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Repetitive Negative Thought and Executive Dysfunction: An Interactive Pathway to Emotional Distress

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Abstract

Repetitive negative thought (RNT) is a transdiagnostic process that predicts the onset, severity, and recurrence of several psychiatric disorders, including anxiety and depression. Despite progress in understanding the affective consequences of RNT, the mechanisms through which RNT contributes to clinical symptoms are not well understood. Executive function (EF), a set of cognitive processes that contributes to the organization of cognition and the regulation of emotion, was hypothesized to enhance the effect of RNT on negative affect (NA), a core symptom shared by anxiety and depression. The present study used latent variable modeling and hierarchical linear regression to test the contributions of RNT, EF, and their interactions to NA. Consistent with hypotheses, high levels of RNT were associated with higher NA, and EF deficits enhanced this association. Results provide evidence that the RNT-EF interaction represents a pathway in the development of NA, and by association, anxiety and depression.

Keywords Repetitive negative thought · Executive function · Anxiety · Depression

Introduction

Anxiety and depression are among the most prevalent, co-occurring, and burdensome forms of psychopathology worldwide (Kessler et al. 2015). Although the extent of their comorbidity is well established, the basis of this comorbidity is poorly understood. Taking a transdiagnostic approach, there has been much speculation that anxiety and depression share diatheses (Clark 1989). Common cognitive processes likely contribute centrally to the onset, recurrence, and course of anxiety and depression (Buckholtz

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and Meyer-Lindenberg 2012; Ehring and Watkins 2008; Ruscio et al. 2011; Segerstrom et al. 2000; Spinhoven et al. 2015) and are likely to account for the significant overlap in symptoms between them. In addition to sharing symptoms of sleep disturbance, fatigue, restlessness, irritability, and concentration problems, anxiety and depression share a fundamental affective feature: elevated negative affect (NA; Clark and Watson 1991). This central component has been repeatedly demonstrated to represent a primary commonality between the two disorders (Brown et al. 1998; Shankman and Klein 2003; Watson et al. 1995a), as well as a risk factor for their development (Loh et al. 2014; Lonigan et al. 2003; Riskind et al. 2013). Taken together, it follows that NA represents a core transdiagnostic risk factor for both disorders, in addition to a shared symptom dimension. Obtaining a clearer understanding of the processes associated with the development and maintenance of NA would also inform a clearer understanding of the transdiagnostic diatheses shared by anxiety and depression.

Another potential risk factor for anxiety and depression is repetitive negative thought (RNT; Segerstrom et al. 2000), a perseverative, iterative style of thinking focused on one's problems, concerns, or negative experiences that is repetitive, intrusive, and difficult to terminate. Response styles theory (Nolen-Hoeksema 1991, 2000) postulates that

those who engage in RNT in response to negative emotions are likely to experience the negative emotions with greater intensity and for a longer duration than those who do not, a process that has implications for the development and maintenance of a wide variety of psychiatric disorders (Nolen-Hoeksema et al. 2008). Worry and rumination, two forms of RNT, are respectively associated with generalized anxiety disorder (Borkovec et al. 1983) and major depressive disorder (Nolen-Hoeksema 1991). Worry is typically characterized as negatively-biased thoughts and images regarding the potential negative outcomes of future events (Borkovec et al. 1983), whereas rumination has been defined as a form of repetitive and negative self-focus (Trapnell and Campbell 1999), dwelling on one's feelings and problems (Nolen-Hoeksema et al. 2008), and the implications, causes, and meanings of a negative mood state (Nolen-Hoeksema 1991). Despite their typical associations, rumination frequently occurs in generalized anxiety disorder, and worry frequently occurs in major depressive disorder (Segerstrom et al. 2000). Additionally, elevated levels of both forms of RNT have been found in almost all anxiety and mood disorders, as well as other forms of psychopathology (e.g., eating disorders), suggesting that they are transdiagnostic processes (Ehring and Watkins 2008). It is likely that either worry or rumination, or perhaps RNT in general, represent mechanisms through which NA, and consequently anxiety and depression, develop and/or are maintained.

Executive dysfunction represents another potential risk factor for NA, anxiety, and depression (Buckholtz and Meyer-Lindenberg 2012), and there are a multitude of findings that demonstrate deficits in executive function (EF) frequently accompany anxiety, depression, worry, and rumination (Bishop 2009; Bredemeier et al. 2016; Caselli et al. 2004; Castaneda et al. 2008; Derakshan et al. 2009a, b; Harvey et al. 2004; Krompinger and Simons 2011; Letkiewicz et al. 2014; Levin et al. 2007; Madian et al. 2015; Meiran et al. 2011; Rose and Ebmeier 2006; Segerstrom et al. 2010; Snyder 2013; Warren et al. 2013; Whitmer and Banich 2007; Whitmer and Gotlib 2012). EF is a broadly defined cognitive domain that plays a key role in regulating emotions, focusing attention, prioritizing and sequencing activities, inhibiting behaviors and thoughts, shifting between tasks and mental sets, making decisions, and managing working memory (WM; Banich 2009; Miyake et al. 2000).

Worry and rumination have also been hypothesized to involve WM, potentially filling it with negative cognitive material and leaving less capacity for other information (Eysenck et al. 2007). Consistent with this assumption, multiple studies demonstrate that worrying (Crowe et al. 2007; Hayes et al. 2008) and ruminating (Curci et al. 2013) diminish WM capacity. In addition to reduced WM, experimentally-induced RNT is also associated with the development of negative mood states (Nolen-Hoeksema and

Morrow 1993). This relationship appears to be circular, as experimentally-induced negative mood states are also associated with increased rumination (Carr et al. 1991; Curci et al. 2013). The existence of a circular relationship between negative thinking and negative mood states has been widely postulated (Lara and Klein 1999). The differential activation hypothesis (Teasdale 1983, 1988) asserts that negative thought processes activated in negative mood states induce progressively more severe and longer-lasting negative mood states that can persist into clinical phenomena, and subsequently maintaining psychiatric disorders once established (Lara and Klein 1999). Consistent with both the differential activation hypothesis (Teasdale 1983, 1988) and the response styles theory (Nolen-Hoeksema 1991, 2000), there is experimental evidence that rumination predicts the subsequent experience of NA states, and that NA states also predict subsequent engagement in rumination (Moberly and Watkins 2008), ultimately leading to a prolonged experience of NA consistent with the stable, trait-like forms of NA present in anxiety and depression (Clark and Watson 1991).

Despite experimental support for the differential activation hypothesis, most individuals who experience negative affective states or negative thoughts do not become trapped in a "vicious cycle" and do not develop clinical psychopathology (Lara and Klein 1999), suggesting that there are moderating factors present to account for this discrepancy. Given the role of EF in managing the contents of working memory, it was hypothesized that EF could represent one such moderating factor. Specifically, it was anticipated that EF would moderate the relationship between RNT and NA. Strong EF could act as a protective factor against NA through several possible mechanisms, such as purging RNT-related negative material in WM before it can significantly affect mood, terminating RNT outright, or shifting to alternative and less detrimental patterns of thinking. Thus, the "vicious cycle" would be attenuated due to the diminished effect of RNT on NA. Conversely, weak EF could act as a risk factor for NA, as weak EF would be insufficient to purge WM of RNT-related material, terminate RNT processes, or shift to alternative thoughts and behaviors, ultimately allowing the "vicious cycle" to progress unabated. Unfortunately, EF can be difficult to measure, and a satisfactory, unified definition remains elusive (Jewsbury et al. 2016; Jurado and Rosselli 2007; Stuss and Alexander 2000). Similarly, modeling worry and rumination distinctively has proven to be equally challenging due to significant overlap between them (Watkins et al. 2005). To provide more statistically reliable and precise measurements of RNT and EF constructs, this study employs a latent variable approach. Specifically, this study leverages the statistical strength of factor analysis to investigate the structure of and extract latent variable factor scores from measures of RNT and EF. The present study consists of

three separate analyses designed to (1) replicate and test a factor model of RNT, (2) replicate and test a factor model of EF, and then (3) use hierarchical linear regression to test whether EF moderates the relationship between RNT and NA.

Analysis 1: The RNT Model

Worry and rumination share features such as being difficult to control, repetitive, focused on negative content, predominantly verbal, and relatively abstract (Ehring and Watkins 2008; Segerstrom et al. 2000; Watkins et al. 2005). However, worry and rumination also differ in certain aspects: for example, ruminative thought generally focuses on content relating to the past, whereas worry generally contains more content relating to the future (Berenbaum 2010; Papageorgiou and Wells 1999; Watkins et al. 2005). Research supports the validity of a functional process common to worry and rumination (Drost et al. 2014; McEvoy et al. 2013; Ruscio et al. 2011; Segerstrom et al. 2000), but also suggests that worry and rumination are distinct despite their similarities (Fresco et al. 2002; Hong 2007; Muris et al. 2004; Yang et al. 2014). A lack of consensus on the composition of worry and rumination presents a challenge for how to best operationalize RNT.

It is possible that worry and rumination share common characteristics and are simultaneously distinguished by unique features. Such a structure could be represented by a bi-factor model, composed of a general factor reflecting commonalities among all items, and multiple group factors, comprised of certain clusters of items that account for variance not captured by the general factor (Reise et al. 2010). Thus, the bi-factor model of worry and rumination proposed by Hur et al. (2017), was used to operationalize RNT for subsequent analyses. This model derives three factors from worry and rumination: a general RNT factor capturing the common qualities of worry and rumination, a worry-specific RNT group factor, and a rumination-specific RNT group factor. In Hur et al.'s analysis of their bi-factor model (2017), the general RNT factor significantly correlated with both anxious arousal and anhedonic depression, supporting its role as a transdiagnostic risk factor for anxiety and depression.

