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RUMINATION MEDIATES THE RELATIONSHIP BETWEEN NEUROTICISM AND COGNITIVE FUNCTION

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Elizabeth Munoz Diaz

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The thesis of Elizabeth Munoz Diaz was reviewed and approved* by the following:

Martin J. Sliwinski
Professor of Human Development and Family Studies
Director, Center for Healthy Aging
Thesis Advisor

David M. Almeida
Professor of Human Development and Family Studies

Douglas M. Teti
Professor of Human Development and Family Studies and Psychology
Graduate Professor-in-Charge, Human Development and Family Studies

*Signatures are on file in the Graduate School

Abstract

Although recent research has found a negative association between trait neuroticism and cognition, no studies have directly examined the mechanisms that underlie this relationship. Trait rumination, the tendency to experience repetitive negative thoughts, is elevated in those who score high in neuroticism and has been associated with poor cognitive performance. This thesis investigated whether rumination, by depleting attentional resources, functions as a mediator in the negative relationship between neuroticism and cognitive performance. Three hundred-forty six adults ($M_{age} = 49.43$) completed five attention-demanding cognitive tasks (i.e., working memory, episodic memory, fluid intelligence, primary memory, and processing speed) as well as self-report measures of rumination, negative affect, and trait neuroticism. Rumination significantly mediated the relationship between trait neuroticism and cognitive performance; these results remained after accounting for negative affect. Contrary to expectations, age did not moderate these results. These findings suggest that rumination is a viable psychological mechanism through which trait neuroticism influences cognitive performance.

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Chapter 1. Literature Review

Trait neuroticism is consistently associated with poor physical and psychological health. It is linked with both subjective health reports (Charles & Almeida, 2006) as well as with objective physical health outcomes such as cardiovascular disease and asthma (Smith & MacKenzie, 2006; Lahey, 2009). Negative mental health outcomes associated with neuroticism include depression and anxiety disorders (for review, see Lahey, 2009). Neuroticism has also been recently associated with indices of cognitive health, including inefficient cognitive performance (Robinson & Tamir, 2005), cognitive decline (Wilson, Bennett, Mendes de Leon, Bienias, Morris, & Evans, 2005), and increased risk of Alzheimer's disease among older adults (Duchek, Balota, Storandt & Larson, 2007; Wilson, Arnold, Schneider, Li, & Bennett, 2007). Despite this growing body of evidence, the psychological mechanisms through which trait neuroticism might influence cognitive function have yet to be elucidated.

Neuroticism is a personality trait that is associated with elevated levels of anxiety, hostility, and negative affect. Consequently, it is often referred to as distress proneness, stress reactivity, or negative affectivity (Larsen & Ketelaar, 1991;Eysenck & Calvo, 1992; Wilson et al., 2005). Individuals with high levels of neuroticism are more susceptible to experiencing emotional distress and exhibit heightened vulnerability to repetitive and ruminative thought processes that maintain their distress (e.g., Kokkonen & Pulkinen, 2001). These mental processes may contribute to the neuroticism-cognition relationship by competing for limited attentional resources that are required to effectively perform attention-demanding tasks (e.g., working memory). The goal of this thesis is to evaluate the mediating role of rumination in the negative relationship between neuroticism and cognitive function.

Neuroticism and Cognition

Studies of the relationship between trait neuroticism and cognition can be categorized into ones that examine general intellectual function, and those that examine specific cognitive abilities. In addition, there have been a few prospective studies that examine longitudinal changes in cognitive health according to levels of neuroticism. Studies on the relationship between personality and intelligence find weak negative associations with neuroticism. Ackerman and Heggestad (1997) reviewed studies that examined the relationship between personality and intelligence and found modest negative associations between neuroticism and general intelligence as well as with fluid and crystallized intelligence. Similarly, using the Eysenck Personality Profiles (EPP), Furnhamn, Ford, and Cotter (1998) reported a negative relationship between factors related to neuroticism and measures of general intelligence. In their sample of middle-aged adults, the authors conceptualized neuroticism as scoring low in measures of emotional stability and found that those low in emotional stability performed poorly on the intelligence tasks.

Specifically assessing the two main components of intelligence, crystallized and fluid, studies report negative associations between neuroticism and crystallized intelligence, but no significant relationships with fluid intelligence (Schaie, Willis, & Caskie, 2004; Chamorro-Premuzic, Furnham, & Petrides, 2006). Chamorro-Premuzic and colleagues (2006) also used the EPP in which low emotional stability was conceptualized as trait neuroticism. Their sample of middle-aged adults completed two timed tasks of verbal and numerical ability that measure crystallized and fluid intelligence respectively. They found that neuroticism was not significantly correlated with measures of numeric ability, but significantly correlated with verbal ability. Similar findings have been reported from the Seattle Longitudinal Study in which scores from the neuroticism scale of the NEO personality Inventory were positively correlated with measures of crystallized intelligence, such as verbal ability (Schaie et al., 2004). Measures of fluid intelligence, however, were not related with neuroticism (Schaie et al., 2004). These findings are at odds with studies that measure specific cognitive abilities, most of which report negative associations with cognitive abilities that are characteristic of fluid intelligence.

Findings from studies looking at specific cognitive domains are mixed but most suggest that trait neuroticism is more strongly associated with cognitive tasks that demand attentional control. Although an early study by Pearson (1993) reported a positive relationship between neuroticism and cognitive performance, as measured with information/orientation and mental ability tests, most studies report negative associations. For instance, Costa, Fozard, McCrae and Bosse (1976) found that trait anxiety (a dimension of neuroticism) was related to lower cognitive performance. Using a male sample from the Normative Aging Study with an age range from 25 to 82 years, they found that older adults performed lower overall, but those who scored high in trait anxiety performed more poorly as compared to their less anxious counterparts. After controlling for education and socioeconomic status (SES), there was no longer a difference in performance in crystallized intelligence between those high in anxiety and their counterparts. Nonetheless, the difference in performance remained for fluid intelligence tasks. Other studies have also reported negative associations between trait neuroticism and episodic memory, simple and choice reaction time, numeric and abstract reasoning, and tasks of perceptual speed (Jorm, MacKinnon, Christensen, Henderson, Scott, & Korten, 1993; Moutifa, Furnham, & paltiel, 2005). These findings suggest that the negative relationship between neuroticism and cognitive performance is stronger for attention-demanding tasks, such as those tasks characteristic of fluid intelligence.

In addition to these correlational studies, there are a handful of prospective studies examining how trait neuroticism predicts longitudinal changes in cognitive health. Crowe, Andel, Pedersen, Fratiglioni, and Gatz (2006) found that individuals from the Swedish Twin Registry, who scored high in trait neuroticism according to a short form of the Eysenck Personality Inventory, were at greater risk of cognitive impairment 25 years later. In this study, data on personality was collected 25 years prior to cognitive assessment at which time participants were 69 years of age on average. These findings are in line with Wilson and colleagues who report a greater risk of developing Alzheimer's disease and dementia among those individuals who tend to experience psychological distress. In their Religious Orders Study involving Catholic nuns, priests, and brothers who are 65 years and older, they find that individuals with the highest levels of distress proneness are twice as likely to develop Alzheimer's disease compared to individuals with the lowest levels of distress proneness (Wilson, Evans, Bienias, Mendes de Leon, Schneider, & Bennett, 2003). Other analyses from the same study revealed that chronic distress is associated with a greater likelihood of developing dementia and of having lower levels of cognitive function overall (Wilson et al., 2007).

