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The Association of Gender, Rumination, and Depression on the WAIS-IV Working Memory Index

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To the Graduate Council:

I am submitting herewith a thesis written by Audrey Ashton File entitled "The Association of Gender, Rumination, and Depression on the WAIS-IV Working Memory Index." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

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The Association of Gender, Rumination, and Depression

on the

WAIS-IV Working Memory Index

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Abstract

Due to the prevalence of depression in college students and associated functional and cognitive impairment, a developing body of research is exploring factors that may negatively impact cognitive efficiency. Recent research has highlighted rumination as one variable that may reduce cognitive efficiency and exacerbate depression. This study examined the impact of rumination and gender on working memory in depressed (n = 29) and non-depressed undergraduates, (n = 68) by examining performance on the Working Memory Index (WMI) of the WAIS-IV. Prior to WMI subtests, participants were randomly assigned to a rumination or distraction condition. After controlling for pre-experimental rumination, test anxiety, mathematics anxiety, and general intelligence, results indicated that depressed males exposed to rumination achieved lower WMI and arithmetic subtest scores than non-depressed males exposed to rumination. The performance of females was comparatively unaffected by rumination, whether depressed or non-depressed. When examined as a continuous variable, there also was evidence that depression negatively affected WMI and arithmetic subtest performance. Findings support research highlighting the negative impact of rumination on cognitive-behavioral experimental tasks but reveal important gender differences previously unidentified. Results are discussed in the context of gender differences in rumination whereby a decreased reliance on rumination as a coping mechanism among males may increase performance deficits when confronted with this cognitive experience.

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Chapter 1

Introduction and General Information

Major Depressive Disorder (MDD) affects approximately 35 million adults in the United States and has a lifetime prevalence of 16% (Kessler et al., 2003). MDD is diagnosed in about 20% of university students, with increasing incidence in the past two decades (American College Health Association, 2007; Benton, Robertson, Tseng, Newton, & Benton, 2003; Gallagher, 2007; Voelker, 2003). College depression is in part related to environmental stressors that include academic demands, a new living environment, financial responsibilities, changes in social support structure, and preparing for post-graduation (Kerr, Johnson, Gans, & Krumrine, 2004). Depression in college students is highly coexistent with anxiety disorders and substance abuse (Grant & Harford, 1995; Weitzman, 2004; Wu et al., 2007), and independently or in combination with these conditions may result in substantial functional impairment. For example, college students with depression engage less frequently in social, physical, and educational behaviors (Hopko & Mullane, 2008), and academic performance and retention are negatively impacted by depression (Fazio & Palm, 1998; Gallagher, 2007; Pritchard & Wilson, 2003).

It is well documented that females have higher rates of MDD, (American Psychiatric Association, 2000; Kessler et al., 2003), and beginning around the age of 15, females are twice as likely to be depressed as males (Nolen-Hoeksema & Girgus, 1994). Both chronic and acute negative life stressors, decreased perceptions of self-mastery, and rumination are more common in females and are significant mediators of the gender-depression relationship (Nolen-Hoeksema, Larson, & Grayson, 1999; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Biological factors including hormonal and adrenal functioning, as well as psychosocial influences including more aversive and traumatic childhood experiences, gender role factors (competing social roles, role

restriction), differential coping skills, increased vulnerability to emotional pain of others, relationship distress, increased neuroticism, and differential attributions of life experiences also contribute to the gender discrepancy (Goodwin & Gotlib, 2004; Hankin, Mermelstein, Roesch, 2007; Kessler & McLeod, 1984; Nolen-Hoeksema, 2001; Nolen-Hoeksema & Hilt, 2009; Piccinelli & Wilkinson, 2000).

Chapter 2

Cognitive Vulnerability, Depression, and Rumination

Cognitive vulnerability refers to certain cognitive processes and tendencies to make negative inferences about the causes, consequences, and self-worth implications of stressful events, a cognitive style linked with the onset and maintenance of depression (Abramson, Metalsky, & Alloy, 1989, 2002; Haeffel et al., 2008). Cognitive vulnerability has informed influential etiological models of depression including helplessness, hopelessness, and schema-based conceptualizations of depression (Abela & Seligman, 2000; Abramson et al., 1989, 1998; Alloy et al., 2000; Alloy, Lipman, & Abramson, 1992; Beck, Rush, Shaw, & Emery, 1979; Haeffel et al., 2003; Sturman, Mongrain, & Kohn, 2006; Young, Klosko, & Weishaar, 2003).

Also considered a cognitive vulnerability factor, mental rumination significantly impacts depression severity. Rumination is a response to distress that involves repetitively (and passively) focusing on the symptoms of distress and on its possible causes and consequences (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). As with depression, rumination is correlated with various maladaptive cognitive styles, including negative inferential or attributional styles, dysfunctional attitudes, hopelessness, pessimism, self-criticism, low mastery, dependency, sociotropy, neediness, and neuroticism (Nolen-Hoeksema et al., 2008). Rumination prolongs depression via increased frequency, severity, and focus on negative thoughts, by interfering with effective coping mechanisms such as problem-solving skills and instrumental behaviors, and through negatively impacting relationship quality and social support (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Individuals prone to rumination exhibit higher levels of negative affect following stressful life experiences and are significantly more likely to develop major depression (Lyubomirsky & Tkach, 2004; Nolen-Hoeksema, 2000, 2004; Nolen-

Hoeksema & Morrow, 1991, 1993; Papageorgiou & Siegle, 2003; Robinson & Alloy, 2003). In addition to contributing to depression severity, rumination is linked to other psychological problems such as anxiety disorders, substance abuse, and eating disorders (Nolen-Hoeksema, 2000; Nolen-Hoeksema et al., 2008; Skitch & Abela, 2008; Wells & Matthews, 2004).

