ATTENTIONAL AND AFFECTIVE MECHANISMS IN WORRY AND RUMINATION

BY

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ABSTRACT

Negative repetitive thinking, such as worry and rumination, is considered a common risk factor for anxiety and depression. Compared to traditional research that has focused almost exclusively on the content and amount of worrying, Berenbaum (2010) proposed an initiation–termination (IT) two-phase model of worrying in which the initiation and termination phases of worry are differentiated. Extending the IT model to rumination, we aimed to explore cognitive and affective mechanisms involved in different phases of worry and rumination. We first examined the relationship between worry and rumination, focusing on testing the potential utility of the bi-factor model as an alternative to traditional "common" vs. "distinctive" approaches. Next, we examined the utility of new tools (i.e., laboratory tasks, ecological momentary assessment) developed to assess the initiation and termination phases of worry and rumination. Lastly, we investigated which attentional and executive processes, if any, are involved in the initiation and termination of worry and rumination, while considering the potential influence of negative temperament.

We found that the structural relationship between worry and rumination is best represented by a bi-factor model, which suggests that worry and rumination share certain common aspects (negative repetitive thinking), but that there are still unique aspects to each. In addition, we found that 1) worry and rumination are linked with different types of attentional bias (e.g., threat/danger, loss/failure), and 2) the initiation and termination phases are differentially associated with executive functions when taking negative temperament into account. This research highlights the potential value of paying attention to both common and unique aspects of worry and rumination and distinguishing different phases of worry and rumination when investigating the attentional and affective mechanisms involved.

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CHAPTER 1

INTRODUCTION

Worry, Rumination, Psychopathology

Repetitive and prolonged thinking is essentially a normal and adaptive process that everyone engages in, sometimes involving positive outcomes such as self-reflection or cognitive and emotional processing of an event (Segerstrom, Stanton, Alden, & Shortridge, 2003; Watkins, 2008). However, it can also have maladaptive and unconstructive consequences depending on some of its characteristics, such as the content of thoughts and their controllability (Segerstrom et al., 2003; Watkins, 2008). For example, persistent negative thinking, such as worry and rumination, is a hallmark feature of emotional disorders (Ruscio, Seitchik, Gentes, Jones, & Hallion, 2011; Watkins, 2008). Worry involves a stream of thoughts and images that are negatively valenced and relatively uncontrollable. It is concerned with future events that entail possible negative outcomes (Berenbaum, 2010; Borkovec, Robinson, Pruzinsky, & DePree, 1983) and it involves a subjective experience of unpleasantness (Berenbaum, 2010). Rumination is defined as repetitive, self-referential thinking on a theme related to personal goals and concerns in the absence of immediate external demands requiring such thinking (Martin & Tesser, 1996). It is mainly about past events, especially past loss or failure (Martin & Tesser, 1996; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008).

Worry and rumination are closely linked to psychopathology, particularly anxiety disorders and depression. Worry is a defining feature for anxiety disorders, especially generalized anxiety disorder (GAD) (Brown, Barlow, & Liebowitz, 1994). The main diagnostic criteria for GAD include “excessive worry” and “a sense of uncontrollability of worry” (American Psychiatric Association, 2013). Rumination is considered an important vulnerability

factor for depression (Smith & Alloy, 2009). Studies have shown that rumination is closely associated with the onset, duration, and severity of current depressive symptoms and is a strong predictor of future depressive episodes (Nolen-Hoeksema et al., 2008).

Although worry and rumination are distinguished in certain aspects (e.g., time-orientation) (Nolen-Hoeksema et al., 2008), they appear to share a considerable number of characteristics (Ruscio et al., 2011; Segerstrom et al., 2003; Watkins, 2008). For example, both are negatively valenced, repetitive thinking that are primarily verbal-linguistic (Stokes & Hirsch, 2010) and self-focused (Mor & Winquist, 2002). In particular, with an increased focus on the trans-diagnostic mechanisms underlying cognitive-affective dysfunctions across disorders, recent research proposes that worry and rumination represent a common core process of perseverative or repetitive thought and a tendency to engage in negative thinking in a repetitive, dyscontrolled manner (Ehring & Watkins, 2008; Segerstrom et al., 2003). Negative repetitive thinking is considered a common risk factor for the emotional difficulties observed in GAD and major depressive disorder (MDD) (Ruscio et al., 2011; Watkins, 2008).

Link Between Attentional and Executive Processes and Worry/Rumination

A growing body of research suggests a close link between impairments in executive functions and worry and rumination. For example, impaired performance on attention control tasks was associated with the increased frequency of intrusive thoughts (Verwoerd, de Jong, & Wessel, 2008; Wessel, Overwijk, Verwoerd, & de Vrieze, 2008). Similarly, individuals with greater working memory capacity showed enhanced suppression of negative thoughts (C. Brewin & Beaton, 2002; C. R. Brewin & Smart, 2005). Furthermore, Bredemeier and Berenbaum (2013) found that working memory deficits predicted changes in levels of worry over time, suggesting that working memory impairment may function as a risk factor for excessive worry. Rumination

has also been associated with deficits in executive functions (Von Hippel, Vasey, Gonda, & Stern, 2008; Whitmer & Banich, 2007). Even after controlling for depressive symptoms, rumination was associated with perseverative tendencies on the Wisconsin Card Sorting Task (Davis & Nolen-Hoeksema, 2000), leading the researchers to link rumination with "attentional inflexibility." Studies have shown that ruminators show difficulty shifting from current thoughts to other topics and updating their thinking with new ideas (Koster, De Lissnyder, Derakshan, & De Raedt, 2011) and suppressing automatic or prepotent responses.

Both worry and rumination have also been associated with attentional bias to negative information. Compared to controls, individuals with pathological worry (e.g., in GAD) show longer latencies to name the colors of threat words than neutral words, indicating that their attention is automatically grabbed by threat-related information (Becker, Rinck, Margraf, & Roth, 2001). Rumination has also been associated with an attentional bias, particularly for mood-congruent information (De Raedt & Koster, 2010; Donaldson, Lam, & Mathews, 2007; Leyman, De Raedt, Schacht, & Koster, 2007). Ruminators show difficulty preventing information from entering working memory (Joormann, 2004) as well as difficulty disengaging attention from negative materials (Joormann & Gotlib, 2008; Koster et al., 2011).

In investigating the attentional/cognitive processes involved in worry and rumination it is important to consider the modulating effect of affective factors, such as negative temperament. Negative temperament, defined as a tendency to experience negative emotions such as anxiety, anger, guilt, and depressed mood (Watson & Clark, 1984), has been shown to have an impairing effect on cognitive control. For example, recent findings examining brain activity during an emotional Stroop task indicated that negative temperament was associated with reduced activity in the left posterior DLPFC, which is involved in top-down, goal-directed control of attention

(Crocker et al., 2012). Similarly, high trait anxiety (a construct related to trait NA) was associated with deficient recruitment of DLPFC in a response-conflict task even in the absence of threat-related stimuli (Bishop, 2009).

Berenbaum (2010)'s Initiation – Termination Two-Phase Model of Worry

Berenbaum (2010) proposed an initiation–termination (IT) two-phase model of worrying in which the initiation and termination phases of worry are differentiated. He argued that worry should not be considered a static entity, but should instead be thought of as a dynamic process that unfolds over time (Berenbaum, 2010). Compared to traditional research that has focused on the content and the amount of time spent on worrying, the IT model suggests that the following three aspects of worrying need more attention: (a) how easily worrying is initiated; (b) how easily worrying is terminated; and (c) the pattern of worrying over time. Berenbaum (2010) further proposed that each phase is influenced by different cognitive-affective factors. In relation to worry initiation, he proposed that attention biases to threat contribute to the perception of threat and hence initiate worry. The strong association between attention bias toward threat and GAD supports this link (Mogg & Bradley, 2005). When it comes to worry termination, Berenbaum (2010) proposed that a perseverative-iterative style (Davey & Levy, 1998), the tendency to dwell on a topic of concern, leads to delayed/absent acceptance of the prospect of threat, which in turn contributes to delayed/absent worry termination. Although not explicitly mentioned, a perseverative-iterative style can relate to attention processes such as attentional control, since it may influence the ability to control and inhibit negative thoughts. To my knowledge, no such comprehensive cognitive model has been suggested in relation to rumination.

Overview of Research Questions and Studies

The overarching goal of the proposed research was to explore cognitive and affective mechanisms involved in worry and rumination. In Chapter 2, we examined the relationship between worry and rumination, focusing on testing the potential utility of the bi-factor model as an alternative to traditional "common" vs. "distinctive" approaches. In Chapter 3, we examined the utility of new tools (i.e., laboratory tasks, ecological momentary assessment) developed to assess the initiation and termination phases of worry and rumination. In Chapter 4, we investigated which attentional and executive processes, if any, are involved in the initiation and termination of worry and rumination, while considering the potential influence of negative temperament. The long-term goal of this program of research is to elucidate common and unique mechanisms involved in the development and maintenance of anxiety and depression, which may in turn inform the development of targeted interventions to reduce anxiety and depressive symptoms.

CHAPTER 2

A BI-FACTOR APPROACH TO MODELING THE STRUCTURE OF WORRY AND RUMINATION

Repetitive and prolonged thinking is essentially a normal and adaptive process that everyone engages in, sometimes involving positive outcomes such as self-reflection or cognitive and emotional processing of an event (Segerstrom et al., 2003; Watkins, 2008). However, it can also have maladaptive and unconstructive consequences depending on some of its characteristics, such as the content of thoughts and their controllability (Segerstrom et al., 2003; Watkins, 2008). Worry and rumination are examples of potentially maladaptive repetitive thinking. Worry involves a stream of thoughts and images that are negatively valenced and relatively uncontrollable. It is concerned with future events that entail possible negative outcomes and it involves a subjective experience of unpleasantness (Berenbaum, 2010; Borkovec et al., 1983). Rumination is defined as repetitive, self-referential thinking on a theme related to personal goals and concerns in the absence of immediate external demands requiring such thinking (Martin & Tesser, 1996). It is mainly about past events, especially past loss or failure (Martin & Tesser, 1996; Nolen-Hoeksema et al., 2008). Thus, worry and rumination are thought to differ in their content and temporal focus, such that worry concerns thoughts of future potential threat, whereas rumination concerns thoughts of past losses and failures (Borkovec et al., 1983; Martin & Tesser, 1996).

Negative repetitive thinking is a hallmark feature of emotional disorders (Ruscio et al., 2011; Watkins, 2008). Worry is a defining feature of anxiety disorders, especially generalized anxiety disorder (GAD) (Brown et al., 1994). The main diagnostic criteria for GAD include "excessive worry" and "a sense of uncontrollability of worry" (APA, 2013). Rumination, on the

other hand, is considered an important vulnerability factor for depression. Studies have shown that rumination is closely associated with the onset, duration, and severity of current depressive symptoms and is a strong predictor of future depressive episodes (Nolen-Hoeksema et al., 2008).

Whereas the majority of past research has focused on the unique and specific features of worry and rumination (Beck, Brown, Steer, Eidelson, & Riskind, 1987; Clark, Beck, & Brown, 1989), a number of recent studies have drawn attention to common characteristics shared by worry and rumination (McEvoy, Watson, Watkins, & Nathan, 2013; Ruscio et al., 2011; Segerstrom et al., 2003; Watkins, 2008). For example, both worry and rumination are primarily verbal-linguistic and involve self-focused negative thoughts (Mor & Winquist, 2002; Stokes & Hirsch, 2010). With an increased focus on the transdiagnostic mechanisms underlying cognitive-affective dysfunctions among mood and anxiety disorders, recent research proposes that worry and rumination represent a common core process of perseverative thought and a tendency to engage in negative thinking in a repetitive, uncontrolled manner (Segerstrom et al., 2003; Watkins, 2008). Similarly, whereas previous research suggested that worry was correlated more strongly with anxiety than with depression, and that rumination was correlated more strongly with depression than anxiety (Beck et al., 1987; Kendall & Ingram, 1989), recent studies found that "negative repetitive thinking" is a common risk factor for the emotional difficulties observed in both GAD and major depressive disorder (McEvoy et al., 2013; Ruscio et al., 2011; Watkins, 2008).

The nature of the relation between worry and rumination remains unclear. As described above, two major approaches that have been proposed in the literature thus far are: (1) worry and rumination are distinct entities (Beck et al., 1987; Clark et al., 1989); and (2) worry and rumination represent common functional processes (Ruscio et al., 2011). Alternatively, it is

possible that worry and rumination share some common characteristics, but there remain some unique aspects to each – in other words, a bi-factor structure. Investigation of a bi-factor model has proven to be effective in elucidating the complicated relationships among highly relevant psychological constructs. For example, the bi-factor model was successfully employed to describe the structural relationship of general and specific factors (e.g., interpersonal, affective, impulsivity) of psychopathy as assessed by the Psychopathy Checklist-Revised (Patrick, Hicks, Nichol, & Krueger, 2007). Similarly, a bi-factor model of ADHD latent symptom structure (with a general factor and specific factors of inattention and hyperactivity-impulsivity) was found to be superior to existing factor models of ADHD (Martel, Von Eye, & Nigg, 2010). To date, the structural relationship between worry and rumination has not been tested to examine whether it would be better explained by a bi-factor model.

