Differential Associations between Rumination and Intelligence Subtypes

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April 2, 2018

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Abstract

Rumination is a process of repetitive negative thoughts believed to maintain symptoms of depression. Mixed literature indicated a potentially unique association between rumination and intelligence masked by the frequent focus on depression. The present study extended previous research by controlling depression, examining ruminative subtypes (reflection and brooding), and intelligence subtypes (verbal and performance). Participants were 751 individual twins, 351 monozygotic and 400 dizygotic, recruited from the Colorado Longitudinal Twin Study. Primary data were collected at age 23. Rumination was measured by the Ruminative Response Scale's reflection and brooding subscales, and intelligence was measured using Raven's Advanced Progressive Matrices (RPM). Depression symptoms were measured by both the Center for Epidemiological Studies –Depression Scale, and the Diagnostic Interview Schedule-IV. Data collected at age 16 from the Wechsler Adult Intelligence Scale were used to evaluate verbal and performance IQ. Primary findings indicated that RPM had a significant positive association with reflection, whereas brooding had a negative and marginally significant association. After controlling for depression, although the association between reflection and RPM remained statistically significant and positive, the marginal negative association between brooding and RPM was not significant. Differences also emerged between reflection and brooding with intelligence types: verbal and performance. These results suggest brooding may not have a significant relationship with intelligence when controlling for shared variance with depression. The finding that subtypes of rumination have unique associations with IQ subtests suggests the need to look at rumination as a multifaceted construct in future research.

Key Words: Rumination, Reflection, Brooding, Intelligence, Depression

Differential Associations between Rumination and Intelligence Subtypes

Rumination is a pattern of self-focused repetitive negative oriented thoughts about the causes and consequences of one's distress (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Rumination has been used in past studies with depression to study associations with intelligence. These processes are often studied together due to rumination being a risk factor for depression. Rumination has been a predictor for depression severity (Just & Alloy, 1997) and length of depressive episodes (Nolen-Hoeksema, 1991). Frequently, studies of cognitive abilities use measures of depression rumination in addition to depression and largely indicate a negative association (Davis & Nolen-Hoeksema, 2000; Lyubomirsky & Nolen-Hoeksema, 1995; Philippot & Brutoux, 2006; Lyubomirsky et al., 2003). However, this negative relation may result from shared features with depression rather than cognitive features unique to rumination. Less is known about the independent effect of rumination separate from depression. This study aims to examine the broader effects of rumination on intelligence, controlling for depression. More specifically, we examine the relations of brooding and reflection rumination with full scale, verbal, and performance IQ, with and without controlling for depression.

Rumination and Intelligence

Much of the previous literature on rumination and intelligence has found a negative association. One study by Davis and Nolen-Hoeksema (2000) found that participants who endorsed one or more items on the RRS performed more poorly and made more errors on tasks measuring cognitive processes, specifically cognitive flexibility, than participants who did not endorse any items. Additionally, Lyubomirsky et al. (2003) showed that dysphoric students induced to ruminate showed impaired problem solving. However, much of this literature also utilized a measure of total rumination, as opposed to the individual subscales of brooding and

reflection. The subscales of the Ruminative Response Scale (RRS) — brooding rumination and reflection — were not an original part of the RRS, but resulted from removing overlap with depression inventories (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Contemporary research understands brooding as a pattern of thoughts regarding events and the negative consequences or causes (e.g. “Why do I have problems other people don’t have?”), whereas reflection is thought of as an analysis of emotions and thoughts of self (e.g. I analyze recent events to try to understand why I am depressed") (Verhaeghen, Aikman, & Joorman, 2014).

Despite this effort to clarify the effects of rumination from depression, one shortcoming of the previous literature was the frequent use of dysphoric individuals who ruminate and the lack of literature focusing on ruminators who are not depressed. Philippot and Brutoux (2006) conducted a study that included both dysphoric individuals and non-dysphoric individuals and proposed executive functions deficits, specifically for flexibility and inhibition, in depressed individuals may result from ruminative tendencies. However, ruminative tendencies only indicated a negative association with executive functions in dysphoric individuals, results were not significant for nondysphoric individuals (Philippot & Brutoux, 2006).