Rumination is also associated with difficulties in cognitive functioning, problem solving, and other executive tasks (Davis & Nolen-Hoeksema, 2000; Philippot & Brutoux, 2008; Van der Linden et al., 2002; Ward et al., 2003). Specifically, rumination serves the function of reducing available cognitive resources, decreasing cognitive efficiency, and limiting the ability to perform various cognitive and behavioral tasks (Addis & Martell, 2001; Eysenck & Calvo, 1992; Nolen-Hoeksema et al., 2008). Cognitive inflexibility, or perseveration, is the failure to modify behavior or cognitive processes when given corrective feedback (Hertel, 1998; Lezak, 1995). Individuals who ruminate tend to exhibit cognitive inflexibility, which may increase rumination and negative affect because of an inability to adjust and focus attention onto another topic or task (Davis & Nolen-Hoeksema, 2000). Dysphoric rumination creates a cycle of negative thoughts and behaviors accompanied by decreased motivation to engage in adaptive behaviors that could potentially elevate mood (Watkins & Teasdale, 2001). Dysphoric rumination also increases the likelihood of processing deficits and makes tasks that require increased focus and concentration more difficult, such as reading, listening, and comprehension (Joorman, 2004; Lyubomirsky, Fazilet, & Zehm, 2003). Davis and Nolen-Hoeksema (2000) examined the relation of rumination severity and performance on the Wisconsin Card Sorting Task (WCST), where ruminators displayed more perseverative errors and failed to maintain cognitive sets more frequently than non-ruminators. In another study, dysphoric individuals made more perseverative and non-perseverative errors on the WCST than non-dysphoric individuals (Channon, 1996). Watkins and

Brown (2002) found that induced rumination prior to a random number generation task resulted in decreased inhibitory control (i.e., stereotyped counting responses) only in depressed individuals, demonstrating the interaction of rumination and depressed mood on executive functioning deficits. Rumination also interferes with cognitive flexibility in dysphoric individuals in the form of increased Stroop Task errors (Philippot & Brutox, 2008) and it is well documented that ruminators tend to remain fixed in their methods of problem solving despite other potentially more viable solutions (Nolen-Hoeksema et al., 2008).

Chapter 3

Gender Differences

In a separate body of research on executive functioning, gender differences as a function of depression and IQ have been observed, such that depression in adolescent males was associated with increased IQ, and depression in females linked with lower IQ (Glaser et al., 2011). In terms of the effects of depression and anxiety on intelligence task performance in adults, negative affect is inversely related to IQ (Hopko et al., 2005; Mortensen, Sorensen, Jensen, Reinisch, & Mednick, 2005; Naismith, et al., 2003; Stordal, et al., 2004). With only a couple exceptions (Iverson, Woodward, & Green, 2001; Morasco, Gfeller, & Chibnall, 2006), one of the most robust findings is that depressed individuals perform more poorly on performance IQ tasks, presumably due to slower reaction times (Iverson, Turner, & Green, 1999; Kaufman & Lichtenberger, 2006; Sackeim et al., 1992). Contradicting this theory somewhat, an untimed administration of WAIS-III subtests yielded no significant performance deficits among depressed patients, suggesting IQ differences are not entirely accounted for by slowed processing speed (Sackeim et al., 1992). Accordingly, the relationship between depression and cognitive impairment appears more complex, and the central thesis of this paper is that rumination may have a significant role toward better understanding the relations among gender, depression, and intelligence task performance.

Chapter 4

Hypotheses

Previous research has focused on performance discrepancies as a function of rumination and (non-clinical) dysphoric mood on the WCST and Stroop Task. This study expanded on this research by examining executive functioning of well-diagnosed depressed and non-depressed individuals after induced rumination on three subtests of the Wechsler Adult Intelligence Scale [(WAIS-IV; Wechsler, 2008): Arithmetic, Digit Span, and Letter-Number Sequencing]. These subtests were specifically chosen as they comprise the working memory index (WMI) of the WAIS-IV, and thus were perceived to be most sensitive to deficits in cognitive functioning associated with rumination and depression. Based on prior research, primary hypotheses were as follows: (1) relative to non-depressed individuals, depressed individuals would perform more poorly on WAIS-IV subtests, (2) performance deficits of depressed participants would be magnified when exposed to rumination, and (3) gender differences would be observed on WAIS-IV subtests such that females would be affected more than males by rumination because of increased vulnerability toward rumination (Nolen-Hoeksema et al., 2008).

Chapter 5

Method

Participants

Participants were 97 undergraduate students (n = 43 males; 54 females) recruited from introductory psychology courses at a southeastern university. All participants were designated as either depressed (n = 29) or non-depressed (n = 68) based on a structured clinical interview and randomly assigned to either a rumination or distraction induction condition. The entire sample consisted of 73 Caucasians (75.3%), 11 African Americans (11.3%), 3 Hispanic/Latino (3.1%), 3 Asian Americans (3.1%), 1 Native American (1%), 4 Indian/Middle Eastern (4.1%), and 2 participants who self-identified as "other" (2.1%). The mean age of participants was 19.6 years (SD = 4.8 years). Following a series of independent sample t-tests for continuous variables and chi-squared analyses for categorical variables, no significant differences on demographic variables were found as a function of depression group or experimental condition (i.e., distraction or rumination). Participant demographics as a function of depression group are presented in Table 1. As expected, depressed participants reported more depression [$t(95) = 6.63$, $p < .001$], rumination [$t(95) = 6.10$, $p < .001$], test anxiety [$t(95) = 2.04$, $p < .05$], and math anxiety [$t(95) = 2.02$, $p < .05$]. Depressed and non-depressed individuals did not significantly differ on the WMI and individual subtests of the WAIS-IV. Accordingly, for all statistical analyses, pre-experimental rumination, test, and math anxiety scores were used as covariates. Participants' scores on the RRS were used to control for pre-experimental propensity toward rumination to better isolate the effect of the experimental rumination induction. The potential impact of test anxiety on performance was controlled using TAI scores as a covariate, given research demonstrating the strong and inverse relationship between test anxiety and IQ

performance (Hopko, Crittendon, Grant, & Wilson, 2005). Finally, AMAS scores were used as a covariate given strong inverse relationships between math anxiety with both arithmetic task and IQ performance (Ashcraft & Ridley, 2005; Hopko et al., 2003).