The current study examined the relationship between worry and rumination, focusing on testing the potential utility of the bi-factor model as an alternative to traditional "common" vs. "distinctive" approaches. Specifically, we examined, using confirmatory factor analysis, the fit of three models, which are illustrated in Figure 1. First, the single-factor model posits that a common factor (negative repetitive thinking) represents all the worry and rumination items. This model is consistent with the recent proposal that worry and rumination share a common process that is characterized by negative perseverative thought (McEvoy et al., 2013; Ruscio et al., 2011; Watkins, 2008). Next, the two-factor model suggests that worry and rumination are highly correlated, but are fundamentally unique constructs (Beck et al., 1987; Clark et al., 1989). Finally, the bi-factor model includes a common factor (negative repetitive thinking) that saturates each specific worry and rumination item as well as separate worry-specific and rumination-specific

factors that capture unique variance of worry and rumination items. These three factors are uncorrelated.

Furthermore, to elucidate the nature of the constructs underlying the factors derived from the best fitting model, we examined how each of the factors in the best fitting model was associated with motivational traits (avoidance and approach temperament) and distinct anxiety/depression symptoms. Motivational traits are known to be closely related to individuals' stress responses and coping strategies across a broad range of situations. Considering that worry and rumination are a form of cognitive coping in the face of distress, delineating how the worry/rumination factors are associated with motivational traits has implications for advancing our understanding of their working mechanisms. Specifically, although heightened avoidance temperament has been implicated as a common risk factor for both worry and rumination (Manfredi et al., 2011), the degree to which this vulnerability factor is associated with the common vs. unique aspects of worry and rumination has not been tested. On the other hand, approach motivation (or positive temperament) has been associated with the enhanced ability to regulate negative emotions and the use of adaptive emotion regulation strategies (Hur et al., 2015; Nes & Segerstrom, 2006). As such, it is possible that approach motivation may function as a protective factor for negative repetitive thinking. The degree to which approach temperament is associated with worry and rumination remains an open question, however. In addition, given that worry and rumination have been frequently implicated as risk factors for a wide range of emotional disorders, it is important to elucidate how specific aspects of negative repetitive thinking are associated with anxiety and depression symptoms. Such investigation has the potential for advancing both current transdiagnostic and disorder-specific approaches in the assessment and treatment of mood and anxiety disorders.

METHOD

Participants

Five hundred sixty-four undergraduate students (71% female; mean age = 18.8 years) participated in the study for course credit. All participants provided informed consent. The research protocol was approved by the Institutional Review Board at the University of Illinois at Urbana-Champaign. Participants in this study were involved in a large screening project examining dimensions of personality and psychopathology. Although there is some overlap between the participants and a subset of the measures reported in this paper and those reported in Tengshe et al. (in preparation), they examine distinct questions using different approaches.

Self-Report Questionnaires

Worry and Rumination

Worry was measured using the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990). Participants rated how each of 16 statements describes them (e.g., "My worries overwhelm me") on a scale from 1 (*not at all typical*) to 5 (*very typical*). The PSWQ has excellent test-retest reliability, as well as good convergent and discriminant validity in undergraduate and clinical samples (Meyer, Miller, Metzger, & Borkovec, 1990; Nitschke, Heller, Imig, McDonald, & Miller, 2001). There was no missing data and the internal consistency in our sample was excellent (α =.94).

Rumination was measured using the rumination subscale of Rumination/Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999). Previous studies used the Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991), which primarily assessed individuals' responses to their depressive symptoms, possibly obscuring the relationship between rumination and depression. To assess rumination more accurately and precisely, the current study used a

rumination questionnaire (RRQ) that minimizes the use of symptom-specific terms. Participants rated how each of 12 statements describe them (e.g., "I tend to ruminate or dwell over things that happened to me for a really long time afterward") on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The rumination subscale has excellent test-retest reliability and convergent and discriminant validity in undergraduate and clinical samples (Ruscio et al., 2011; Segerstrom et al., 2003). There was one participant with missing data and the internal consistency in our sample was excellent (α =.93).

Approach and Avoidance Temperament

In order to measure approach and avoidance temperaments, we used the following three questionnaires: the Behavioral Activation and Behavioral Inhibition Scales (Carver & White, 1994), the Extraversion and Neuroticism sub-scales of the NEO-Five Factor Inventory (Costa Jr & McCrae, 1992), and the Positive and Negative Temperament sub-scales of the General Temperament Survey (Watson & Clark, 1993). Approach motivation is characterized by behaviors instigated or directed by a positive/desirable event or possibility, whereas avoidance motivation is characterized by behaviors instigated or directed by a negative/undesirable event or possibility (Elliot & Thrash, 2002).

1) Behavioral Activation and Behavioral Inhibition Scales. The Behavioral Activation Scale (BAS) is composed of 13 items, such as "When I see an opportunity for something I like, I get excited right away." The Behavioral Inhibition Scale (BIS) is composed of 7 items, such as "If I think something unpleasant is going to happen, I usually get pretty 'worked up.'" Each item was rated on a 1 (*strongly disagree*) to 4 (*strongly agree*) scale. The reliability and validity of these measures are well-documented (Carver & White, 1994). There

were 3 and 7 participants with missing data for the BAS and BIS, respectively. Internal consistency in our sample was adequate (α =.75 for BAS, α =.74 for BIS).

2) Extraversion and Neuroticism. Two sub-scales of the NEO-Five Factor Inventory (Costa Jr & McCrae, 1992) were used to assess extraversion and neuroticism: the 12-item Extraversion (NEO-E) and the 12-item Neuroticism (NEO-N) scales. The NEO-E scale consists of items such as "I like to be where the action is," whereas the NEO-N scale consists of items such as "When I'm under a great deal of stress, sometimes I feel like I'm going to pieces." Each item was rated on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale. The reliability and validity of these measures are well-established (Costa Jr & McCrae, 1992). There were 4 and 2 participants with missing data for the NEO-E and NEO-N scales, respectively. Internal consistency in our sample was excellent (α =.84 for NEO-E, α =.86 for NEO-N).

3) Positive and Negative Emotionality. The following subscales of the General Temperament Survey (Watson & Clark, 1993) were used to assess positive and negative emotionality: the 27-item Positive Temperament (GTS-PT) and the 28-item Negative Temperament (GTS-NT) scales. The GTS-PT consists of items such as "I often feel lively and cheerful for no good reason," whereas the GTS-NT consists of items such as "I can get very upset when little things don't go my way." Each item was coded 0 (false) or 1 (true).
The reliability and validity of these measures are well-established (Watson & Clark, 1993). There were 48 and 49 participants with missing data for the GTS-PT and GTS-NT scales, respectively. Internal consistency in our sample was excellent (α =.90 for GTS-PT, α =.94 for GTS-NT).

Depression and Anxious Arousal Symptoms

Anhedonic depression was measured using the relevant 22-item (e.g., "felt like nothing was very enjoyable", "felt really slowed down") scale of the Mood and Anxiety Symptoms Questionnaire (MASQ; Watson, Clark, et al., 1995; Watson, Weber, et al., 1995). Anxious arousal was measured using the relevant 17-item (e.g., "Startled easily"; "Was trembling or shaking") MASQ scale. Research has indicated that these scales have good convergent and discriminant validity in undergraduate and community samples and are psychometrically and physiologically distinct constructs from worry (Engels et al., 2007; Engels et al., 2010; Keller et al., 2000; Nitschke et al., 2001; Watson et al., 1995). Each item was rated on a 1 (*not at all*) to 5 (*extremely*) scale. There was no missing data for these measures. Internal consistency in our sample was good (α =.86 for anxious arousal, α =.78 for anhedonic depression).

Analytic Strategy

Confirmatory factor analysis (CFA) was used to examine the fit of the three worry/rumination models (i.e., single factor, two-factor, and bi-factor model). Model fit was evaluated using commonly used fit indices: the chi-square (χ^2) fit statistic, the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). The Chi-Square ($\chi 2$) value is the traditional measure for evaluating overall model fit, assessing the magnitude of discrepancy between the sample and fitted covariances matrices (Hu & Bentler, 1999). The CFI takes into consideration model complexity and reflects the extent to which the current model fit is better than a model in which the variables are constrained to be uncorrelated (Tabachnick & Fidell, 2007). The RMSEA also accounts for model complexity and reflects the extent to which the model-implied covariance matrix fits the predicted population covariance matrix (Hooper, Coughlan, & Mullen, 2008). Chi-square values ranging between 2.0 and 5.0 indicate a good model fit (Tabachnick & Fidell, 2001). CFI values greater than .95 (Hu & Bentler, 1999) and

RMSEA values less than .08 indicate a good fit to the data, while values less than .05 indicate a very good fit (Hooper, Coughlan, & Mullen, 2008). Models were fit using the `lavaan` package in R (Rosseel, 2012), treating the data as ordered categorical data using a weighted least squares estimator (Muthén, 1984). This was done to accommodate the likelihood of non-equal interval lengths in the Likert-scaled data. The χ^2 difference test was used to directly compare the three proposed models and identify the best fitting model.

Once the best fitting model was identified, we next used a structural equation modeling (SEM) approach to evaluate its descriptive validity by estimating the associations between the PSWQ/RRQ factors (derived from the best fitting model) and approach/avoidance temperaments and anxiety/depression symptoms. Approach and avoidance temperament latent variables were modeled following Elliot and Thrash's (2002) and Spielberg et al.'s (2011) CFA model. GTS-PT, NEO-E, and BAS scales were indicators for approach temperament; GTS-NT, NEO-N, and BIS scales were indicators for avoidance temperament. Maximum likelihood estimation was used and the factor loadings were derived from the current sample. The latent factors of avoidance and approach temperament and the self-reported anxiety/depression symptom measures were incorporated into the structural model of PSWQ/RRQ items. This approach has several advantages. First, because the PSWQ/RRQ factors are modeled as latent variables, measurement errors were controlled for, maximizing the effect sizes with personality latent factors and anxiety/depression symptoms. Second, since the structural modeling approach allowed for missing data with categorical data using a pairwise present approach, both the information obtained from the sample and the sample size were maximized, yielding more accurate parameter estimates than listwise deletion (Asparouhov & Muthén, 2010). Two analytic approaches were used: (1) entering each criterion variable into the model separately; and (2)

entering all four criterion variables into the model simultaneously. All analyses were conducted using the `lavaan` package in R (Rosseel, 2012).

RESULTS

Confirmatory Factor Analyses

Table 1 shows the fit statistics and specific details for the competing factor models of the PSWQ/RRQ items. Among the three models, the bi-factor model was the best fitting model to the data. Specifically, the two-factor model showed an improved fit to the data compared to the single-factor model, $\Delta \chi^2(1) = 2268.93$, $p < .001$, and the bi-factor model showed an improved fit compared to the two-factor model, $\Delta \chi^2(22) = 518.46$, $p < .001$. This suggests that worry and rumination share certain common aspects (negative repetitive thinking) but there are still some unique aspects to each. The bi-factor model provides an adequate to good fit for all item sets.

Table 2 shows the standardized factor loadings for the bi-factor model for each of the PSWQ/RRQ items. Within the bi-factor model, all the PWSQ and RRQ items loaded significantly on the common factor (negative repetitive thinking), which indicates that the common factor variance accounts for the internal consistency and homogeneity of the PSWQ/RRQ items. All PSWQ items loaded significantly on the other factor (worry specific) that was orthogonal to the common factor. All RRQ items except one ("My attention is often focused on aspects of myself I wish I'd stop thinking about") loaded significantly on the other factor (rumination-specific) that was orthogonal to the common factor.

Descriptive Validity of the PSWQ/RRQ Factors Model

Table 3 shows the structural associations between the PSWQ/RRQ factors and the approach/avoidance temperaments and symptom measures. When each criterion variable was entered separately, the common factor (negative repetitive thinking) was significantly correlated

with all four criterion variables. Specifically, it showed a very strong positive relationship with avoidance temperament and a moderate negative relationship with approach temperament. In addition, it showed a strong positive relationship with anhedonic depression and a modest positive relationship with anxious arousal. The worry-specific factor showed a modest positive relationship with both avoidance and approach temperaments and a weak positive relationship with anxious arousal. It was not correlated with anhedonic depression. The rumination-specific factor showed a weak negative relationship with approach temperament, and was not significantly correlated with the other criterion variables. When all four criterion variables were entered into the model simultaneously, all the results stayed the same except that the significantly negative correlation between the rumination-specific factor and approach temperament disappeared.

DISCUSSION

The findings of the present study suggest that the structural relationship between worry and rumination is best represented by a bi-factor model. The bi-factor model suggests that worry and rumination appear to be comprised of a single factor that captures common variance in worry and rumination, as well as separate worry-specific and rumination-specific factors that capture unique variance. Without establishing the structural relationship between worry and rumination, findings focusing on either the unique aspects of worry and rumination or the common functionality are inherently limited. The bi-factor conceptualization provides a framework for reconciling the diverging perspectives regarding worry and rumination, suggesting the need to pay attention to both common and unique aspects of worry and rumination.

Within the bi-factor model, the common factor (negative repetitive thinking) showed a strong, positive correlation with avoidance temperament and a moderate, negative correlation with approach temperament. Research has proposed the importance of avoidance temperament for the development and maintenance of emotional disorders (Dickson & MacLeod, 2004; Hur et al., 2015; Spielberg et al., 2011). The present findings suggest that avoidance temperament may function as a critical risk factor for negative repetitive thinking. This result is consistent with the finding of Ruscio et al. (2011) that pervasive thought, measured by negative thought intrusions during a focused breathing task, was positively correlated with negative affective temperament. In addition, the present findings suggest that high levels of approach temperament may function as a broader, protective factor against negative repetitive thinking. This result is consistent with previous research showing that approach motivation is associated with enhanced ability to regulate negative emotions and the use of adaptive emotion regulation strategies, such as reappraisal (Hur et al., 2015; Nes & Segerstrom, 2006).