A subset of literature suggests that rumination may be beneficial. Rumination has been proposed to be an evolutionary response to complex problem solving (Andrews & Thomson, 2009). The Analytical Rumination (AR) hypothesis proposed that rumination facilitated by depression is an adaption for complex problem solving. Andrews and Thomson (2009) proposed that depression allows for enhanced problem solving through rumination, arguing that rumination allows for a problem to be analyzed more thoroughly. This theory claimed that the impaired performance of depressed individuals in lab studies is most likely due to ruminating on the problem which triggered the depressive episode rather than the lab tasks at hand. The authors

found a wealth of support for their theories (garnering support in neuroanatomy, genetics, and pharmacology) as well as some inconsistencies in the body of literature (Andrews & Thomson, 2009). One of these discrepancies was that depressed individuals sometimes outperformed their non-depressed counterparts. Further, the AR hypothesis proposed that performance may be negatively impacted due to increased working memory load (Andrews & Thomson, 2009). This hypothesis proposed that because more cognitive resources are being used by depression and ruminative thoughts, the amount of information in working memory increases and makes performance on tasks more difficult (Andrews & Thomson, 2009).

Building on this study, Penney, Miedema, and Mazmanian (2015) proposed that anxiety may have been an evolutionary adaption based upon the notion that over-preparing for a threat would not have the same potentially fatal evolutionary outcome as under-preparing for a threat. Rumination was also studied due to it being the primary cognitive process of major depressive disorder (Nolen-Hoeksema, 2000, quoted in Penney et al., 2015). This study found when controlling negative state affect and test anxiety there was a positive association between rumination and verbal IQ; the authors suggested these findings may be affected by post-event processing in ruminators. The authors proposed that verbal intelligence may be associated with more detailed memory leading to more intense rumination and worry. These findings indicate that the cognitive risk factor, rumination, might not be associated with limited cognitive abilities, rather these negative implications on cognition might have resulted from shared variance between rumination and depression. In congruence with the AR hypothesis, this study theorized that it may be the symptoms of depression, rather than other processes (i.e. rumination), that lowers ability to perform on intelligence tests, but may not be indicative of lower intelligence.

The positive implications of this study show some support for evolutionary theories, like that of Andrews and Thomson (2009), which propose that rumination may have beneficial applications.

Ruminative Subtypes

There are many types of rumination, including anger rumination and worry rumination, this study will focus only on depression rumination due to its purported association with intelligence (Penney, Miedema, & Mazmanian, 2015; Davis & Nolen-Hoeksema, 2000) in addition to its concurrence with depression and intelligence (Beaujean, Parker, & Qiu, 2013; Sackeim et al., 1992). Brooding rumination was consistently shown to be significantly and positively related to longitudinal depression whereas reflection rumination was shown to be negatively associated with longitudinal depression (Treynor, Gonzalez, & Nolen-Hoeksem, 2003). In the present study, we examined the associations of both brooding and reflection to determine whether the differences in ruminative subtype may contribute to the mixed literature examining rumination and intelligence.

Intelligence Scales

It is possible that the inconsistency in the previous literature on rumination and intelligence may be due to the operationalization of intelligence. Although the literature on rumination and intelligence is limited, there is evidence that ruminators may score better on measures of verbal IQ than performance IQ (Penney et al., 2015). The Wechsler Adult Intelligence Scale (WAIS) measures performance IQ— which includes inductive, deductive reasoning, and response speed— in addition to verbal IQ—which measures general knowledge such as vocabulary and arithmetic (The Gale Group, Inc., 2008). The subscales that aggregate to performance IQ and verbal IQ can also be thought of in terms of fluid intelligence, which includes thinking adaptively with new information and recognizing patterns, in addition to

crystalized intelligence, which includes previous learned information (Cattell, 1963). The WAIS matrices subscale can be used as an indicator of fluid intelligence and the vocabulary subscale can be used as a measure of crystalized intelligence (Wang & Kaufman, 1993). However, not every study uses the WAIS to measure intelligence. For example, Lyubomirsky et al. (2003) used puzzle solving tasks as well as self-reported concentration on a taped lecture as indicators for problem solving ability. Another common measure of problem solving is the Means End Problem Solving task (MEPS), which differs from the WAIS in that it focuses on ultimate goal driven action (Watkins & Moulds, 2005). The Raven's Advanced Progressive Matrices (RPM), used in the current study as a nonverbal measure of intelligence, is one of the best measures of fluid intelligence (Carroll, 1993).

