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To the Graduate Council:

I am submitting herewith a thesis written by Kerry Margaret Cannity entitled "The Impact of Rumination Induction on IQ Performance." 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.

Derek R. Hopko, Major Professor

We have read this thesis and recommend its acceptance:

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Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

The Impact of Rumination Induction on IQ Performance

A Thesis Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville

Kerry Margaret Cannity

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Abstract

Performance deficits on cognitive tasks have been demonstrated consistently in depressed and anxious individuals. Processing efficiency theory asserts that these deficits might be accounted for by task-irrelevant processes, including the negative impact of rumination. This study was designed to better understand the relationship between cognitive deficits and depression by creating a ruminative state in healthy control subjects to determine if they would exhibit performance deficits similar to those observed in patients with depression. Specifically, the effect of rumination induction on select subtests of the Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV) was examined. Participants were college students with no current depression, anxiety, ADHD, or substance abuse disorders, who also are not currently taking psychoactive medications or receiving psychotherapy. Participants were randomized to a rumination or distraction condition and administered subtests from the WAIS-IV hypothesized to be most affected by rumination and depression. Controlling for test, math, and trait anxiety, as well as pre-experimental rumination, individuals in the rumination condition performed more poorly on one subtest within the processing speed domain, as well as on the Processing Speed Index score. These results support the processing efficiency model of cognitive deficits in depression, suggesting that rumination induction interferes in the efficient completion of mental tasks. Future research can build on these findings by studying this model in a clinical population and by continuing to improve the effectiveness of mood induction tasks for research on the effects of this widespread and significantly impairing disorder.

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Chapter 1

Introduction

The National Comorbidity Survey (NCS-R; Kessler et al., 2003) suggested major depression has a lifetime prevalence of 16%, which is consistent with prevalence rates in college students (15-20%), with the incidence steadily increasing in the past two decades (American College Health Association, 2007; Benton, Robertson, Tseng, Newton, & Benton, 2003; Gallagher, 2007; Voelker, 2003). Depression in college students is associated with medical problems (Katon, Lin, & Kroenke, 2007; Rawson, Bloomer, & Kendall, 1994), maladaptive thinking patterns (Abramson, Metalsky, & Alloy, 1989; Hollon & Kendall, 1980; Rude, Gortner, & Pennebaker, 2004), behavioral avoidance of adaptive activities (Carvalho & Hopko, 2011; Hopko, Armento, Cantu, Chambers, & Lejuez, 2003; Hopko & Mullane, 2008), sleep problems (Buboltz, Brown, & Soper, 2001; Voelker, 2004), and difficulties with interpersonal relationships (Kessler, Walters, & Forthofer, 1998; Weissman, Markowitz, & Klerman, 2000). Depression also is highly co-existent with anxiety disorders (Eisenberg, Gollust, Golberstein, & Hefner, 2007; Kessler, et al., 2003) and substance abuse (Cranford, Eisenberg, & Serras, 2009; Lenz, 2004; Weitzman, 2004). Among university students, academic performance and retention also are negatively impacted (Fazio & Palm, 1998; Gallagher, 2007; Pritchard & Wilson, 2003). Problematically, there is limited treatment outcome research for depressed college students, and depression in college students is largely under-recognized (Gawrysiak, Nicholas, & Hopko, 2009; Hunt & Eisenberg, 2010; Lee, 2005). Rumination is commonly associated with depression (Dobson & Dozois, 2008; Nolen-Hoeksema, 2000, 2004; Nolen-Hoeksema & Hilt, 2009), and its

impact on the cognitive abilities of college students has only recently begun to be explored. The primary aim of this study was to elaborate on recent research and explore the impact of rumination on IQ performance in college undergraduates.

Depression and Cognitive Deficits

Cognitive deficits in depression are widespread and include impairment in neuropsychological functions such as reasoning, memory, attention, and visual-spatial tasks (Baune et al., 2010; Blanchette & Leese, 2011; Naismith et al., 2003; Reischies & Neu, 2000), with studies generally demonstrating small to medium effect sizes and moderate variability (Lee, Hermens, Porter, & Redoblado-Hodge, 2012; McIntyre et al., 2013). In general, individuals with depression perform more poorly than healthy controls on executive functioning tasks, including the Delis-Kaplan card sorting task (Fossati, Amar, Raoux, Ergis, & Allilaire, 1999) and the Wisconsin Card Sorting Task (WCST: Moritz et al., 2002). Additionally, the number of depressive episodes may mediate the relation between depression and WCST performance, with more episodes associated with greater performance deficits (Karabekiroglu, Topcuoglu, Gimzal Gonentur, & Karabekiroglu, 2010; Ravnkilde et al., 2002). Consistent with WCST data, depressed individuals experience greater cognitive interference on the Stroop task, a neuropsychological measure of cognitive inhibition (Karabekiroglu et al., 2010; Moritz et al., 2002; Ravnkilde et al., 2002; Stordal et al., 2004), deficits that may persist despite attenuation of depressive symptoms (Årdal & Hammar, 2011). There also are data suggesting increased depression is associated with EEG activation during Stroop tasks (Krompinger & Simons, 2011).

Verbal memory skills also are deficient in depressed individuals as measured by the Rey Auditory Verbal Learning Task (Austin et al., 1992; Reischies & Neu, 2000) and California

Verbal Learning Test (CVLT: Basso & Bornstein, 1999; Smith, Muir, & Blackwood, 2006).

Pertaining to the latter, depressed patients recalled fewer words on the initial trial of the CVLT-II, but showed no differences in subsequent trials (Hammar, Isaksen, Schmid, Årdal, & Strand, 2011). Similar to WCST findings, patients with recurrent depressive episodes performed poorest on the CVLT-II (Basso & Bornstein, 1999). On verbal fluency tasks that assess basic vocabulary and the ability to quickly and creatively recall vocabulary words, with few exceptions (Gohier et al., 2009), depressed patients generally recall fewer words than control subjects (Fossati et al., 1999; Moritz et al., 2002; Ravnkilde et al., 2002).