The common factor was also positively correlated with both anxiety and depression symptoms, suggesting that negative repetitive thinking represents a common cognitive vulnerability for both anxiety and depression. This result is consistent with emerging evidence suggesting that negative repetitive thinking is a transdiagnostic process that confers risk for multiple emotional disorders and their comorbidity (McEvoy et al., 2013; Ruscio et al., 2011). Taken together, it is possible that avoidance temperament and negative repetitive thinking may function as distal and proximal risk factors for emotional disorders, respectively.

The worry-specific factor was positively correlated with both avoidance and approach temperament. Past research has consistently found a link between avoidance temperament and worry (Davidson, 2002; Spielberg et al., 2011), but our results suggest that worry is also

associated with approach motivation. This result is not only consistent with Spielberg et al.'s (2011) finding that worry (measured by PSWQ) is positively associated with approach temperament, but also further demonstrates that it is the unique features of worry, above and beyond the common factor, that is responsible for the association. This finding also reveals how worry is distinct from rumination. Unlike rumination, worry may be a means by which individuals cope with uncertainty by attempting to increase their sense of certainty and preparedness (Segerstrom et al., 2003). Thus, worry may represent a motivation to avoid negative future events, but also involve motivation to approach the situation in order to reduce uncertainty. It is also possible that the future oriented process of worry is linked to approach motivation. Some cognitive features related to prospection (e.g., simulation, prediction, and planning) that are involved in worry may be driven by motivation to achieve personally valued future goals (Szpunar, Spreng, & Schacter, 2014). The worry-specific factor was also positively correlated with anxiety symptoms, but not with depressive symptoms, which replicates previous findings (Beck et al., 1987; Kendall & Ingram, 1989).

The rumination-specific factor was negatively correlated with approach temperament (although this effect disappeared when all criterion variables were entered into the model). This result is consistent with previous findings that rumination is linked with behavioral and experimental avoidance (Giorgio et al., 2010). It will be important for future research to explore other variables that may be associated with the rumination-specific factor. For example, we hypothesize that the rumination-specific factor is associated with: (a) past-oriented negative thinking that is characterized by excessive self-criticism and self-blaming; and (b) negatively biased interpretation of situations (e.g., minimizing positives, overgeneralizing failure). These characteristics may contribute to reduced self-confidence and optimism, which in turn, lead to

low motivation to approach problem situations. In contrast to previous findings that showed rumination is specifically linked to depression (Beck et al., 1987; Kendall & Ingram, 1989), the rumination-specific factor was not correlated with depressive symptoms. Our finding therefore suggests that the common process involved in negative repetitive thinking, rather than rumination-specific features, is a risk factor for depression.

Given that the current findings are based on specific self-report measures (i.e., PSWQ, RRQ), future research should examine if the bi-factor model holds using different questionnaires or laboratory-based measures (Rapee, 1993; Ruscio et al., 2011). Of course, a great deal of research is needed to further our understanding of the nature and significance of the three orthogonal factors (i.e., negative repetitive thinking, worry-specific, rumination-specific). It would be valuable to explore potential attentional (e.g., deficits in attention control, negative attentional bias) and affective (e.g., negative temperament, mood) variables that may contribute to each factor. In addition, future research is warranted to examine how motivational contexts and individual differences in motivational temperaments confer risk for negative repetitive thinking, worry-specific and rumination-specific cognitions, and in turn contribute to the development and maintenance of mood and anxiety disorders and their comorbidity. It would be also valuable to build on the present research by including positive and neutral repetitive thinking (e.g., self-reflection, future-oriented positive thinking) to elucidate the common and specific elements for all forms of repetitive thinking. What is learned from such research has the potential to be incorporated into transdiagnostic approaches to emotional disorders and to further inform the development of more effective and individualized interventions for individuals with anxiety and depression.

CHAPTER 3

DEVELOPMENT OF NEW INSTRUMENTS FOR MEASURING THE INITIATION AND TERMINATION OF WORRY AND RUMINATION

Worry and rumination are examples of maladaptive repetitive thinking that are important vulnerability factors for emotional disorders, such as generalized anxiety disorder (GAD) and major depressive disorder (MDD) (Ruscio et al., 2011; Smith & Alloy, 2009; Watkins, 2008). Worry involves a stream of thoughts and images that are negatively valenced and relatively uncontrollable. It is concerned with future events that entail possible negative outcomes (Berenbaum, 2010; Borkovec et al., 1983). Rumination is defined as repetitive, self-referential thinking on a theme related to personal goals and concerns in the absence of immediate external demands that require such thinking (Martin & Tesser, 1996; Watkins, 2008). It is mainly about past events, especially past loss or failure (Kirkegaard Thomsen, 2006; Nolen-Hoeksema et al., 2008; Papageorgiou, 2006; Segerstrom et al., 2003).

Until quite recently, there have been two opposing perspectives regarding the structural relationship between worry and rumination. The "traditional view" (Beck et al., 1987; Clark et al., 1989) proposes that worry and rumination are distinct constructs, focusing on their unique and specific features (e.g., worry concerns future potential threat, whereas rumination concerns past loss or failure). In contrast, the "common view" (Segerstrom et al., 2003; Watkins, 2008) proposes that worry and rumination represent a common core process of perseverative thought and a tendency to engage in negative thinking in a repetitive, uncontrolled manner. These two opposing views were recently reconciled by using a bi-factor approach in which worry and rumination share certain common aspects, while there remain some unique aspects to each (see Chapter 2). Confirmatory factor analyses indicated that the structural relationship between worry

and rumination was better represented by a bi-factor model than by a single-factor or a two-factor model (see Chapter 2). The bi-factor conceptualization provides a framework for reconciling the diverging perspectives regarding worry and rumination, suggesting the need to pay attention to both common and unique aspects of worry and rumination. This model is also useful for identifying the psychological correlates of the common and specific components of worry and rumination.

Research on worry and rumination has focused almost exclusively on the content and amount of worrying/ruminating. More recently, however, Berenbaum (2010) proposed an initiation–termination (IT) two-phase model of worrying in which the initiation and termination phases of worry are differentiated. He argued that worry should not be considered a static entity, but should instead be thought of as a dynamic process that unfolds over time (Berenbaum, 2010). The IT model suggests that the following three aspects of worrying need more attention: (a) how easily worrying is initiated; (b) how easily worrying is terminated; and (c) the pattern of worrying over time. Berenbaum (2010) further proposed that each phase is influenced by different cognitive-affective factors. An initial test of the IT model of worry using ecological momentary assessment found that: (a) worry initiation and termination incrementally predicted global worry and GAD symptom severity; and (b) worry initiation and termination were differentially associated with worry beliefs and with the perceived costs of undesirable outcomes (Berenbaum et al., under review). These results highlight the potential value of distinguishing between the initiation and termination of worrying.

Although Berenbaum's (2010) model was formulated in relation to worry, it is possible to extend the model to rumination. Similar to worry, it is possible that different cognitive-affective factors are associated with the initiation and termination phases of rumination. Regardless of the

degree to which the specific predictions made by the IT model prove to be accurate, there can be little doubt that the initiation of repetitive thinking can be distinguished from the termination of repetitive thinking. As a result, for the purpose of studying the initiation and termination of repetitive thinking, it will be valuable to have tools to measure them.

Although questionnaires and interviews are commonly used for assessing worry and rumination (Meyer et al., 1990; Sheehan et al., 2001; Trapnell & Campbell, 1999), none of them differentiates the different phases of worry and rumination. Two alternative strategies for capturing the different phases of worry and rumination are laboratory tasks and ecological momentary assessment (EMA). Several studies have used laboratory tasks to measure individuals' worry and rumination patterns. For example, repetitive negative thoughts were measured via thought sampling during a focused breathing task (FBT; Borkovec et al., 1983; Ruscio et al., 2011). During 5 minutes of FBT, participants were signaled four times at varying intervals (from 30 to 120 seconds apart); at each signal, they answered a set of questions that assessed whether they were engaging in negative thoughts at the moment. Although FBT showed good predictive validity (Ruscio et al., 2011), it remains unclear whether what is captured during FBT is specific to the ease of initiating negative thoughts, difficulty terminating those thoughts, or both. In addition, studies using FBT did not differentiate worry and rumination but rather assessed negative automatic thoughts. In other studies (Eysenck, 1984; Rapee, 1993), worry was measured during a thinking period during which participants were instructed to simply worry about the worry topic they had previously identified. During the 5-minute thinking period, an auditory stimulus (e.g., beep sound) was presented every 15 seconds and participants answered whether they had been worrying when the signal occurred. Although Eysenck (1984) showed the modulation effect by trait NA and state NA on different time points of the worry process (e.g.,

initial 75 seconds vs. later), his experiment was not designed to capture individual differences in worry initiation and termination. These studies did not assess rumination.

Another strategy to consider is EMA. Unlike questionnaires and laboratory tasks, which are limited by recall bias and not well suited to capture behavioral changes over time and across contexts, EMA involves repeated sampling of participants' behaviors and experiences in real time in the contexts in which they naturally occur (Shiffman, Stone, & Hufford, 2008). Given that worry and rumination are cognitive processes that are commonly experienced in real-life contexts, using this approach has the potential for more precisely and meaningfully capturing individuals' actual patterns of worry and rumination. Thus far, there has been one study that used EMA to measure different phases of worry (Berenbaum et al., submitted). In their study, each participant was given a handheld electronic device that delivered prompts by emitting an audible beep. Participants were prompted six times per day over the course of one week. At each prompt, participants were asked whether they had been worrying about something new since the last prompt (an index of ease of worry initiation) or about the same thing they were worried about in the last prompt (an index of difficulty with worry termination). Berenbaum et al. found that the indices of worry initiation and worry termination incrementally predicted global worry and General Anxiety Disorder symptom severity. In their study, rumination was not measured either.

In this study, we developed laboratory instruments and EMA measures to enable the examination of the initiation and termination of worry and rumination. We modified an FBT task that had been used by Borkovec et al. (1983) and Ruscio and Borkovec (2004) in order to capture individual differences in the ease of worry and rumination initiation. We modified (Eysenck, 1984; Rapee, 1993) assessment of the worry process as a way to measure participants' difficulty terminating worry and rumination. As an alternative approach, these constructs were

also measured using EMA. For EMA, we largely adopted Berenbaum et al.'s (submitted) method but expanded it to measure rumination in addition to worry.

The goal of this study was to examine laboratory and EMA measures of the initiation and the termination of both worry and rumination. We examined how these measures would be associated with factor scores derived from the bi-factor model (i.e., common factor, worry-specific, rumination-specific) using the self-report questionnaires. In addition we examined how these measures would be associated with each other. We were especially interested in exploring the degree to which these two alternative measurement approaches (lab vs. EMA) would distinguish between: (a) worry and rumination; and (b) initiation and termination.

METHOD

Participants

Participants were 46 undergraduate students (66.7% female; mean age = 20.3 years). The majority of participants (59.1%) were White, followed by 29.5% Asian, and 9.1% African American; 2.3% chose to describe themselves as "other." All participants completed a voluntary informed consent at the start of the session and received monetary compensation for their participation. The research protocol was approved by the university institutional review board. Participants were tested individually.

Self-Report Questionnaires

Worry was measured using the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990). Participants rated how each of 16 statements described them (e.g., "My worries overwhelm me") on a scale from 1 (*not at all typical*) to 5 (*very typical*). The PSWQ has excellent test-retest reliability as well as good convergent and discriminant validity in

undergraduate and clinical samples (Meyer et al., 1990; Nitschke et al., 2001). There was no missing data and the internal consistency in our sample was excellent (α =.90).

Rumination was measured using the rumination subscale of Rumination/Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999). Participants rated how each of 12 statements described them (e.g., I tend to ruminate or dwell over things that happened to me for a really long time afterward") on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The rumination subscale has excellent test-retest reliability and convergent and discrimination validity in undergraduate and clinical samples (Ruscio et al., 2011; Segerstrom et al., 2003). There was no missing data and the internal consistency in our sample was good (α =.87).

The PSWQ and RRQ were used in confirmatory factor analysis as a means of generating common, worry-specific, and rumination specific scores. Based on previous research (see Chapter 2), the bi-factor model was fit using the `lavaan` package in R (Rosseel, 2012), treating the data as ordered categorical data using a weighted least squares estimator (Muthén, 1984) (see Figure 1 in Chapter 2). This model included a common factor (negative repetitive thinking) that saturates each specific worry and rumination item as well as separate worry-specific and rumination-specific factors that capture unique variance of worry and rumination items. These three factors are uncorrelated. Three factor scores (common, worry-specific, and rumination-specific factors) were extracted with the regression method.

Laboratory Assessment of Initiation and Termination of Worry/Rumination

Worry Initiation Task

To measure worry initiation, participants engaged in three trials of a quiet time (QT) task, each of which was preceded by a brief priming phase. The QT task was adapted from the Focused Breathing Task by Borkovec et al. (1983) and Ruscio and Borkovec (2004). During the

QT, which lasted one minute, participants were instructed to close their eyes and pay attention to their breathing. They were signaled twice (first after 30 seconds, and then again after 1 minute) and, at each signal, participants were first asked to indicate whether they had been engaging in some thoughts at least some of the time during the preceding 30 seconds. If they answered affirmatively, they were asked the following questions: (a) whether these thoughts were positive, negative, or neutral; (b) whether what they were thinking about concerned something that happened in the past; and (c) whether what they were thinking about something that could happen in the future. Participants who indicated that they were thinking about something negative that could happen in the future were judged to have initiated worry.