The goal of this analysis was to replicate the bi-factor model of RNT proposed by Hur et al. (2017) and test its fit against two competing models to determine which model best fit the data. In addition to the bi-factor model, a single-factor model representing worry and rumination as one construct, and a two-factor model representing worry and rumination as two correlated but fundamentally distinct constructs, were also tested.

Methods

Participants

Participants were 418 adults (234 females; 178 males; 6 not reported) between the ages of 17–55 (*M* age = 19.6 years, SD = 3.3) identifying as White (64.8%), Asian (12.2%), Other (9.6%), Black (6.7%), unreported or unknown (4.1%), or more than one race (2.6%); 8.6% identified as Hispanic or Latino ethnicity. Participants were recruited from undergraduate psychology courses (N = 395) and from the community (N = 23) via advertisements targeting individuals experiencing anxiety, depression, or no symptoms. Participants recruited from the community were screened with the Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Non-patient Edition (SCID-I/NP; First et al. 2002) to ensure a substantial range of psychopathology. However, a deliberate choice was made not to recruit participants based on SCID diagnosis alone, as there were concerns that this approach might truncate the symptom dimensions of interest and reduce meaningful variance. A subset of the undergraduate participants (N = 125) were recruited based on their responses to the Positive and Negative Affect Schedule (PANAS; Watson et al. 1988), a measure consisting of two, 10-item scales, measuring positive affect (PA) and NA. Specifically, participants were selected if they (1) scored at or above the 80th percentile on the NA subscale and at or below the 50th percentile on the PA subscale (12.4% of screened undergrads); or if they (2) scored at or below the 50th percentile on the NA subscale and at or above the 80th percentile on the PA subscale (9.6% of screened undergrads); or if they (3) scored at or below the 50th percentile on both subscales (21.7% of screened undergrads). This selection method was chosen to ensure a wide range of NA distribution in the sample.

All participants completed worry and rumination questionnaires. Undergraduate participants received course credit, and community participants received financial compensation for their participation.

Questionnaires

Worry was measured by the Penn State Worry Questionnaire (PSWQ; Meyer et al. 1990; Table 1), a 16-item self-report questionnaire with items (e.g., "I am always worrying about something") rated on a 5-point Likert scale from (1) "not at all typical of me" to (5) "very typical of me." The PSWQ demonstrates good convergent and discriminant validities in undergraduate clinical and non-clinical samples (Meyer et al. 1990; Nitschke et al. 2001), as well

Table 1 Repetitive negative thought standardized item loadings

Item	General	Rumination	Worry
PSWQ 1—If I do not have enough time to do everything, I do not worry about it	**− 0.359**		**− 0.441**
PSWQ 2—My worries overwhelm me	**0.579**		**0.561**
PSWQ 3—I do not tend to worry about things	**− 0.483**		**− 0.519**
PSWQ 4—Many situations make me worry	**0.627**		**0.590**
PSWQ 5—I know I should not worry about things, but I just cannot help it	**0.613**		**0.616**
PSWQ 6—When I am under pressure I worry a lot	**0.551**		**0.595**
PSWQ 7—I am always worrying about something	**0.617**		**0.613**
PSWQ 8—I find it easy to dismiss worrisome thoughts	**− 0.531**		**− 0.480**
PSWQ 9—As soon as I finish one task, I start to worry about everything else I have to do	**0.507**		**0.557**
PSWQ 10—I never worry about anything	**− 0.537**		**− 0.608**
PSWQ 11—When there is nothing more I can do about a concern, I do not worry about it any more	**− 0.471**		**− 0.295**
PSWQ 12—I have been a worrier all my life	**0.539**		**0.613**
PSWQ 13—I notice that I have been worrying about things	**0.586**		**0.607**
PSWQ 14—Once I start worrying, I cannot stop	**0.634**		**0.493**
PSWQ 15—I worry all the time	**0.601**		**0.643**
PSWQ 16—I worry about projects until they are all done	**0.433**		**0.546**
RRQ 1—My attention is often focused on aspects of myself I wish I'd stop thinking about[a]	**0.644**	**0.290**	
RRQ 2—I always seem to be rehashing in my mind recent things I've said or done	**0.614**	**0.572**	
RRQ 3—Sometimes it is hard for me to shut off thoughts about myself	**0.683**	**0.411**	
RRQ 4—Long after an argument or disagreement is over with, my thoughts keep going back to what happened	**0.734**	**0.359**	
RRQ 5—I tend to "ruminate" or dwell over things that happen to me for a really long time afterward	**0.789**	0.255	
RRQ 6—I don't waste time rethinking things that are over and done with[b]	**− 0.663**	− 0.111	
RRQ 7—Often I'm playing back over in my mind how I acted in a past situation	**0.736**	**0.476**	
RRQ 8—I often find myself reevaluating something I've done	**0.623**	**0.508**	
RRQ 9—I never ruminate or dwell on myself for very long	**− 0.551**	− 0.174	
RRQ 10—It is easy for me to put unwanted thoughts out of my mind[b]	**− 0.791**	− 0.042	
RRQ 11—I often reflect on episodes in my life that I should no longer concern myself with	**0.683**	**0.299**	
RRQ 12—I spend a great deal of time thinking back over my embarrassing or disappointing moments	**0.591**	**0.377**	

Significant item loadings are in boldface

[a]This item was correlated with its respective group factor in the present analysis, but not in the Hur et al. model

[b]This item was not correlated with its respective group factor in the present analysis, but was in the Hur et al. model

as high internal consistency and good test–retest reliability (Meyer et al. 1990). Internal consistency within the present sample was excellent (α = 0.95).

Rumination was measured with the 12-item Rumination subscale of the Rumination-Reflection Questionnaire (RRQ; Trapnell and Campbell 1999; Table 1), a self-report questionnaire with items (e.g., "I always seem to be rehashing in my mind recent things I've said or done") rated on a 5-point Likert scale from (1) "strongly disagree," to (5), "strongly agree." The Rumination subscale of the RRQ demonstrates good convergent and discriminant validities in undergraduate and community samples (Ruscio et al. 2011; Segerstrom et al. 2003), as well as good internal reliability in undergraduate samples (Segerstrom et al. 2003; Trapnell and Campbell 1999). Internal consistency within the present sample was again excellent (α = 0.92).

Data Analysis

Confirmatory factor analysis (CFA) was used to create the RNT factors from self-report questionnaire measures of worry and rumination. Consistent with procedures described in Hur et al. (2017), PSWQ and RRQ-Rumination items were treated as ordered categorical data. To generate the bi-factor model, all items were saturated by a general RNT factor. PSWQ items were additionally restricted to load onto a worry-specific group factor, and RRQ-Rumination items were additionally restricted to load onto a rumination-specific group factor. All factors were specified as orthogonal, consistent with standard procedures for bi-factor modeling (Reise 2012). As the mean- and variance-adjusted unweighted least squares (ULSMV) estimator has performance superior to that of the mean- and variance-adjusted weighted least squares estimator (Savalei and Rhemtulla

2013), particularly for small-to-medium sample sizes, this estimator was used for the CFAs, which were tested using Mplus 7.4 (Muthén and Muthén 2015). Two competing models were also tested: a single-factor model in which all PSWQ and RRQ-Rumination items loaded onto a common factor, and a two-factor model in which PSWQ items were restricted to load onto a worry factor and RRQ-Rumination items were restricted to load onto a rumination factor. In contrast to the orthogonal bi-factor model, in the two-factor model, the worry and rumination factors were permitted to covary.

Model fit was evaluated using standard fit indices: the Chi square (χ^2) test of model fit (Barrett 2007), the root mean square error of approximation (RMSEA; Steiger 1990), and the comparative fit index (CFI; Bentler 1990). A significant χ^2 p-value (<0.05) indicates model misfit, thus a nonsignificant p-value is desirable. As the χ^2 test of model fit is sensitive to large sample sizes and excessive Type I error rates (Kline 2011), additional fit statistics were used: RMSEA < 0.06 and a CFI ≥ 0.95 (Hu and Bentler 1999). To make direct comparisons, the bi-factor model was used as the parent model, with the single-factor and two-factor models nested within it. As the ULSMV estimator was used, models could not be compared using the χ^2 difference test in the traditional way, since the Chi square difference values for nested models using WLS-type estimators are not χ^2 distributed (Muthén and Muthén 2015). Instead, a modified form of this test was computed in Mplus using the DIFFT-EST option, which includes shift parameters and scale factors to more closely approximate a typical χ^2 (Asparouhov and Muthén 2010) A significant p value from the DIFFTEST option would signify that restriction of the model worsened model fit.

Results

The bi-factor model emerged as an adequate-to-good fit for the worry and rumination questionnaire data (RMSEA $= 0.058$; CFI $= 0.960$). Although the p value for the χ^2 test of model fit was <0.05, this was also the case for the original Hur et al. (2017) model. The two-factor model also emerged as an adequate-to-good fit for the worry and rumination questionnaire data (RMSEA $= 0.050$; CFI $= 0.968$). The single-factor model represented a poor fit to the data (RMSEA $= 0.127$; CFI $= 0.793$, χ^2 $p < 0.05$). Critically, direct model comparisons through DIFFTEST revealed that the bi-factor model was a significantly better fit to the data (both ps < 0.05) than the other models. Thus, the bi-factor model was selected to operationalize RNT for the subsequent analyses. The standardized item loadings for the bi-factor model are reported in Table 1. Item-level findings are consistent with the Hur et al. (2017) model.