Lexical decision tasks are frequently used to examine reaction time associated with vocabulary identification and recall. Lexical studies with depressed patients have shown that while reaction time is generally slowed, performance is relatively equivalent to non-depressed individuals, known as a speed-accuracy tradeoff (Besche-Richard, Passerieux, & Hardy-Baylé, 2002; Georgieff, Ford Dominey, Michel, Marie-cardine, & Dalery, 1998; Stip, Lecours, Chertkow, Elie, & O'Connor, 1994). Both clinically depressed and sub-syndromal dysphoric subjects show significantly greater priming effects for depression-related words than control subjects (Bradley, Mogg, & Millar, 1996). Interestingly, depressed patients also have difficulty in word reasoning tasks that use words with negative valence (Blanchette & Leese, 2011).

Theorists hypothesize such deficits are due to reduced abilities to perform effortful activities or a misallocation of cognitive resources to complete such activities (Channon & Green, 1999; Hammar et al., 2011; Krompinger & Simons, 2011).

Cognitive Theory of Performance Deficits

Working memory skills have been specifically implicated as deficient in patients with depression. For example, depressed individuals have difficulty with traditional verbal memory span tasks that require repetition of numbers or words (both forward and backward), along with visual-spatial working memory tasks (Fossati et al., 1999). Cognitive processing and mental manipulation of (backward) working memory digit-span and visual-spatial tasks appear particularly difficult for patients with depression (Moritz et al., 2002; Ravnkilde et al., 2002). In addition to working memory deficits, general processing speed may be compromised in people with depression. For example, simple reaction time (Azorin, Benhaim, Hasbroucq, & Possamai, 1995; Friedman, 1964) and performance on psychomotor speed-dependent tests such as trail-making are lower among depressed patients (Austin et al., 1992; Moritz et al., 2002; Reischies & Neu, 2000; Smith et al., 2006). Important to acknowledge, a recent study of patients with depression, anxiety, and healthy controls revealed no differences on tests of executive functioning when controlling for IQ (Smitherman et al., 2007).

Highly relevant to the current study, cognitive deficits associated with depression in some studies may at least partially be accounted for by failure to systematically control for the possible impact of lower IQ. Alternatively, it may also be the case that performance deficits would be observed in depressed individuals even in the absence of IQ differences. In line with this hypothesis, an early study indicated that depressed patients performed more poorly on reaction time and visual discrimination tasks despite being similar to a control group on subtests of the Wechsler Adult Intelligence Scale (Wechsler, 1981), and tests of attention and executive functioning (Friedman, 1964). While research on cognitive deficits and depression is therefore somewhat equivocal, comprehensive neuropsychological evaluations on patients with depression

generally highlight a trend towards decreased cognitive functioning in this population (Austin et al., 1992; Baune et al., 2010; Reischies & Neu, 2000).

Depression and Intelligence

During childhood and adolescence, the relation between depressive symptoms and IQ performance is inconsistent. In a recent study, higher IQ was correlated with decreased depression in younger children whereas in adolescence, IQ was positively correlated with depression (Glaser et al., 2011). This study also found gender differences in the depression-IQ relationship, with depression in adolescent males associated with increased IQ, and depression in females linked with lower IQ. The authors posited that in childhood, children with higher IQs have stronger coping skills and more stress resilience than their peers. In adolescence, however, increased stress associated with puberty, academic demands, and social factors may limit the protective effects of higher intelligence (Ge, Conger, & Elder, 1996, 2001).

In terms of the effects of depression and anxiety on intelligence task performance in adults, negative affect is inversely related to IQ (Mortensen, Sorensen, Jensen, Reinisch, & Mednick, 2005; Naismith et al., 2003; Stordal et al., 2004). With only a few exceptions (Iverson, Woodward, & Green, 2001; Morasco, Gfeller, & Chibnall, 2006), one of the most robust findings has been that depressed individuals perform more poorly on performance IQ tasks, presumably due to slower reaction times (Iverson, Turner, & Green, 1999; Kaufman & Lichtenberger, 2006; Pernicano, 1986; Sackeim et al., 1992). In contrast to this finding, however, an untimed administration of the WAIS-III for depressed patients produced similar results, suggesting that IQ differences are not entirely accounted for by slowed processing speed (Sackeim et al., 1992). When tested following depression remission, IQ scores improved, but the

significant discrepancy between performance and verbal IQ remained (Sackeim et al., 1992). This finding suggests depression severity is linked to cognitive deficits on IQ tests (Mandelli et al., 2006), a hypothesis supported by documented relationships between depression severity and cognitive deficits on tests of executive functioning (Austin et al., 1992; Karabekiroglu et al., 2010). The relationship between depression severity and cognitive impairment appears more complex, however, in that several studies indicated that cognitive deficits in depressed patients did not attenuate subsequent to symptom improvement (Reischies & Neu, 2000).

Depression and Information Processing

Using functional imaging strategies, researchers have recently begun to examine the neurological basis of cognitive deficits in patients with depression. One hypothesis is that abnormal functioning of the prefrontal cortex elicits cognitive and emotional processing deficits (Steele, Currie, Lawrie, & Reid, 2007). Supporting this theory, depressed patients require increased cognitive effort to complete tasks with the same effectiveness as healthy controls (Wagner et al., 2006) because of insufficient cognitive resources due to poor frontal lobe inhibition (Harvey et al., 2005). A second neurological explanation is that depressed patients require greater cognitive control to perform similar to healthy controls, with the ACC implicated in improving task performance based on the possibility of obtaining rewards associated with successful performance.

In the context of possible working memory deficits highlighted earlier, these findings suggest a fundamental problem with depressed individuals may involve information processing deficits. Supporting this theory is the finding that depression severity is positively associated with the duration of time distracted by an extraneous stimulus during a cognitive task

(Bredemeier et al., 2012). Consistent with Eysenck and Calvo's (1992) processing efficiency theory, given increased cognitive burden (e.g., rumination), people with heightened depression may adopt simpler or less effective processing methods due to more limited cognitive resources. The result may be increased response latencies to task-relevant stimuli and poorer performance, particularly on more complicated tasks. Supporting this notion, relative to control participants on an attention task, depressed individuals had increased activation in affective brain regions and decreased activation in performance regions (Jones, Siegle, Muelly, Haggerty, & Ghinassi, 2010). This finding suggests decreased performance may be due to poor resource allocation, rather than to depleted resources in one or more brain regions. Using the D-KEFS Color-Word Interference task (a variation of the Stroop task) and the Attentional Network Test (ANT: Fan, McCandliss, Sommer, Raz, & Posner, 2002), researchers found that inhibition/switching was most difficult for patients with depression and comorbid anxiety and distinguished them from patients with only depression and healthy controls. In addition, results from the ANT indicated that depressed subjects had particular difficulty with sustained attention, but not orientation or other executive processes (Lyche, Jonassen, Stiles, Ulleberg, & Landro, 2011). These results suggest that while depressed individuals have difficulty with sustained mental effort, they are particularly vulnerable to poor performance on tasks requiring effortful processing.