Additional analyses also conducted by Wilson and colleagues (2005) have shown that neuroticism may be an added risk factor for cognitive decline. This study assessed the longitudinal changes in cognitive function according to levels of distress proneness (a trait used to describe the tendency to experience negative emotional states) and found that those who score high in distress proneness experience significantly greater declines in cognition. In their sample of adults aged 65 and older, Wilson and colleagues (2005) found that those who scored high in this facet of neuroticism decline an average of thirty percent faster than those low in this trait. The authors assert that distress proneness is a central component of neuroticism and postulate that the reported cognitive decline may be due to the cumulative exposure to stress that has shown to impair cognitive functioning (Wilson et al., 2005). In accordance with studies looking at specific cognitive abilities, they report declines in attention-demanding tasks, such as episodic memory, making it imperative to understand what specific aspects of this personality trait interfere with attentional processes that lead to cognitive decline.

Theoretical perspectives

There are two theoretical perspectives that can explain the negative relationship between neuroticism and cognition. A *psychogenic* perspective posits that a cognitive tendency to worry occupies attentional resources that disrupt cognitive processing, and another *biogenic* perspective posits that neuroticism is an index of cumulative exposure to stress. Neuroticism may indicate cumulative exposure to stress due to the tendencies that these individuals have to experience distress (Wilson et al., 2005). Individuals with greater levels of trait neuroticism are more likely to experience more negative life events, both subjectively and objectively (Magnus, Diener, Fujita & Pavot, 1993; Bolger & Zuckerman, 1995). This propensity to experience negative life events exposes individuals to greater levels of stress hormones, such as cortisol, that are associated with neurocognitive impairment. Although cortisol can enhance some forms of memories during acute or transient stress (Cahill, Weber, & MacGagh, 1994) it can also impair memory in the long run. Specifically, chronic activation of the hypothalamic-pituitary-adrenal (HPA) axis during repeated or ongoing negative experiences exposes the brain to excess levels of cortisol leading to neuronal loss of brain structures essential for cognitive performance (Sapolsky, Krey, & McEwen, 1986). This biogenic perspective accounts for the negative relationship between trait neuroticism and cognition through constant physiological activation.

The psychogenic perspective posits that neuroticism is an indicator of worry and rumination that inhibit attentional control. Those who have a greater disposition to worry perceive more threats in their environment, regardless of whether a threat is actually present or not (Matthews, 1990). These perceptions put individuals under a constant state of vigilance that disrupts attentional processes as attention is constantly being directed toward irrelevant stimuli (perceived threats) and not toward the tasks at hand. The cognitive disposition to worry or ruminate among individuals who are under a constant state of anxiety (Eysenck, 1992) interferes with the allocation of attentional resources resulting in impaired cognitive performance. This cognitive style depletes attentional resources leading to lower cognitive performance (Eysenck, 1992; Matthews, 1990).

The Processing Efficiency Theory (PET) proposed by Eysenck (1992) provides one perspective on how worry and rumination might impair cognitive performance. According to PET, the cognitive disposition to worry and ruminate associated with anxiety has a negative effect on the efficiency rather than the effectiveness of processing. Effectiveness of processing refers to the quality of task performance whereas efficiency refers to the attention and effort directed toward a given task. Individuals experiencing greater levels of anxiety are able to perform just as effectively as those who do not experience anxiety but lack the ability to efficiently process the information that is necessary for a specific task. For example, those who are under a constant state of anxiety score just as well on cognitive tasks but it takes them longer to perform those tasks as opposed to individuals who are not as anxious.

This lack of processing efficiency results due to highly anxious individuals’ tendency to worry about their task performance. Their tendencies to worry causes interference in online processing and results in impaired task performance. In fact, differences in task performance have been observed according to the type of tasks participants complete. Eysenck, Derakshan, Santos, and Calvo (2007) have reported that under timed conditions, anxious individuals perform poorly on cognitive tasks, but this disadvantage is removed when there are no time restrictions. In their study, they find that there are no significant differences in performance between low and high anxious individuals under the untimed condition. According to Eysenck's processing efficiency theory (1992), the cognitive tendency to worry or ruminate about task performance is a characteristic associated with anxiety that interferes with attentional control and this is what leads to poor cognitive performance among those with greater levels of anxiety.

Because research has identified anxiety as a common characteristic of neuroticism (Eysenck, 1992), it is likely that a cognitive tendency to worry or ruminate drives the negative relationship between neuroticism and cognitive function. This form of repetitive thought maintains levels of distress that, from a biogenic perspective, results in a prolonged stress response (Brosschot, Gerin, & Thayer, 2006) that can potentially cause neuronal damage to brain structures essential for cognitive performance (Sapolsky et al., 1986). A cognitive tendency to experience repetitive and ruminative thoughts can therefore help to unify these two areas of reasoning in understanding the negative association between neuroticism and cognition.

Rumination

A tendency to experience ruminative thoughts is proposed to be a mechanism through which trait neuroticism influences cognitive performance. Rumination is a cognitive style that has been approached in various ways in the literature. Two common characteristics of the different forms of ruminative thinking found in the literature are that they occupy attentional resources and are repetitive or perseverative in nature.

Ruminative mental habits are not always detrimental (Watkins, 2008), but they can have detrimental effects when they occur in a negative context. In a review of the literature on the consequences of repetitive thinking, Watkins (2008) concludes that there are unconstructive and constructive consequences to repetitive thought. The adaptive and beneficial consequences of repetitive thought include better planning, recovery from traumatic events and depression, and the uptake of healthy behaviors (Watkins, 2008). After having experienced a negative and unsolvable life event, individuals who engage in repetitive thought that is specifically aimed at finding benefit from the event rather than engaging in thoughts aimed toward trying to understand it, experience better psychological adjustment (Watkins, 2008). Repetitive thought can also lead to better planning, preparation, and recovery from depression. These positive effects are nonetheless dependent on the properties of the thought content. For instance, engaging in concrete, rather than abstract repetitive thought is implicated in more positive outcomes from depression (Watkins, 2008).

Perseverative cognition is referred to as the chronic cognitive representation of one or more psychological stressor (Brosschot, Gerin, & Thayer, 2006). It is an unconstructive form of repetitive thought that persists even after the stressor is no longer present. This form of ruminative thought process is postulated to be a mechanism through which stress leads to disease. Ruminative thinking that persists after a stressor prolongs the stress response for longer than necessary. This form of chronic activation is associated with negative health outcomes including cardiovascular disease (Brosschot, Gerin, & Thayer, 2006). Such negative outcomes associated with ruminative thinking can also be extended to those that affect brain systems through prolonged physiological activation that leads to excess levels of cortisol resulting in impaired cognitive functioning (Sapolsky et al., 1986).

The unconstructive consequences of repetitive thought during stressful situations occur when the thought content is negative and is characterized by an abstract level of construal (Watkins, 2008). This can have additional unproductive consequences within an intrapersonal context (Watkins, 2008). Negative representations of the self or maladaptive expectations for the self, for example, can lead to more negative outcomes because the focus on one's own negative emotions can set the stage for even more negative experiences. Moberly and Watkins (2008), for example, have found that this form thought exacerbates its negative consequences by amplifying and prolonging negative mood states. In their experience-sampling study they find that an experience of a negative event is associated with greater levels of negative affect at the following measurement point and this relationship is mediated by ruminative thinking (Moberly & Watkins, 2008).

