subtypes of rumination with distinct functional effects, with brooding being more depressogenic and reflection being less depressogenic. In the current study, the brooding subscale but not the reflection subscale was strongly correlated with mean levels of momentary ruminative self-focus. Furthermore, brooding predicted mean levels of momentary negative affect after controlling for depressive symptomatology, whereas reflection did not. These results complement Treynor et al. (2003) finding that brooding but not reflection was associated with more depression over time and suggest that the tendency to focus on self-discrepancies analytically and evaluatively may be a uniquely harmful

component of rumination (Watkins, 2004; Watkins & Moulds, 2005; Watkins & Teasdale, 2001; 2004).

Although we believe that this study constitutes an important advance in the study of ruminative self-focus and its relationship with negative mood, we acknowledge a number of limitations. First, our sample consisted mainly of students, so the extent to which these results can be generalized to a broader population is not known. Second, the demands of ESM studies mean that self-selection biases (Scollon et al., 2003) are probable. Our participants may have been more agreeable, more conscientious, and more rumination-prone than the wider population. Third, the short time period available for completing the ratings may have biased the sampled occasions to those when the participant was least engaged in particular activities. This is true of all signal-contingent protocols, in that there is a trade-off between maximizing the number of sampled occasions and increasing the susceptibility to recall bias at longer delays (Scollon et al., 2003). Because we were measuring fluctuating affective and cognitive states that are particularly susceptible to recall bias, we considered it more important to ensure that our reports were contemporaneous with the signal. Fourth, the 1-week sampling period was relatively short and we may not have captured the full range of participants' moods and thinking styles within this period. Longer studies may improve the reliability of our findings and increase power to detect interaction effects. Fifth, although participants were explicitly instructed to make their ratings with reference to the moment immediately before the watch beep, we cannot rule out the possibility that the negative affect ratings influenced the subsequent ruminative self-focus ratings after a particular signal. Thus, the rumination rating could have been artificially inflated on occasions when participants reported higher levels of negative affect. However, this possibility seems less likely when one considers that the 'focus on feelings' rating did not specifically address *negative* feelings. Moreover, the inclusion of the 'focus on problems' rating reduced the overlap between the

ruminative self-focus composite and the negative affect ratings. Finally, it is worth noting that contamination across ratings is also possible with a reversed rating order. Completing ratings of ruminative self-focus could influence subsequent reports of negative affect. Because negative affect was our primary outcome variable in the prospective analyses, we judged that it was better for affect ratings to precede self-focus ratings in order to test our hypotheses.

The operationalization of ruminative self-focus used in this study was novel and deserves further comment. Though we believe that our two-item composite captured key elements of a ruminative self-focusing style, such as focus on feelings, it did not address some aspects of rumination that have been emphasized in the wider literature, such as its repetitive quality (Nolen-Hoeksema, 1991). Although our measure addressed the intensity of self-focus at individual moments, it did not assess either the duration of this thinking style or the extent to which it was repetitive. A measure of momentary ruminative self-focus that incorporates this sense of 'stuckness' might yield stronger relationships with negative affect. Our self-focus measure also did not tap the self-critical, evaluative style addressed by some rumination measures (e.g., "Why do I always react this way?" in the RSQ). Further, our composite measure did not explicitly address ruminative self-focus as a response to negative affect. This allowed us to investigate ruminative self-focus across a broad range of contexts and situations, while reducing the confounding of negative affect and rumination that is inherent in measures such as the RSQ (Treynor et al., 2003). Nevertheless, a challenge for future ESM research will be to develop measures that capture diverse facets of ruminative self-focus while minimizing the burden on participants.

Although we recruited participants with a wide range of depressive symptoms, we collected no information about diagnostic status. The observed relationship between ruminative self-focus and negative affect may differ for a clinically depressed group. Given that the relationship between ruminative self-focus and negative affect was stronger for

persons with higher depressive symptomatology, it is likely that this relationship would also be stronger for clinically depressed persons. RST proposes that ruminative responses are associated with greater negative affect for individuals who are already experiencing symptoms of depression (Nolen-Hoeksema, 1991). Further, Mor and Winquist's (2002) meta-analysis revealed that the relationship between self-focused attention and negative affect was stronger in clinical groups than for either subclinical or non-clinical groups. Finally, we speculate that the higher levels of ruminative self-focus in clinically depressed individuals would yield greater levels of within-person stability than were found in our sample.

In conclusion, this study contributes new information about the nature and consequences of naturally occurring ruminative thought in everyday settings. By randomly sampling the everyday experience of our participants, we found that a dispositional trait measure of rumination is related to mean levels of ruminative self-focus, as operationalized by focus on feelings and problems. The findings were broadly consistent with the predictions of RST, although there was considerable moment-by-moment variability in ruminative self-focus that trait rumination did not explain. Our results also indicated that a bidirectional relationship exists between negative affect and ruminative self-focus. Importantly, these results complement the finding that rumination is a vulnerability factor for negative affect, as reported in prospective longitudinal studies, and confirm that a similar relationship is observed when ruminative self-focus is assessed in real-time, real-world settings.