The distinction between effortful and automatic processing is important in understanding cognitive deficits in depressed individuals, with depression having a more significant impact on the former (Hammar, Strand et al., 2011; Levens, Muhtadie, & Gotlib, 2009; Suslow, 2009). This relationship is mediated by the severity of depressive symptoms, the severity of cognitive rumination, and the emotional valence of tasks (Hartlage, Alloy, Vázquez, & Dykman, 1993; Levens et al., 2009). Automatic processing requires minimal demands on mental resources, but

when engaging in effortful processing, depressed patients with limited or inefficient processing abilities may be overwhelmed, resulting in slower or more error-prone performance (Channon & Green, 1999). It may be that depressed subjects are less likely to spontaneously generate effective strategies for completing unfamiliar tasks (Hertel & Hardin, 1990). Interestingly, even when depressed individuals are educated on more effective strategies, some data suggest performance still does not equal that of healthy controls (Channon & Green, 1999).

Mood Induction and Cognitive Deficits

Research showing a positive correlation between depression severity and executive functioning deficits supports the hypothesis that increased negative affect may directly induce performance deficits (Austin et al., 1992; Basso & Bornstein, 1999; Karabekiroglu et al., 2010; Mandelli et al., 2006). Some studies on depressive rumination have suggested that ruminative thinking is correlated with longer depressive episodes, serving to maintain the negative affect because individuals continually are reminded of negative thoughts and events (Nolen-Hoeksema, Morrow, & Fredrickson, 1993; Wood et al., 1990). Others have hypothesized that rumination is an indicator or even a side effect of depression, but in itself does not have a strong impact on the clinical presentation in depression (Smets, Luyckx, Wessel, & Raes, 2012) or that it may even be adaptive and provide a means of self-reflection for problem solving (Andrews & Thomson, 2009; Watkins & Moulds, 2005).

Presumably, when negative affect remits, cognitive difficulties should be alleviated. To examine this possibility, research methodology has included positive and negative mood induction strategies to examine performance on neuropsychological tasks. Indeed, depressive mood induction negatively affects reasoning abilities (Radenhausen & Anker, 1988).

Conversely, positive mood induction has been shown to decrease nonverbal reasoning performance differences between depressed and non-depressed samples (Raps, Reinhard, & Seligman, 1980). Positive mood induction is proposed to tax central executive resources in solving logic and reasoning problems, but facilitate performance on problems requiring creative and abstract thinking (Isen, 1987; Oaksford, Morris, Grainger, & Williams, 1996). One method of mood induction involves watching films with positive or negative affective content, then assessing whether this manipulation impacts task performance. For example, both positive and negative mood induction resulted in suppression of reasoning skills on a real-world logic test (Oaksford et al., 1996). An alternative to mood induction via cinematography is a rumination/distraction task that has been shown to temporarily increase feelings of despondency (Watkins & Teasdale, 2001). In a study including dysphoric and non-dysphoric undergraduate students, Stroop interference was significantly higher when participants were exposed to the rumination task (Philippot & Brutoux, 2008). One interpretation of these findings was that rumination, rather than being a direct consequence of depressive affect, causes executive functioning deficits, depletes cognitive resources, and thereby contributes to the depressive experience (Philippot & Brutoux, 2008).

Current Study

This study focused on whether rumination induction increased cognitive impairment on selected subtests of the Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV; Wechsler, 2008). Studies using previous versions of the WAIS found that psychiatric patients had lower IQ scores than normative samples, with depression most strongly correlated with deficits in working memory, processing speed skills (Boone, 1992; Micco et al., 2009; Stordal et

al., 2004), and nonverbal reasoning skills (Kaufman & Lichtenberger, 2006; Mandelli et al., 2006; Sackeim et al., 1992). While these deficits are well-documented in depressed patients, the mechanisms by which these deficiencies occur remain unclear. Processing efficiency theory suggests depressed individuals are vulnerable to having cognitive resources depleted by negative affect and rumination (Nolen-Hoeksema & Hilt, 2009), a process that would negatively affect task performance. The primary aim of this study was to further explore the impact of rumination on cognitive task performance among healthy younger adults. Specifically, following rumination manipulation, participants were administered time-pressured WAIS-IV subtests that might be most sensitive to interference from rumination. These tasks included Block Design and Visual Puzzles (Gorlyn et al., 2006; Groth-Marnat, 2009; Naismith et al., 2003), and working memory tasks including Digit Span, Letter-Number Sequencing, and Arithmetic (Fossati et al., 1999; Harvey et al., 2004; Moritz et al., 2002; Ravnkilde et al., 2002). The Letter-Number Sequencing subtest incorporates aspects of the Digit Span backwards subtest, requiring rehearsal to maintain the stimuli and mental manipulation to correctly respond. Similarly, Arithmetic requires both rehearsal and active problem solving to provide the correct answer for verbally presented mathematical problems. These tasks require effortful processing, which hypothetically should be more difficult for participants undergoing rumination induction.