A brief priming phase preceded the QT task in order to avoid obtaining skewed data (i.e., a lot of individuals showing no initiation of worry) and capture a wide range of initiation proneness. The priming phase was composed of reading some bogus statistics and a personal narrative. The bogus statistics described high probabilities of the occurrence of negative events. It was written in such a way that the statistics were from a survey of undergraduates, and the contents involved topics that undergraduates could easily engage in. The personal narrative was a short paragraph consisting of a stream of thoughts about possible negative future events. The narrative was written in an ambiguous way (in terms of context) to prevent the story from invoking any strong emotions. The bogus statistics and personal narratives fell into one of the following categories of concern: study/work, social/relationships, and financial, each of which varied in topics and contents for each trial.

For each trial of the worry initiation task, the ease of worry initiation was measured on a scale from 0 to 3 (0 = not initiated at either 1st or 2nd beep; 1 = initiated worry only at 2nd beep; 2

= initiated worry only at 1st beep, 3 = initiated worry at both 1st and 2nd beeps). The index of ease of worry initiation was measured by adding the scores from all three QT trials.

Rumination Initiation Task

The rumination initiation task was almost identical to the worry initiation task, with one exception -- the content of the bogus statistics and personal narrative during the priming phase differed. Specifically, the bogus statistics used for the worry initiation task described high probabilities of future negative events, whereas the bogus statistics used for the rumination initiation task described past negative events. The narrative used for the worry initiation task was mostly composed of a chain of thoughts concerning possible future negative events, whereas the narrative used for the rumination initiation task was mostly composed of a chain of thoughts concerning past negative events.

During the QT, participants who indicated that they were thinking about something negative that happened in the past were judged to have initiated rumination. For each trial of the rumination initiation task, the ease of rumination initiation was measured on a scale from 0 to 3 (0 = not initiated at either 1st or 2nd beep; 1 = initiated rumination only at 2nd beep; 2 = initiated rumination only at 1st beep, 3 = initiated rumination at both 1st and 2nd beeps). The index of ease of rumination initiation was measured by adding the scores from all three QT trials of QT.

Worry Termination Task

To measure worry termination, participants engaged in two trials of a thinking period, during which participants were instructed to worry about their worry topic (see details below). The procedure for the thinking period was adapted mainly from Eysenck's (1984) and Rapee's (1993) assessment of the worry process. Participants were first asked to think of three current worries. These worries were to be of moderate and comparable intensity. Participants wrote a

brief description of each worry and categorized the content of their worry topics as work/study, social/relationships, physical, financial or other. They rated the intensity of each worry on a 100-point scale ranging from 0 (*not worrying at all*) to 100 (*the most worrying thing you can possibly imagine*). The experimenter reviewed the three worry topics and chose two that fell within a moderate range of intensity (between 40 and 80) and were distinct from each other. Any participants who mentioned more than two worries outside this range were asked to think of other moderate-intensity worries.

The experimenter and the participant then discussed the first worry topic for around 1 minute to remind the participant of all salient aspects. This process was designed to make sure the vast majority of participants began worrying. During the thinking period, which lasted 3 minutes, participants were instructed to worry about the topic just discussed with their eyes closed. Participants were signaled six times (every 30 seconds) at which time they were to indicate what they were doing at the time of the signal. At each signal, participants were first asked, "Since you started this exercise (or since the last beep), have you been worrying continuously?" Participants indicated one of the following: (1) Yes, I have been worrying continuously, (2) No, I stopped worrying, but then I started up worrying again, or (3) No, I stopped worrying and did not start again. They were then asked to indicate how much of the time they had been worrying on a scale of 1 (*not at all*) to 5 (*the entire time*). At the end of the task, participants were asked how difficult they found it to stop worrying during the exercise on a scale of 1 (*not at all*) to 5 (*extremely*).

This whole procedure, which was considered a trial, was repeated for the second worry topic. For each trial, a composite score was created by averaging the z-scores of the following variables that were highly correlated (correlations ranged from 0.6 to 0.9): the frequency of

continuing worrying, the time spent on worrying, and difficulty stopping worrying. The index of difficulty with worry termination was measured by adding the composite scores from the two trials.

Rumination Termination Task

The rumination termination task was almost identical to the worry termination task except for two things. First, instead of indicating worry topics, participants were asked to think of three current ruminations: things that happened in the past that currently concern them and that they have been dwelling on (e.g., something they did that they wish they had not done and/or something they did not do but wish they had). Two of the three rumination topics were selected for the rumination termination task (the ones that fell in the moderate range of intensity). During the thinking period, participants were instructed to dwell on the topic previously identified with their eyes closed.

Second, the questions asked during the thinking period differed. At each signal, participants were first asked, "Since you started this exercise (or since the last beep), have you been thinking continuously about something negative that happened in the past?" Participants indicated one of the following: (1) Yes, I have been dwelling on what happened in the past continuously, (2) No, I stopped thinking about what happened in the past, but then I started it up again, or (3) No, I stopped thinking about what happened in the past and did not start again. They were then asked how much of the time they had been dwelling on something negative that happened in the past on a scale of 1 (*not at all*) to 5 (*the entire time*). At the end of the task, participants were asked how difficult they found it to stop thinking about something negative that happened in the past on a scale of 1 (*not at all*) to 5 (*extremely*).

This whole procedure, which was considered a trial, was repeated for the second rumination topic. For each trial, a composite score was created by averaging the z-scores of the following variables that were highly correlated (correlations ranged from 0.6 to 0.9): the frequency of continual ruminating, the time spent on ruminating, and the difficulty to stop ruminating. The index of difficulty with rumination termination was measured by adding the composite scores from the two trials.

Ecological Momentary Assessment of Initiation and Termination of Worry/Rumination

Survey signals were generated using Qualtrics software (2005, Provo) and were delivered as a text message through participants' smartphones. The text message contained a survey link that included a series of questions about worry and rumination. Participants were prompted six times per day over the course of five consecutive days. Participants were allowed to choose the time frame (8am – 11pm, 9am – 12pm, 10am – 1am or 11am – 2am) they would prefer, all of which covered 15 hours per day. Prompts were randomly dispersed within two and a half hour time periods throughout the day, such that one message would occur within every two and a half hour time period (i.e., one message between 10AM – 12:30PM, and the next message sent between 12:30PM – 3PM, etc). Prompts occurred as few as 150 and as many as 198 minutes apart (M = 181, SD = 32). Participants were given up to 20 minutes to respond to each prompt and subsequent series of questions. When participants did not respond, the survey link for that prompt expired, recording missing data for that prompt. Participants responded to between 13 and 30 prompts (M = 24.6, SD = 4.0) out of a total of 30 prompts. Response rate to prompts was not significantly correlated with either PSWQ (r = .18, p > .2) or RRQ (r = .22, p > .1) scores.

At each prompt, participants were asked a set of worry and rumination related questions. The order of questions (worry vs. rumination) was counterbalanced. For worry, participants were

first asked whether they had worried at any time since the last prompt. If they had worried, participants were asked: (a) during the most recent block of time (since the last message), whether they started worrying about anything new that they had not been worrying about during the preceding block of time (0 = *no*, 1 = *yes*); (b) during the most recent block of time (since the last message), whether they continued worrying about something that they had already been worrying about during the preceding block of time (1 = *No, I have not been worrying about anything that I had already been worrying about during the preceding block of time*; 2 = *Yes, I have been worrying about something that I had already been worrying about during the preceding block of time, but it has been off and on*; 3 = *Yes, I have been worrying about something that I had already been worrying about during the preceding block of time, and I have worried about it continuously*); (c) since the last message, how difficult it has been to stop worrying (0 = *not at all difficult* to 5 = *I was unable to stop worrying*); and (d) since the last message, how much of the time had they been worrying?" (0 = *never* to 4 =*all of the time*).

Due to the nature of the questions asked (using the time frame of "since the last message"), the first prompted message of the day did not include question (a) or question (b). The first question asked (i.e., whether they worried since they woke up) was instead used for assessing the initiation of worry. If participants reported not having worried since the last message, they were asked the same questions, but regarding the last time they had worried. These responses were not included in the analyses; they were included to discourage participants from reporting they had not worried as a strategy to have to answer fewer questions.

The proportion of prompts on which participants had new worries (question a), which was adjusted based on the number of prompts to which they responded, was used as an index of ease of worry initiation. As an index of difficulty with worry termination, a composite score was

created by averaging the z-scores of the following variables that were highly correlated (correlations ranged from 0.6 to 0.8): 1) proportion of prompts on which they had continuing worries (question b), adjusted based on the number of prompts responded to, 2) difficulty stopping worrying (question c), and 3) the time spent worrying (question d).

The rumination questions were structured in the exact same way. First participants were asked whether they had ruminated at any time since the last prompt. If they had ruminated, participants were asked the following questions: (a) during the most recent block of time (since the last message), whether they started ruminating about anything new that they had not been worrying about during the preceding block of time (0 = *no*, 1 = *yes*); (b) during the most recent block of time (since the last message), whether they continued ruminating about something that they had already been ruminating about during the preceding block of time (1 = *No, I have not been ruminating about anything that I had already been ruminating about during the preceding block of time*; 2 = *Yes, I have been ruminating about something that I had already been ruminating about during the preceding block of time, but it has been off and on*; 3 = *Yes, I have been ruminating about something that I had already been ruminating about during the preceding block of time, and I have ruminated about it continuously*); (c) since the last message, how difficult has it been to stop ruminating (0 = *not at all difficult* to 5 = *I was unable to stop ruminating*); and (d) since the last message, how much of the time have they been ruminating? (0 = *never* to 4 = *all of the time*).

The proportion of prompts on which participants reported new ruminations (question a), adjusted based on the number of prompts to which they responded, was used as an index of ease of rumination initiation. As an index of difficulty with rumination termination, a composite score was created by averaging the z-scores of the following variables that were highly correlated

(correlations ranged from 0.6 to 0.8): 1) proportion of prompts on which they had continuing ruminations (question b), adjusted based on the number of prompts responded to, 2) difficulty to stop ruminating (question c), and 3) the time spent on ruminating (question d).

RESULTS

Descriptive Statistics

Table 4 shows descriptive statistics for all variables used. As mentioned, worry termination was measured by creating a composite score of the z-scores of 1) frequency of continual worrying, 2) the time spent on worrying, and 3) the difficulty to stop worrying. Rumination termination was measured by creating a composite score of the z-scores of 1) frequency of continual ruminating, 2) the time spent on ruminating, and 3) the difficulty to stop ruminating. The following final variables were positively skewed and thus log-transformed: Lab rumination initiation, EMA worry initiation, EMA rumination initiation, EMA rumination termination.

Correlations Between LAB/EMA Measures and Factor Scores From Bi-factor Model

We first examined the relationship between each measure from the LAB and EMA and the factor scores derived from the bi-factor model (i.e., common factor, worry-specific, rumination-specific) using the self-report measures to assess the degree to which LAB/EMA worry and rumination measures tap into the common vs. specific factors of worry and rumination. As can be seen in Table 5, in general, LAB measures, compared to EMA measures, showed better specificity in measuring worry vs. rumination features. That is, LAB worry measures of initiation and termination were highly correlated with a worry-specific factor, but not with a rumination-specific factor. LAB rumination measures of initiation and termination were highly correlated with a rumination-specific factor, but not with a worry-specific factor.

On the other hand, EMA worry measures of initiation and termination were most highly correlated with a repetitive thinking factor (as opposed to worry-specific and rumination-specific factors,) although EMA worry termination showed a higher correlation with a worry-specific factor score than with a rumination-specific factor. EMA rumination termination was highly correlated with both repetitive thinking and rumination-specific factors. EMA rumination initiation was not correlated with any of the bi-factor scores.

Correlations Between LAB and EMA Measures

We next examined the relationship among and between LAB and EMA initiation and termination measures. As can be seen in Table 6, LAB measures did not show good specificity in measuring the initiation vs. termination phases of worry and rumination. For example, LAB worry initiation was strongly correlated with LAB worry termination and LAB rumination initiation was strongly correlated with LAB rumination termination. On the other hand, EMA measures showed good specificity in measuring the initiation vs. termination phases of worry and rumination. The strongest correlations were found between EMA worry initiation and rumination initiation and between EMA worry termination and rumination termination. EMA worry initiation was not significantly correlated with EMA worry termination; and EMA rumination initiation was not significantly correlated with rumination termination.

When compared across LAB and EMA measures, the only measure that showed good specificity of tapping initiation vs. termination was the LAB rumination termination task; LAB rumination termination was highly correlated with EMA rumination termination but not with EMA rumination initiation. On the other hand, other tasks show less specificity. For example, LAB worry termination was highly correlated with EMA worry termination but it was also highly correlated with EMA worry initiation. LAB worry initiation was more strongly correlated

with EMA worry termination than with EMA worry initiation. LAB rumination initiation did not show significant correlation with either EMA rumination initiation or termination.

DISCUSSION

Based on Berenbaum's (2010) IT model, two alternative measures (i.e., LAB and EMA) were developed to assess the initiation and termination phases of worry and rumination. We explored the utility of these measures by examining 1) their ability to measure worry vs. rumination specific features, and 2) specificity in tapping initiation vs. termination phases of worry and rumination. The results of this research highlight the potential value of these new measurements as well as their relative strengths and weaknesses.