Whether ruminative thinking has constructive or unconstructive consequences also depends on the level of construal. Compared to abstract repetitive thoughts, concrete repetitive thinking promotes efficient problem solving, as individuals are able to think of a step-by-step solution to a problem. This form of thinking promotes effective emotional regulation by reducing anxiety (Watkins, 2008). Conversely, abstract thinking is counterproductive to self-regulation as it facilitates overgeneralization of feelings where a single failure is perceived in terms of a global personality quality (Watkins, 2008).

Worry and depressive rumination are two similar forms of unconstructive ruminative thoughts that are associated with neuroticism and that can negatively influence cognition. These forms of cognitive styles occupy attentional resources and are repetitive in nature. Worry occupies attentional resources through the experience of repetitive thoughts that are negative and future oriented (Borkovec, Ray, & Stober, 1998). This type of cognitive style is a strategy of abstraction or disengagement from emotional control that has negative consequences. When exposed to an emotionally arousing event, individuals who tend to worry are unable to immediately process their emotional responses because they focus their attention on future events rather than on the events they are experiencing at that particular moment. Worrisome thoughts therefore interfere with emotional processing by inhibiting individuals' ability to properly process the emotions that they experience after a negative event. This form of interference prolongs negative moods states and depletes attentional resources due to a constant focus on negative events.

Depressive rumination is yet another form of intrusive or repetitive thought that can potentially interfere with cognitive processing and contribute to lower performance. Nolen-Hoeksema (1991) asserts that adopting a type of response directed toward negative thinking prolongs depressive symptoms. This form of thinking is past oriented and has a primary focus on the individual's negative feelings. Becoming stuck in such a negative and self-focused style of thinking prolongs negative affectivity in this case, depression (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco ,& Lyubomirsky, 2008). Previous research has identified a negative association between depressed mood and cognitive performance. Plenty of evidence indicates that depressive mood is related to slower information processing and greater declines in performance on attention-demanding tasks (Backman, Hill, & Fursell, 1996; Dotson, Resnick, & Zonderman, 2007). Nonetheless, additional evidence also indicates that rather than the emotional valence of thoughts, it is the repetitive nature thereof that can have suboptimal consequences for cognition (e.g., Nolen-Hoeksema et al., 2008).

Rumination and Cognition

Rumination is related with poor cognitive performance and an ability to control such thoughts has been associated with better performance in attention demanding tasks such as working memory. Klein and Boals (2001) have demonstrated that the experience of ruminative thoughts about a stressful life event predicts lower working memory capacity. They assessed ruminative thinking using the Impact of Events Scale (IES) that consists of items that ask the participant how often they experienced intrusive thoughts about a stressful event that they tried to inhibit or avoided thinking about. In their sample of college students, Klein and Boals (2001a) reported that participants who experience more of these cognitive representations of stress performed lower on working memory tasks. Similar results were reported in a sample of older adults by Stawski, Sliwinski, and Smyth (2006) who found that stress-related cognitive interference (also assessed via the IES) was associated with poor performance in attention-demanding tasks. Specifically, they found that this cognitive style was associated with poor performance in working memory, episodic memory, and processing speed tasks. The authors propose that the experience of these types of intrusive and off-task thoughts act as a dual-task load that deplete attentional resources resulting in impaired performance in such attention-demanding tasks as working memory.

Further support for this idea comes from an expressive-writing intervention designed by Klein and Boals (2001b) to reduce cognitive intrusions related to negative life events. This intervention consisted of writing tasks in which individuals either wrote about a negative experience, a positive experience, or a trivial topic. In their sample of college students, they found that this form of expressive-writing task was associated with declines in intrusive thinking and greater working memory capacity; the greatest improvement was found among participants who wrote about negative experiences. Additionally, they report that reductions of intrusive thoughts mediate the relationship between expressive writing and working memory. This intervention provides further support for the idea that intrusive thoughts deplete attentional resources and suggest that the ability to control this form of off-task and intrusive thinking frees up working memory resources resulting in improved performance.

Unsworth and Engle (2007) have in fact argued that an ability to inhibit interfering thoughts about information that is no longer relevant for a particular task is related to greater working memory capacity. Similarly, Brewin and colleagues report that efficient thought suppression is related to better performance in attention demanding tasks, such as working memory and fluid intelligence tasks, and unrelated to crystallized intelligence tasks (Brewin & Beaton, 2002; Brewin & Smart, 2005). These findings are in line with the previously examined negative relationship between trait neuroticism and attention demanding cognitive tasks (e.g., Jorm et al., 1993; Moutifa et al., 2005; Altamirano, Miyake, & Whitmer, 2010).

Rumination and Neuroticism

Individuals who score high in trait neuroticism are therefore more likely to perform lower in cognitive tasks if they exhibit an inability to control interfering thoughts. Lower cognitive performance due to this form of thoughts can result from depleted attentional resources (e.g. Stawski et al., 2006), or a prolongation of negative mood states that maintain physiological arousal and lead to neurological damage (Wilson et al., 2005). Work by Robinson, Wilkowski, Kirkeby, and Meier (2006) report that an inability to inhibit behavioral responses is associated with prolonged negative mood states. In their studies, Robinson and colleagues (2006) find that those who score high in trait neuroticism have more perseverative behavioral tendencies that are associated with negative outcomes, such as negative affect and lower life satisfaction. In this study, Robinson and colleagues (2006) assessed perseveration through participants' inability to switch their response to a task if their response proved to be inefficient. The authors found that participants who persevered in their responses had more stable negative emotional experiences over time and that this perseveration interacted with trait neuroticism to predict negative mood states. This lack of behavioral inhibition is related with a general inability to inhibit perseverative cognitive responses as individuals are unable to disengage from a given task. Work by Compton (2000) found similar results and showed that individuals who are unable to disengage attention from one task and focus on another, experience greater levels of negative affect compared to those who are able to disengage. Thus, individuals who score high in trait neuroticism and have a greater tendency to perseverate in their cognitive responses are prone to experiencing prolonged negative mood states.

Negative mood states among individuals who score high in trait neuroticism, and who have perseverative response tendencies, can be amplified due to the suboptimal coping strategies that they adopt in response to stress. Individuals who score high in neuroticism report greater number of stressors (Bolger & Zuckerman, 1995) and respond to them in an unconstructive manner. They tend to utilize maladaptive coping strategies (Costa & McCrae, 1986) in response to such events, which exacerbates the negative states they are already experiencing. A study by Bolger and Zuckerman (1995), for example, reported that those high in neuroticism are more likely to respond to interpersonal conflicts in a confrontational coping manner. Such maladaptive coping strategies are more likely to expose these individuals to an even greater number of stressors and result in greater feelings of distress. These negative consequences can result from a greater tendency to ruminate. For instance, Muris, Roelofs, Rassin, Franken, and Mayer (2005) demonstrate that rumination and worry mediate the effects of neuroticism on anxiety and depression. Rumination thus plays an important role as a mechanism through which neuroticism influences negative mood states and it is likely that this cognitive style also influences cognitive function.