Within the processing speed domain, good performance requires processing speed abilities as well as reasoning and motor control skills (Groth-Marnat, 2009; Kaufman & Lichtenberger, 2006). Depressed patients generally have slower processing speed on various neuropsychological tests (Hammar, Lund, & Hugdahl, 2003). The Symbol Search subtest of the WAIS-IV is a visual search task requiring brief cognitive maintenance of two target geometric shapes. This subtest requires planning abilities (Kaufman & Lichtenberger, 2006), but its

primary purpose is to assess rapid stimulus processing (Groth-Marnat, 2009). The Coding subtest might represent a particularly difficult task for depressed individuals because it requires significant processing efficiency and psychomotor speed (Kaufman & Lichtenberger, 2006; Ravnkilde et al., 2002). This subtest is less stable than others within the WAIS-IV battery (e.g., Vocabulary) and more sensitive to cognitive dysfunction (Groth-Marnat, 2009). Previous research supports the hypothesis that participants who undergo rumination, highly associated with depression (Nolen-Hoeksema & Holy, 2009), will experience significantly greater cognitive interference in the form of poorer performance on WAIS-IV subtests assessing Perceptual Reasoning, Working Memory, and Processing Speed. Accordingly, the primary objective was to elucidate the degree that cognitive performance deficits in depressed individuals was accounted for by the process of rumination frequently observed in this population. Because ADHD, as well as test, math, and general trait anxiety have been associated with cognitive performance deficits in previous research (Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lonnqvist, 2008; Dyck & Piek, 2012; Hopko et al., 1998, 2003, 2006; Mäntylä, Still, Gullberg, & Del Missier, F., 2012; Torralva, Gleichgerricht, Lischinsky, Roca, & Manes, 2012; Vytal, Cornwell, Arkin, & Grillon, 2012), these variables were controlled for in statistical analyses.

Hypotheses

1. Participants in the rumination condition would perform significantly poorer than those in the control condition on tasks within the Perceptual Reasoning Index, particularly on the effortful *Block Design* subtest.

2. Participants in the rumination condition would perform significantly poorer than those in the control condition on subtests within the Working Memory Index, specifically on tasks requiring significant mental manipulation: *Arithmetic* and *Letter-Number Sequencing*.
3. Participants in the rumination condition would perform significantly poorer than those in the control condition on all tasks in the Processing Speed domain, particularly on the *Coding* subtest.

Chapter 2

Method

Participants

Participants were recruited from undergraduate introductory psychology classes at a large Southeastern university. They were assessed for depression based on the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) and the Depression and Dysthymia modules of the Anxiety Disorders Interview Schedule (ADIS-IV; Brown, DiNardo, & Barlow, 1994). To be included, participants had to be at least 18 years of age and have minimal symptoms of depression ($BDI-II \leq 14$); no current or past diagnosis of depression (ADIS-IV); no current cognitive impairment ($MMSE \geq 25$); no current anti-depressant, anti-anxiety, or stimulant medication use; and no current engagement in psychotherapy. Of the 358 participants who signed up for the experiment, 114 were excluded immediately due to not meeting study criteria. Participants provided informed consent to participate, and the university Institutional Review Board approved the protocol. Students received research credit for their participation.

The sample included 78 participants: 43 females (56%) and 34 males (44%), with an average age of 19.0 years ($SD = 1.39$) and education of 12.3 years ($SD = 0.70$). Ethnic distribution of participants was as follows: 87% Caucasian ($n = 67$), 5% African-American ($n = 4$), 3% Asian-American ($n = 2$), 1% Native American ($n = 1$), 3% Mixed Race/Ethnicity ($n = 2$), and 1% Other ($n = 1$). Marital status included 64% single ($n = 49$), 35% dating ($n = 27$), and 1% married/partnered ($n = 1$).

As presented in Table 1, participants were randomly assigned to receive either a rumination-inducing visualization exercise ($n = 39$) or distraction task ($n = 38$) that served as a control condition. Groups did not differ as a function of age [$F(1,75) = 0.43, p = .51$], gender [$X^2(1) = 0.17, p = 0.68$], ethnicity [$X^2(5) = 3.00, p = 0.70$], relationship status [$X^2(2) = 1.83, p = 0.40$], sexual orientation [$X^2(3) = 3.04, p = 0.39$], education level [$X^2(3) = 0.47, p = 0.93$], GPA [$X^2(5) = 5.73, p = 0.33$], family income [$X^2(5) = 4.98, p = 0.42$], living situation [$X^2(5) = 5.43, p = 0.37$], or pre-test anxiety [$X^2(2) = 3.36, p = 0.19$] and depression [$X^2(1) = 0.19, p = 0.67$]. Religious orientation differed by treatment condition, with more individuals in the rumination condition identifying as Catholic ($n = 8$) relative to the distraction condition ($n = 1$) [$X^2(3) = 9.45, p = 0.02$]. Research suggests that denomination type is less likely to contribute to differences in psychological well-being or treatment response than is subjects' degree of religiosity (e.g. strongly religious, not at all religious) (Armento, McNulty & Hopko, 2012; Williams, Larson, Buckler, Heckmann & Pyle, 1991). To confirm this and to ensure that no significant group differences resulted, religious denomination was controlled for in additional analyses. As illustrated in Table 2, groups also did not differ on self-report measures administered pre-experimentally that assessed depression, rumination, general anxiety, math anxiety, test anxiety, and ADHD symptoms.

Assessment Measures

Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV; Brown, DiNardo, & Barlow, 1994). The ADIS-IV is a semi-structured interview that comprehensively assesses all anxiety and mood disorders. For this study, only the major depression and dysthymia modules were administered. The ADIS-IV has very good reliability and validity, as indicated by high

associations with other measures of anxiety and depression (Brown, Campbell, Lehman, Grisham, & Mancill, 2001).

Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996). The BDI-II is a self-report measure that assesses depression severity over the past two weeks and includes 21 items rated on a 4-point Likert scale (range = 0–63). Sample items include degree of “sadness” and “loss of pleasure.” The scale has excellent internal consistency ($\alpha = 0.92$) and test-retest reliability (one-week: $r = .93$; Beck, Steer, Ball, & Ranieri, 1996), and the instrument has excellent psychometric properties among depressed younger and older adults (Nezu, Ronan, Meadows, & McClure, 2000). In the present study, internal consistency was acceptable ($\alpha = .72$).

Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991). The RRS is part of the Response Style Questionnaire and used to assess ruminative responses to depressed mood, with higher scores indicating more rumination (range = 22–88). The RRS consists of 22 items on a Likert-type scale, with values ranging from 1 (almost never) to 4 (almost always). Items such as “go away by yourself and think about why you feel this way” or “try to understand yourself by focusing on your depressed feelings” are used to assess ruminative coping responses. Internal consistency of the RRS is very good ($\alpha = .90$; Nolen-Hoeksema & Morrow, 1991), including the present study ($\alpha = .91$).