Assessment Measures

The *Anxiety Disorder Interview Schedule* (ADIS-IV) is a semi-structured interview that assesses mood, anxiety, somatoform, substance abuse, and psychotic disorders (Brown, Di Nardo, Lehman, & Campbell, 2001). Symptoms are rated on a nominal scale and are also given severity ratings based on a continuum of severity or interference. The ADIS-IV has very good inter-rater reliability in the assessment of major depression, panic disorder, specific phobia, and social phobia (Brown et al., 2001).

The *Beck Depression Inventory-II* (*BDI-II*; Beck, Steer, & Brown, 1996) consists of 21 items rated on a 4-point Likert scale. Sample items assess the frequency and intensity of "sadness", "guilt", and other core symptoms of depression. The BDI-II has excellent psychometric properties, and has excellent internal reliability and strong convergent validity with other measures of depression with depressed younger and older adults (Beck et al., 1996; Nezu, Ronan, Meadows, & McClure, 2000; Hopko, Lejuez, Armento, & Bare, 2004). In this study, internal consistency of the BDI-II was excellent (α = .92).

The Test Anxiety Inventory (TAI; Spielberger, 1977) is a 20-item instrument that measures anxiety associated with test-taking situations. Internal reliability is strong (α = .93 to .96), as is convergent validity with other measures of test anxiety (r = .85 to .95; Sarason, 1978) and state and trait anxiety (r = .77 to .86; Spielberger, 1977; Spielberger, Gonzalez, Taylor, Algaze, & Anton, 1978). Internal consistency of the TAI in this study was excellent (α = .95).

The Abbreviated Math Anxiety Scale (AMAS; Hopko et al., 2003) is a 9-item measure of anxiety elicited via numerical tasks. The instrument consists of two factors, learning-math anxiety and math-evaluation anxiety. Internal consistency (α = .83 - .90) and test-retest reliability of the measure are high (r = .85). Convergent validity of the AMAS is evident with measures of math anxiety (r = .85: Math Anxiety Rating Scale Revised; Plake & Parker, 1982), test anxiety (r = .52; TAI, Spielberger, 1977), performance in math courses (r = -.34 to -.52), and other measures of anxiety-related constructs (r = .26 to .33; Hopko et al., 2003). Internal consistency of the AMAS in this sample was high (α = .81).

The *Ruminative Response Scale* (RRS; Nolen-Hoeksema & Marrow, 1991) is a 22-item self-report measure that assesses tendencies to ruminate. Each item is rated on a 4-point scale. The RRS assesses three types of ruminative responses: focus on the self, symptoms, and the possible consequences and causes of moods. Sample items include '[How often do you…] Think about how alone you feel?' and "Think 'what am I doing to deserve this?" The instrument has good two-year test-retest reliability (r = 0.67) and good convergent and predictive validity (Nolen-Hoeksema & Morrow, 1991; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Internal consistency of the RRS in this study was excellent (α = .93).

The *Wechsler Adult Intelligence Scale-IV* (WAIS-IV: Wechsler, 2008) is an intelligence assessment battery composed of 10 core and 5 supplemental subtests that combine to create a full scale IQ score (FSIQ). The core subtests form four indexes: verbal comprehension, perceptual reasoning, working memory, and processing speed. There is strong support for the construct validity of these indexes, and split-half (r = .98) and test-retest reliability (r = .98) of the FSIQ are strong. In the present investigation, the three working memory subtests (arithmetic, letter-number sequencing, and digit span) and their aggregate score (Working Memory Index: WMI)

were examined as dependent variables. In addition, the Vocabulary subtest is a good measure of general intellectual ability and correlates most highly with FSIQ for individuals in this sample [age: 18-19 (r = .78); 20-24 (r = .81); Lichtentenberger & Kaufman, 2009; Wechsler, 2008)]. Although an independent samples t-test revealed no significant differences [t (95) = 1.10, p = .28] between depressed (M = 10.48, SD = 3.22) and non-depressed participants (M = 11.08, SD = 2.11), this subtest was used as a covariate in all analyses to control for pre-experimental IQ.

Procedure

Upon arrival to the research laboratory, participants were guided through the informed consent procedure. After agreeing to participate, they completed a demographic questionnaire, TAI, AMAS, RRS, and BDI-II. When all self-report measures were completed, a trained research assistant administered the Major Depressive Disorder and Dysthymic Disorder modules of the ADIS-IV. Next, the vocabulary subtest of the WAIS-IV was administered. Participants were then randomly assigned to either the rumination or distraction induction experimental condition. A second experimenter conducted the remainder of the study and was blind to whether participants were depressed or non-depressed. The study followed the same induction method used in prior studies (Lyubomirsky & Nolen-Hoeksema, 1995; Nolen-Hoeksema & Morrow, 1991; Philippot & Brutox, 2008; Watkins & Teasdale, 2001). All participants were given a list of 45 typed items and asked to focus on and imagine each item individually. Following Nolen-Hoeksema's (1991) definition of ruminative responses, the rumination condition required participants to focus their attention on thoughts that were emotion focused, symptom focused, and self-focused, although students were not told specifically to think about negative emotions or negative personal attributes. For example, they were asked to think about "your current level of energy," "the physical sensations in your body," "what your feelings might mean," "the kind of