Analysis 2: The EF Model

As with RNT, there is a longstanding debate over the composition of EF. Numerous definitions of EF have been proposed, ranging from the very broad to the very specific. Moreover, the construct validity of most EF tasks is not well established, raising questions pertaining to the sensitivity and specificity of tasks classified as EF measures (Miyake et al. 2000). Further complicating the measurement of EF is the task impurity problem (Phillips 1997). As EF acts on non-executive processes (e.g., processing speed, simple attention), all EF tasks include systematic variance attributed to relatively basic cognitive abilities that are task specific (e.g., color processing during a Stroop task; Snyder et al. 2015a). Consequently, EF cannot be directly measured independently from the other cognitive functions it acts upon (Lezak 1982). Additionally, correlations among purportedly distinct EF tasks can be high, as many of the clinical neuropsychological measures typically used to assess EF measure multiple components of EF simultaneously (Snyder et al. 2015b). The vagueness of EF constructs, the intercorrelations among EF components, and the task impurity problem can render raw scores from individual EF tests conceptually indistinct. A latent variable approach was used in the present study to maximize construct variance, account for correlations among factors, remove error variance, and avoid the task impurity problem.

Miyake et al.'s (2000) three-factor model was used to operationalize EF. This model separates EF into inhibition, shifting, and updating factors which represent correlated but distinct constructs. Briefly, inhibition is defined as the ability to stop automatic or overlearned behavior responses (Logan 1994). Shifting or "task switching" concerns alternating attention between tasks, operations, or mental sets (Monsell 1996). Updating is the ability to modify information in WM by monitoring incoming information, revising old information with new information, and removing the old, irrelevant information (Morris and Jones 1990). In addition to controlling for the task impurity problem through its use of latent variable modeling, this model also resolves issues of construct validity inherent in most EF measures. More complex measures of EF tend to have relatively low reliability (Denckla 1996; Miyake et al. 2000). Moreover, it is often unclear whether these complex tasks measure the functions that they profess to (Miyake et al. 2000). In contrast, the inhibition, shifting, and updating factors represent relatively simpler, "purer" functions with significantly better construct validity: the three-factor model is one of the most well-validated and replicated models in the literature (Friedman et al. 2008; Lehto et al. 2003; Miyake et al. 2000; Miyake and Friedman 2012; Rose et al. 2011; Vaughan and Giovanello 2010).

In addition to the three-factor model, a bi-factor model proposed by Friedman et al. (2008), was also considered a strong candidate to operationalize EF. This model, also referred to as the nested factors model, serves as a revision to the three-factor model described above (Miyake and Friedman 2012). This bi-factor model also derives three factors from EF: a common EF factor capturing a goal-maintenance function, theorized to promote continued engagement with a behavior or goal by inhibiting attention to distractors, a shifting-specific EF factor analogous to the three-factor model's shifting factor, and an updating-specific EF factor analogous to the three-factor model's updating factor (Miyake and Friedman 2012).

The goal of this analysis was to replicate the three-factor model of EF proposed by Miyake et al. (2000) and the revised bi-factor model of EF proposed by Miyake and Friedman (2012), and to test their fit to determine which model best fit the current data. In addition to the three-factor model and revised bi-factor model, a single-factor model representing those elements common to a wide variety of frontal executive functions (i.e., a unitary, general EF) was also tested. CFA was employed to create latent EF factors from variables indexing performance on several neuropsychological tests of EF (described below).

Method

Participants

Participants were 125 adults (*M* age = 21.0; SD = 5.0; 51.2% female), a subset from Analysis 1 above. They completed neuropsychological tasks administered in randomized, counterbalanced order during 1, 3-h session. Participants were financially compensated.

Experimental Tasks

Three behavioral measures were available for each of the three target EF domains. Multiple measures per EF domain were included to reduce contributions from other non-executive domains of cognition (e.g., task impurity).

Measures of Inhibition

D-KEFS Color-Word Interference Test The Inhibition subtest (Delis et al. 2001) is a variant of the original Stroop (1935) procedure. Participants were shown a page with a series of color-name words printed in a non-corresponding ink color (e.g., the word "Red" printed in blue ink). Participants were instructed to name the ink color in which each word was printed as quickly and accurately as possible. Completion time was used as a measure of inhibition efficiency.

Stop-Signal Task In the Stop-Signal task (van den Wildenberg et al. 2003), participants were presented with a series of left- or right-facing green arrows in the center of a computer monitor. In the first condition of the task, participants were instructed to press the left arrow key as quickly as possible upon seeing a left-facing arrow and to press the right arrow key as quickly as possible upon seeing a right-facing arrow. Participants completed a practice series of 10 arrows and an experimental series of 50 arrows. In the second condition of the task, participants were instructed to withhold their response when they saw a red arrow. The arrows changed to red (i.e., the stop signal) on 25% of the trials. The timing of the color change was dynamically adjusted by the stimulus software in steps of 50 milliseconds so that each participant would be able to inhibit his/her key presses approximately 50% of the time. Participants completed a practice series of 48 trials and then three experimental series of 80 trials each. The observed variable for this factor analysis was the latency of the stop process, the difference between the mean reaction time on non-stop-signal trials and the mean stop-signal delay (Logan 1994).

Tower of London Task A computerized version of the Tower of London task, originally based on Shallice (1982), was developed by W. K. Berg (Berg and Byrd 2002) with input from the second author (SLW) and collaborators. On a computer screen, participants were simultaneously shown a "move board" and a "goal board," each with configurations of three colored balls on three pegs of different heights. Participants were instructed to move the balls on the move board to match the configuration of balls on the goal board by dragging the balls from peg to peg, using the fewest number of moves possible. Three rules restricting the movement of the balls were in place: (1) only one ball could be moved at a time, (2) a ball could only be moved if no other balls were on top of it, and (3) up to three balls could be placed on the tallest peg, two on the middle peg, and only one ball on the shortest peg. Each trial of the test was designed to become progressively more complex, requiring more moves to solve. The observed variable for this factor analysis was the number of extra moves made on correct trials above a minimum complexity threshold. Extra moves represent a failure to adequately plan an optimally efficient series of movements, signifying at least one and possibly multiple lapses in the ability to inhibit responding long enough to plan ahead accurately. Trials in which responding is inhibited are generally only noted to occur during sufficiently complex trials, i.e. trails in which at least one ball must be moved out of the way to rearrange the others (Berg and Byrd 2002). Thus, only performances on these complex trials were anticipated to capture failure of inhibition.

Measures of Shifting

D-KEFS Trail Making Test In the Number-Letter Switching condition (Delis et al. 2001), participants were presented with a sheet of paper consisting of circles with a number or letter inscribed within. Participants were instructed to draw lines connecting numbers and letters in ascending and alphabetical order, respectively, switching each time between a number and a letter (e.g., 1-A-2-B-3-C). Total completion time was used in this analysis as a measure of shifting efficiency.

D-KEFS Verbal Fluency Test In the Category Switching condition (Delis et al. 2001), participants were asked to generate words in two different semantic categories (e.g., vegetables and clothing), switching between categories after responding with one word for a given category (e.g., lettuce-pants-carrot-sweater). Participants were given 60 s to generate as many words as possible. The number of accurate switches was used in this analysis as a measure of shifting effectiveness.

Plus-Minus Task In the Plus-Minus task (adapted from Miyake et al. 2000), originally based on Jersild (1927) and Spector and Biederman (1976), participants were presented with three lists of 30 randomized, two-digit numbers on a sheet of paper. Participants were instructed to add 1 to each number on the first list, subtract 1 from each number on the second list, and alternate between adding and subtracting 1 from each number on the third list, recording their written responses next to each number. Time to complete each list was recorded. Shifting cost, a measure of shifting efficiency, was calculated as the difference between the time to complete the third list and the average of the times to complete the first and second lists (Miyake et al. 2000).

Measures of Updating

Keep Track Task In the Keep Track task (adapted from Miyake et al. 2000), originally based on Yntema (1963), participants viewed a screen on which words were presented at a rate of one word every 2 s. All words belonged to six categories (animals, colors, countries, distances, metals, and relatives), with six words in each category, for a total of 36 words. Before and during the presentation of the words, participants were shown between two and five categories along the bottom of the screen and were instructed to keep track of the last word presented from each of the target categories. In each trial of the task, participants were shown between 15 and 24 words in randomized sequence. After two practice trials, participants completed 16 trials of the task, with four trials each keeping track of two, three, four, and five categories, in randomized order. Participants were instructed to

verbally recall the last word presented for each of the target categories at the end of each trial, recalling a total of 56 words. The observed variable for this factor analysis was the number of words recalled correctly, a measure of updating effectiveness (Miyake et al. 2000).

Letter Memory Task In the Letter Memory task (adapted from Miyake et al. 2000), originally based on Morris and Jones (1990), participants were shown a sequence of letters on a screen, one letter every three seconds. Sequences of 9, 11, or 13 letters were presented. After each letter was shown, participants were instructed to rehearse out loud the last four letters they saw, in sequential order, adding the most recent letter seen and dropping the fifth letter back. For example, if the letters presented were "A, B, C, D, E," the correct rehearsal would be "A… AB… ABC… ABCD… BCDE." At the end of each trial, participants were instructed to recite the last four letters they saw, in sequential order. Twelve trials were presented, with four sequences each of 9, 11, and 13 letters, in randomized order. With 4 letters recalled at the end of each sequence, 48 letters were recalled in total. The observed variable for this factor analysis was the number of letters recalled correctly, a measure of updating effectiveness (Miyake et al. 2000).