Trait subscale of the State-Trait Anxiety Inventory (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The Trait subscale of the STAI was used to assess chronic symptoms of anxiety, with higher scores indicating greater anxiety (range = 20–80). The STAI-T consists of 20 items on a Likert scale, with values ranging from 1 (not at all) to 4 (very much so). Items such as “I worry too much over something that really doesn’t matter” or “I feel nervous or

restless” assess trait anxiety. The STAI-T has high internal consistency ($\alpha = .88-.92$; Spielberger, Gorsuch, & Lushene, 1970), which was evident in the present study ($\alpha = .88$).

Test Anxiety Inventory (TAI; Spielberger, Gonzalez, Taylor, Anton, Algaze, Ross, & Westberry, 1980). The TAI is used to assess symptoms of anxiety that occur before, during, and after examinations (range = 20-80). The TAI contains 20 items on a Likert scale, with values ranging from 1 (almost never) to 4 (almost always). This questionnaire includes items such as “Even when I’m well-prepared for a test, I feel very nervous about it” or “During tests, I feel very tense.” The internal consistency of the TAI is excellent ($\alpha = .95$; Szafranski, Barrera, & Norton, 2012). In the present study, internal consistency was similarly high ($\alpha = .93$).

The Abbreviated Math Anxiety Scale (AMAS; Hopko, Mahadevan, Bare, & Hunt, 2003) is used to assess anxiety due to engagement in numerical tasks, with higher scores corresponding to greater anxiety. The AMAS is a 9-item measure using a Likert scale, with values ranging from 1 (low anxiety) to 5 (high anxiety). This instrument consists of two factors, learning-math anxiety (LMA) and math-evaluation anxiety (MEA). The internal consistency of the AMAS is excellent ($\alpha = .90$), as is the internal consistency for the LMA ($\alpha = .85$) and the MEA factors ($\alpha = .88$) (Hopko, Mahadevan et al., 2003). In the present study, internal consistency of this scale was acceptable ($\alpha = .78$).

The Conners’ Adult ADHD Rating Scale – Short Form (CAARS-S; Conners, Erhardt, & Sparrow, 1999) is used to assess inattention and hyperactivity symptoms, with higher scores indicating increased attention problems (range = 0-78). The CAARS-S includes 26 items on a Likert scale, with values ranging from 0 (Not at all, or never) to 3 (Very much, very frequently). This questionnaire includes items assessing inattention such as “It’s hard for me to keep track of several things at once,” and items assessing hyperactivity such as “I feel restless even if I am

sitting still.” The internal consistency of the four factors of the CAARS-S is very good ($\alpha = .86 - .92$) (Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999). Internal consistency of this scale in the present study was good ($\alpha = .79$).

Rumination Induction Task

Participants were randomly assigned to either the rumination induction or distraction condition. The study followed the same method used in prior studies (Watkins & Teasdale, 2001; Philippot & Brutox, 2008). All participants were given a list of 45 written items and asked to focus on and imagine each item individually (See Appendix A). In the rumination condition, they received instructions to think about the “causes, meanings, and consequences of...” a series of self-reflection statements, such as “Think about your character and who you strive to be” and “Think about why you react the way you do.” In the distraction condition, participants were instructed to imagine a set of vivid, but emotionally neutral, scenarios, such as “Think about and picture a full moon on a clear night” and “Think about two birds sitting on a tree branch.” This condition was designed as a control in that it has not been shown to induce ruminative thought or alter mood state, but controls for the methodology of completing a visualization task. Completion of either the rumination or distraction procedure took approximately 8 minutes.

Procedure

Participants were randomly assigned to receive either the rumination or distraction condition. After providing demographic information and informed consent, participants provided a Likert-scale rating of their current level of depressed and anxious mood on a scale of 1-10.

Participants then received instructions on how to self-administer the rumination/distraction task, which they continued for 8 minutes. Following this task, participants completed selected subtests of the WAIS-IV. From the Perceptual Reasoning Index, Block Design and Visual Puzzles were administered; from the Working Memory Index, Digit Span, Arithmetic, and Letter-Number Sequencing were used; and from the Processing Speed Index, Symbol Search, Coding, and Cancellation were administered. The order of subtest presentation was counterbalanced to prevent order effects. These subtests were chosen because they are most likely to require effortful cognitive processing, which has been shown to be affected in individuals with depression. Following each subtest, another briefer (2-minute) manipulation occurred, followed by the next WAIS-IV subtest. Each participant continued this process until all eight cognitive tasks were completed. After completing the WAIS-IV subtests, participants again were asked to provide the two Likert-scale ratings, and participants in all conditions received a brief version of the distraction task (5 minutes) to reduce any existing rumination or negative affect. All participants were debriefed, which involved an explanation of the purpose of the study as well as referrals for any desired mental health support services.

Chapter 3

Results

Bivariate Correlations

Descriptive data and Pearson Product-Moment Correlations among all study self-report measures are presented in Table 2. Significant correlations were noted between depression (BDI-II), ADHD symptoms (CAARS), rumination (RRS), trait anxiety (STAI-T), and test anxiety (TAI). Indeed, all correlations were statistically significant with the exception of the relationship between math anxiety and depression, ADHD symptoms, and rumination. Participants' pre-test self-ratings of anxiety and depression significantly correlated with self-reported depression, rumination, trait anxiety and ADHD symptoms and pre-test depression ratings also correlated with test anxiety, mathematics anxiety, and pre-test anxiety ratings.

WAIS-IV Performance

Descriptive data collapsed across all participants, as well as separately as a function of experimental condition, are presented in Table 3. All between-group differences on WAIS-IV indices and individual subtests were statistically assessed using one-way ANOVAs. Statistical testing revealed significantly stronger performance on the *Symbol Search* subtest by individuals in the Distraction condition relative to those in the Rumination condition [$F(1,76) = 4.03, p < .05$]. Participants in the Distraction condition also performed more strongly than those in the

Rumination condition on the Processing Speed Index [$F(1,76) = 4.03, p < .05$]. No other significant main effects were identified for WAIS-IV dependent variables.¹

As presented in Table 4, there were several notable correlations among self-report measures and WAIS-IV performance variables. Participants' ratings of pre-test anxiety were significantly negatively correlated with scores on the Processing Speed Index and performance on the Coding subtest, and ratings of pre-test depression were significantly negatively correlated with scores on this subtest. In addition, Symbol Search subtests scores were significantly negatively correlated with test anxiety. Also, math anxiety was significantly negatively correlated with performance on the Arithmetic subtest. These correlations suggested that regardless of the experimental manipulation, there was an association between increased pre-experimental anxiety or depression and poorer performance on processing speed tasks, and those individuals who endorsed higher math anxiety were more likely to have difficulty on the Arithmetic subtest.