person you are," and "why you react the way you do." In contrast, participants in the distraction condition focused their attention on thoughts that were focused externally and not related to symptoms, emotions, or the self. For example, they were asked to think about "a boat slowly crossing the Atlantic," "clouds forming in the sky, " and "a double-decker bus driving down the street." This initial induction procedure lasted 8 minutes. After their respective cognitive manipulation (i.e., rumination or distraction), all participants were administered 2 tasks, including either the Arithmetic, Digit Span, or Letter-Number Sequencing subtest from the WAIS-IV. Presentation of these tasks was counterbalanced across participants. Following these cognitive tasks, another briefer 4-minute manipulation occurred, followed by the remaining WAIS-IV subtest. The purpose of this second manipulation was to function as a "booster," to facilitate continued rumination or distraction. All participants were then given a study debriefing form, contact information for mental health resources, and research credit for participation.

Chapter 6

Results

Bivariate Correlations

As reported in Table 2, Pearson Product-Moment correlations were used to examine the relationships among gender, depression, rumination, test anxiety, math anxiety, the four WAIS-IV subtest scaled scores, and the WMI of the WAIS-IV (mean scaled score of Arithmetic, Digit Span, and Letter-Number Sequencing subtests). As indicated, all three WAIS-IV WMI subtests were significantly correlated with the overall WMI (r = .70 to .79), as was the WAIS-IV Vocabulary subtest (r = .34). Self-reported depression (BDI-II) was strongly correlated with rumination (RRS: r = .81) and test anxiety (TAI: r = .65), and moderately correlated with mathematics anxiety (AMAS: r = .55) and a diagnosis of major depression (r = -.54). Consistent with the literature (cf. Nolen-Hoeksema et al., 2008), diagnosed major depression was significantly correlated with rumination (RRS: r = .53). Gender was significantly correlated with performance on the arithmetic subtest (r = -.29), potentially due to the increased prevalence of math anxiety and associated performance deficits on arithmetic tasks often observed among females (Ashcraft & Ridley, 2005; Hopko et al., 2003).

The Effects of Gender, Rumination, and Depression on WAIS-IV Performance

All outcomes were analyzed using 2 (experimental condition: distraction or rumination) x 2 (depression: depressed or non-depressed) x 2 (gender) mixed model analyses of variance. Four separate analyses were conducted to examine the WMI score as well as the scaled scores of the Arithmetic, Letter-Number Sequencing, and Digit-Span subtests. As indicated, four pre-experimentally assessed variables were used as covariates in these analyses, including the vocabulary subtest as a proxy for FSIQ, rumination, test anxiety, and math anxiety.

Collapsed across all participants and considering the college-educated sample, performance on the WMI (M = 11.02, SD = 2.19), Arithmetic (M = 10.81, SD = 2.91), Letter-Number Sequencing (M = 10.95, SD = 2.87), Digit-Span (M = 11.08, SD = 2.78), and Vocabulary subtests was normative (M = 10.91, SD = 2.49). As illustrated in Figure 1, the mixed model ANOVA with WMI as the criterion variable resulted in a 3-way interaction between experimental condition, depression, and gender, whereby depressed males were significantly impacted in the rumination condition and achieved a significantly lower WMI score [F (1,85) = 4.54, p = .03]. Non-depressed males were not negatively impacted by the rumination induction. This interaction had a strong effect size (d = .73). As indicated in Figure 2, this effect was not replicated among females. In addition to the significant triple interaction, there was a marginally significant interaction between experimental condition and depression [F (1,85) = 3.41, p = .07] such that there was a trend for depressed individuals in the rumination condition to exhibit WMI performance deficits not observed among non-depressed individuals exposed to rumination. Finally, there was a significant main effect of gender [F (1,85) = 5.01, p = .03] whereby males (M = 11.54, SD = 2.51) outperformed females (M = 10.61, SD = 1.82) on the WMI. All other main effects and interactions were non-significant for WMI performance. As illustrated in Figure 3, the mixed model ANOVA with arithmetic as the criterion variable also resulted in a 3-way interaction between experimental condition, depression, and gender, whereby similar to WMI findings, depressed males in the rumination condition scored significantly lower on arithmetic [F (1,85) = 4.36, p = .04; d = .65] than non-depressed males in the rumination condition. As illustrated in Figure 4, for females, this effect was not observed. As expected given correlative data presented earlier, the main effect of gender also was significant [F (1,85) = 6.70, p = .01] whereby males (M = 11.76, SD = 3.41) outperformed females (M = 10.05, SD = 2.21) on the

Arithmetic subtest. For the Letter-Number Sequencing subtest, only the 2-way interaction between experimental condition and depression was significant [F (1,85) = 4.52, p = .04; d = .20]. Specifically, non-depressed participants performed significantly better in the rumination condition (M = 11.81, SD = 3.46) relative to the distraction condition (M = 9.90, SD = 1.16). For the Digit-Span subtest, there were no significant interactions or main effects.