Spatial Updating Task The Spatial Updating task was developed in the laboratory (Warren et al. in prep) as a visuospatial analog to the letter memory task, with similarities to the Corsi portion of the Hebb-Corsi test (Corsi 1972). Participants viewed a screen with a spatial array of 21 small boxes. Sequences of 9, 11, or 13 boxes were darkened in a random order, one box at a time. After a brief (500 ms) appearance of each darkened box, participants were instructed to indicate the last four boxes that darkened in proper sequential order, using the mouse to select from the boxes on the screen. Like the Letter Memory task, participants were instructed to remember the location and sequence of the last four boxes they saw, updating their WM by adding the most recent box and dropping the fifth box back. After two practice trails, participants completed four sequences each of 9, 11, and 13 blocks, in counterbalanced order, for a total of 12 sequences. The observed variable for this factor analysis was the average reaction time across correct trials of intermediate-length sequences.

Data Analysis

All EF performance scores were z-scored to improve model convergence, normalize their contributions to the latent factors, and simplify the interpretability of the factor loadings. As some variables were positively correlated with poor performance, and others were negatively correlated with poor performance, negatively-correlated

variables were multiplied by − 1 to simplify the interpretation of the factor loadings. The factors were structured in such a way that higher factor scores would always correspond to worse EF task performance. Because CFA is sensitive to non-normality and outliers (Kline 2011), and the EF score variables were skewed and kurtotic, the variables were transformed prior to factor analysis. The standardized assessment scores were winsorized by a process similar to the procedures described in Miyake et al. (2000) and Friedman et al. (2008): any scores that were more than three standard deviations (SDs) away from the sample mean were set to 3 SDs away from the mean. Nine participants had scores adjusted in this way. Kurtosis and skew were substantially reduced for each of the assessment score variables, but some of the values were still high enough to be concerning for multivariate non-normality, so the maximum likelihood estimator with robust standard errors (MLR) was used for the final CFAs.

To generate the three-factor model, observed variables indexing performances on the nine measures were saturated by their respective EF factors (i.e., performances on the inhibition measures could load onto the inhibition factor, performances on the shifting measures could load onto the shifting factor, and performances on the updating measures could load onto the updating factor). The three factors were allowed to correlate. To generate the bi-factor model, all measures of EF performance could load on the general EF factor, whereas the shifting measures were additionally allowed to load onto the shifting-specific factor, and the updating measures were additionally allowed to load onto the updating-specific factor. All factors were specified as orthogonal, consistent with standard procedures for bi-factor modeling (Reise 2012) and with the original model (Friedman et al. 2008). Finally, a single-factor model in which all nine measures loaded onto a single general EF factor was also tested.

Model fit was again evaluated using standard fit indices as referenced in Analysis 1 above: χ^2 test of model fit (Barrett 2007), RMSEA (Steiger 1990), and CFI (Bentler 1990). As the MLR estimator was used, a modified χ^2 difference test based on loglikelihood and scaling correction factors was used to directly compare models (Satorra and Bentler 2010). To make direct comparisons, the bi-factor model was used as the parent model, with the single-factor model nested within it. Then, the single factor-model was used as the parent model, with the three-factor model nested within it. A significant p value from the difference test would signify that restriction of the model worsened fit. As the three-factor model and bi-factor model represented non-nested models, they were compared indirectly, using Akaike's information criterion (AIC; Akaike 1974). A model can be considered a relatively better fit than a competing model if its AIC is lower (Hooper et al. 2008).

Results

The three-factor model was a good fit for the data, meeting the most stringent criteria for good absolute fit on all fit statistics (χ^2 $p = 0.164$; RMSEA = 0.047; CFI = 0.950). All observed variables loaded significantly onto their respective factors ($p < 0.05$). However, estimated correlations among the latent variables were very high (0.897 between Inhibition and Shifting, 0.762 between Inhibition and Updating, and 0.832 between Shifting and Updating), relative to the correlations obtained by Miyake et al. (2000). The single-factor model was also a good fit to the data based on absolute fit statistics (χ^2 $p = 0.1573$; RMSEA = 0.047; CFI = 0.946), and the χ^2 difference test based on loglikelihood and scaling correction factors revealed that the single-factor model was a significantly better fit to the data ($p < 0.05$) than the three-factor model. The bi-factor model failed to converge in this sample. Thus, the single-factor model was selected to operationalize EF for the subsequent analyses. Descriptive statistics for the nine observed EF measures from which the latent EF variables were extracted are presented in Table 2. Pearson correlations among the EF measures, presented in Table 3, ranged from − 0.074 to 0.436. The standardized item loadings for the single-factor model are reported in Table 4. All observed variables loaded significantly onto the single EF factor ($p < 0.05$).

Analysis 3: Executive Function and Repetitive Thought in Emotional Distress

The analyses above established RNT and EF factors to be tested in hierarchical linear regressions predicting NA. As noted above, NA is a fundamental symptom dimension shared by anxiety and depression (Clark and Watson 1991), and is central to the experience and course of both disorders. NA can be subdivided into state affect, representing transient fluctuations in mood, and trait affect, representing stable dispositions to experience that affect. State and trait NA are interrelated, and high levels of one frequently co-occur with the other (Watson and Pennebaker 1989). However, despite their similarities and close correspondence, state and trait NA are distinct and appear to involve separate cognitive processes. For example, in a study by Crocker et al. (2012), only state NA, and not trait NA, was associated with disrupted neuropsychological task performance. Consequently, it was thought that state NA would represent the most pertinent form of NA to examine as an outcome variable in testing for the hypothesized moderation of RNT by EF.

Table 2 Descriptive statistics for executive function measures

Task	N	M	SD	Min	Max	Skewness	Kurtosis	Skewness (trimmed)	Kurtosis (trimmed)
Inhibition									
Stroop	123	41.97 s	9.16	21	74	0.95	1.90	0.84	1.45
Stop signal	118	226.91 ms	40.01	83.33	313.17	−0.173	0.81	−0.02	0.26
Tower of London	122	15.44	9.24	1	50	0.91	1.29	0.76	0.61
Shifting									
Trails	124	58.54 s	26.88	27	215	3.02	12.64	1.90	4.39
Verbal fluency	124	13.75	3.39	6	22	0.06	0.00	0.06	0.00
Plus minus	125	15.13 s	12.61	−3	82	1.89	6.06	1.191	1.36
Updating									
Keep track	125	43.25	5.02	25	53	0.77	1.33	0.64	0.79
Letter memory	123	33.82	8.85	5	48	0.75	0.53	0.68	0.26
Spatial updating	125	725.63 ms	132.01	501.14	1234.68	1.26	2.20	1.03	1.19

Table 3 Correlations among executive function measures

Measure	Stroop	Stop signal	Tower of London	Trails	Verbal fluency	Plus minus	Keep track	Letter memory	Spatial updating
Inhibition									
Stroop	–								
Stop signal	**0.235 (p = 0.010)**	–							
Tower of London	**0.243 (p = 0.008)**	−0.069 (p = 0.461)	–						
Shifting									
Trails	**0.410 (p = 0.000)**	**0.193 (p = 0.036)**	0.104 (p = 0.257)	–					
Verbal fluency	**0.256 (p = 0.004)**	0.020 (p = 0.834)	**0.216 (p = 0.017)**	**0.256 (p = 0.004)**	–				
Plus minus	**0.446 (p = 0.000)**	0.086 (p = 0.355)	0.113 (p = 0.214)	**0.318 (p = 0.000)**	**0.218 (p = 0.015)**	–			
Updating									
Keep track	**0.459 (p = 0.000)**	**0.232 (p = 0.011)**	**0.180 (p = 0.048)**	**0.379 (p = 0.000)**	**0.296 (p = 0.001)**	0.156 (p = 0.082)	–		
Letter memory	**0.336 (p = 0.000)**	−0.041 (p = 0.661)	0.130 (p = 0.156)	**0.380 (p = 0.000)**	0.125 (p = 0.168)	**0.289 (p = 0.001)**	**0.395 (p = 0.000)**	–	
Spatial updating	**0.251 (p = 0.005)**	**0.192 (p = 0.037)**	0.038 (p = 0.676)	0.161 (p = 0.073)	0.000 (p = 0.996)	**0.151 (p = 0.092)**	**0.215 (p = 0.016)**	0.138 (p = 0.128)	–

Significant correlations are in boldface

Also noted above, the differential activation hypothesis (Teasdale 1983, 1988) postulates that negative thinking and state NA have a circular relationship, a "vicious cycle" that over time results in the emergence of clinical psychopathology (Lara and Klein 1999). Although much research demonstrates that a circular relationship between RNT and state NA exists (Carr et al. 1991; Curci et al. 2013; Moberly and Watkins 2008; Nolen-Hoeksema and Morrow 1993), it is also evident that a moderating effect must be present, since many individuals experience RNT and state NA without developing clinical psychopathology (Lara and Klein 1999). The current study tested EF as a potential moderator of the this theorized circular relationship between negative thinking and NA.

In addition to investigating the interactive effects of RNT and EF on state NA, the proposed moderation analysis also presents a unique opportunity to clarify a long-standing debate regarding the respective roles of worry

Table 4 Executive function standardized item loadings

Item	General EF loading
Inhibition	
Stroop	0.772
Stop signal	0.258
Tower of London	0.279
Shifting	
Trails	0.579
Verbal fluency	0.437
Plus minus	0.487
Updating	
Keep track	0.613
Letter memory	0.494
Spatial updating	0.319

All measure loadings were significant ($p < 0.05$)

and rumination in anxiety and depression. Several previous studies have attempted to delineate which RNT process is most closely associated with psychopathology, with mixed results. For example, one analysis demonstrated that only worry, and not rumination, predicted symptoms of anxiety and depression (Muris et al. 2004), whereas another study demonstrated that it was rumination, and not worry, that predicted symptoms (McLaughlin and Nolen-Hoeksema 2011). Some studies demonstrated that a general RNT factor was the best predictor of anxiety and depression (Drost et al. 2014; Spinhoven et al. 2015) whereas others demonstrated that worry and rumination independently predicted anxiety and depression, respectively (Fresco et al. 2002; Hong 2007; Yang et al. 2014). Based on Hur et al.'s (2017) RNT model and findings (i.e., only the general RNT factor correlated unambiguously with risk for psychopathology), it was hypothesized that only general RNT (not the worry-specific or the rumination-specific RNT factors) would influence NA. The general EF factor was tested as a moderator on the relationships between RNT factors (general, worry-specific, and rumination-specific) and state NA. A significant main effect of general RNT on state NA was anticipated. Moreover, we hypothesized that this relationship would be moderated by EF, with weak EF enhancing the effect of RNT on state NA, and strong EF attenuating this effect.