The LAB measure showed good specificity in measuring worry vs. rumination. This may reflect the fact that there were clear procedures in the LAB tasks that elicited thoughts that were specific to worry vs. rumination. For example, the LAB worry initiation task involved a story prompt that consisted of thoughts concerning a future threat, whereas the LAB rumination initiation task involved a story prompt that consisted of thoughts concerning past loss or failure. The LAB worry termination task involved an explicit instruction to help participants engage in their worry topics, whereas the LAB rumination termination task involved instruction to help them engage in their rumination topics. On the other hand, the LAB tasks did not show good specificity in measuring the initiation vs. termination phases of worry and rumination, as indicated by the high correlations between the initiation and termination scores for both worry and rumination. It is possible that the current measurements for the initiation and termination processes tap into some common underlying factors (e.g., avoidance tendency, distractibility, negative temperament), rather than specific factors unique to each process. It is also possible that initiation and termination processes by nature are not entirely independent of each other and are

intertwined, which makes it difficult to separate one from another. Compared to LAB measures, EMA measures showed less specificity in measuring worry vs. rumination specific features. Although this result could be due to measurement errors involved in EMA (e.g., participants' insufficient understanding of the distinction between worry vs. rumination), it is also possible that worry and rumination are not separable in nature, and EMA captures how they actually work. In reality, rumination triggers worry and vice versa, and such interaction occurs in a very dynamic and subtle manner, making it difficult to separate them. On the other hand, EMA measures showed relatively good specificity in measuring the initiation vs. termination phases of worry and rumination. This result may be due to the kinds of questions used to measure initiation vs. termination. For example, unlike LAB tasks, for initiation of worry participants were asked whether they started worrying about a new topic between the times when the messages were sent, whereas, for termination of worry, participants were asked whether they continued to worry about the same topic that they had been worrying about. Thus, the frequency in initiating new worry topics may have been a key factor that needed to be measured in order to differentiate initiation vs. termination phases of worry. It is also possible that the EMA is inherently a better approach than the laboratory tasks for more precisely capturing an individual's natural pattern of initiation vs. termination of worry and rumination.

The present study was limited by its modest sample size. As a result, the interpretation of the results using factor scores derived from the bi-factor model needs to be done with caution, for example. Future research needs to replicate this finding with larger sample sizes. This would allow us to explore the different factors contributing to the initiation and termination of worry and rumination, such as negative interpretation bias and desire for certainty. Second, given that worry and rumination are important features of anxiety disorders and depression, research with a

clinical sample is warranted. Doing so would enable us to capture a broader range of worry and rumination patterns among individuals and to make claims about psychopathology related to these thinking patterns.

The LAB and EMA measures showed relative strengths and weaknesses. The LAB measures were better at assessing worry vs. rumination specific features than was EMA, whereas the EMA measures were better at assessing initiation vs. termination phases of worry and rumination. Future research can incorporate this information to improve both measurements. For example, it would be worth experimenting with different sampling periods with EMA (e.g., how many days, the interval between signals) to determine the most effective ways of capturing individuals' natural patterns of worry and rumination. It is also possible that worry and rumination are better captured using different kinds of experience sampling methods. For example, instead of using the signal contingent method (a beep notifies participants to record data) that we used, the event-contingent method, in which participants record data when worry and rumination occurs, may better capture individual differences in worry and rumination patterns in real-life contexts. Finally, more research and discussion is needed in regards to how to conceptualize and operationalize the initiation and termination of worry and rumination. For example, it would be worthwhile to consider conceptualizing the initiation and termination phases of worry and rumination as an interactive process in which negative repetitive thoughts influence each other, and developing measurements that can capture such dynamic processes. In doing so, the use of psychophysiological measures (e.g., EEG, fMRI) could help assess changes in neural activities so as to index the initiation, disengagement, and re-initiation of worrisome and ruminative thoughts over time. Despite its limitations, the results of this study highlight the potential value of developing novel tasks to distinguish the initiation and termination of worry

and rumination while paying attention to the utility of the measures in measuring worry vs. rumination specific features.

CHAPTER 4

ATTENTIONAL AND AFFECTIVE MECHANISMS IN DIFFERENT PHASES OF WORRY AND RUMINATION

Worry and rumination are examples of maladaptive repetitive thinking that are important vulnerability factors for emotional disorders, such as generalized anxiety disorder (GAD) and major depressive disorder (MDD) (Ruscio et al., 2011; Smith & Alloy, 2009; Watkins, 2008). A growing body of research suggests a close link between attention and worry and rumination. Despite its clinical significance, thus far, only loosely connected and scattered evidence exists to explain the attentional mechanisms associated with worry and rumination (Von Hippel et al., 2008). The goal of this paper is to examine the common and distinctive attentional mechanisms associated with worry and rumination while considering potential moderation of negative temperament.

Two critical aspects of attention processes that might be related to worry and rumination are attention bias to negative information and executive functions. Attentional bias is the tendency to attend to salient emotional information when presented concurrently with neutral stimuli. Executive functions (EFs) are defined as a set of higher-order cognitive processes responsible for purposeful, goal-directed behaviors (Gioia, Isquith, & Guy, 2001; Miyake et al., 2000). Theories of executive function suggest that executive function is multi-dimensional and can be parsed into three distinctive domains: inhibition, shifting, and updating (e.g., Miyake et al., 2000). Inhibition is defined as the ability to suppress automatic or prepotent responses, shifting is the ability to switch between multiple tasks or mental sets, and updating is the ability to monitor and manipulate working memory representations (Miyake et al., 2000). Whereas biased attentional processing is an automatic and involuntary response (e.g. to threat cues) that draws

attention in a bottom-up manner, executive functions are effortful and carry out more voluntary attentional functions that are related to the goal-directed, top-down attentional system (Corbetta & Shulman, 2002; Petersen & Posner, 2012).

Deficits in executive function have been implicated in both worry and rumination. For example, impaired performance on attention control tasks was associated with the increased frequency of intrusive thoughts (Verwoerd et al., 2008; Wessel et al., 2008). Similarly, individuals with great working memory capacity showed enhanced suppression of negative thoughts (C. Brewin & Beaton, 2002; C. R. Brewin & Smart, 2005). Furthermore, Bredemeier and Berenbaum (2013) found that working memory deficits predicted changes in levels of worry over time, suggesting that working memory impairment may function as a risk factor for excessive worry. Rumination has also been associated with deficits in executive functions (Von Hippel, Vasey, Gonda, & Stern, 2008; Whitmer & Banich, 2007). Even after controlling for depressive symptoms, rumination was associated with perseverative tendencies on the Wisconsin Card Sorting Task (Davis & Nolen-Hoeksema, 2000), leading the researchers to link rumination with "attentional inflexibility." Though the functions most frequently related to depression and rumination are inhibition and set shifting (Koster et al., 2011), some studies have found that rumination is associated with a deficit in inhibition rather than set-switching (De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Whitmer & Banich, 2007). Despite scattered evidence pointing to EF deficits in worry and rumination, these studies did not assess different kinds of executive functions or examine both worry and rumination in the same study, making it difficult to conclude whether worry and rumination are associated with similar or distinctive executive functions.

Worry and rumination have also been implicated in attentional bias to negative information. Worry, in particular, has been conceptualized as repeated ideation focused on to-be-avoided threats (Mathews & MacLeod, 2005). Attention bias to threat has been associated with anxiety disorders, including GAD. For example, compared to controls, individuals with GAD showed longer latencies to name the colors of threat words than neutral words, indicating that their attention is automatically grabbed by threat-related information (Becker et al., 2001; Mathews & MacLeod, 1985; Mogg, Mathews, & Weinman, 1989). Although chronic worry is a defining feature of GAD, evidence coming from GAD studies cannot be generalized to worry since they did not differentiate worry from emotional components of the anxiety response involved in GAD. It is generally unclear whether worry plays any role distinct from general anxiety in attentional bias. To my knowledge, only a couple of studies have examined a direct relationship between worry and attention bias to threat by employing an attention modification approach to demonstrate that attentional bias causally impacts worry or negative automatic thoughts (Hayes, Hirsch, & Mathews, 2010; Krebs, Hirsch, & Mathews, 2010). For example, high worriers were randomly assigned to either a training condition in which participants were trained either to attend away from threat information or to attend toward neutral information, and found that the former group (who were trained to attend away from threat) displayed significantly fewer negative thought intrusions after the training. However, these studies either pre-selected participants based on their worry scores (e.g., recruiting moderate or high worriers) or did not assess worry per se, rather assessing negative automatic thoughts. Thus, although there is evidence linking worry with attention bias to threat, additional work is necessary to determine the nature of the relationship.

Though attentional bias to mood-congruent information has been demonstrated in people with depression (Gotlib & Joormann, 2010; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005), only a few studies have examined the direct relationship between rumination and attentional bias. These studies found rumination to be associated with bias to mood-congruent stimuli (e.g., sad faces), even after controlling for depressive symptoms (Donaldson et al., 2007; Joormann, Dkane, & Gotlib, 2006). In addition, individuals with high trait rumination showed increased amygdala activity to negative stimuli compared to controls (Siegle, Steinhauer, Thase, Stenger, & Carter, 2002). One important limitation in this line of literature, however, stems from a narrow conceptualization of rumination. Previously, rumination has been defined as "behaviors and thoughts that focus one's attention on one's depressive symptoms and on the implications of those symptoms" (Nolen-Hoeksema, 1991). Thus, studies investigating attentional bias in rumination have focused on how "dysphoric" stimuli are processed. However, rumination can be more broadly conceptualized as a response to failure in satisfactorily progressing toward a goal (Martin, Tesser, & McIntosh, 1993; Smith & Alloy, 2009) and is not limited to depressive symptoms. Nonetheless, no studies thus far have investigated a potential link between rumination and attention bias to loss/failure.

In order to understand the precise mechanisms linking attentional processes to worry and rumination, it is important to consider the potential modulation effect of affective factors, such as negative temperament. Negative temperament, defined as a tendency to experience negative emotions such as anxiety, anger, guilt, and depressed mood (Watson & Clark, 1984), has been shown to modulate attentional processes (Crocker et al., 2012; Dolcos, Iordan, & Dolcos, 2011; Hur et al., 2015). Neural research suggests the attention networks are strongly modulated by brain systems involved in the processing of emotions, reward, and stress (Crocker et al., 2012;

Dolcos et al., 2011; Hur et al., 2015; Pessoa, 2009; Rosseel, 2012). Negative temperament, in particular, has been shown to exacerbate the impairing effect of negative stimuli on cognitive control (Hur et al., 2015), suggesting that the likelihood of observing impaired cognitive control in negative contexts depends on a preexisting vulnerability conferred by high negative temperament. Considering worry and rumination as a reaction to internal or external negative stimuli (e.g., stress, memory), it is possible that elevated negative temperament activates the existing vulnerability in executive function to have an impairing effect on thought regulating processes. Despite the close association between negative temperament and executive processes, most studies investigating the mechanisms of worry and rumination have only examined one of these factors (i.e., either executive function or negative temperament), making it difficult to draw conclusions about their additive or interactive effects. It is conceivable that worry and rumination are influenced by interactions between executive function and negative temperament.

The studies reviewed thus far have investigated attentional mechanisms involved in worry and rumination and have focused almost exclusively on the amount of worrying/ruminating. More recently, however, Berenbaum (2010) proposed an initiation–termination (IT) two-phase model of worrying in which the initiation and termination phases of worry are differentiated. He argued that worry should not be considered a static entity, but should instead be thought of as a dynamic process that unfolds over time (Berenbaum, 2010). The IT model suggests that the following three aspects of worrying need more attention: (a) how easily worrying is initiated; (b) how easily worrying is terminated; and (c) the pattern of worrying over time. An initial test of the IT model of worry using ecological momentary assessment found that: (a) worry initiation and termination incrementally predict global worry and GAD symptom severity; and (b) worry termination, but not worry initiation, is associated

with emotion-induced blindness, an index of the difficulty in disengaging from emotional distractors (Berenbaum et al., under review). These results highlight the potential value of distinguishing between the initiation and termination of worrying. Recently, Hur and Berenbaum extended this model to rumination (see Chapter 3). Further, they developed laboratory instruments to measure worry initiation, worry termination, rumination initiation, and rumination termination.

Except for a few theoretical proposals that implicate the importance of differentiating the phases of mental processes (Berenbaum, 2010; Eysenck, 1984), no studies thus far have empirically examined the attentional and affective mechanisms involved in the ***initiation*** and ***termination*** processes of both worry and rumination. In order to advance our understanding of the mechanisms involved in worry and rumination, it is important to investigate common and distinctive attentional processes involved in the initiation and termination of worry and rumination while considering the potential influence of affective factors, such as negative temperament. I hypothesized that worry is associated with attentional bias to threat whereas rumination is associated with attentional bias to loss/failure. In addition, I hypothesized that termination of worry and rumination are influenced by executive functions (e.g., inhibition, switching ability) which are further modulated by negative temperament.

METHODS

Participants

Participants were 223 undergraduate students (69.8% female; mean age = 18.9 years). The majority of participants (59.0%) were White, followed by 19.5% Asian, 11.8% African American, and 5.2% biracial; 4.5% chose to describe themselves as "other." All participants completed a voluntary informed consent at the start of the session and received monetary

compensation for their participation. The research protocol was approved by the university institutional review board. Participants were tested individually.

Self-Report Questionnaires

Worry was measured using the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990). Participants rated how each of 16 statements described them (e.g., "My worries overwhelm me") on a scale from 1 (*not at all typical*) to 5 (*very typical*). The PSWQ has excellent test-retest reliability as well as good convergent and discriminant validity in undergraduate and clinical samples (Meyer et al., 1990; Nitschke et al., 2001). There was no missing data and the internal consistency in our sample was excellent (α =.93).