¹ Due to statistical differences in the prevalence of religion/denomination between groups, additional post hoc analyses were conducted. Data analyses revealed no significant findings between groups when including religious denomination as a covariate.

Chapter 4

Discussion

The lifetime prevalence rate of depression (16%; NCS-R; Kessler et al., 2003) and its commensurate rate in college students (15-20%; American College Health Association, 2007) necessitate understanding of both the causes and effects of this disorder. Among a variety of psychosocial consequences, depression in college students is linked to maladaptive thinking patterns (Abramson, Matalsky, & Alloy, 1989; Hollon & Kendall, 1980; Rude, Gortner, & Pennebaker, 2004), and lowered academic performance and retention (Fazio & Palm, 1998; Gallagher, 2007; Pritchard & Wilson, 2003). Areas of cognitive deficits in individuals with depression include reasoning, memory, attention, and visual-spatial ability (Baune et al., 2010; Blanchette & Leese, 2011; Naismith et al., 2003; Reischies & Neu, 2000), and these deficits are positively correlated with depression severity (Austin et al., 1992; Basso & Bornstein, 1999; Karabekiroglu et al., 2010; Mandelli et al., 2006).

Studies of the impact of depression and anxiety on intelligence task performance revealed that negative affect is inversely related to IQ and reaction time (Iverson, Turner, & Green, 1999; Mortensen, Sorensen, Jensen, Reinisch, & Mednick, 2005; Pernicano, 1986; Sackeim et al., 1992; Stordal, et al., 2004). These findings support the hypothesis that such performance deficits might directly be caused by negative affect. This hypothesis theoretically is supported by Eysenck and Calvo's (1992) processing efficiency theory and by neuropsychological research (Jones, Siegle, Muelly, Haggerty, & Ghinassi, 2010; Lyche, Jonassen, Stiles, Ulleberg, & Landro, 2011). Researchers also have demonstrated that such negative effects on reasoning and

executive functioning abilities can be reproduced using a variety of mood induction tasks (Oaksford et al., 1996; Radenhausen & Anker, 1988; Raps, Reinhard, & Seligman, 1980; Watkins & Teasdale, 2001).

The deleterious effects of depression also have been demonstrated previously on the WAIS (Wechsler, 1981; Wechsler, 1997), including findings that working memory and processing speed domains were most affected by depression symptomology (Boone, 1992; Micco et al., 2009; Stordal et al., 2004), while some studies found similar patterns in nonverbal reasoning skills (Kaufman & Lichtenberger, 2006; Mandelli et al., 2006; Sackeim et al., 1992). The current study elaborated on this research by utilizing the WAIS-IV (Wechsler, 2008) and focusing on specific intellectual domains perceived as most likely affected by cognitive rumination associated with negative mood states. Through the use of a rumination induction task, this study sought to demonstrate that rumination in healthy college students would create a pattern of cognitive deficits similar to those exhibited among individuals with depression.

Results of the study revealed that individuals randomized to the rumination condition performed more poorly than those in the control condition on the *Symbol Search* subtest, as well as on the Processing Speed Index. Although limited support in the context of other null findings, these results are somewhat supportive of the processing efficiency theory (Eysenck & Calvo, 1992) suggesting that when individuals have added cognitive burden, such as increased ruminative thoughts, their ability to quickly and accurately process information may be compromised, resulting in less efficient methods of completing cognitive tasks.

Additionally, this study demonstrated several correlations that are consistent with existing research on cognitive deficits in depression and anxiety. As expected, for example, performance on the *Arithmetic* subtest was negatively correlated with math anxiety, irrespective

of experimental condition. In addition, pre-test anxiety was negatively correlated with performance on the Processing Speed Index. More specifically, *Symbol Search* scores were negatively related to test anxiety, while *Coding* performance was negatively correlated with pre-test anxiety and depression. Accordingly, these results provide some support for previous research demonstrating that processing speed is one area of intelligence most strongly affected by cognitive processes linked with depression, which is due in part to slower reaction times frequently found in individuals with cognitive deficits (Iverson, Turner, & Green, 1999; Kaufman & Lichtenberger, 2006; Pernicano, 1986; Sackeim et al., 1992). Scores from this experiment showed a trend on all processing speed tasks towards worse performance by those in the rumination condition, with the difference reaching statistical significance on the *Symbol Search* task. This is arguably the simplest subtest within the domain, and it may be that the greatest difference was shown on this task because the effect was strongest on simple reaction time – creating the greatest between-group difference on the task which most taxes this skill. In this study, the rumination induction visualization task mimicked this process, although its effects were limited to the processing speed domain, without generalizing to the nonverbal reasoning and working memory domains.

Several factors likely contribute to this slightly narrowed finding, including the increased sensitivity of subtests in the processing speed domain to psychological effects, including depression. In addition, this experiment utilized an undergraduate sample, which contributed to a higher-than-average score distribution, especially on subtests in the nonverbal reasoning and working memory domains. Because of the stability of performance on verbal subtests of the WAIS-IV and their insensitivity to depression as found in previous studies, these tasks were not included in this study. Subsequent research could benefit from the inclusion of verbal tasks as a

means of controlling for IQ to further clarify the effect of the manipulation. It may be that in future research, a sample with greater power or increased range of score distribution would illuminate greater differences in not only the processing speed index, but the other two domains as well.