Methods

Participants

Participants were those used in Analysis 2, except for four participants who did not complete measures of RNT and NA ($N = 121$; 103 undergraduates and 22 community

participants). As noted previously, participants were not recruited based on clinical diagnosis due to concerns that such an approach might truncate the symptom dimensions of interest. However, based on participants' responses to symptom questionnaires and the SCID, it was possible to determine sample proportions who met clinical criteria for generalized anxiety disorder and major depressive disorder diagnoses. Undergraduate participants completed the Mood and Anxiety Symptoms Questionnaire (MASQ; Watson and Clark 1991; Watson et al. 1995b), to provide supplementary dimensional measures of anxious and depressive symptoms. Based on the cutoff scores established by receiver-operating characteristic analyses of the PSWQ (Behar et al. 2003; Fresco et al. 2003) and the anhedonic depression (AD) scale of the MASQ (Bredemeier et al. 2010), between 8.2 and 14% of the sample were above the clinical cutoff for generalized anxiety disorder, between 7.4 and 9.1% of the sample were above the clinical cutoff for major depressive disorder, and between 5.8 and 9.9% of the sample were above the clinical cutoffs for both disorders. For the subset of the sample screened with the SCID (22 community participants), 50% met clinical criteria for diagnoses of both an anxiety disorder and a depressive disorder, 9.5% met clinical criteria for a diagnosis of anxiety alone, and 14.3% met criteria for subclinical anxious and depressive symptoms, and/or met criteria for other clinical diagnoses.

Measures of Negative Affect and Factor Scores

State NA was measured using the NA subscale of the PANAS (Watson et al. 1988). Participants rated the intensity of their feelings on 10 negative emotion-word items (e.g., "Upset," "Irritable," "Ashamed") on a 5-point Likert scale from (1) "very slightly or not at all" to (5) "extremely." Participants were instructed to rate how they felt "Right now, that is, at the present moment," to obtain a measure of state NA. The NA subscale of the PANAS demonstrates good convergent and discriminant validities in undergraduate and community samples (Ruscio et al. 2011), as well as good internal reliability in community samples (Crawford and Henry 2004). Internal consistency within the present sample was strong ($\alpha = 0.88$). Despite the use of a non-continuous cutoff strategy in the selection of the participants, the histogram demonstrated a unimodal distribution of NA scores.

Factor Scores

Factor scores representing the components of RNT (a general RNT factor, a worry-specific factor, and a rumination-specific factor) were drawn from Analysis 1. The factor score representing general EF was drawn from Analysis 2.

Table 5 Executive function and repetitive negative thought factor score correlations

Variable	General RNT	Worry-specific	Rumination-specific	General EF	State NA
General RNT	–				
Worry-specific	**0.208 (p = 0.020)**	–			
Rumination-specific	**0.433 (p = 0.000)**	**− 0.231 (p = 0.009)**	–		
General EF	− 0.039 (p = 0.669)	0.112 (p = 0.215)	0.079 (p = 0.380)	–	
State NA	**0.403 (p = 0.000)**	0.144 (p = 0.115)	**0.214 (p = 0.018)**	**0.246 (p = 0.006)**	–

Significant correlations are in boldface

Table 6 ANOVA table for the interaction of RNT and EF on state NA

Model	Sum of squares	df	Mean square	F	Sig
1—No interaction terms entered					
Regression	27.862	4	6.965	8.769	0.000
Residual	92.138	116	0.794		
Total	120	120			
2–2-way interaction terms entered					
Regression	42.111	7	6.016	8.728	0.000
Residual	77.889	113	0.689		
Total	120	120			

Data Analysis

A hierarchical multiple regression was conducted using the RNT and EF factor scores and their interactions as the independent variables and state NA as the dependent variable. Three interaction terms were computed, representing the product of each latent RNT factor score and the general EF factor. The factor scores were z-scored prior to computing their interaction terms (Cohen et al. 2003). In the first step, the three RNT factor scores and the EF factor score were entered as independent variables. In the next step, the three 2-way interaction terms were added to the regression. The regression analysis was conducted in SPSS (Version 23.0; IBM Corp. 2015). Significant interactions were probed, and the significance of their simple slopes calculated using procedures described in Dawson (2014). Simple slopes were tested with the moderators set at one SD above the mean (weak EF) and one SD below the mean (strong EF).

Results

Pearson correlations among the first-order variables are summarized in Table 5. Greater executive dysfunction was associated with elevated state NA. All three RNT factor scores were significantly correlated with each other, although the worry-specific factor was inversely correlated with rumination-specific factor. Of the three RNT factors, only the general and rumination-specific factors correlated with state

Table 7 RNT × EF on state NA regression table

	Model	t	Sig.
1	(Constant)	0.064	0.949
	General RNT	3.972	0.000
	Worry-Specific RNT	0.425	0.671
	Rumination-Specific RNT	0.358	0.721
	General EF	3.047	0.003
2	(Constant)	− 0.015	0.988
	General RNT	3.546	0.001
	Worry-Specific RNT	0.624	0.534
	Rumination-Specific RNT	0.131	0.896
	General EF	1.631	0.106
	General RNT*General EF	2.790	0.006
	Worry-Specific RNT*General EF	1.281	0.203
	Rumination-Specific RNT*General EF	0.952	0.343

Significant terms are in boldface

NA. These two correlations were positively signed, with higher levels of RNT associated with higher state NA.

The full regression model accounted for considerable variance in state NA ($R^2 = 0.351$, $p < 0.001$). The ANOVA and regression tables for the hierarchical multiple regression are reproduced in Tables 6 and 7, respectively. The 2-way interaction between the general RNT and the general EF factor provided 12% of the variance in state NA ($p < 0.001$). A simple-slopes analysis (Fig. 1) revealed only one significant slope: general RNT enhanced state NA only in the presence of weak EF ($p < 0.001$). The slope representing the effect of
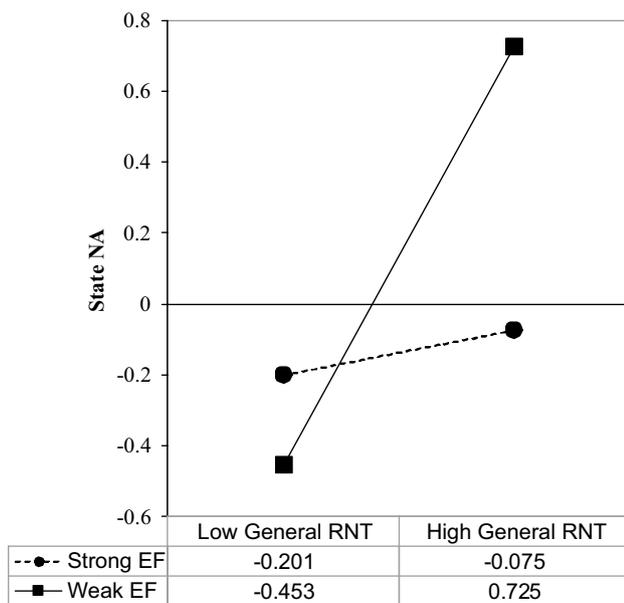
Fig. 1 Plot of the 2-way interaction of general RNT and general EF on state NA. Only the slope of the line representing the effects of general RNT with weak EF on state NA is significantly different from zero

general RNT on state NA in the presence of strong EF was nonsignificant ($p = 0.665$). Worry-specific RNT, rumination-specific RNT, and their interactions with general EF were not significant predictors of state NA.

Discussion

As predicted, EF moderated the effect of general RNT on state NA, with higher levels of general RNT associated with higher levels of state NA, but only for those with relatively weak EF. When EF was relatively strong, the effect of general RNT on state NA was not significant. These results suggest that without the requisite executive abilities to halt, redirect, or expunge RNT, those with high levels of RNT and relatively weak EF experience higher levels of state NA compared to those whose executive abilities are relatively strong. Additionally, results suggest that stronger EF is a protective factor against state NA for those with high levels of RNT. Also concurrent with predictions, neither worry-specific RNT, rumination-specific RNT, nor their interactions with EF predicted NA when entered into the model with general RNT. Thus, there is no evidence that the unique elements of worry and rumination, respectively, represent distinct risk factors for state NA. This finding suggests that only the common element of worry and rumination demonstrably represents a potential risk factor for state NA.

These results provide support for Nolen-Hoeksema's response styles theory (1991, 2000) through its confirmation of the relationship between RNT and state NA, as well as support for Teasdale's differential activation hypothesis (1983, 1988) by providing a potential explanation for why the postulated "vicious cycle" does not always occur. Specifically, since strong EF seems to protect against state NA for those with high RNT (disrupting the first "stage" of the cycle), the second "stage" of the cycle, through which the higher levels of state NA drive further negative thinking, should also be attenuated. With the cycle disrupted, RNT and state NA would no longer contribute to the subsequent development of the stable, trait-like forms of NA present in anxiety and depression (Clark and Watson 1991), at least not via the mechanism proposed by the differential activation hypothesis. In contrast, those with high RNT and weak EF would experience the "vicious cycle" unabated and could go on to develop clinical psychopathology. In this way, the interaction of RNT and EF represents not only a risk factor for state NA, but also a potential transdiagnostic risk factor for anxiety and depression.