Rumination was measured using the rumination subscale of Rumination/Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999). Participants rated how each of 12 statements described them (e.g., I tend to ruminate or dwell over things that happened to me for a really long time afterward") on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The rumination subscale has excellent test-retest reliability and convergent and discrimination validity in undergraduate and clinical samples (Ruscio et al., 2011; Segerstrom et al., 2003). There was no missing data and the internal consistency in our sample was good (α =.90).

The PSWQ and RRQ were used in confirmatory factor analysis as a means of generating common, worry-specific, and rumination specific scores. Based on previous research (see Chapter 2), the bi-factor model was fit using the `lavaan` package in R (Rosseel, 2012), treating the data as ordered categorical data using a weighted least squares estimator (Muthén, 1984) (see Figure 1 in Chapter 2). This model included a common factor (negative repetitive thinking) that saturates each specific worry and rumination item as well as separate worry-specific and rumination-specific factors that capture unique variance of worry and rumination items. These

three factors are uncorrelated. Three factor scores (common, worry-specific, and rumination-specific factors) were extracted with the regression method.

The Negative Temperament subscale of the General Temperament Survey (GTS) (D. Watson & Clark, 1993) was used to assess negative temperament. Participants were instructed to decide whether statements mostly described them and to rate each item as true/false. The Negative Temperament subscale includes 28 items such as "I sometimes get all worked up as I think about things that happened during the day." Prior research attests to the reliability and validity of this measure (D. Watson & Clark, 1993). Internal consistency in our sample was good ($\alpha = 0.86$).

Lab measures of Worry and Rumination

We developed four different laboratory tasks to measure the following constructs: worry initiation, worry termination, rumination initiation, and rumination termination. See the Methods section of Chapter 3 for more details.

Measures of Attention Bias

A total of 253 pictures were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) and from a sorted source on the web. We selected pictures that potentially fall in one of the following stimulus types: physical threat/danger (e.g., man with knife), loss/failure (e.g., people crying), and neutral (e.g., woman reading). These pictures were rated independently by seven raters using the Valence and Arousal scales of the Self-Assessment Manikin (SAM; Bradley and Lang, 1994) which ranged from 1 (low pleasure, low arousal) to 9 (high pleasure, high arousal). Each picture was rated on two additional scales, physical threat/danger and loss/failure, on a scale of 1 (not at all relevant) to 5 (extremely relevant). Pictures were categorized as *physical threat/danger* if they received an average rating

of greater than 3.5 on the physical threat/danger scale, less than 2.5 on the loss/failure scale, and less than 3.5 on the valence scale. Pictures were categorized as *loss/failure* if they received an average rating of greater than 3.5 on the loss/failure scale, less than 2.5 on the physical threat/danger scale, and less than 3.5 on the valence scale. Finally, pictures were categorized as *neutral* if they received an average rating of less than 2.5 on both physical threat/danger and loss/failure scales, and higher than 4.5 on the valence scale. These selection criteria resulted in the selection of 120 pictures (48 from the IAPS; 72 from the web); 24 pictures for physical threat/danger, 24 pictures for loss/failure, and 72 pictures for neutral. The descriptive statistics of the physical thereat/danger, loss/failure, valence, and arousal ratings are reported in Appendix A. Another 24 neutral pictures were selected for the practice trials. In line with the procedure of Mogg et al. (2000), three types of stimulus pairs were created: physical threat/danger – neutral (24 pairs), loss/failure – neutral (24 pairs), neutral – neutral (24 pairs). The pictures were carefully matched with respect to valence and arousal ratings and the presence of a person and concreteness. Pictures had a height of 4.6 cm and a mean width of 6.5 cm. The dot-probe task was programmed and presented using E-Prime (Schneider, Eschman, & Zuccolotto, 2002).

Each of the 48 emotion picture pairs (physical threat/danger, loss/failure) was presented four times and each of the 24 neutral picture pairs was presented two times, for a total of 240 trials, which were presented in a new, fully randomized order for each participant. Each trial started with a fixation cross in the middle of the screen for 500 ms. Then, two pictures appeared, one 2.2 cm above and one 2.2 cm below, the center of the screen for 500 ms. Following the offset of the pictures, a blank screen showed for 14 ms and a single dot or a double dot (target) appeared in the center of the screen location where one of the pictures had been and remained on the screen until the participant pressed one of the two keys on the keyboard to indicate whether

the target is a single dot or a double dot. The accuracy and latency of each response was recorded. The inter-trial interval was one of the following, in a random order: 500, 750, 1000, and 1250 ms. The emotional stimulus pictures (physical threat/danger, loss/failure) appeared in the upper and the lower positions with equal probability, with the matched neutral picture of each pair appearing in the other position. The target (a dot or a double dot) was also presented in both positions with equal probability.

Participants were told that the target could appear in the upper or lower position on the screen and were instructed to indicate whether the target was a single dot or a double dot as quickly and accurately as possible by pressing the left arrow key if the target was a single dot and by pressing the right arrow key if the target was a double dot. Participants first completed 12 practice trials before completing the actual task.

Measures of Executive Function

The task-switching paradigm (Mayr & Keele, 2000) was used to obtain an index of set-switching and an index of inhibition of previously relevant information. In this task, participants were instructed to identify the spatial location of a deviant object among four rectangles arranged into a 2 x 2 matrix. The rectangles varied on one of the following three dimensions: size, motion, or orientation. A centrally presented cue, which was presented briefly before the rectangles appear, identified the dimension that should be used to identify the rectangular that differs from the others. The location of the deviant rectangle was random. Responses were made using keys that have the same spatial position on the number pad as the rectangles on the screen (i.e., keys "1," "2," "4," "5").

There were four different types of trials: inhibitory, repeat, control, and unclassified trials. The trial type is determined by the relation between the final trial and the preceding one or two

trials. Inhibitory trials are defined as those in which the cue is different from the cue on the immediately preceding trial (n – 1) but the same as the cue two trials back (n – 2). Control trials are defined as those in which the cue is different from the cue on the preceding two trials, which also have different cues from each other. Repeat trials are defined as those in which the same task set is used as the previous trial. Unclassified trials are defined as those in which the cue is different from the cue on the preceding trial, which is preceded by the trial using the same cue. Non-inhibitory trials include control, repeat, and unclassified trials.

RTs were used as an index of performance. Set-switching cost was measured by the RT difference between non-inhibitory trials (control and unclassified trials) and repeat trials. The larger the difference, the worse switching ability. Inhibition ability was measured by the RT difference between inhibitory trials and control trials. Both control and inhibitory trials were preceded by at least two task switches. In order to not be confounded by switching abilities, inhibition was measured by the extra time involved in switching back to a recently abandoned task set compared to a less recently abandoned task set. The larger the difference, the better inhibition ability.

Procedures

We used a within-subject design in which participants completed all of the following tasks: four laboratory tasks measuring the initiation and termination of worry and rumination, dot-probe task, task-switching paradigm, and questionnaires. To minimize fatigue and potential transfer effects between tasks, the study was conducted in two separate sessions, each held on a different day. The order of tasks were counterbalanced, such that half of the participants completed rumination lab tasks on the first day while completing the worry lab tasks on the

second day, and the other half started with worry tasks. The order of administering questionnaires and attention tasks was also randomized.

RESULTS

Data Preparation

***Dot-probe task*.** Data from 3 participants were removed from analysis because their overall accuracy was less than 80%. After exclusion, overall accuracy was 96.5 (SD = 0.03) %. We excluded from analysis trials in which the RTs were shorter than 200 ms, exceeded 2,500 ms, were 3SDs above each participant's mean, or were incorrect.

Attention bias indices were calculated for each stimulus type (i.e., physical threat/danger and loss/failure) using MacLeod and Mathews' (1988) method where RTs on congruent trials are subtracted from RTs on incongruent trials. Thus, an index for attention bias to physical threat/danger was created by subtracting RTs on congruent trials from RTs on incongruent trials for physical/danger stimuli (i.e., Threat/danger Incongruent RTs – Threat/danger Congruent RTs). A positive attention bias score indicates attention toward the threatening pictures, a negative attentional bias score indicates avoidance of threat, and zero indicates no attentional bias. Similarly, an index for attention bias to loss/failure was created by subtracting RTs on congruent trials from RTs on incongruent trials for loss/failure stimuli (i.e., Loss/Failure Incongruent RTs – Loss/Failure Congruent RTs).

Task-switching paradigm. Overall accuracy was 96.9 (SD = 0.03) %. In accordance with the methods used by Mayr and Keele (2000), we excluded from analysis trials in which the RTs exceeded 2,500 ms, incorrect trials, and the two trials after each incorrect trial. As mentioned above, set-switching cost was measured by the RT difference between non-inhibitory trials (control, repeat, and unclassified trials) and repeat trials.

Descriptive Statistics

Table 7(a) shows descriptive statistics for all the laboratory variables. Lab worry initiation and Lab rumination initiation measures were positively skewed and thus log-transformed. Descriptive statistics of attention bias indices and executive function scores (i.e., inhibition, switching cost) are reported in Table 7(b).

Correlations between Lab Measures of Worry and Rumination and Bi-Factor Scores

Correlations between laboratory measures of worry and rumination and the factor scores derived from the bi-factor model (i.e., common factor, worry-specific, and rumination-specific) using the self-report measures were examined to assess the degree to which lab worry/rumination measures tap into common vs. specific factors of worry and rumination. As shown in Table 8, all four lab measures were most strongly correlated with the common factor, that is, repetitive negative thinking. Rumination initiation was also significantly correlated with the rumination-specific factor, but negatively correlated with the worry-specific factor. Worry termination was significantly correlated with the worry-specific factor, but not with the rumination-specific factor.

Correlations between Attention Measures and Worry/Rumination Measures

As shown in Table 9, worry initiation was negatively correlated with attention bias to threat, such that the more avoidance of threat, the greater the likelihood of initiating worry. Though not significant (p = .08), worry termination was also negatively correlated with attention bias to threat. Neither worry initiation nor worry termination was correlated with attention bias to loss/failure. Rumination termination was positively correlated with attention bias to loss/failure, such that the more orienting towards loss/failure, the greater the difficulty terminating rumination; rumination termination was not correlated with attention bias to threat. Rumination initiation was not correlated with either attention bias to loss/failure or attention bias to threat.

None of the lab measures of worry and rumination was significantly correlated with executive function measures (i.e., inhibition, switching cost).

None of the factor scores derived from the bi-factor model (i.e., common factor, worry-specific, and rumination-specific) using the self-report measures were significantly correlated with any of the attention measures.

Negative Temperament (NT) Modulates the Relationship between Executive Function and Worry/Rumination

We examined whether specific executive functions would predict different phases of worry and rumination via its interaction with negative temperament. As seen in Table 10 (a), the relationship between inhibition function and rumination termination was modulated by negative temperament, $\Delta R^2 = .03$, $F(1, 217) = 7.56$, $p < .01$. We further examined this interaction following Aiken and West (1991). As depicted in Figure 2, among individuals with high negative temperament, there was a trend for inhibition ability to be negatively associated with difficulty terminating rumination (i.e., the greater inhibition ability, the easier it was to terminate rumination), $\beta = -.16$, $p = .09$. In contrast, among individuals with low negative temperament, inhibition ability was positively associated with difficulty terminating rumination (i.e., the greater inhibition ability, the harder it was to terminate rumination), $\beta = .17$, $p = .03$.

As seen in Table 10 (b), the relationship between switching cost and worry initiation was modulated by negative temperament, $\Delta R^2 = .02$, $F(1, 215) = 3.95$, $p < .05$. We further examined this interaction following Aiken and West (1991). As depicted in Figure 3, switching cost was positively associated with the ease of initiating worry (i.e., the lower the ability to switch mental sets, the easier it was to initiate worry) among individuals with high negative temperament, $\beta = .23$, $p = .03$, but not among individuals with low negative temperament, $\beta = -.08$, $p > .4$.

As seen in Table 10(a) and (b), the relationship between executive function (i.e., inhibition, switching) and worry termination was not modulated by negative temperament. The relationship between executive function (i.e., inhibition, switching) and rumination initiation was not modulated by negative temperament, either. In addition, none of the relationships between attention bias measures (i.e., attention bias to threat or attention bias to loss) and worry or rumination measures were modulated by negative temperament, suggesting that the moderation effect of negative temperament is specific to the relationship between executive function and worry/rumination. Finally, I explored whether the relationship between executive function and any of the bi-factor scores was moderated by negative temperament. None of the bi-factor scores were predicted by the interaction between executive function and negative temperament.

DISCUSSION

This research highlights the potential value of distinguishing different phases of worry and rumination when investigating the attention mechanisms involved. We found that worry and rumination are linked with different types of attentional bias (e.g., threat/danger, loss/failure). In addition, we found some evidence that the initiation and termination phases are differentially associated with executive functions when taking negative temperament into account. Below, we discuss each finding in more detail.

We found that worry initiation was associated with bias to threat, whereas rumination termination was associated with bias to loss/failure. This finding is consistent with the existing conceptualization that describes worry as repeated ideation focused on to-be-avoided threats, and rumination as focused on to-be-understood loss or failure (Mathews & MacLeod, 2005; Smith & Alloy, 2009). This finding also strengthens the view that worry and rumination each have unique

aspects which may involve different types of attentional processes (Beck et al., 1987; Clark et al., 1989).

Although attention bias to threat has been associated with anxiety disorders, including GAD, only a couple of studies have examined a direct relationship between worry and attention bias to threat. To my knowledge, there are only two attention bias modification studies (Hayes et al., 2010; Krebs et al., 2010) which demonstrated the link between worry and attention bias to threat. However, these studies either pre-selected participants based on their worry scores (i.e., recruiting high worriers) or did not assess worry per se, rather assessing negative automatic thoughts. It still remains unclear if there is a direct correlational relationship between worry and attentional bias to threat in an unselected, non-clinical population. Using a laboratory measure of worry, we found that the ease of initiating worry was associated with a tendency to orient attention *away* from threat information. This finding contradicts what was expected given the previous findings showing that clinical anxiety patients and nonclinical populations with high levels of anxiety vulnerability orient attention *toward* threat-related information (Mathews & MacLeod, 2005).