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Footnotes

[1]The small proportion of males in our sample resulted in low power to detect effects of gender and so this variable was not included in the main analyses.

[2]BDI-II score (square root transformed) was positively associated with the RSQ total score ($r = .55$, $p < .001$), with RSQ brooding ($r = .46$, $p < .001$), and with RSQ reflection ($r = .25$, $p = .01$). Because these variables were correlated, we entered BDI-II and RSQ scores into the model simultaneously. When BDI-II and RSQ were entered sequentially, RSQ significantly improved model fit regardless of entry order but BDI-II only significantly improved model fit when it was entered first. Results were very similar when the RSQ brooding and reflection subscales were entered together instead of the full RSQ.

[3]When negative affect at the previous occasion was included as a covariate to partially control for any possible autocorrelation between subsequent negative affect ratings (using a subset of the data for which ratings were recorded at immediately subsequent occasions), the pattern of results was identical.

[4]Additional cross-lagged multivariate models predicting each of the individual T2 negative affect items together with T2 ruminative self-focus yielded similar results. Both cross-lagged paths were significant in the analysis of sad mood. In the analysis of anxious mood, the path linking T1 ruminative self-focus to T2 anxiety just failed to reach statistical significance ($p = .05$) while the other cross-lagged path was significant. In the analysis of irritated mood, the path linking T1 irritation to T2 ruminative self-focus narrowly failed to reach statistical significance ($p = .07$) while the other cross-lagged path was significant.

[5]In a final step, we tested whether T1 ruminative self-focus interacted with depressive symptomatology (BDI-II) to predict the T2 variables, and whether T1 negative affect interacted with dispositional rumination (RSQ) to predict the T2 variables. However, neither of these interaction terms significantly improved the model fit.

Table 1

Multilevel Fixed Effects Estimates for Ruminative Self-focus

	Model	
Predictor	1	2
BDI-II	0.169 (0.090)	0.183 (0.082)*
RSQ	0.028 (0.009)**	—
RSQ-B	—	0.113 (0.036)**
RSQ-R	—	0.005 (0.031)

Note. Analyses include all 3992 occasions. Models also include linear and quadratic effects of time of day and linear effect of day. Standard errors in parentheses. Asterisks indicate that the coefficient differs significantly from 0. BDI-II = Beck Depression Inventory–II (root transformed), RSQ = Ruminative Response Scale, RSQ-B = Ruminative Response Scale Brooding Subscale, RSQ-R = Ruminative Response Scale Reflection Subscale.

* $p < .05$. ** $p < .01$.

Table 2

Multilevel Fixed Effects Estimates for Concurrent Negative Affect

Predictor	Model	
	1	2
Dispositional variables		
BDI-II	0.458 (0.103)***	0.481 (0.095)***
RSQ	0.023 (0.010)*	—
RSQ-B	—	0.124 (0.040)**
RSQ-R	—	–0.056 (0.034)
Momentary variable		
Rum	0.494 (0.027)***	0.494 (0.027)***
Cross-level interaction		
Rum x BDI-II	0.059 (0.021)**	0.057 (0.021)**

Note. Analyses include all 3992 occasions. Model also includes linear and quadratic effects of time of day and linear effect of day. Standard errors in parentheses. Asterisks indicate that the coefficient differs significantly from 0. Rum = ruminative self-focus, BDI-II = Beck Depression Inventory–II (root transformed), RSQ = Ruminative Response Scale, RSQ-B = Ruminative Response Scale Brooding Subscale, RSQ-R = Ruminative Response Scale Reflection Subscale.

p < .05. ***p* < .001.

Table 3

Multilevel Fixed Effects Estimates for Cross-Lagged Bivariate Analysis

	Variable	
Predictor	T2 NA	T2 Rum
Dispositional variables		
BDI-II	0.386 (0.083)***	0.031 (0.066)
RSQ	0.023 (0.008)**	0.026 (0.006)***
Momentary variables		
T1 NA	0.298 (0.026)***	0.085 (0.020)***
T1 Rum	0.106 (0.026)***	0.174 (0.026)***

Note. Analyses include 2958 occasions. Model also includes linear and quadratic effects of time of day, linear effect of day, and time interval between subsequent observations. Standard errors in parentheses. Asterisks indicate that the coefficient differs significantly from 0. T2 NA = occasion-level negative affect at Time 2, T2 Rum = ruminative self-focus at Time 2, T1 NA = occasion-level negative affect at Time 1, T1 Rum = ruminative self-focus at Time 1, BDI-II = Beck Depression Inventory–II (root transformed), RSQ = Ruminative Response Scale.

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