There are, however, several caveats to this interpretation. As noted above, it is the trait-like aspects of NA that are most closely associated with anxiety and depression (Clark and Watson 1991), and the above regression analysis dealt exclusively with state NA. Although the differential activation hypothesis suggests that the reciprocal relationship between negative thinking and state NA contributes to the development of trait NA and the associated psychopathologies of anxiety and depression, these relationships were not tested directly. Incorporating measure of trait NA into the above regression analysis would provide a more definitive test of the RNT-EF interaction as a transdiagnostic risk factor for anxiety and depression.

Additionally, the above regression analysis measured only one aspect of the "vicious cycle" proposed by the differential activation hypothesis: that negative thinking is associated with more intense negative mood states. The converse relationship, that more intense negative mood states are reciprocally associated with more negative thinking, an equally important component of the differential activation hypothesis, was not tested in this analysis. Although the results of this analysis suggest implications for the "vicious cycle," they do not definitively confirm or deny this proposed mechanism in its entirety. Unfortunately, a model accounting for such a circular relationship cannot be probed without structural equation modeling (which was not a suitable option for this analysis in the present study due to the limited sample of individuals completing both symptom questionnaires and neuropsychological testing) and/or longitudinal data. However, structural equation modeling and longitudinal data analyses would very likely prove to be fruitful avenues for future research.

Another potential area for future research would be to examine the effects of the RNT-EF interaction on the

unique, rather than the shared, factors of anxiety and depression. Based on the results of this study, it appears that the interaction of EF and the factor common to worry and rumination is significantly correlated with NA, a core shared symptom of anxiety and depression. Likewise, it may be the case that the unique aspects of worry and rumination account for the unique features of anxiety and depression, such as low positive affect in depression (Clark and Watson 1991), which is not characteristic of anxiety. Such research has the potential to further differentiate general, worry-specific, and rumination-specific RNT (and, by association, anxiety and depression), which would facilitate the development of treatments specifically tailored to the unique elements of each type of disorder. Yet another potential area for future research would be to examine the interactions of EF with other forms of RNT, such as anger rumination, obsessions in obsessive–compulsive disorder (OCD), or intrusive memories in posttraumatic stress disorder (PTSD). Indeed, there is evidence for EF deficits in many disorders with a component of repetitive thought or behavior (OCD: Meiran et al. 2011; Snyder et al. 2015a; PTSD:; DeGutis et al. 2015; LaGarde et al. 2010).

Despite the noted caveats, the findings of the present study contribute to the current literature on risk for depression and anxiety by demonstrating that excessive RNT coupled with relatively weak EF contributes to state NA, a central transdiagnostic feature. Additionally, by providing support for Nolen-Hoeksema's response styles theory (1991, 2000) and Teasdale's differential activation hypothesis (1983, 1988), current findings suggest that the RNT–EF interaction represents a transdiagnostic risk factor for anxiety and depression, as an initial component of a pathway in the development of stable, trait-like forms of NA. Further investigation of this interaction is warranted and could have potentially far-reaching implications, including for the development and implementation of psychotherapeutic interventions. For example, a deeper understanding—biological, computational, cognitive—of the roles of EF in psychopathology could inform treatment selection for individuals with comorbid affective and cognitive disorders, or for individuals with highly perseverative patterns of thinking. Continued investigation of transdiagnostic symptom dimensions and mechanisms such as the interaction of RNT and EF is likely to yield valuable theoretical and clinical information, supporting the development of both more targeted and more universal interventions in the future.

Compliance with Ethical Standards

References

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control, 19*(6), 716–723. https://doi.org/10.1109/tac.1974.1100705.

Asparouhov, T., & Muthén, B. O. (2010). *Simple second order chi-square correction*. Retrieved from http://www.statmodel.com/download/WLSMV_new_chi21.pdf.

Banich, M. T. (2009). Executive function: The search for an integrated account. *Current Directions in Psychological Science, 18*(2), 89–94. https://doi.org/10.1111/j.1467-8721.2009.01615.x.

Barrett, P. (2007). Structural equation modelling: Adjudging model fit. *Personality and Individual Differences, 42*(5), 815–824. https://doi.org/10.1016/j.paid.2006.09.018.

Behar, E., Alcaine, O., Zuellig, A. R., & Borkovec, T. D. (2003). Screening for generalized anxiety disorder using the Penn State Worry Questionnaire: A receiver operating characteristic analysis. *Journal of Behavior Therapy and Experimental Psychiatry, 34*(1), 25–43.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238–246. https://doi.org/10.1037/0033-2909.107.2.238.

Berenbaum, H. (2010). An initiation–termination two-phase model of worrying. *Clinical Psychology Review, 30*, 962–975. https://doi.org/10.1016/j.cpr.2010.06.011.

Berg, W. K., & Byrd, D. L. (2002). The Tower of London spatial problem-solving task: Enhancing clinical and research implementation. *Journal of Clinical and Experimental Neuropsychology, 24*(5), 586–604. https://doi.org/10.1076/jcen.24.5.586.1006.

Bishop, S. J. (2009). Trait anxiety and impoverished prefrontal control of attention. *Nature Neuroscience, 12*(1), 92–98. https://doi.org/10.1038/nn.2242.

Borkovec, T. D., Robinson, E., Pruzinsky, T., & DePree, J. A. (1983). Preliminary exploration of worry: Some characteristics and

processes. *Behaviour Research and Therapy, 21*(1), 9–16. https://doi.org/10.1016/0005-7967(83)90121-3.

Bredemeier, K., Spielberg, J. M., Silton, R. L., Berenbaum, H., Heller, W., & Miller, G. A. (2010). Screening for depressive disorders using the mood and anxiety symptoms questionnaire anhedonic depression scale: A receiver-operating characteristic analysis. *Psychological Assessment, 22*(3), 702–710. https://doi.org/10.1037/a0019915.

Bredemeier, K., Warren, S. L., Berenbaum, H., Miller, G. A., & Heller, W. (2016). Executive function deficits associated with current and past major depressive symptoms. *Journal of Affective Disorders, 204*, 226–233.

Brown, T. A., Chorpita, B. F., & Barlow, D. H. (1998). Structural relationships among dimensions of the DSM-IV anxiety and mood disorders and dimensions of negative affect, positive affect, and autonomic arousal. *Journal of Abnormal Psychology, 107*(2), 179–192. https://doi.org/10.1037/0021-843X.107.2.179.

Buckholtz, J. W., & Meyer-Lindenberg, A. (2012). Psychopathology and the human connectome: Toward a transdiagnostic model of risk for mental illness. *Neuron, 74*(6), 990–1004.

Carr, S. J., Teasdale, J. D., & Broadbent, D. (1991). Effects of induced elated and depressed mood on self-focused attention. *The British Journal of Clinical Psychology, 30*(3), 273–275.

Caselli, R. J., Reiman, E. M., Hentz, J. G., Osborne, D., & Alexander, G. E. (2004). A distinctive interaction between chronic anxiety and problem solving in asymptomatic APOE e4 homozygotes. *The Journal of Neuropsychiatry and Clinical Neurosciences, 16*(3), 320–329. https://doi.org/10.1176/appi.neuropsych.16.3.320.

Castaneda, A. E., Tuulio-Henriksson, A., Marttunen, M., Suvisaari, J., & Lönnqvist, J. (2008). A review on cognitive impairments in depressive and anxiety disorders with a focus on young adults. *Journal of Affective Disorders, 106*(1–2), 1–27. https://doi.org/10.1016/j.jad.2007.06.006.

Clark, L. A. (1989). The anxiety and depressive disorders: Descriptive psychopathology and differential diagnosis. In P. C. Kendall & D. Watson (Eds.), *Anxiety and depression: Distinctive and overlapping features* (pp. 83–129). San Diego: Academic Press.

Clark, L. A., & Watson, D. (1991). Tripartite model of anxiety and depression: Psychometric evidence and taxonomic implications. *Journal of Abnormal Psychology, 100*(3), 316–336. https://doi.org/10.1037/0021-843X.100.3.316.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences*, 3rd ed. Mahwah: Lawrence Erlbaum Associates Publishers.

Corsi, P. M. (1972). Human memory and the medial temporal region of the brain. Unpublished doctoral dissertation. McGill University, Montreal.

Crawford, J. R., & Henry, J. D. (2004). The positive and negative affect schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 43*(3), 245–265.

Crocker, L. D., Heller, W., Spielberg, J. M., Warren, S. L., Bredemeier, K., Sutton, B. P., & Miller, G. A. (2012). Neural mechanisms of attentional control differentiate trait and state negative affect. Frontiers in Psychology. https://doi.org/10.3389/fpsyg.2012.00298.

Crowe, S. F., Matthews, C., & Walkenhorst, E. (2007). Relationship between worry, anxiety and thought suppression and the components of working memory in a non-clinical sample. *Australian Psychologist, 42*(3), 170–177. https://doi.org/10.1080/00050060601089462.

Curci, A., Lanciano, T., Soleti, E., & Rimé, B. (2013). Negative emotional experiences arouse rumination and affect working memory capacity. *Emotion, 13*(5), 867–880. https://doi.org/10.1037/a0032492.

Dawson, J. F. (2014). Moderation in management research: What, why, when, and how. *Journal of Business and Psychology, 29*(1), 1–19. https://doi.org/10.1007/s10869-013-9308-7.