A couple of features of this study may account for why worry initiation was associated with orienting attention *away* from threat information. First the mildly threatening stimuli used in our dot-probe paradigm might be one possible reason. A few studies found that, in a probe task using neutral and threatening stimuli, higher stimulus threat levels led to faster detection (vigilance), whereas low levels of stimulus threat led to slowed detection of probes in the same location (avoidance) (Koster, Crombez, Verschuere, & De Houwer, 2006; Wilson & MacLeod, 2003). We did not use the types of threat stimuli Koster et al. (2006) defined as highly threatening (e.g., mutilated face), but rather used threat stimuli that corresponded to what they

defined as mildly threatening (e.g., man with knife). Second, it is possible that the types of threat stimuli used in our dot-probe paradigm did not match the participants' specific worry topics. Some evidence indicates that the attentional bias toward threat information is determined by the specific worries reported by participants – e.g., only those patients with predominant physical worries were disrupted by the presence of physical threat words (Mathews & MacLeod, 1985). We used stimuli specifically related to physical threat or danger (but not social or other types of threat) in order to differentiate them from the loss/failure stimuli. Thus, it is possible that only using stimuli of physical threat and danger might have failed to capture the broader range of worry topics in which individuals typically engage and instead elicited bias away from threat stimuli.

It is also possible that the current result could be attributed to the unreliability of the dot-probe task. Although a dot-probe task is one of the most frequently used attention bias measures, it has poor psychometric properties, being neither internally consistent nor stable over time (Schmukle, 2005). It should not be entirely surprising then that results with the dot probe paradigm have been largely inconsistent, particularly with a non-clinical population., Only some studies using threat-related stimuli found the expected attentional bias *towards* threat among individuals with high anxiety (Bradley, Mogg, Falla, & Hamilton, 1998; Mogg & Bradley, 1999). In contrast, other studies reported that individuals with high anxiety orient their attention *away* from threat-related stimuli (Mansell, Clark, Ehlers, & Chen, 1999) or found no attention bias (Bradley et al., 1997; Bradley, Mogg, & Millar, 2000; Mogg & Bradley, 1999).

Recently, however, some researchers have proposed that the inconsistent results using the dot-probe task may not be due to the paradigm itself, but rather to the way we have conceptualized attention bias (Zvielli, Bernstein, & Koster, 2014, 2015). Zvielli and colleagues

(2015) argue that attention bias is not a static entity as traditionally assumed, but rather is a dynamic process that fluctuates over time. Accordingly, they proposed a novel way of conceptualizing attention bias that focuses on the dynamic features of attention bias expression, including phasic bursts, variability and changes over time (Zvielli et al., 2014, 2015).

We found that difficulty terminating rumination, but not rumination initiation, was positively associated with attentional vigilance (orienting) toward loss/failure information. Previous research has shown that rumination is related with difficulty disengaging from dysphoric stimuli, and such attention bias was typically observed when the stimuli was exposed for one second or longer (Gotlib et al., 2004; Joormann & Gotlib, 2007), suggesting that the bias may occur at a late stage of processing. In our study, even when the stimuli was presented relatively briefly (500 ms), the bias *toward* loss and failure information was clearly observed, especially in association with difficulty terminating rumination. In addition, the present research suggests that an attentional bias associated with rumination is not limited to mood-congruent stimuli, but encompasses stimuli with the broader theme of loss and failure. This finding suggests that a bias oriented to loss and failure information may be a maintaining factor that prohibits individuals from terminating rumination.

Although a number of studies looked into the relationship between specific executive function and worry or rumination (e.g., Bredemeier & Berenbaum, 2013; De Lissnyder et al., 2012), they did not assess different kinds of executive functions or examine both worry and rumination in the same study. Nor were the different phases of worry and rumination assessed. Current findings suggest that difficulty in terminating rumination is more associated with inhibition, but not switching ability, and negative temperament needs to be taken into consideration in assessing such relationship. This result is consistent with findings from an anti-

saccade task (De Lissnyder et al., 2012) showing that ruminators, compared to non-ruminators, experience impaired performance on inhibition. Similarly, Whitmer and Banich (2007) showed that rumination is associated with a deficit in inhibition ability but not with switching ability. Different from previous findings, however, we observed such trend (lower inhibition, higher rumination) only among individuals with high levels of negative temperament. Furthermore, such relationship held only in association with difficulty terminating rumination but not with the ease of initiating rumination. Unexpectedly, individuals with low neuroticism showed the opposite relationship; the higher the inhibition, the greater the difficulty in terminating rumination. The current finding suggests that the maintenance of rumination may depend on both executive function (i.e., inhibition) and temperament. As previous research suggested that the likelihood of observing impaired cognitive control in negative contexts depends on a preexisting vulnerability conferred by high negative temperament (Hur et al., 2015), it is possible that in the presence of internal or external negative stimuli (e.g., stress, negative memory), elevated negative temperament activates the existing vulnerability in executive function to disrupt thought regulating processes, making it difficult to disengage from ruminative thoughts. It is also possible that individuals with high negative temperament have more frequent negative thoughts regarding past behaviors, and, when they have difficulty inhibiting those thoughts, the stream of negative thoughts may be more reinforced. It is important to note, however, that the way inhibition was operationalized in the task-switching paradigm was very specific and narrow (i.e., how easy it is to overcome a recently inhibited dimension) and may not capture different aspects of inhibition. Therefore, the present study's findings regarding inhibition warrants further investigation using a different kind of inhibition task that captures broader aspects of inhibition.

On the other hand, the ease of initiating worry was shown to be associated with both switching ability and negative temperament, such that for participants high in negative temperament (but not those low in negative temperament), switching cost was positively associated with the ease of initiating worry. Though the executive function most frequently related to worry is working memory (Bredemeier & Berenbaum, 2013; Hayes, Hirsch, & Mathews, 2008; Leigh & Hirsch, 2011), these studies rarely examined other executive functions such as inhibition and switching function. Dosenbach et al. (2008) proposed a dual-network framework of top-down control in which two functional systems involved in goal-directed, executive processes are differentiated: a set-maintenance (maintenance) system and a rapid-adaptive (flexibility) system. Since both working memory and switching function are highly relevant to the flexibility system (Niznikiewicz et al., in preparation; Dosenbach et al., 2008), it is possible that worry is specifically related to difficulty in continuous monitoring of and adjustment to the environment. The current finding further suggests that the initiation of worry may depend on both the shifting function and negative temperament. It is possible that individuals with high negative temperament may come up with negative thoughts about the future more easily, and when they have difficulty switching from this negative thought, the worry process is initiated. It is also possible that affective instability combined with difficulty in cognitively re-adjusting to the environment may manifest an initiation of worry as a maladaptive coping strategy. Though it was initially expected that the executive function and moderation effect of negative temperament would be particularly associated with the termination phase, no such relationship was observed in association with difficulty terminating worry.

Although we found some links between attention (i.e., attention bias, executive function) and the different phases of worry and rumination measured by laboratory tasks, it is important to

note that we did not find any relationship between attention measures and the bi-factor scores derived from the worry and rumination questionnaires (PSWQ, RRQ). This may indicate that the individual differences in attention associated with worry and rumination are better captured when using behavioral tasks differentiating the initiation and termination phases of worry and rumination, as compared to when using self-report measures with no such distinction.

The current study highlights the possibility that attentional biases to different types of emotional information are involved in worry vs. rumination, and that the interactive effect of distinct executive function and negative temperament may predict different phases of worry and rumination. We acknowledge that a limitation of the current study is that multiple tests were performed, yet no adjustment for multiple testing (e.g., Bonferroni correction) was made. Thus, replication of the current findings with a larger and diverse sample (potentially including a clinical sample) is warranted. Future research needs to further examine the mechanisms and nature of the interaction between executive functions and negative temperament in predicting worry and rumination processes. It is also important to point out that the current lab measure of different phases of worry and rumination may not optimally capture the inter- and intra-variability of individual differences in worry and rumination patterns of interest. Continuous effort is needed to develop and improve measurements for assessing worry and rumination as a dynamic process that unfolds over time. In addition, traditional tasks used to measure attentional bias can be supplemented with additional measures of cognitive processing and performance, including implicit measures like eye tracking and psychophysiological measures such as EEG and neuroimaging. Given that the present findings are based on a cross-sectional design, future research is warranted to investigate the causal relationships of distinctive attentional processes

and different phases of worry and rumination, using rigorous longitudinal designs or experimental manipulations.

CHAPTER 5

FUTURE DIRECTIONS

The present research has yielded a number of interesting findings that help shed light on the nature of the attentional and affective mechanisms associated with worry and rumination. In Chapter 2, we found that the structural relationship between worry and rumination is best represented by a bi-factor model. This suggests that worry and rumination share certain common aspects (negative repetitive thinking), but that there are still unique aspects to each. In Chapter 3, we examined the utility of two new alternative measures (i.e., laboratory tasks, ecological momentary assessment) in assessing the initiation and termination phases of worry and rumination based on Berenbaum's (2010) IT model. In Chapter 4, we found that 1) worry and rumination are linked with different types of attentional bias (e.g., threat/danger, loss/failure), and 2) the initiation and termination phases are differentially associated with executive functions when taking negative temperament into account. These findings highlight several important directions for future research examining the attentional mechanisms associated with worry and rumination.

A great deal of research is needed to further our understanding of the nature of the common and specific features of worry and rumination. First, researchers need to examine the mechanisms of *repetitiveness* in worry and rumination that bring about a sense of uncontrollability. For example, it would be valuable to explore how the self-focused attention and negative interpretation biases that are commonly associated with worry and rumination may reinforce negative thoughts. It would also be important to examine how worry and rumination mutually influence each other in maintaining the negative stream of thoughts. Second, more research is need to examine the differential temporal orientations (i.e., future-oriented vs. past-

orientated) involved in worry and rumination as a way to delineate the unique characteristics of each. In doing so, it would be worth paying attention to the different basic cognitive processes (e.g., memory, attention, planning, creativity, problem-solving) involved in future-oriented vs. past-oriented thinking. For example, an understanding of the degree to which individuals with excessive worry are able to engage in specific modes (or aspects) of future thinking (e.g., simulation, prediction, intention, planning) could shed light on the mechanisms specifically involved in worry. Similarly, if we could distinguish the cognitive and affective processes involved in reflection vs. rumination we may better understand rumination-specific features.

Future research is also warranted to further examine the mechanisms involved in the modulating effect of negative temperament in the relationship between specific executive functions and worry/rumination. It would valuable to examine which specific characteristics of negative temperament confer vulnerability to negative repetitive thinking in individuals with executive deficits and how they operate. One such characteristic is the increased reactivity to stressors involved in negative temperament (Ingram et al., 1998). It is possible that such sensitivity creates a context for individuals with executive deficits to become more vulnerable to worry and rumination. In addition, research should explore the causal antecedents of executive function deficits and negative temperament (e.g., genes) to delineate their link to worry and rumination. For example, when combined with negative temperament and other factors (e.g., life stress), executive function deficits may serve as 'endophenotypes' (Gottesman & Gould, 2003) to confer risk for worry and rumination. More research is needed to examine the nature of their interaction.

Next, future research should continue to investigate better ways to measure worry and rumination processes. First, it will be important to continue to explore which specific methods

(e.g, laboratory, experience sampling method) and design features (e.g., whether to incorporate individuals' specific worry/rumination topic, time intervals for thought sampling) best capture within- and between- individual differences in worry and rumination. In doing so, there may not be one optimal method. Rather, the best method to use may change depending on researchers' interests and goals (e.g., assessing worry vs. rumination specific features or a temporal process of repetitive thinking). In addition, it will be worthwhile to consider conceptualizing the initiation and termination phases of worry and rumination as an interactive process in which negative repetitive thoughts influence each other, and developing measurements that can capture such dynamic processes. For example, termination of a negative thought may contribute to the initiation of another negative thought. Thus, it may be important to assess the intensity and variability of negative thoughts over an extended period of time. In doing so, the use of psychophysiological measures (e.g., EEG, fMRI) could help assess changes in neural activities so as to index the initiation, disengagement, and re-initiation of worrisome and ruminative thoughts over time.

I have several recommendations regarding future research examining the relation between worry and rumination and attentional bias and executive functions. First, increasing evidence indicates that attention bias is not a stable and static entity but rather a dynamic process that fluctuates over time (Zvielli et al., 2014, 2015). Thus, researchers should to pay attention to different features of attention bias, such as phasic bursts, variability, and changes over time by adopting measurement methods and approaches that can index such features (Zvielli et al., 2014, 2015). Second, future researchers should assess not just individual differences in "capacity" of executive functions, but also how those differences "fluctuate" (the degree to which each function drops from the individual's baseline) at a given trigger (e.g., stress). Third, given that

performance-based measures of executive function only provide information regarding performance in a highly structured environment (i.e., processing efficiency), it is also important to consider supplementing performance-based measures of executive functions with other measurements, such as rating measures and experience sampling methods (Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011) in order to capture different aspects of executive function (e.g., individual goal pursuit) and an individual's functioning in real-life contexts.