The Present Study

The purpose of this study is to examine the mediating role of rumination in the negative relationship between neuroticism and cognition. It is hypothesized that neuroticism will be related to lower cognitive performance and with a greater tendency to ruminate (Eysenck, 1992). It is also expected that rumination will be associated with lower cognitive performance (Klein & Boals, 2001; Stawski et al., 2006). Consequently, it is hypothesized that the tendency to experience ruminative thoughts will mediate the relationship between neuroticism and cognitive function.

Three additional follow up hypotheses were examined. First, the unique contribution of rumination was further evaluated by comparing it to negative affect. Since plenty of research finds a negative association between negative affectivity and cognition (e.g., Dotson et al., 2007), the mediating role of rumination was compared to that of negative affect in order to ascertain the unique contribution of rumination that is independent of negative affect. Second, because previous evidence indicates that older adults tend to have lower inhibitory abilities that prevent them from suppressing unwanted or intrusive thoughts (Hasher, Zacks, & May, 1999), it was hypothesized that age would moderate these results. We thus expected that older adults who score high in trait neuroticism, and who tend to ruminate, would score lower in the cognitive tasks as compared to their younger counterparts. Finally, exploratory analysis addressed the question of whether off-task, as opposed to on-task, intrusive thoughts would be more predictive of cognitive performance (Matthews, 1990).

Chapter 2. Method

Overview

Participants were given a brief introduction to the study and informed consent was obtained as approved by the Syracuse University Institutional Review Board. Participants were told that they were participating in a study examining the relations among health, cognition, and personality throughout the lifespan. Participants were tested in two sessions scheduled one week apart. During in-lab sessions, participants completed the cognitive tasks as well as a number of health measures. In between sessions, participants filled out a booklet of questionnaires assessing a range of personality, health behaviors, and life experiences.

Participants

Three hundred-forty six adults were recruited for participation in a study of health, life experiences, and cognition. Participants were recruited using advertisements in local newspapers, flyers in community centers and other public venues (e.g., libraries, senior centers), and through referrals from community leaders (e.g., local church). Each participant was compensated commensurate with their level of participation up to $75 for compliance with all pieces of the protocol. Average age of the current sample was 49 (SD = 17.23, range = 19 - 83) and was 49.69% female. The average years of education were 13 years (SD = 2.71); 52.11% were white, 37.65% black, 1.51% Hispanic, and 8.74% other.

Measures

Episodic memory. Participants completed three tests of episodic memory performance: logical memory-I (Wechsler, 1997), verbal paired associates (Wechsler, 1997), and auditory verbal learning test (AVLT; Schmidt, 1996). In Logical Memory-I the examiner read two stories, one at a time, to the participant and then asked them to recall as much about the story as possible.

This task was scored according the guidelines outlined by the Wechsler Memory Scale manual (Wechsler, 1997). In the verbal paired associates task the examiner read eight pairs of unrelated words to participants at a rate of one pair every three seconds. Participants were then given the first word in the pair and produced the second. This was repeated four times, with the same pairs presented in a different fixed random order each time. The dependent measure is the total number of words correctly recalled out of 32. In the AVLT, participants were given one minute to study a list of 15 unrelated words. At the end of the minute, participants were given one minute to recall as many words as possible. The dependent measure was the total number of words correctly recalled out of 15.

Fluid intelligence. Participants completed the odd-numbered matrices of the Raven's Progressive Matrices (Raven, 1958). In this reasoning task, participants were presented a series of incomplete abstract figures and chose one of several abstract figures that best completed the figure. The dependent measure for this task was the number of abstract figures completed correctly out of 30.

Primary memory. Participants completed three tests: digit span (Conway, Cowan, Bunting, Theirrault, & Minkoff, 2002), word span (Conway et al., 2002), and spatial span (Kane, Hambrick, Tuholski, Wilhelm, Payne, & Engle, 2004). In the digit span, participants saw a series of digits one at a time for one second each. After some number of digits, the participant recalled all of the digits they could recall in the order they saw them. Total number of digits in each series ranged from five to nine and participants attempted two at each length. The word span followed a similar procedure except that the total number of words in each series ranged from four to eight. Finally, in the spatial span, participants saw a series of X's appear in random positions in a 4x4 grid. After a series of X's the participant clicked on squares in the grid where the X's they appeared in the order they appeared. For these tasks, the dependent variable was the number of stimuli recalled in the correct order.

Working memory. Participants completed three tests of working memory: counting span, operation span, and reading span (Conway et al., 2002; Daneman & Carpenter, 1980). In the counting span, participants were presented with a series of displays that included dark blue circles (targets) and dark blue squares and light blue circles (distracters). After some number of displays, three question marks ‘‘???’’ prompted the participant to recall all of the count totals from that series. The number of displays per series varied from two to six with three series at each length presented in a fixed random order. In the operation span, participants verified equations aloud while trying to remember words. As with the counting span, after a series of number of equations and words was presented, participants were prompted to recall all the words from that series. The number of equation and word pairs per series varied from two to five with three series of each length presented in a fixed random order. In the reading span, participants verified sentences aloud while trying to remember unrelated letters. After some number of sentences and letters was presented, participants were prompted to recall all the letters from that series. The number of sentence and letter pairs per series varied from two to five with three series of each length presented in a fixed random order. The dependent measure for these tasks was the total number of items recalled in the correct position.

Processing speed. The number comparison task (NC) required participants to compare two strings of either 3 digits to determine whether the same digits were in each string, regardless of their order. Participants performed a block of 40 trials and average reaction time from correct trials served as the dependent measure for this task where greater reaction times indicates lower processing speed ability.

Positive and negative affect. In the Positive and Negative Affect Schedule-Expanded Form (Watson & Clark, 1994) participants indicated the extent to which a series of adjectives described how they felt in general. Ratings were made from not at all to extremely. Positive affect items were *attentive, strong, inspired, alert, active, excited, proud, enthusiastic, determined,* and *interested*. Negative affect items were *irritable, afraid, upset, guilty, nervous, hostile, jittery, ashamed, scared,* and *distressed*. Also included in the current form was the fatigue subscale which included *sluggish, tired, sleepy,* and *drowsy*. Cronbach's alphas were .88 for the positive affect subscale, .89 for the negative affect subscale, and .81 for the fatigue subscale.

Trait anxiety. Participants completed the trait version of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1974). Participants rate 20 Likert items on a scale of 1 (quite untrue) to 4 (quite true) that assessed the extent to which a participant generally experienced a variety of feelings ranging from happiness to tension (e.g., "I feel content," "I feel like a failure"). Cronbach's alpha for the current study was .91.

Neuroticism. Participants rated whether 10 statements accurately described how they perceived themselves in general on a scale of 1 (very inaccurate) to 5 (very accurate). Items were taken from the International Personality Item Pool (Goldberg et al.,2006) and included statements such as "often feel blue" and "dislike myself." Cronbach's alpha for the current study was .82.

Demographics. Participants completed a measure assessing general demographic characteristics including age, gender, education, income, marital status, and ethnicity.