To further assess findings from a non-clinical model of depression severity (i.e., as a continuous variable) in contrast to diagnosed clinical depression, regression analyses were conducted. In these analyses, criterion variables were the WAIS-IV factors (WMI, Arithmetic, Letter-Number Sequencing, Digit-Span), and predictor variables were depression severity (BDI-II score centered), gender, and experimental condition (both variables dummy-coded), and all interaction terms. As with previous analyses, pre-experimental rumination, test anxiety, math anxiety, and FSIQ as estimated via the WAIS-IV vocabulary subtest were used as covariates. These variables were entered into the first block of the regression analyses followed by the predictor variables entered into the second block. After controlling for covariates, predictor variables accounted for significant incremental variance for the WMI [F (11, 85) = 3.39, p < .01, r^2 = .31], Arithmetic [F (11, 85) = 3.91, p < .001, r^2 = .34], Letter-Number Sequencing [F (11, 85) = 2.62, p < .01, r^2 = .25], and Digit-Span subtests [F (11, 85) = 2.20, p < .05, r^2 = .22]. For the WMI, the 3-way interaction between experimental condition, depression, and gender was again significant [t = 2.08, p < .05], whereby depressed males were most affected by the rumination induction. Different from analyses with depression as a categorical variable, when examined as a continuous variable, increased self-reported depression was associated with poorer WMI performance [t = 2.26, p < .05, partial r = -.24]. For the Arithmetic subtest, the 3-way interaction also was once again significant, with poorer arithmetic performance in depressed

males exposed to rumination [$t = 1.96$, $p = .05$]. Moreover, depression was associated with poorer Arithmetic performance [$t = 2.16$, $p < .05$, partial $r = -.23$]. For Letter-Number sequencing, only depression was marginally associated with performance [$t = 1.84$, $p = .07$, partial $r = -.20$]. For Digit Span, consistent with prior analyses, no predictor variables were significant.

Chapter 7

Discussion

The primary aim of this study was to examine the effects of depression and rumination on executive functioning, specifically tasks requiring working memory resources. Because depression and rumination are more common among females (American Psychiatric Association, 2000; Kessler et al, 2003; Nolen-Hoeksema & Girgus, 1994; Nolen-Hoeksema et al., 2008), in addition to the hypothesis that depressed individuals would perform more poorly on WAIS-IV working memory subtests (Arithmetic, Digit Span, and Letter-Number Sequencing), this effect was predicted to be particularly pronounced among depressed females exposed to a rumination induction. There was some direct support for the first hypothesis, that depressed individuals would exhibit performance deficits on WAIS-IV WMI subtests. Although no differences were identified with depression assessed as a categorical variable (i.e., presence or absence of a diagnosis), both the WMI and arithmetic subtest scores were negatively affected when depression was examined as a continuous variable (i.e., self-reported depression). Indeed, as highlighted earlier, the relationship between depression and IQ performance is somewhat controversial. Although performance deficits as a function of depression are commonly identified (Mortensen et al., 2005; Naismith, et al., 2003; Stordal, et al., 2004), in some studies they are not observed, (Iverson et al., 2001; Morasco et al., 2006), and in those where they are identified, performance deficits are often attributed to slowed reaction times (Iverson, Turner, & Green, 1999; Kaufman & Lichtenberger, 2006; Sackeim et al., 1992). In this context of this body of work, study findings are logical. As only the arithmetic subtest of the WMI is a timed task, consistent with other findings (Kaufman & Lichtenberger, 2006; Sackeim et al., 1992), untimed WAIS-IV WMI subtests may not be sensitive enough to fully capture cognitive limitations of

depressed patients that might include decreased concentration and propensity toward rumination. This theory extends to other areas of research that includes findings that mathematics and test anxiety negatively impact academic performance only when tasks are timed (Onwuegbuzie & Seaman, 1995; Tsui & Mazzocco, 2007). Although decreased WMI scores as a function of depression may partially be accounted for by the arithmetic-depression association, alternative explanations also are conceivable.

One alternative that directly pertains to the second and third study hypotheses is that increased rumination and associated depletion of cognitive resources (Eysenck & Calvo, 1992; Nolen-Hoeksema et al., 2008) might account for WAIS-IV performance deficits. Indeed, study findings on the impact of rumination and gender on WMI subtests were supportive of this prediction and highly provocative. In particular, two significant three-way interactions were observed whereby the performance of depressed males on both the WAIS-IV WMI and Arithmetic subtest was significantly affected by rumination, whereby females were largely unaffected by the rumination indication. These findings are consistent with previous research supporting the synergistic negative impact of depression and rumination on various cognitive and behavioral tasks (Davis & Nolen-Hoeksema, 2000; Philippot & Brutoux, 2008; Van der Linden et al., 2002; Ward et al., 2003; Joorman, 2004; Dehaene & Changeux, 1991). Accordingly, there was moderate support for the hypothesis that depressed individuals would be more negatively affected by rumination than non-depressed individuals. However, the relationships among depression, rumination, and gender are more complex in that females were comparatively less affected by rumination. These results collectively provide preliminary support that relative to depressed females, depressed males' cognitive performance may be substantially more impaired by rumination. Although one possible explanation for these findings is the general notion that

structural interference causes reduced cognitive resources when rumination is triggered (Philippot & Brutox, 2008), the more gender-specific explanation is that because males less frequently use rumination as a coping strategy relative to females, this more novel and potentially uncomfortable cognitive experience may elicit more substantial cognitive impairment when attempting to efficiently engage in working memory tasks. Alternatively, as females have increased exposure to rumination as a coping strategy, they may experience comparably minimal cognitive interference when engaged in task-relevant WMI subtests.

Taken together, study findings indicate that depression and rumination may be associated with performance deficits on IQ tests, specifically among depressed males, and interestingly on the WMI of which subtests largely are untimed. Accordingly, it might be expected that the observed effects might be even more robust if the study was replicated with a more severely depressed sample of males who completed timed subtests of the WAIS-IV. Implications of such findings would be substantial, and thus examining the combined effects of depression and rumination on the complete WAIS-IV battery seems warranted. For the purpose of methodological generalization, it would also be prudent to examine whether study findings would be replicated on other neuropsychological assessment tasks, both timed and untimed. Important to highlight, study findings have important implications for cognitive assessment. In particular, if the objective is to formulate a "pure" estimation of IQ, just as it might be necessary to control for test anxiety (Hopko et al., 2005), it may be necessary to consider the potential detrimental effects of rumination, particularly in depressed males. Although the interaction of gender, depression, and rumination on working memory processes was unexpected based on past research, methodological differences might account for such discrepancies, such as prior studies including smaller sample sizes, use of self-report measures of depression rather than a structured

diagnostic interview, and the exclusion of male participants in one study (Watson & Brown, 2002; Philippot & Brutoux, 2008).