DeGutis, J., Esterman, M., McCulloch, B., Rosenblatt, A., Milberg, W., & McGlinchey, R. (2015). Posttraumatic psychological symptoms are associated with reduced inhibitory control, not general executive dysfunction. *Journal of the International Neuropsychological Society, 21*(5), 342–352. https://doi.org/10.1017/S1355617715000235.

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan executive function system (D-KEFS)*. San Antonio, TX: The Psychological Corporation.

Denckla, M. B. (1996). A theory and model of executive function: A neuropsychological perspective. In G. R. Lyon & N. A. Krasnegor (Eds.), *Attention, memory, and executive function* (pp. 263–278). Baltimore: Paul H Brookes Publishing.

Derakshan, N., Ansari, T. L., Hansard, M., Shoker, L., & Eysenck, M. W. (2009a). Anxiety, inhibition, efficiency, and effectiveness: An investigation using the antisaccade task. *Experimental Psychology, 56*(1), 48–55. https://doi.org/10.1027/1618-3169.56.1.48.

Derakshan, N., Smyth, S., & Eysenck, M. W. (2009b). Effects of state anxiety on performance using a task-switching paradigm: An investigation of attentional control theory. *Psychonomic Bulletin and Review, 16*(6), 1112–1117. https://doi.org/10.3758/PBR.16.6.1112.

Drost, J., van der Does, W., van Hemert, A. M., Penninx, B. W. J. H., & Spinhoven, P. (2014). Repetitive negative thinking as a transdiagnostic factor in depression and anxiety: A conceptual replication. *Behaviour Research and Therapy, 63*, 177–183. https://doi.org/10.1016/j.brat.2014.06.004.

Ehring, T., & Watkins, E. R. (2008). Repetitive negative thinking as a transdiagnostic process. *International Journal of Cognitive Therapy, 1*(3), 192–205. https://doi.org/10.1680/ijct.2008.1.3.192.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7*(2), 336–353. https://doi.org/10.1037/1528-3542.7.2.336.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (2002). *SCID-I/NP: Structured clinical interview for DSM-IV-TR axis I disorders, research version, non-patient edition*. New York: Biometrics Research, New York State Psychiatric Institute.

Fresco, D. M., Frankel, A. N., Mennin, D. S., Turk, C. L., & Heimberg, R. G. (2002). Distinct and overlapping features of rumination and worry: The relationship of cognitive production to negative affective states. *Cognitive Therapy and Research, 26*(2), 179–188. https://doi.org/10.1023/A:1014517718949.

Fresco, D. M., Mennin, D. S., Heimberg, R. G., & Turk, C. L. (2003). Using the Penn State Worry Questionnaire to identify individuals with generalized anxiety disorder: A receiver operating characteristic analysis. *Journal of Behavior Therapy and Experimental Psychiatry, 34*(3–4), 283–291.

Friedman, N. P., Miyake, A., Young, S. E., DeFries, J. C., Corley, R. P., & Hewitt, J. K. (2008). Individual differences in executive functions are almost entirely genetic in origin. *Journal of Experimental Psychology: General, 137*(2), 201–225. https://doi.org/10.1037/0096-3445.137.2.201.

Harvey, P. O., Le Bastard, G., Pochon, J. B., Levy, R., Allilaire, J. F., Dubois, B., & Fossati, P. (2004). Executive functions and updating of the contents of working memory in unipolar depression. *Journal of Psychiatric Research, 38*(6), 567–576. https://doi.org/10.1016/j.jpsychires.2004.03.003.

Hayes, S., Hirsch, C., & Mathews, A. (2008). Restriction of working memory capacity during worry. *Journal of Abnormal Psychology, 117*(3), 712–717. https://doi.org/10.1037/a0012908.

Hong, R. Y. (2007). Worry and rumination: Differential associations with anxious and depressive symptoms and coping behavior.

Behaviour Research and Therapy, 45(2), 277–290. https://doi.org/10.1016/j.brat.2006.03.006.

Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods, 6*(1), 53–59.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118.

Hur, J., Heller, W., Kern, J. L., & Berenbaum, H. (2017). A bi-factor approach to modeling the structure of worry and rumination. *Journal of Experimental Psychopathology, 8*(1), 1–30.

IBM Corp. (2015). *SPSS Statistics for Windows, Version 23.0 [Computer software]*. Armonk: IBM Corp.

Jersild, A. T. (1927). Mental set and shift. *Archives of Psychology*, Whole No. 89.

Jewsbury, P. A., Bowden, S. C., & Strauss, M. E. (2016). Integrating the switching, inhibition, and updating model of executive function with the Cattell—Horn—Carroll model. *Journal of Experimental Psychology: General, 145*(2), 220–245. https://doi.org/10.1037/xge0000119.

Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychology Review, 17*(3), 213–233. https://doi.org/10.1007/s11065-007-9040-z.

Kessler, R. C., Sampson, N. A., Berglund, P., Gruber, M. J., Al-Hamzawi, A., Andrade, L., Bunting, B., Demyttenaere, K. (2015). Anxious and non-anxious major depressive disorder in the World Health Organization World Mental Health Surveys. *Epidemiology and Psychiatric Sciences, 24*(03), 210–226.

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.)). New York: Guilford Press.

Krompinger, J. W., & Simons, R. F. (2011). Cognitive inefficiency in depressive undergraduates: Stroop processing and ERPs. *Biological Psychology, 86*(3), 239–246. https://doi.org/10.1016/j.biopsycho.2010.12.004.

LaGarde, G., Doyon, J., & Brunet, A. (2010). Memory and executive dysfunctions associated with acute posttraumatic stress disorder. *Psychiatry Research, 177*(1–2), 144–149. https://doi.org/10.1016/j.psychres.2009.02.002.

Lara, M. E., & Klein, D. N. (1999). Psychosocial processes underlying the maintenance and persistence of depression: Implications for understanding chronic depression. *Clinical Psychology Review, 19*(5), 553–570.

Lehto, J. E., Juujarvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive function: Evidence from children. *British Journal of Developmental Psychology, 21*(1), 59.

Letkiewicz, A. M., Miller, G. A., Crocker, L. D., Warren, S. L., Infantolino, Z. P., Mimnaugh, K. J., & Heller, W. (2014). Executive function deficits in daily life prospectively predict increases in depressive symptoms. *Cognitive Therapy and Research, 38*(6), 612–620.

Levin, R. L., Heller, W., Mohanty, A., Herrington, J. D., & Miller, G. A. (2007). Cognitive deficits in depression and functional specificity of regional brain activity. *Cognitive Therapy and Research, 31*, 211–233.

Lezak, M. D. (1982). The problem of assessing executive functions. *International Journal of Psychology, 17*(2–3), 281–297. https://doi.org/10.1080/00207598208247445.

Logan, G. D. (1994). On the ability to inhibit thought and action: A users' guide to the stop signal paradigm. In D. Dagenbach & T. H. Carr (Eds.), *Inhibitory processes in attention, memory, and language* (pp. 189–239). San Diego: Academic Press.

Loh, J., Schutte, N., & Thorsteinsson, E. (2014). Be happy: The role of resilience between characteristic affect and symptoms of depression. *Journal of Happiness Studies, 15*(5), 1125–1138.

Lonigan, C. J., Phillips, B. M., & Hooe, E. S. (2003). Relations of positive and negative affectivity to anxiety and depression in children: Evidence from a latent variable longitudinal study. *Journal of Consulting and Clinical Psychology, 71*(3), 465–481.

Madian, N., Warren, S. L., Towers, D. N., Miller, G. A., & Heller, W. (2015). The impact of perseverative thought on negative affect: The role of updating ability. New Orleans: Poster presented at the meeting of the Society for Research in Psychopathology.

McEvoy, P. M., Watson, H., Watkins, E. R., & Nathan, P. (2013). The relationship between worry, rumination, and comorbidity: Evidence for repetitive negative thinking as a transdiagnostic construct. *Journal of Affective Disorders, 151*(1), 313–320. https://doi.org/10.1016/j.jad.2013.06.014.

McLaughlin, K. A., & Nolen-Hoeksema, S. (2011). Rumination as a transdiagnostic factor in depression and anxiety. *Behaviour Research & Therapy, 49*(3), 186–193. https://doi.org/10.1016/j.brat.2010.12.006.

Meiran, N., Diamond, G. M., Toder, D., & Nemets, B. (2011). Cognitive rigidity in unipolar depression and obsessive compulsive disorder: Examination of task switching, Stroop, working memory updating and post-conflict adaptation. *Psychiatry Research, 185*(1–2), 149–156. https://doi.org/10.1016/j.psychres.2010.04.044.

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy, 28*(6), 487–495. https://doi.org/10.1016/0005-7967(90)90135-6.

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science, 21*(1), 8–14. https://doi.org/10.1177/0963721411429458.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734.

Moberly, N. J., & Watkins, E. R. (2008). Ruminative self-focus and negative affect: an experience sampling study. *Journal of Abnormal Psychology, 117*(2), 314–323. https://doi.org/10.1037/0021-843X.117.2.314.

Monsell, S. (1996). Control of mental processes. In V. Bruce (Ed.), *Unsolved mysteries of the mind: Tutorial essays in cognition* (pp. 93–148). Oxford: Erlbaum (UK) Taylor & Francis, Publ.

Morris, N., & Jones, D. M. (1990). Memory updating in working memory: The role of the central executive. *British Journal of Psychology, 81*(2), 111–121. https://doi.org/10.1111/j.2044-8295.1990.tb02349.x.

Muris, P., Roelofs, J., Meesters, C., & Boomsma, P. (2004). Rumination and worry in nonclinical adolescents. *Cognitive Therapy and Research, 28*(4), 539–554.

Muthén, L. K., & Muthén, B. O. (2015). *Mplus user's guide* (7th edn.). Los Angeles: Muthén & Muthén.