Perseverative Thinking

Rumination. Assessed using the White Bear Suppression inventory. This scale consisted of 15 items designed to assess the experience of intrusive thoughts and what the individual does to control these thoughts. Items included “I wish I could stop thinking about certain things” and “I often do things to distract myself from my thoughts” and responses were made on a 5-point scale from strongly disagree to strongly agree. Reliability estimates ranged from .87 to .89 in previous studies (Wegner & Zanakos, 1994) and was .93 in the current study.

Thought Occurrence Questionnaire. Participants completed 28 items assessing the types of thoughts they have while “they have to concentrate on something.” The scale consists of three subscales that measures *Task-related, Task-unrelated,* and *Thoughts of escape.* Thoughts of escape items (not used in the current analysis) include, “I think about running away” or “I think about stopping.” Task-related thinking included items such as, “I think about how poorly I am doing” and task-unrelated thinking included items such as, “I think about friends.” There was a 5-point response scale from never to very often. Previous research found a Cronbach’s alpha of .93 (Sarason, Saranson, Keefe, Hayes, & Shearin, 1986) and the alpha was .92 in the current study.

Procedure

The order of administration of tasks and measures was fixed across participants. At the first session participants completed the following: Trail Making Test, Logical Memory I, Existence CRT, Size CRT, Digit span, Verbal set switching, Reading span, Verbal paired associates, Number comparison, and the Auditory Verbal Learning Test. During the second session participants completed the remaining cognitive tasks in the following order: category fluency, Parity CRT, Magnitude CRT, Word span, Number set switching, Counting span, Raven's progressive matrices, letter fluency, Orientation CRT, Location CRT, Spatial span, Spatial set switching, Operation span, and the Shipley Vocabulary test.

Chapter 3. Results

Analytical approach

The current analyses were conducted using SAS (SAS Institute, 2008) and Mplus software (Muthen & Muthen, 1998). Descriptive and correlation analyses were calculated with SAS and mediation and moderated mediation analyses applying bootstrap methodology were conducted using Mplus. Descriptive statistics and correlations between the predictor and outcome variables are presented first. Results from mediation analyses are subsequently presented for rumination and negative affect and these are followed by a test for moderation with age for rumination. Results for on-task and off-task intrusive thoughts are presented last to ascertain which form of thought content is a better predictor of cognitive performance in relation to neuroticism.

Descriptive Statistics and Correlations

Descriptive statistics for the individual and composite cognitive measures, neuroticism, and rumination are presented in Table 1. With the exception of the fluid intelligence task, scores on cognitive tasks were z-scored and averaged to form composite cognitive measures of episodic memory, primary memory, working memory, and processing speed. As shown in the table, all of the composite cognitive measures as well as the personality and rumination measures were within acceptable ranges for assumptions of normality for the current regression analyses.

The correlations matrix in Table 2 shows the raw and age-partialled correlations among the variables. The magnitude of these correlations increases when controlling for age indicating that age may moderate our results. Overall, the relationships among the variables are in the expected direction. Neuroticism is positively correlated with rumination (r=.55, p<.05), trait anxiety (r=.78, p<.05), and negative affect (r=.61, p<.05). Neuroticism is also negatively correlated with most all the cognitive measures (*r*s range from -.11 to -.25, $p<.05$) with the exception of processing speed (r=.02, *ns*), although the relationship is correlated in the expected direction (greater response times are indicative of lower performance). Rumination is also strongly associated with trait anxiety ($r=.60$, $p<.05$), and negative affect ($r=.46$, $p<.05$). Likewise, rumination was significantly associated with the cognitive measures in the direction that was expected (*r*s range from -.29 to .17, $p<.05$); greater rumination associated with worse cognitive performance. As demonstrated in Table 2, there is a large amount of shared variance between trait anxiety, neuroticism, and the cognitive measures. The current analyses therefore control for trait anxiety so as to determine the unique contribution of rumination in the negative relationship between neuroticism and cognitive function that is above and beyond trait anxiety.

These correlations also demonstrate that negative affect was strongly associated with all the variables of interest in the expected direction. Because neuroticism is often referred to as negative affectivity and depressed mood is oftentimes associated with cognitive performance (e.g., Dotson et al., 2007), the mediating effect of negative affect was also examined. Of particular interest was to examine whether the effect of rumination on the neuroticism-cognition relationship is independent of negative affect. Negative affect was therefore included as an alternative indirect effect so as to allow us to observe whether rumination or negative affect accounted for the variance in this relationship.

Mediation

The current mediation analyses applied Baron and Kenny's (1986) approach to test for statistical mediation and a bootstrap approach to test for the significance of the indirect effect (Shrout & Bolger, 2002). Figure 1 shows the elements of the mediation analyses as established by Baron and Kenny (1986). Neuroticism (*N*) is to first be associated with cognition (C; path *c*).

When the mediating variable, rumination (*RUM*) is then introduced, the indirect effect, or the product of path *a* and *b*, is to be equal to the total effect (path *c*) for there to be total mediation. An alternate for total mediation is to estimate whether the indirect effect significantly reduces the total effect using a bootstrap approach (Shrout & Bolger, 2002). Boostrap was used as opposed to a Sobel test because the latter approach assumes normality in the sample distribution of the product of the two paths (*a* and *b*) that construct the indirect effect. The bootstrap approach relaxes this assumption of normality in the product terms and, instead, constructs a sampling distribution of the product of path *a* and *b* from the current sample (Shrout & Bolger, 2002; Preacher & Hayes, 2008).

In the current analysis, mediation was estimated for neuroticism (*N*) in relation to each cognitive measure (*C*), using rumination as the mediating variable (*RUM*). We applied bootstrap methodology to test for the significance of the indirect effect that is the product of a_{rum} by b_{rum} (Figure 2), allowing for 5,000 random samples with replacement from the dataset. Table 3 presents the raw estimates and standard error of the total, direct, and indirect effects of the mediation analyses. With the exception of primary memory (B= -.022, p<.05), the total effects (path *c*) for most of the cognitive measures were no longer significant after rumination was introduced to the model. With rumination as a mediating variable, all direct effects (path *c'*) were smaller and lost significance compared to the total effect (*Bs* range from -.089 to -.002m, *ns*). Of importance are the observed results for the indirect effects though rumination (*RUM*) where the effects significantly accounted for the variance between *N* and *C* (*Bs* range from -.035 to .005, p<.05). Rumination thus accounts for a significant amount of variance of he neuroticism-cognition relationship regardless of trait anxiety.

Next, we introduced negative affect (NA) as a separate mediator (*NA*). This allowed us to determine if it is negative affect or rumination that is driving the negative relationship between neuroticism and cognition. As shown in table 3, the indirect effect through NA was not significant for any of the cognitive measures (*Bs* range from -.007 to .001, *ns*). Although NA covaries with all the cognitive tasks, it does not account for a significant amount of variance when rumination is also included as an indirect path. Moreover, rumination remains a significant mediator after controlling for NA. This suggests that rumination serves as a more viable mechanism through which neuroticism affects cognitive function.