Although study findings are intriguing, a few limitations are noteworthy. First, it was decided that participants would be left alone in the research laboratory during rumination and distraction inductions to reduce the likelihood of being interrupted, distracted, or otherwise socially influenced by experimenter presence. Because of this methodology it is possible that some participants may have been less compliant in following experimental induction instructions. Indeed, other then directly observing participants focusing on written prompts, because of the cognitive nature of the rumination and distraction tasks, it is difficult to precisely assess participant compliance with the protocol. Second, because depression and anxiety disorders frequently co-occur and the notion that rumination is also strongly related to anxiety (Nolen-Hoeksema, 2000), future studies should more systematically assess for the co-existence of anxiety disorders and symptoms and their potential relations with rumination and performance on intelligence tasks. Third, as the sample was largely an educated Caucasian sample, generalizability to samples with other demographic and clinical presentations should be explored. In the context of these limitations, study findings provide novel insights toward understanding potentially important gender differences in rumination and their impact on cognitive functioning. Further inquiry with additional clinical and non-clinical samples and utilization of other cognitive-behavioral experimental tasks will better elucidate the social, clinical, and academic implications of these findings.

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Appendix

Table 1.
Patient Demographics as a Function of Depression

	Depressed (n = 29)	*Non-depressed (n = 68)*	*Significance (p)*
Age	20.0 (4.8)	19.4 (4.8)	.58
Gender			
Male	13 (44.8%)	30 (44.1%)	.56
Female	16 (55.2%)	38 (55.9%)	
Ethnicity			.51
White/Caucasian	21 (72.4%)	52 (76.4%)	
African American	3 (10.3%)	8 (11.8%)	
Hispanic/Latino	2 (6.9%)	1 (1.5%)	
Asian American	1 (3.4%)	2 (2.9%)	
Native American	1 (3.4%)	0 (0.0%)	
Indian/Middle E.	1 (3.4%)	3 (4.4%)	
Other	0 (0.0%)	2 (2.9%)	
Relationship Status			.43
Single	19 (65.5%)	45 (66.2%)	
Dating	9 (31.0%)	22 (32.4%)	
Married	1 (3.4%)	0 (0.0%)	
Divorced	0 (0.0%)	1 (1.5%)	
Academic Level			
Freshman	19 (65.5%)	50 (73.5%)	.50
Sophomore	5 (17.2%)	11 (16.2%)	
Junior	2 (6.9%)	5 (7.4%)	
Senior	3 (10.3%)	2 (2.9%)	
GPA			.15
1.0 – 1.5	0 (0.0%)	1 (1.5%)	
1.5 – 2.0	0 (0.0%)	1 (1.5%)	
2.0 – 2.5	1 (3.4%)	5 (7.4%)	
2.5 – 3.0	5 (17.2%)	11 (16.2%)	
3.0 – 3.5	8 (27.6%)	25 (36.8%)	
3.5 – 4.0	15 (51.7%)	24 (35.3%)	
Unknown (blank)	0 (0.0%)	1 (1.5%)	
BDI-II	22.3 (9.9)	11.0 (7.4)	.00
TAI	47.3 (13.5)	41.4 (12.7)	.04
AMAS	20.9 (5.2)	18.8 (4.6)	.04
RRS	54.7 (10.6)	39.0 (12.0)	.00
WMI	11.1 (2.2)	11.0 (2.2)	.84
ARITH	10.1 (2.7)	11.1 (3.0)	.12
LNS	11.0 (3.1)	11.0 (2.8)	.91
DS	11.7 (3.1)	10.9 (2.6)	.19

Note. BDI-II = Beck Depression Inventory II; TAI = Test Anxiety Inventory; AMAS = Abbreviated Math Anxiety Scale; RRS = Ruminative Response Scale; WMI = Working Memory Index; ARITH = Arithmetic; LNS = Letter-Number Sequencing; DS = Digit-Span.

Table 2.
WAIS-IV, Self-Report Measures, Depression, and Gender Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	*M*	*SD*
1.WMI	-	.70*	.79*	.78*	.34*	-.03	-.02	-.21	-.19	-.21	-.02	11.0	2.2
2.Arith		-	.36*	.31*	.37*	-.14	-.09	-.21	-.11	-.29*	.16	10.8	2.9
3.DS			-	.58*	.29*	.15	.13	-.08	-.10	-.04	-.14	11.1	2.8
4.LNS				-	.25	-.05	-.07	-.17	-.22	-.06	-.01	10.9	2.9
5.Vocab					-	-.11	-.01	-.09	-.19	.13	.11	10.9	2.5
6.BDI-II						-	.81*	.65*	.55*	.15	-.54*	14.4	9.7
7.RRS							-	.58*	.44*	.13	-.53*	43.7	13.6
8.TAI								-	.69*	.17	-.20	43.2	13.1
9. AMAS									-	.14	-.19	19.5	4.8
10.Gender										-	.01	-	-
11.MDD											-	-	-

Note. WMI = WAIS-IV Working Memory Index Scaled Score; Arith = Arithmetic Scaled Score; DS = Digit Span Scaled Score; LNS = Letter-Number Sequencing Scaled Score; Vocab = Vocabulary Scaled Score; BDI-II = Beck Depression Inventory II; RRS = Ruminative Response Scale; TAI = Test Anxiety Inventory; AMAS = Abbreviated Math Anxiety Scale; Gender (Male = 1, Female = 2); MDD by ADIS-IV (Depressed = 1, Non-depressed = 2).
* Correlation significant ($p < 0.01$).