Several limitations of this study are worth addressing via future research. First, it is difficult to determine the extent to which the mood induction manipulation was successful in producing rumination. For example, analysis of the manipulation check revealed no significant difference in participants' pre- to post-test ratings of depression and a trend ($p < 0.1$) towards greater anxiety in participants' post-test ratings. One possible explanation discerned from direct observation of participants was that they varied widely in the amount of time spent focusing on items on the mood induction task. The mood induction task used in this study included the instruction to spend a minute or two on each item, but did not include further instruction in the event that participants were completing the task too quickly. While some moved through all items by the end of the initial presentation period, others had only proceeded through half of the items. It is not clear from this or previous studies whether the effects of this task vary based on the speed at which items are presented, but it is likely that when participants are more engaged and spend more time on each item, stronger effects of the manipulation and greater change in pre-/post-test ratings would be demonstrated. In addition, although the visualization manipulation caused a demonstrated difference between the experimental and control groups, the extent to which it caused rumination is unclear. It is possible that the mood-induction task affects cognition merely by increasing reflective thought, rather than creating depressive rumination, which nonetheless creates some disruption on cognitive tasks in healthy participants.

Future research could benefit from methodological development whereby the mood induction task is presented more systematically and consistently across participants. One potential alteration in the manipulation which would likely create increased negative affect in addition to rumination would be to play on the self-reflection created by the Watkins & Teasdale (2001) task by increasing the emotional intensity of individual items (ex. “Think about a time when you did something you later regretted,” “Think about the last time you were extremely worried”). By creating a mood-induction task which attempts to more strongly induce thought patterns more like those of depressed individuals, both the strength of the effect and the similarity to depressive rumination.

An additional direction for future research would be including clinical samples to further assess the impact of rumination on WAIS-IV performance. While the effects of depression have been shown in previous versions of this measure (Boone, 1992; Micco et al., 2009; Stordal et al., 2004), they have not been demonstrated on the WAIS-IV. Such studies will be useful toward further conceptualizing study findings to better understand how rumination contributes to cognitive deficits in clinically depressed individuals and to assess whether mood induction can exacerbate or reduce these deficiencies.

Further exploration of personality factors and symptom clusters contributing to cognitive deficits in depression is also warranted. For example, Nolen-Hoeksema, Wisco, and Lyubomirsky (2008) suggested that rumination induction is effective only in individuals with current negative affect/depressive symptomatology. It is also possible that certain personal factors (such as decreased attentional abilities, susceptibility to suggestion, etc.) increase or mitigate the disruption rumination can cause on cognitive tasks. Further examination of such

possible interactions could further explain the mechanism creating the effect demonstrated in the current study.

Further exploring the cognitive correlates of depression will significantly impact cognitive models of depression and anxiety and likely have strong clinical implications. Cognitive-behavioral research theorizes that emotions, cognition, and behavior comprise the major symptom clusters of depression, and of these, the cognitive symptoms of depression have been the least studied in modern clinical science (Beck, 1979; Beck, 2011; Gotlib & Joorman, 2010). This study contributes to our understanding of the impact of rumination on modern intelligence testing, as well as provides some limited support for the processing efficiency model.

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Appendix

Table 1.
Participant Characteristics as a Function of Treatment Condition.

Characteristic	Rumination condition (n = 39)	Distraction condition (n = 38)
Age	19.0 years (<i>SD</i> = 0.51)	19.0 years (<i>SD</i> = 0.49)
Gender		
Male	20 (51%)	14 (37%)
Female	19 (49%)	24 (63%)
Ethnicity/Race		
White/Caucasian	33 (85%)	34 (90%)
Black/African-American	3 (8%)	1 (3%)
Asian-American	1 (3%)	1 (3%)
Native American	0 (0%)	1 (3%)
Mixed Race/Ethnicity	1 (3%)	1 (3%)
Other	1 (3%)	1 (3%)
Relationship Status		
Single	27 (69%)	22 (58%)
Dating	12 (31%)	15 (40%)
Married/Partnered		1 (3%)
Sexual Orientation		
Heterosexual	35 (90%)	37 (97%)
Gay	1 (3%)	1 (3%)
Lesbian	1 (3%)	0 (0%)
Bisexual	2 (5%)	0 (0%)
Education Level	12.3 years (<i>SD</i> = 0.69)	12.4 years (<i>SD</i> = 0.71)
Grade Point Average		
1.0-1.5	1 (3%)	0 (0%)
1.5-2.0	1 (3%)	0 (0%)
2.0-2.5	2 (5%)	3 (8%)
2.5-3.0	5 (13%)	2 (5%)
3.0-3.5	10 (26%)	17 (45%)
3.5-4.0	20 (51%)	16 (42%)
Religion		
Catholic	8 (21%)	1 (3%)
Non-Catholic/Christian	24 (62%)	33 (87%)
Atheist/Agnostic	7 (18%)	3 (8%)
Other	0 (0%)	1 (3%)
Family Income		
Less than \$20,000	2 (5%)	2 (5%)
\$20,000-40,000	5 (13%)	7 (18%)
\$40,000-60,000	5 (13%)	5 (13%)
\$60,000-80,000	8 (21%)	7 (18%)
\$80,000-100,000	2 (5%)	7 (18%)
More than \$100,000	17 (44%)	10 (26%)

Table 1. Continued.

Characteristic	Rumination condition (n = 39)	Distraction condition (n = 38)
Living Situation		
Alone off campus	1 (3%)	4 (11%)
Alone on campus	4 (10%)	1 (3%)
One roommate	23 (59%)	20 (53%)
Two roommates	3 (8%)	4 (11%)
Three roommates	4 (10%)	7 (18%)
Four roommates	4 (10%)	2 (5%)
Pre-Test Anxiety Rating		
Not at all	9 (23%)	10 (26%)
Mildly	27 (69%)	20 (53%)
Moderately	3 (8%)	8 (21%)
Severely	0 (0%)	0 (0%)
Pre-Test Depression Rating		
Not at all	9 (23%)	10 (26%)
Mildly	27 (69%)	20 (53%)
Moderately	3 (7%)	8 (21%)
Severely	0 (0%)	0 (0%)

Table 2.
Correlations and Descriptive Data for Self-Report Instruments.