Moderation

To determine whether age moderated the results from the mediation analyses, we adopted the Edwards and Lambert (2007) approach where we combined a first and second stage moderation model to determine whether the indirect effect through rumination varied according to age. As shown in Figure 3, we tested the hypothesis that age (*AGE*) moderates the path from neuroticism (*N*) to rumination (*RUM*) labeled as path a_{NXage} (first stage moderation) and the path from rumination to cognition (*C*) labeled as path b_{MXage} (second stage moderation). Results showed that the effect of neuroticism on rumination did not vary across levels of age (*B*= .001, *ns*). As shown in Table 4, age did not significantly moderate the effect of rumination on cognitive function (*B*s range from .000 to .003, *ns*). Given the non-significant interactions, we expected the direct, indirect, and total effects to not change significantly. The coefficients in fact did not differ from those presented in Table 3. These results suggest that the effect of neuroticism on rumination and the effect of rumination on cognition do not vary according to age.

Task-related and task-unrelated Thoughts

Lastly, we explored the question of whether a tendency to experience thoughts related to the task being performed as opposed to more general, task-unrelated, thoughts would more strongly influence the relationship between neuroticism and cognitive performance. Results from multiple regression analysis, presented on table 5 indicate that the tendency to experience task-unrelated thoughts significantly predicts cognitive performance (*Bs* range from -.171 to.027, $p < .05$) for most cognitive tasks and moderately predicts performance in primary memory ($B = -.023$, $p<.10$).Task-related thoughts, on the contrary, did not significantly predict cognitive performance (*Bs* ranged from -.019 to .001, *ns*). We then tested a mediation model were task-related and task-unrelated rumination were introduced as separate mediators and their effects were compared. Results from the mediation analyses (Table 6) indicated that neither task-related nor task-unrelated thoughts mediated the relationship between neuroticism and cognitive function.

Because work by Eysenck (1992) proposes that anxiety is an indicator of worry or rumination about task performance, we treated anxiety as an indicator of task-unrelated thinking. Thus, we examined the question of whether task-unrelated thoughts or anxiety would mediate the neuroticism-cognition relationship. As shown in Table 7, when both of these constructs were included in the same mediation model, anxiety did not mediate the neuroticism-cognition relationship (*Bs* ranged from -.008 to .007, *ns*). Task-unrelated rumination did mediate the relationship for most cognitive measures (*B*s ranged from -.072 to .009, $p<.05$) and partially mediated for working memory ($B=-.007$, $p<.10$).

Chapter 4. Discussion

Our primary results demonstrated that rumination and neuroticism are positively associated with each other and they are both associated with lower performance in attention-demanding cognitive abilities (episodic, primary and working memory, processing speed, and fluid intelligence). We also determined that rumination accounted for the negative association between neuroticism and cognition. These results are consistent with Eysencks's (1992) Processing Efficiency Theory (PET), which predicts that a cognitive tendency to experience ruminative thoughts depletes attentional resources among individuals who score high in trait neuroticism resulting in lower cognitive performance.

Three additional major findings followed this result. First, we demonstrated that the experience of ruminative thoughts accounts for the relationship between trait neuroticism and cognition above and beyond negative affect (NA). Second, we determined that age did not moderate these findings and third, we found that off-task thoughts were more predictive of lower cognitive performance compared to task-related intrusive thoughts or anxiety. The implications for the three additional findings will be discussed next.

Rumination and Negative Affect

Trait neuroticism exhibits a strong positive correlation with the tendency to experience negative emotions. Moreover, rumination is consistently associated with negative affect and negative affectivity and depressed mood have both been associated with impaired cognitive performance (e.g., Backman et al., 1996). Therefore, it was important to determine whether rumination uniquely contributed to the relationship between neuroticism and cognition independent of NA. We determined that rumination uniquely accounted for the relationship between neuroticism and cognition after controlling for NA. In contrast, NA did not mediate the relationship between neuroticism and any of the cognitive tasks after accounting for rumination. These results support the notion that it is how one thinks, rather than how one feels that accounts for the negative association between neuroticism and cognitive performance.

This finding highlights the importance of distinguishing between the affective and cognitive component of rumination. Rumination has been previously defined as self-focused thoughts experienced in response to depressed mood (Nolen-Hoeksema, 1991). Nonetheless, it has been suggested that rumination could be more than just a response to depressive mood but also a style of thinking that is general, repetitive, intrusive, and uncontrollable (Binker & Dozoi, 2009). Binker and Dozois (2009) recently developed a scale which items loaded onto one ruminative thought style factor that was not accounted for by depressive symptoms. This scale includes items such as “I find that some thoughts come to mind over and over throughout the day” that are very similar to the items used in this current study (e.g.,“I have thoughts that I cannot stop”).

Binker and Dozois (2009) also demonstrated that their ruminative thought style items predicted negative affect in a daily diary study. In their study they found that, after controlling for baseline levels of depressive symptoms, ruminative thought style items predicted NA at the one and three-week follow up. Due to the co-occurrence of NA and rumination reported in this study as well as others (e.g. Moberly & Watkins, 2008), it is important to not completely disregard the effect that NA might have in the relationship between neuroticism and cognition. NA could trigger rumination just as rumination could prolong NA and it is therefore important for future research to determine the temporal sequencing of these two constructs.

Neuroticism, Rumination, and Age

Research suggests that older adults might be more vulnerable to the negative consequences of intrusive or off-task thoughts because they are less able to inhibit these thoughts compared to younger adults (Hasher et al., 1999). This led us to predict that rumination should impact performance on attention demanding tasks to a greater extent among older as compared to younger adults. Our hypothesis was not supported; age did not moderate the indirect effect through rumination to influence the neuroticism-cognition relationship. Our results are consistent with an emerging view that, in fact, older adults may not have a specific deficit in inhibitory and attentional control. A recent meta-analysis found a lack of evidence of age-related deficit in tasks of selective attention (such as tasks that require inhibitory control; Verhaeghen, in press). Instead, Verhaeghen finds that there are age–related deficits in tasks that require divided attention, such as mental task-switching tasks.

Our results may also indicate that older adults are more (if not just as) able to regulate their emotion-laden thought processes compared to younger adults. A substantial amount of literature indicates that older adults employ more successful self-regulatory strategies, such as re-appraisals and attention-shifting strategies that allow them to minimize negative emotional states and garner more positive emotional experiences (e.g., Carstensen, Isaacowitz, & Charles, 1999). These regulatory abilities allow older adults to direct attention away from unwanted thoughts and towards stimuli aimed at improving their overall sense of wellbeing (e.g., Isaacowitz, 2006). This improvement in self-regulation suggests that older adults who score high in neuroticism might be better able to regulate their negative affective states that could aid in their performance in cognitive tasks as compared to their younger counterparts.

On-task and Off-task Intrusive Thoughts

We also explored the question of whether thought content mattered. Evidence suggests that intrusive and worrisome thoughts about task performance can interfere with successful completion of attention demanding cognitive tests (Eysenck et al., 2007). We addressed the possibility that rumination correlates with cognitive performance because high ruminators have performance concerns. Our results showed that self-reports of off-task intrusive thoughts predicted cognitive performance whereas tendencies to worry about performance, or on-task thoughts, did not. This, along with the results that rumination and off-task thinking predicted cognitive function after controlling for trait anxiety, supports the conclusion that our results are not attributable to individual differences in the tendency to worry or experience intrusive thoughts about performance concerns. Our results are consistent with those of Stawski and colleagues (2006) who propose that off-task rumination depletes attentional resources that are necessary for attention-demanding cognitive tasks. Thus, failing to focus on the task at hand and experiencing irrelevant thoughts instead is detrimental for cognitive performance.