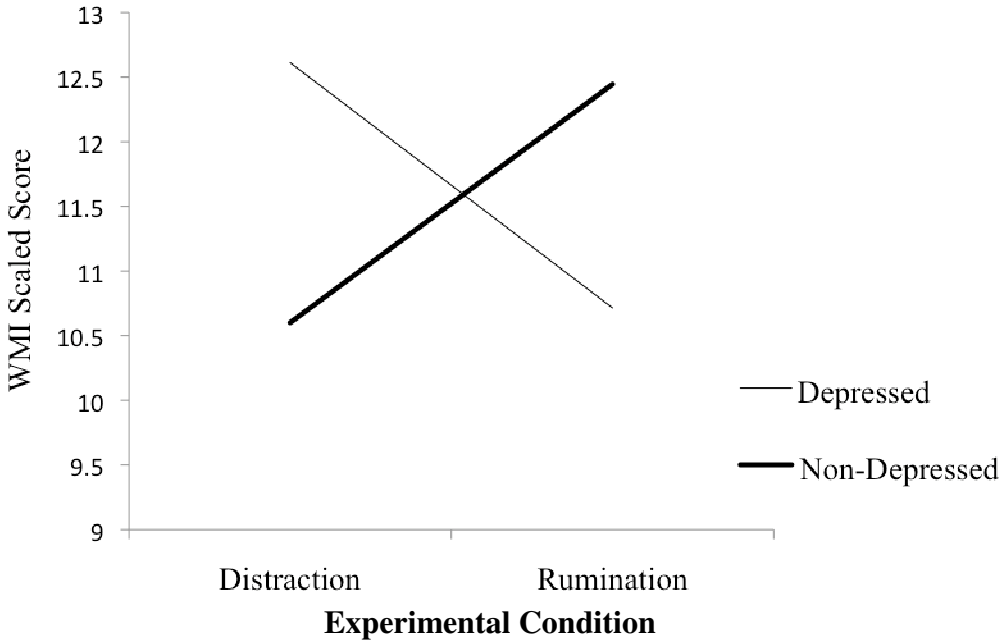

Figure 1. WMI performance in males as a function of rumination and depression

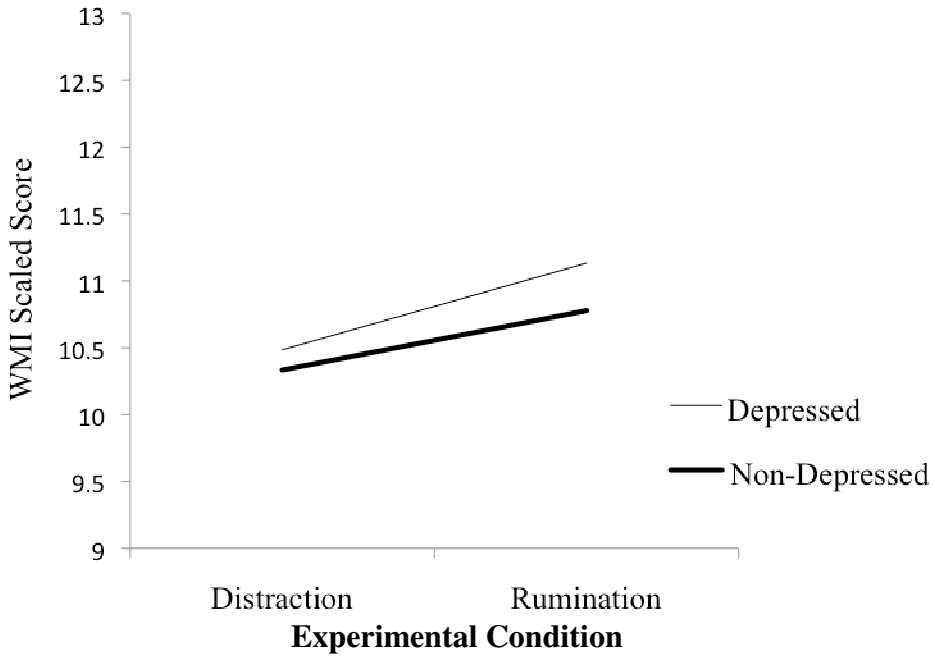

Figure 2. WMI performance in females as a function of rumination and depression

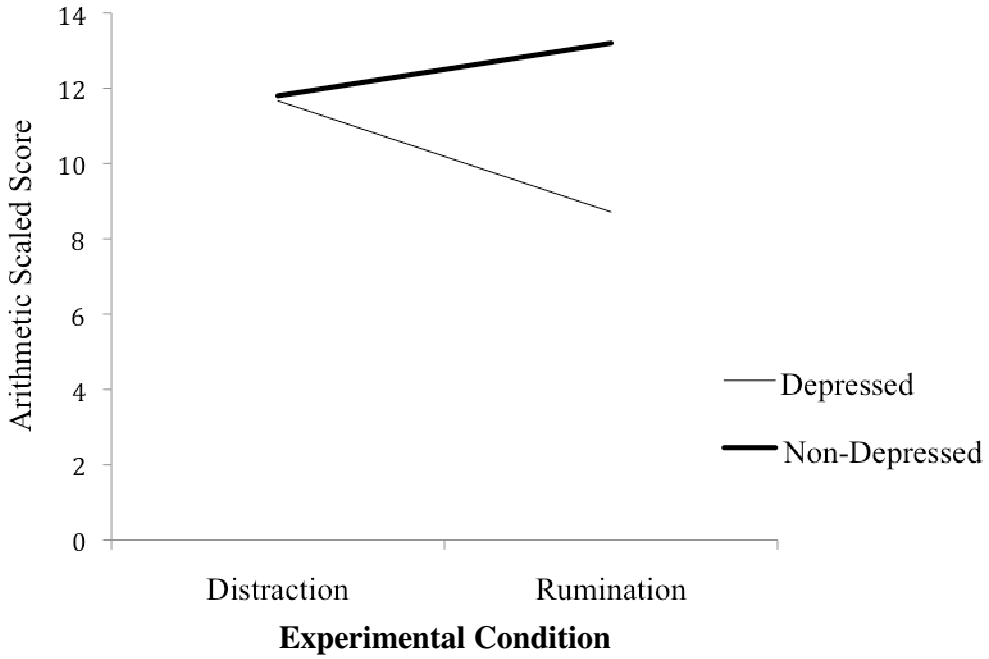

Figure 3. Arithmetic scaled scores in males as a function of rumination and depression

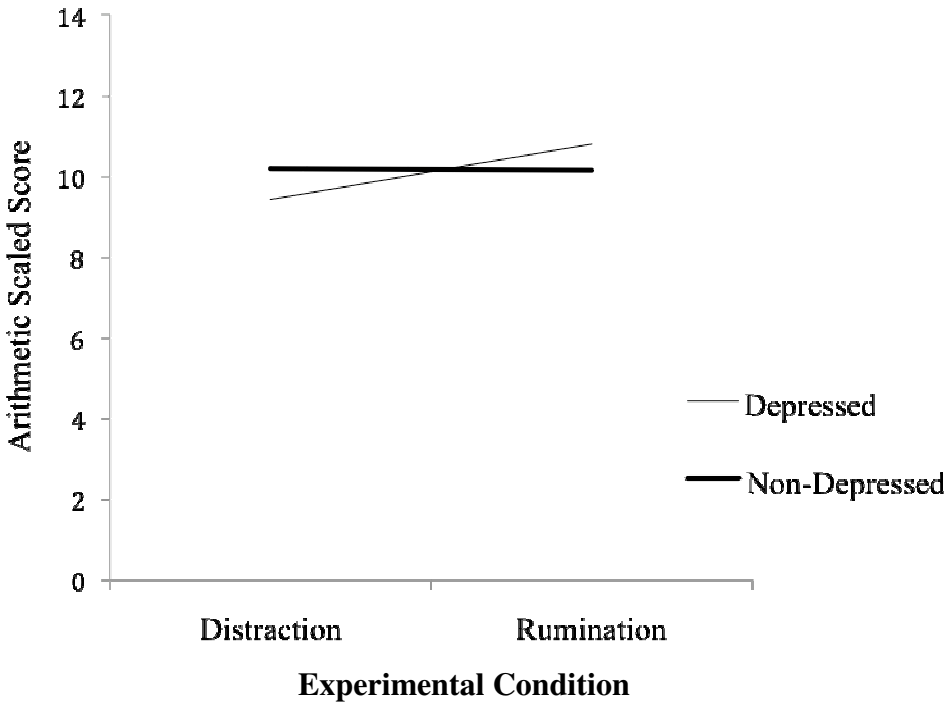