Instrument	1	2	3	4	5	6	7	8	<i>M</i>	<i>SD</i>
1. BDI-II	---	.48**	.54**	.69**	.31**	.22	.48**	.36**	4.36	3.35
2. CAARS		---	.47**	.49**	.39**	.18	.29*	.23*	18.9	7.37
3. RRS			---	.62**	.36**	.22	.50**	.34**	11.2	9.1
4. STAI				---	.44**	.40**	.64**	.40**	14.1	8.0
5. TAI					---	.56**	.17	.24*	16.4	11.5
6. AMAS						---	.09	.27*	16.5	4.1
7. Pre-Anx							---	.45*	2.5	1.4
8. Pre-Dep								---	1.5	0.9

Note. BDI-II = Beck Depression Inventory, 2nd Edition, CAARS = Conners' Adult AD/HD Rating Scale, RRS = Ruminative Response Scale, STAI = State-Trait Anxiety Inventory, State Subscale, TAI = Test Anxiety Inventory, AMAS = Abbreviated Math Anxiety Scale, Pre-Anx = Pre-test 10-point anxiety rating, Pre-Dep = Pre-test 10-point depression rating.

* Correlation significant at the 0.05 level.

** Correlation significant at the 0.01 level.

Table 3.
Descriptive Data for WAIS-IV Subtest Scaled Scores and Composite Index Scores.

Index/Subtest	Index Score <i>M (SD)</i>	Scaled Score <i>M (SD)</i>
Perceptual Reasoning Index	105.05 (12.68)	
Block Design		10.74 (2.88)
Visual Puzzles		10.95 (2.32)
Working Memory Index	108.28 (11.03)	
Digit Span		11.96 (2.51)
Arithmetic		11.04 (2.35)
Letter-Number Sequencing		11.29 (2.43)
Processing Speed Index	102.83 (12.21)	
Symbol Search		10.36 (2.57)
Coding		10.70 (2.59)
Cancellation		8.32 (2.32)
Index/Subtest by Condition	Index Score <i>M (SD)</i>	Scaled Score <i>M (SD)</i>
Perceptual Reasoning Index		
Rumination	105.44 (14.33)	
Distraction	104.66 (10.93)	
Block Design		
Rumination		10.74 (3.19)
Distraction		10.74 (2.58)
Visual Puzzles		
Rumination		11.05 (2.58)
Distraction		10.84 (2.07)
Working Memory Index		
Rumination	108.79 (10.55)	
Distraction	107.76 (11.60)	
Digit Span		
Rumination		11.68 (2.24)
Distraction		12.24 (2.75)
Arithmetic		
Rumination		11.46 (2.55)
Distraction		10.61 (2.07)
Letter-Number Sequencing		
Rumination		11.15 (2.18)
Distraction		11.42 (2.69)
Processing Speed Index		
Rumination	100.13 (8.90)	
Distraction	105.61 (14.47)	
Symbol Search		
Rumination		9.79 (1.89)
Distraction		10.95 (3.03)
Coding		
Rumination		10.31 (2.05)
Distraction		11.11 (3.01)
Cancellation		
Rumination		8.15 (2.43)
Distraction		8.50 (2.22)

Table 4.
Correlations Among Self-Report Instruments and WAIS-IV Performance Indices.

IQ Index/ Subtest	BDI-II	CAARS	RRS	STAI	TAI	AMAS	Pre-Anx	Pre-Dep
PRI	-.02	.00	.14	.12	-.17	-.14	.12	.16
WMI	.08	.07	.17	.07	.03	-.12	.16	.07
PSI	.05	.02	-.08	-.05	-.22	.01	-.29*	-.21
BD	-.05	.08	.14	.10	-.14	-.13	.06	.13
VP	.01	-.10	.05	.08	-.16	-.11	.15	.13
DS	.15	-.02	.07	.09	.09	.10	.15	-.07
AR	-.01	.15	.22	.03	-.03	-.31**	.10	.19
LN	.06	.04	.07	.00	-.02	.00	.02	-.07
SS	.00	-.11	-.07	-.04	-.23*	-.09	-.21	-.10
CO	.10	.15	-.05	-.04	-.16	.11	-.30**	-.26*
CA	.10	.11	-.08	.02	.01	.12	-.09	-.11

Note. BDI-II = Beck Depression Inventory, 2nd Edition, CAARS = Conners' Adult AD/HD Rating Scale, RRS = Ruminative Response Scale, STAI = State-Trait Anxiety Inventory, State Subscale, TAI = Test Anxiety Inventory, AMAS = Abbreviated Math Anxiety Scale, Pre-Anx = Pre-test 10-point anxiety rating, Pre-Dep = Pre-test 10-point depression rating.

PRI = Perceptual Reasoning Index, WMI = Working Memory Index, PSI = Processing Speed Index, BD = Block Design, VP = Visual Puzzles, DS = Digit Span, AR = Arithmetic, LN = Letter-Number Sequencing, SS = Symbol Search, CO = Coding, CA = Cancellation.

* Correlation significant at the 0.05 level.

** Correlation significant at the 0.01 level.

Vita

Kerry Margaret Cannity was born in Raleigh, N.C., to parents Richard and Marjorie Cannity. She has one younger brother, Jeffrey. She attended Mary P. Douglas Creative Arts and Science Magnet Elementary and Emma Conn Active Learning and Technology Magnet Elementary School. Following, she matriculated to John W. Ligon GT Magnet Middle School and continued to William G. Enloe High School, which is perennially ranked in Newsweek's Top 50 Schools and has been rated the top Magnet High School in the Nation by the Magnet Schools Association (2000). It was at Enloe High that Ms. Cannity excelled in her first psychology class and embarked on a course of study which would become both a passion and a lifelong pursuit of knowledge.

After graduation, Ms. Cannity attended the University of North Carolina at Chapel Hill, N.C., a school consistently ranked in the U.S. News and World Report's top universities. At the University of North Carolina, she completed Bachelor of Arts degrees in Psychology and Journalism and Mass Communication in May 2008, in addition to participating in music and club lacrosse. She also attended an international study abroad program at the University of Canterbury in Christchurch, New Zealand, which afforded her the chance to both travel and immerse herself in the educational opportunities and culture of the country.

Following college, she worked as a Resident Patient Assistant at a residential treatment facility for women with eating disorders and as a Neuropsychological Assistant and Psychological Technician at North Carolina Neuropsychiatry, assisting with psychological assessments. In 2011, Ms. Cannity accepted a position in the Clinical Psychology doctoral program at the University of Tennessee at Knoxville, T.N., to work with Derek R. Hopko, Ph.D.

Ms. Cannity graduated with a Masters of Arts degree in Psychology in December 2013. She is continuing her doctoral education at the University of Tennessee at Knoxville, T.N.