Limitations and Future Directions

Due to the cross-sectional nature of this study, however, we cannot rule out other extraneous factors that could have influenced our results. For instance, selection effects can play a major role among the current sample. Wilson and colleges (2005) propose that neuroticism is an index of cumulative stress because those who score high in neuroticism tend to be exposed to more stressors. The constant exposure to stress and the physiological reactivity thereof can predispose adults with greater levels of neuroticism to develop more health problems with age. Previous research indicates that those who score high in this personality trait have worse health outcomes compared to those who score lower in neuroticism (e.g. Lahey, 2009). There might also be mortality effects at play within the current sample, as those who score increasingly higher in neuroticism appear to die younger as compared to those who do not. Mroczek and Spiro (2007) have demonstrated that those who increase in levels of neuroticism have higher mortality rates than those who remain stable or decline in this personality trait over a 12-year period. Older adults who score high on neuroticism and have more health problems would thus not be able to or be willing to participate in this study resulting in selection biases among the current sample.

In order to address the current limitations, future research should examine the longitudinal association between neuroticism, cognition, rumination, and NA. This approach could allow us to determine the temporal sequencing of these constructs. As previously stated, it is possible that rumination precedes NA that can initiate a prolongation of this affective state increasing the risk for disease and health conditions (e.g., inflammation, cardiovascular disease; Kietcolt-Glaser, McGuire, Robles, & Glaser, 2002) known to compromise cognitive function (Yaffee et al., 2004). NA can also predispose individuals to experience ruminative thoughts that disrupt on-line processing resulting in lower cognitive performance (Eysenck et al., 1992). Conducting a longitudinal examination among these constructs, could not only allow us to determine their temporal ordering, but it could also allow us to examine how changes within individuals may be associated with health and mortality outcomes. Additionally, conducting repeated assessments of thought content could allow us to determine whether some thoughts are more detrimental than others and how these consequences differ across the lifespan. We can determine, for example, if older adults are similarly affected by certain cognitive intrusions compared to younger adults. It may be that health-related rumination is more prevalent among older adults for example, and these thoughts are what are associated with more detrimental outcomes because of the saliency of health concerns among older individuals.

Despite its limitations, this study demonstrated that rumination is a mechanism through which personality trait neuroticism relates to cognitive performance. We find that the effect of rumination remains after accounting for negative affect and trait anxiety suggesting that this cognitive characteristic of neuroticism is more predictive of cognitive performance. The current results extend previous findings and suggest that individuals who score high in personality trait neuroticism and who tend to ruminate are more likely to exhibit decrements in cognitive performance.

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Appendix: Tables and Figures

Table 1

Descriptive statistics for cognitive measures and predictor variables

Variable	*M*	*SD*	Skew	Kurtosis
Age	49.43	17.23	0.46	-1.02
Neuroticism	25.83	7.79	.32	-.11
Rumination	46.44	12.95	-.28	-.48
TOQ - TR	16.26	6.38	-.15	-.04
TOQ - UR	20.99	7.72	-.31	0.09
Digit span	40.88	11.11	-.29	.29
Word span	30.54	9.63	.14	-.31
Spatial span	20.63	9.81	.47	-.30
Operation span	19.31	8.67	.31	-0.24
Counting span	30.90	11.24	.07	-.76
Reading span	22.82	7.61	-.17	-.33
Logical memory	24.90	6.91	-.15	-.44
Paired associates	15.23	8.13	.04	-1.10
Free recall	8.11	2.83	.16	-.67
Simple number task	845.49	246.03	2.04	8.50
Location task	719.63	239.63	1.57	3.04
Semantic judgement	1311.32	430.56	1.64	3.65
Primary memory	.01	.85	.06	.27
Working memory	.01	.89	.14	-.39
Episodic memory	.03	.81	.06	-.63
Processing speed	-.02	.86	1.66	4.37
Fluid intelligence	20.53	5.99	-.85	0.22

Note. TOQ-TR = Thought Occurrence Questionnaire – Task Related thoughts. TOQ-UR = Thought Occurrence Questionnaire – Unrelated thoughts.

Table 2

Pearson correlation coefficients

Measure	1	2	3	4	5	6	7	8	9	10	11
1. Neuroticism	-	0.53*	-0.16*	-0.22*	-0.22*	0.09	-0.23*	0.77*	0.58*	0.46*	0.44*
2. Rumination	0.55*	-	-0.27*	-0.34*	-0.33*	0.25*	-0.28*	0.59*	0.43*	0.46*	0.52*
3. Episodic memory	-0.11*	-0.22*	-	0.42*	0.54*	-0.4*	0.46*	-0.18*	-0.15*	-0.13*	-0.19*
4. Primary memory	-0.25*	-0.28*	0.46*	-	0.66	-0.5	0.44*	-0.18*	-0.21*	-0.20*	-0.24*
5. Working memory	-0.17*	-0.29*	0.57*	0.66*	-	-0.48	0.53*	-0.22*	-0.21*	-0.19*	-0.24*
6. Processing speed	0.02	0.17*	-0.44*	-0.54*	-0.51*	-	-0.46*	0.13*	0.11*	0.15*	0.21*
7. Fluid IQ	-0.18*	-0.24*	0.49*	0.48*	0.56*	-0.49*	-	-0.21*	-0.18*	-0.23*	-0.27*
8. Trait anxiety	0.78*	0.6*	-0.14*	-0.13*	-0.18*	0.07	-0.17*	-	0.64*	0.53*	0.47*
9. Negative affect	0.61*	0.46*	-0.1†	-0.15*	-0.17*	0.04	-0.14*	0.66*	-	0.42*	0.45*
10. TOQ - TR	0.48*	0.47*	-0.09	-0.11†	-0.13*	0.08	-0.18*	0.54*	0.45*	-	0.63*
11. TOQ - UR	0.45*	0.51*	-0.17*	-0.19*	-0.20*	0.17*	-0.24*	0.47*	0.46*	0.62*	-

Note: Raw correlations below, age-partialled correlations above.

*p <.05. †p <.10.

Table 3

Total, Direct, and Indirect Effects between Cognitive Measures and Neuroticism

			Indirect through:	
	Total	Direct	Rumination	NA
Primary memory	-.022 (.01)*	-.013 (.01)	-.007(.002)*	-.003 (.002)
Working memory	-.014 (.01)	-.005(.01)	-.006 (.002)*	-.002 (.002)
Episodic memory	-.008 (.01)	-.002 (.01)	-.005 (.002)*	.000 (.002)
Processing speed	-.003 (.01)	-.009 (.01)	.005 (.002)*	.001 (.002)
Fluid intelligence	.130 (.08)†	-.089 (.08)	-.034 (.02)*	-.007 (.014)

Note. Results covaried for age, trait anxiety, and gender

**p* <.05. †*p* <.10.

Table 4

Coefficient Estimates for Rumination, Age, and Interaction

	Rumination	Age	RuminationxAge
Primary memory	-.022(.004)*	-.015 (.003)*	.000(.000)
Working memory	-.020 (.005)*	-.015(.003)*	.000(.000)
Episodic memory	-.018 (.004)*	-.012 (.002)*	.000(.000)
Processing speed	.016 (.004)*	.017 (.003)*	.000(.000)
Fluid intelligence	-.100 (.030)*	-.094 (.020)*	.003(.002)

Note . Results covaried for gender and trait anxiety

**p* <.05.

Table 5

Regression Estimates for Cognition from Task-related and Task-unrelated Thought

	Intercept	Task-unrelated	Task-related
Primary memory	.86 (.26)*	-.023 (.012)†	.005 (.015)
Working memory	.92 (.30)*	-.021 (.009)*	.001 (.012)
Episodic memory	.64 (.26)*	-.023(.009)*	.011 (.012)
Processing speed	-.56 (.25)*	.027 (.011)*	- .003 (.015)
Fluid intelligence	27.50 (1.86)*	-.171 (.062)*	-.019 (.078)

Note. Results covaried for anxiety and gender.
**p* <.05.