Figure 4. Arithmetic scaled scores in females as a function of rumination and depression

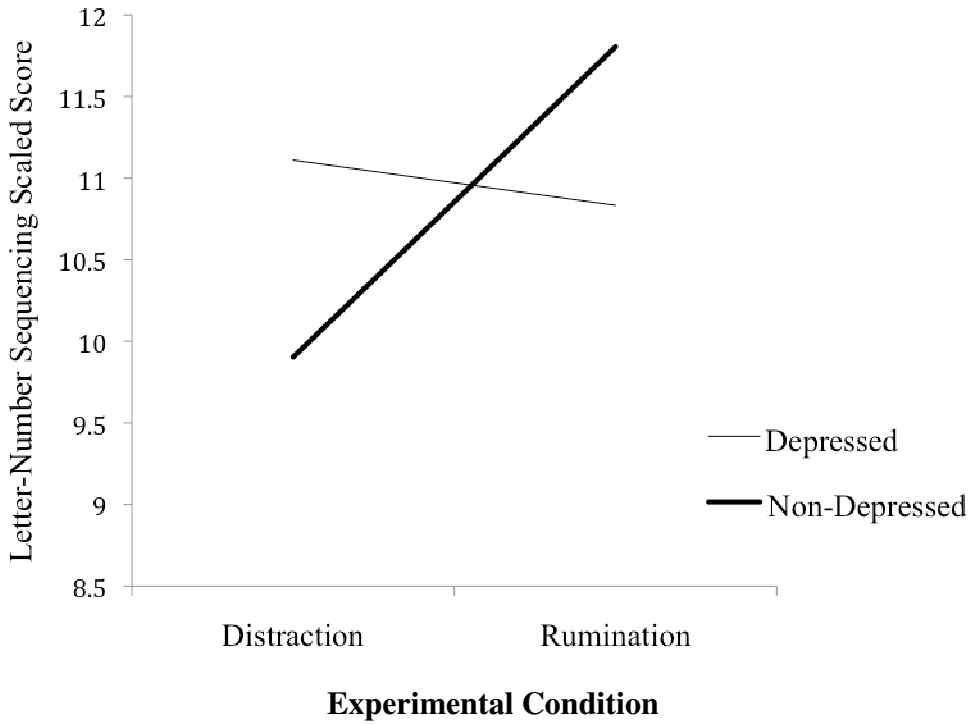

Figure 5. Letter-number sequencing scaled scores as a function of rumination and depression

Vita

Audrey File graduated from West Virginia University in May 2010 with a B.S. in psychology. Her current research interests are in the area of depression, anxiety, and health psychology.