Given that worry and rumination are important features of anxiety disorders and depression, future research should employ some of the strategies in the present research (e.g., using laboratory tasks to measure different phases of worry and rumination) to examine attentional and affective mechanisms in larger and more diverse samples, in particular samples which would be expected include more individuals with diagnosable disorders (e.g., treatment seeking samples). Such an approach would enable us to capture a broader range of worry and rumination patterns among individuals and to make claims about the psychopathology related to these thinking patterns. Given that the present findings are based on a cross-sectional design, future research is warranted to investigate the causal relationships of distinctive attentional processes and different phases of worry and rumination. Longitudinal designs or experimental designs could be employed to test the causal link between attentional and executive processes and worry and rumination and to rule out rival hypotheses. For example, researchers could test whether an attention bias modification program or executive function training program would result in changes in the initiation or termination phases of worry and rumination.

TABLES

Table 1. Goodness of Fit Statistics for Alternative Factor Models of the PSWQ/RRQ

Model	χ^2	*df*	CFI	RMSEA
Single-factor model	3379.52	350	.98	.12
Two-factor model	1110.59	349	.99	.06
Bi-factor model	592.13	322	1.00	.04

Note. $N = 564$. χ^2 = chi-square goodness of fit statistic; *df* = degrees of freedom; CFI = comparative fit index; RMSEA = root mean square error of approximation

Table 2. Factor Loadings for the Best Fitting Bi-Factor Model for the PSWQ/RRQ Items

PSWQ/RRQ items	**Negative Repetitive Thinking**	**Worry Specific**	**Rumination Specific**
PSWQ items			
1. If I don't have enough time to do everything, I don't worry about it.	.32	.46	
2. My worries overwhelm me.	.68	.49	
3. I don't tend to worry about things.	.55	.55	
4. Many situations make me worry.	.67	.50	
5. I know I shouldn't worry about things, but I just can't help it.	.69	.52	
6. When I am under pressure, I worry a lot.	.66	.45	
7. I am always worrying about something.	.63	.55	
8. I find it easy to dismiss worrisome thoughts.	.60	.43	
9. As soon as I finish one task, I start to worry about everything else I have to do.	.49	.49	
10. I never worry about anything.	.61	.54	
11. When there is nothing more I can do about a concern, I don't worry about it anymore.	.43	.36	
12. I've been a worrier all my life.	.54	.49	
13. I notice that I have been worrying about things.	.68	.50	
14. Once I start worrying, I can't stop.	.70	.47	
15. I worry all the time.	.65	.54	
16. I worry about projects until they are done.	.56	.44	
RRQ items			
1. My attention is often focused on aspects of myself I wish I'd stop thinking about.	.74		.01
2. I always seem to be "re-hashing" in my mind recent things I've said or done.	.72		.32
3. Sometimes it is hard for me to shut off thoughts about myself.	.76		.13
4. Long after an argument or disagreement is over with, my thoughts keep going back to what happened.	.72		.33
5. I tend to "ruminate" or dwell over things that happen to me for a really long time afterward.	.84		.27
6. I don't waste time re-thinking things that are over and done with.	.75		.14
7. Often I'm playing back over in my mind how I acted in a past situation.	.69		.66
8. I often find myself re-evaluating something I've done.	.66		.56
9. I never ruminate or dwell on myself for very long.	.72		.13
10. It is easy for me to put unwanted thoughts out of my mind.	.80		-.17
11. I often reflect on episodes in my life that I should no longer concern myself with.	.67		.32
12. I spend a great deal of time thinking back over my embarrassing or disappointing moments.	.67		.32

Note. N = 564. Presented numbers are standardized coefficients (ranging from -1 to 1). All factors are uncorrelated. All factor loadings are significant at $p < .01$ except RRQ item #1's loading on the Rumination-specific factor.

Table 3. Structural Relations Between the PSWQ/RRQ Factors and Approach/Avoidance temperaments and Anxiety/Depression symptoms.

Variables	Results when each criterion variable was entered separately			Results when each criterion variable was entered simultaneously		
	Negative Repetitive Thinking	Worry Specific	Rumination Specific	Negative Repetitive Thinking	Worry Specific	Rumination Specific
Avoidance Temperament	.88*	.37*	.05	.89*	.36*	.04
Approach Temperament	-.24*	.27*	-.15*	-.32*	.13*	.03
Anxious Arousal	.30*	.16*	.05	.32*	.15*	.02
Anhedonic Depression	.56*	-.01	-.05	.60*	-.02	-.06

Note. $N = 564$. Presented numbers are standardized coefficients (ranging from -1 to 1). Asterisks (*) indicate coefficients that were significant at $p < .01$.

Table 4. Descriptive Statistics of LAB and EMA Measures

	Worry				Rumination			
	Initiation	Frequency of continuing worry	Time Spent	Difficulty Terminating	Initiation	Frequency of continuing rumination	Time Spent	Difficulty Terminating
LAB								
Possible Score Range	0 to 9	1 to 3	1 to 5	1 to 5	0 to 9	1 to 3	1 to 5	1 to 5
Mean	2.63	1.94	2.86	2.59	2.37	1.97	2.77	2.63
Std Dev	2.77	.44	.76	.91	2.55	.42	.80	.91
EMA								
Possible Score Range	0 to 1	0 to1	1 to 5	1 to 5	0 to 1	0 to1	1 to 5	1 to 5
Mean	.36	.12	1.75	1.52	.24	.12	1.72	1.48
Std Dev	.22	.16	.49	.65	.22	.17	.48	.74

Table 5. Correlations Between LAB/EMA Measures and Factor Scores From Bi-factor Model

	Repetitive Thinking	Worry-specific	Rumination-specific
Worry			
LAB			
Initiation	.21	.30*	.15
Termination	.31*	.31*	.16
EMA			
Initiation	.40**	.01	.18
Termination	.30*	.20	.02
Rumination			
LAB			
Initiation	.20	-.09	.52**
Termination	.21	.18	.35**
EMA			
Initiation	.07	.03	.07
Termination	.26	.01	.28*

Note: * $p < 0.05$, ** $p < 0.01$, one-tail

Table 6. Correlations Between LAB and EMA Measures

	LAB				EMA			
	Worry		Rumination		Worry		Rumination	
	Initiation	Termination	Initiation	Termination	Initiation	Termination	Initiation	Termination
LAB								
Worry								
Initiation	–––							
Termination	.59**	–––						
Rumination								
Initiation	.39**	.24	–––					
Termination	.28*	.20	.32*	–––				
EMA								
Worry								
Initiation	.10	.33*	.15	.07	–––			
Termination	.30*	.33*	.30*	.50**	.27*	–––		
Rumination								
Initiation	.11	.27*	.19	.07	.76**	.18	–––	
Termination	.02	.15	.20	.42**	.22	.67**	.09	–––

Note: * $p < 0.05$, ** $p < 0.01$, one-tail.

Table 7(a). Descriptive Statistics of Laboratory Measures

	Worry				Rumination			
	Initiation	Frequency of continuing worry	Time Spent	Difficulty Terminating	Initiation	Frequency of continuing rumination	Time Spent	Difficulty Terminating
Possible Score Range	0 to 9	1 to 3	1 to 5	1 to 5	0 to 9	1 to 3	1 to 5	1 to 5
Mean	2.7	2.1	3.0	2.7	2.0	2.0	2.9	2.7
Std Dev	2.4	0.5	0.9	1.0	2.2	0.5	0.9	1.0

Table 7(b). Descriptive Statistics of Attention Measures (RTs in millisecond)

	Attention Bias to Threat	Attention Bias to Loss	Inhibition	Switching Cost
Mean	-1.4	1.9	63.0	85.9
Std Dev	23.5	22.6	70.3	71.6

Table 8. Correlations between Lab Measures of Worry and Rumination and the Bi-factor Scores

	Repetitive Negative Thinking	Worry-specific	Rumination-specific
Worry initiation	.18**	.04	.02
Rumination initiation	.19**	-.14*	.13*
Worry Termination	.25**	.12*	-.05
Rumination Termination	.22**	.09	-.01

Note: * $p < 0.05$, ** $p < 0.01$, one-tail

Table 9. Correlations between Attention Measures and Worry/Rumination Measures

	Attention Bias to Threat	Attention Bias to Loss	Inhibition Ability	Switching Cost
Lab Measures				
Worry Initiation	-.14*	.05	-.01	.07
Worry Termination	-.12	.01	.04	-.10
Rumination Initiation	-.04	.05	.03	.02
Rumination Termination	-.10	.16*	.05	-.01
Bi-Factor Scores				
Common Factor	-.04	.02	-.06	.05
Worry-specific	-.01	.01	.05	-.08
Rumination-specific	.01	.02	-.04	.05

Note: * $p < 0.05$, two-tail

Table 10(a). Summary of Hierarchical Multiple Regression Analyses Predicting Different Phases of Worry and Rumination – Inhibition with Negative Temperament (NT)

	Worry Initiation		Rumination Initiation		Worry Termination		Rumination Termination	
	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2
Step 1		.01		.02		.05**		.03*
Inhibition	.00		.04		.04		.05	
NT	.10		.12		.22**		.18**	
Step 2		.00		.00		.00		.03**
Inhibition x NT	.00		.00		-.02		-.19**	

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

Table 10(b). Summary of Hierarchical Multiple Regression Analyses Predicting Different Phases of Worry and Rumination – Switching Cost with Negative Temperament (NT)

	Worry Initiation		Rumination Initiation		Worry Termination		Rumination Termination	
	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2
Step 1		.02		.01		.06**		.03*
Switching Cost	.07		.02		-.09		.00	
NT	.10		.12		.22**		.18**	
Step 2		.02*		.00		.00		.00
Switching Cost x NT	.13*		.06		.01		.01	

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

FIGURES

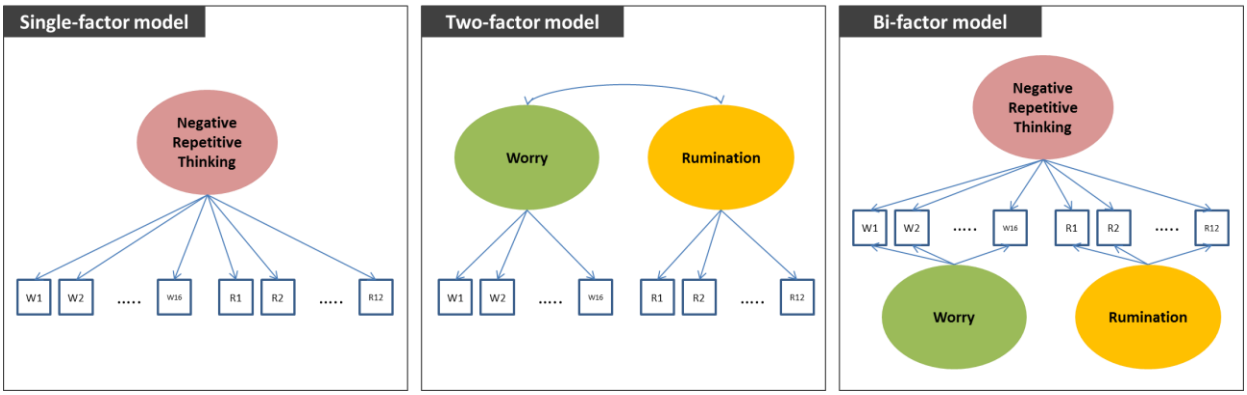

Figure 1. CFA models representing the relationship between worry and rumination

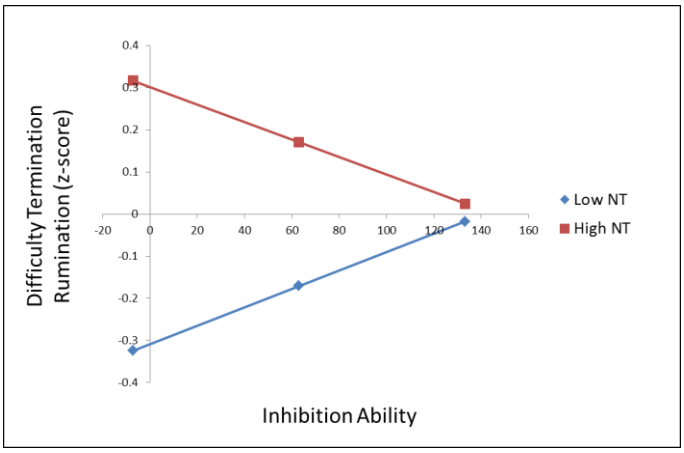

Figure 2. The moderation effect of Inhibition Ability and Negative Temperament in predicting Rumination Termination

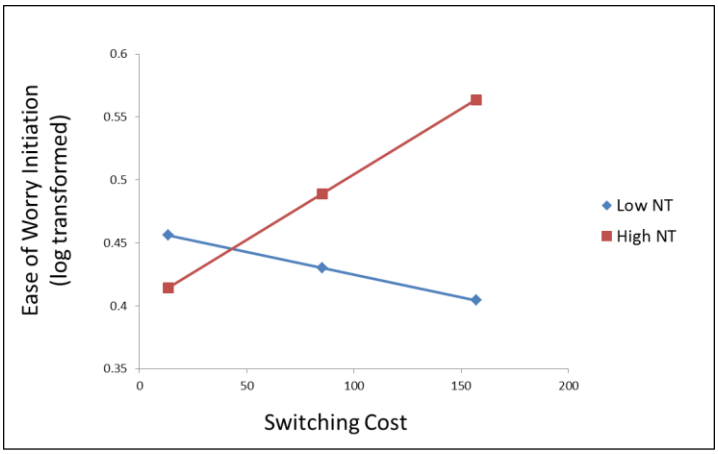

Figure 3. The moderation effect of Switching Cost and Negative Temperament in predicting Worry Initiation

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