Nitschke, J. B., Heller, W., Imig, J. C., McDonald, R. P., & Miller, G. A. (2001). Distinguishing dimensions of anxiety and depression. *Cognitive Therapy and Research, 25*(1), 1–22. https://doi.org/10.1023/A:1026485530405.

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100*(4), 569–582. https://doi.org/10.1037/0021-843X.100.4.569.

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology, 109*(3), 504–511.

Nolen-Hoeksema, S., & Morrow, J. (1993). Effects of rumination and distraction on naturally occurring depressed mood. *Cognition*

and Emotion, 7(6), 561–570. https://doi.org/10.1080/02699 939308409206.

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science, 3*(5), 400–424. https://doi.org/10.1111/j.1745-6924.2008.00088.x.

Papageorgiou, C., & Wells, A. (1999). Process and meta-cognitive dimensions of depressive and anxious thoughts and relationships with emotional intensity. *Clinical Psychology and Psychotherapy, 6*(2), 156–162.

Phillips, L. H. (1997). Do ''frontal tests'' measure executive function? Issues of assessment and evidence from fluency tests. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp. 191–213). Hove: Psychology Press.

Reise, S. P. (2012). Invited paper: The rediscovery of bifactor measurement models. *Multivariate Behavioral Research, 47*(5), 667–696. https://doi.org/10.1080/00273171.2012.715555.

Reise, S. P., Moore, T. M., & Haviland, M. G. (2010). Bifactor models and rotations: Exploring the extent to which multidimensional data yield univocal scale scores. *Journal of Personality Assessment, 92*(6), 544–559. https://doi.org/10.1080/00223 891.2010.496477.

Riskind, J. H., Kleiman, E. M., & Schafer, K. E. (2013). 'Undoing' effects of positive affect: Does it buffer the effects of negative affect in predicting changes in depression? *Journal of Social and Clinical Psychology, 32*(4), 363–380.

Rose, E. J., & Ebmeier, K. P. (2006). Pattern of impaired working memory during major depression. *Journal of Affective Disorders, 90*(2–3), 149–161. https://doi.org/10.1016/j.jad.2005.11.003.

Rose, S. A., Feldman, J. F., & Jankowski, J. J. (2011). Modeling a cascade of effects: The role of speed and executive function in preterm/full-term differences in academic achievement. *Developmental Science, 14*(5), 1161–1175. https://doi.org/10.1111/j.1467-7687.2011.01068.x.

Ruscio, A. M., Seitchik, A. E., Gentes, E. L., Jones, J. D., & Hallion, L. S. (2011). Perseverative thought: A robust predictor of response to emotional challenge in generalized anxiety disorder and major depressive disorder. *Behaviour Research and Therapy, 49*(12), 867–874. https://doi.org/10.1016/j.brat.2011.10.001.

Satorra, A., & Bentler, P. M. (2010). Ensuring positiveness of the scaled difference chi-square test statistic. *Psychometrika, 75*(2), 243–248. https://doi.org/10.1007/s11336-009-9135-y.

Savalei, V., & Rhemtulla, M. (2013). The performance of robust test statistics with categorical data. *The British Journal of Mathematical and Statistical Psychology, 66*(2), 201–223. https://doi.org/10.1111/j.2044-8317.2012.02049.x.

Segerstrom, S. C., Roach, A. R., Evans, D. R., Schipper, L. J., & Darville, A. K. (2010). The structure and health correlates of trait repetitive thought in older adults. *Psychology and Aging, 25*(3), 505–515. https://doi.org/10.1037/a0019456.

Segerstrom, S. C., Stanton, A. L., Alden, L. E., & Shortridge, B. E. (2003). A multidimensional structure for repetitive thought: What's on your mind, and how, and how much? *Journal of Personality and Social Psychology, 85*(5), 909–921. https://doi.org/10.1037/0022-3514.85.5.909.

Segerstrom, S. C., Tsao, J. C. I., Alden, L. E., & Craske, M. G. (2000). Worry and rumination: Repetitive thought as a concomitant and predictor of negative mood. *Cognitive Therapy and Research, 24*(6), 671–688. https://doi.org/10.1023/A:1005587311498.

Shallice, T. (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London Series B, Biological Sciences, 298*(1089), 199–209.

Shankman, S. A., & Klein, D. N. (2003). The relation between depression and anxiety: An evaluation of the tripartite, approach-withdrawal and valence-arousal models. *Clinical Psychology Review,*

23(4), 605–637. https://doi.org/10.1016/S0272-7358(03)00038 -2.

Snyder, H. R. (2013). Major depressive disorder is associated with broad impairments on neuropsychological measures of executive function: A meta-analysis and review. *Psychological Bulletin, 139*(1), 81–132. https://doi.org/10.1037/a0028727.

Snyder, H. R., Kaiser, R. H., Warren, S. L., & Heller, W. (2015a). Obsessive-compulsive disorder is associated with broad impairments in executive function: A meta-analysis. *Clinical Psychological Science, 3*(2), 301–330.

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015b). Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches. *Frontiers in Psychology, 6*, 328–328. https://doi.org/10.3389/fpsyg.2015.00328.

Spector, A., & Biederman, I. (1976). Mental set and mental shift revisited. *American Journal of Psychology, 89*, 669–679.

Spinhoven, P., Drost, J., van Hemert, B., & Penninx, B. W. (2015). Common rather than unique aspects of repetitive negative thinking are related to depressive and anxiety disorders and symptoms. *Journal of Anxiety Disorders, 33*, 45–52. https://doi.org/10.1016/j.janxdis.2015.05.001.

Steiger, J. H. (1990). Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Research, 25*(2), 173.

Stroop, J. R. (1935). Studies of interference in serial verbal reaction. *Journal of Experimental Psychology, 18*, 643–662.

Stuss, D. T., & Alexander, M. P. (2000). Executive functions and the frontal lobes: A conceptual view. *Psychological Research Psychologische Forschung, 63*(3/4), 289.

Teasdale, J. D. (1983). Negative thinking in depression: Cause, effect, or reciprocal relationship. *Advances in Behaviour Research and Therapy, 5*(1), 3–25. https://doi.org/10.1016/0146-6402(83)90013-9.

Teasdale, J. D. (1988). Cognitive vulnerability to persistent depression. *Cognition and Emotion, 2*(3), 247–274. https://doi.org/10.1080/02699938808410927.

Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the five-factor model of personality: Distinguishing rumination from reflection. *Journal of Personality and Social Psychology, 76*(2), 284–304. https://doi.org/10.1037/0022-3514.76.2.284.

van den Wildenberg, W. P. M., van Boxtel, G. J. M., & van der Molen, M. W. (2003). The duration of response inhibition in the stop-signal paradigm varies with response force. *Acta Psychologica, 114*(2), 115–129. https://doi.org/10.1016/S0001-6918(03)00062 -3.

Vaughan, L., & Giovanello, K. (2010). Executive function in daily life: Age-related influences of executive processes on instrumental activities of daily living. *Psychology and Aging, 25*(2), 343–355. https://doi.org/10.1037/a0017729.

Warren, S. L., Crocker, L. D., Spielberg, J. M., Engels, A. S., Banich, M. T., Sutton, B. P., & Heller, W. (2013). Cortical organization of inhibition-related functions and modulation by psychopathology. *Frontiers in human neuroscience, 7*, 271.

Warren, S. L., Towers, D. N., Heller, W., & Miller, G. A. (in prep). Measuring nonverbal updating of working memory: The spatial updating task.

Watkins, E., Moulds, M., & Mackintosh, B. (2005). Comparisons between rumination and worry in a non-clinical population. *Behaviour Research and Therapy, 43*(12), 1577–1585. https://doi.org/10.1016/j.brat.2004.11.008.

Watson, D., & Clark, L. A. (1991). Mood and anxiety symptom questionnaire. *Psyctests.* https://doi.org/10.1037/t13679-000.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The

PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063.

Watson, D., Clark, L. A., Weber, K., Assenheimer, J. S., Strauss, M. E., & McCormick, R. A. (1995a). Testing a tripartite model: II. Exploring the symptom structure of anxiety and depression in student, adult, and patient samples. *Journal of Abnormal Psychology, 104*(1), 15–25.

Watson, D., & Pennebaker, J. W. (1989). Health complaints, stress, and distress: Exploring the central role of negative affectivity. *Psychological Review, 96*(2), 234–254. https://doi.org/10.1037/0033-295X.96.2.234.

Watson, D., Weber, K., Assenheimer, J. S., Clark, L. A., Strauss, M. E., & McCormick, R. A. (1995b). Testing a tripartite model: I. Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. *Journal of Abnormal Psychology, 104*(1), 3–14. https://doi.org/10.1037/0021-843X.104.1.3.

Whitmer, A. J., & Banich, M. T. (2007). Inhibition versus switching deficits in different forms of rumination. *Psychological Science, 18*(6), 546–553. https://doi.org/10.1111/j.1467-9280.2007.01936.x.

Whitmer, A. J., & Gotlib, I. H. (2012). Switching and backward inhibition in major depressive disorder: The role of rumination. *Journal of Abnormal Psychology, 121*(3), 570–578. https://doi.org/10.1037/a0027474.

Yang, M. J., Kim, B. N., Lee, E. H., Lee, D., Yu, B. H., Jeon, H. J., & Kim, J. H. (2014). Diagnostic utility of worry and rumination: A comparison between generalized anxiety disorder and major depressive disorder. *Psychiatry and Clinical Neurosciences, 68*(9), 712–720. https://doi.org/10.1111/pcn.12193.

Yntema, D. B. (1963). Keeping track of several things at once. *Human Factors, 5*, 7.