Table 6

Total, Direct, and Indirect Effects Through Task-Related and Task-Unrelated Thought

			Indirect through:	
	Total	Direct	Task-unrelated	Task-related
Primary memory	-.018 (.010)*	-.015 (.011)	-.004 (.003)	.000 (.002)
Working memory	-.010 (.010)	-.006(.011)	-.003 (.003)	.000 (.001)
Episodic memory	-.004 (.009)	-.001 (.009)	-.004 (.003)	.001 (.002)
Processing speed	-.008 (.012)	-.012 (.011)	.004 (.003)	.000 (.002)
Fluid intelligence	-.120 (.084)	-.073 (.083)	-.027 (.019)	-.002 (.010)

Note . Results covaried for age, anxiety, and gender.
**p* <.05.

Table 7

Total, Direct, and Indirect Effects Through Task-Unrelated Thought and Anxiety

			Indirect through:	
	Total	Direct	Task-unrelated	Anxiety
Primary memory	-.017 (.006)*	-.012 (.011)	-.008 (.004)*	.004 (.008)
Working memory	-.019 (.007)*	-.004(.011)	-.007 (.004)†	-.008 (.009)
Episodic memory	-.012 (.006)	.001 (.009)	-.008 (.003)*	-.005 (.007)
Processing speed	.002 (.006)	-.014 (.011)	.009 (.004)*	.007 (.008)
Fluid intelligence	-.135 (.045)*	-.056 (.077)	-.072 (.025)*	-.007 (.058)

Note . Result covaried for age, gender and task-related thoughts

*p <.05. †p <.10.

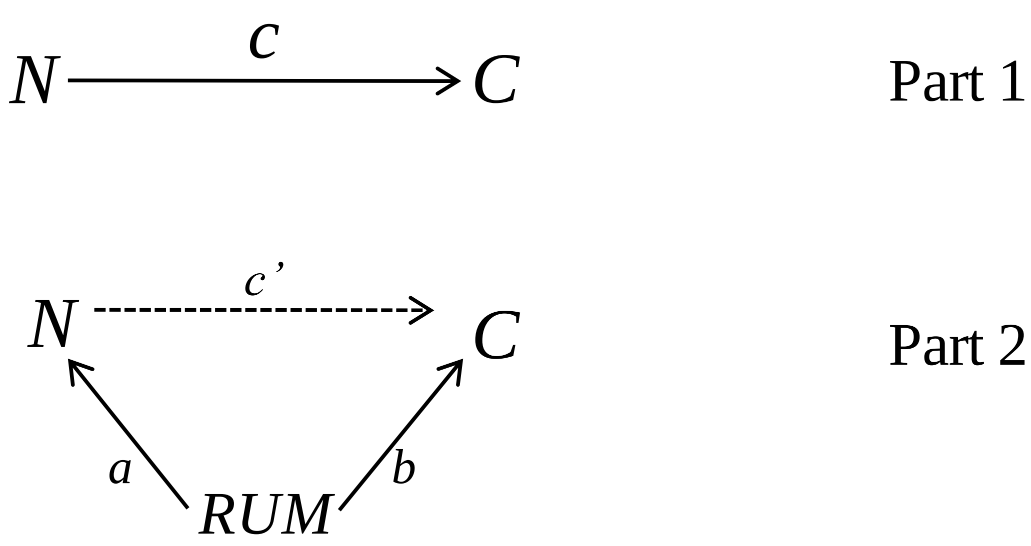

Figure 1. Part 1 is an illustration of a direct effect (path *c*) where Neuroticism (*N*) directly affects Cognition (*C*). Part 2 is an illustration of a mediation design where *N* affects *C* through Rumination (*RUM*) as indicated by the product of paths *a* and *b*.

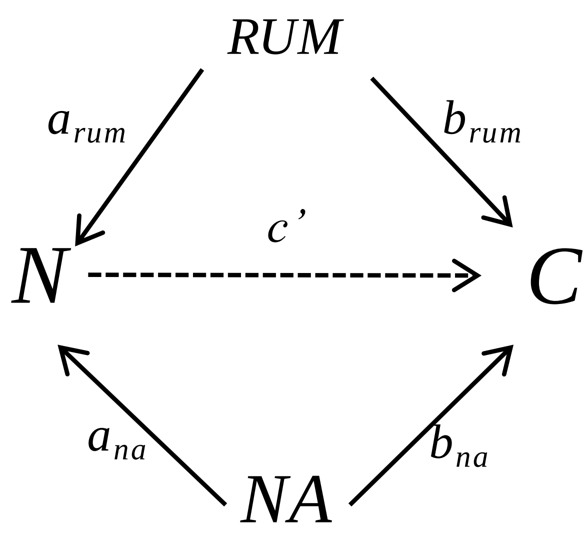

Figure 2. Illustration of a multiple mediation design where Neuroticism (*N*) has an effect on Cognition (*C*) through either rumination (*RUM*) or negative affect (*NA*) as indicated by the products of a_{rum} by b_{rum} or a_{na} by b_{na}.

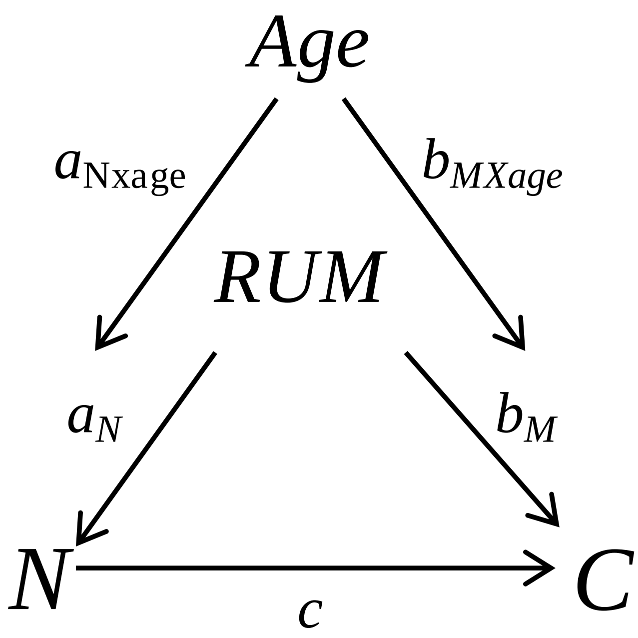

Figure 3. Illustration of a moderated mediation model adapted from Edwards and Lambert (2007). In this model, age moderates the first (effect from *N* to *RUM*) and second stage (the effect from *RUM* to *C*) of the mediation effect.