Even when verbal IQ is used as the measure of intelligence, findings are still inconsistent. Davis and Nolen-Hoeksema (2000) used the verbal IQ scale of the WAIS, in addition to another measure of verbal intelligence, and found no significant relation to rumination. However, this study is limited by its use of rumination induction, having a group of participants "ruminate" by focusing on their current feelings as opposed to distracting, rather than conducting a measure of rumination (Davis & Nolen-Hoeksema, 2000).

Penney et al. (2015) found that, with the inclusion of test anxiety and negative affect, verbal IQ was significantly and positively associated with a measure of total rumination. It is important to note that Penney et al. (2015) used the RRS -Brooding and Reflection created by Treynor et al. (2003). This study indicates that the use of the two-scale rumination measure (brooding and reflection) may be important when studying the independent association between rumination and IQ. Similarly, when Verhaeghen, Aikman, and Joorman (2014) conducted a study on the effects of reflection rumination and brooding rumination on creativity and

dysphoria, they found a positive relationship between reflection and creativity. Reflection was not significantly related to dysphoria (Burwell & Shirk, 2007), and when brooding was analyzed separately from reflection a positive relationship with creativity emerged (Verhaeghen, Aikman, & Joorman, 2014). It is logical to hypothesize that the presence of depression or brooding rumination, that is significantly related to depression, (Treynor, Gonzalez, & Nolen-Hoeksem, 2003) might explain the difference in associations (Verhaeghen, Aikman, & Joorman, 2014). We theorized that once depression is controlled, there would be a significant positive association between verbal IQ and reflection.

The Present Study

In this study, we aimed to clarify the association of rumination with intelligence. Given the inconsistency of findings in previous literature (Penney, Miedema, & Mazmanian, 2015; Davis & Nolen-Hoeksema, 2000), we theorized that by focusing on multiple ruminative subtypes (i.e., brooding or reflection) and IQ scales for intelligence (i.e., verbal and or performance IQ) — which have shown to be significantly different from their more general constructs—the associations between rumination and intelligence might become more clear. Additionally, we ran analyses with and without controlling for depression to see if variance shared between rumination and depression might explain the negative association between rumination and IQ. Analysis of rumination and IQ controlling for depression would provide further insight into the independent effects of rumination alone on IQ.

Our first aim was to replicate prior work examining the association between rumination and IQ, as well as depression and IQ. We predicted that rumination and IQ would have a negative association when we did not account for depression (e.g., Nolen-Hoeksema, 2000), and that depression would be negatively associated with IQ (e.g., Crawford, 1987). Given the

literature that depression has been shown to be related to lower performance IQ (Sackeim et al., 1992) and lower vocabulary sub-scores (Crawford et al., 1987), by separately analyzing and controlling for the effects of depression, the effects of rumination alone on intelligence would be clarified.

Next, we extended prior work by examining the independent association between rumination and IQ after controlling for depression symptoms. We hypothesized that after accounting for depression, the association between rumination and IQ would be positive. As some research suggests that the association between rumination and IQ may be specific to verbal IQ (Penney et al, 2015), we decided to examine verbal and performance IQ separately rather than as an aggregate measure of IQ. After accounting for depression, we predicted separating IQ by scale would reveal a positive association between verbal IQ and rumination. Although previous research has indicated that depression is related to lower performance IQ (Sackeim et al., 1992), there is little evidence to indicate that rumination is associated with performance IQ. Thus, we expected a negative association between depression and performance IQ and no association between rumination and performance IQ.

Method

Participants

Participants were twins in the Colorado Longitudinal Twin Study (LTS), which focuses on behavioral, emotional and cognitive development of twins. A sample of 751 individual twins (350 men and 401 women), 351 from monozygotic pairs and 400 from same-sex dizygotic pairs (some individuals' co-twins did not participate, accounting for the odd *n*s), completed a longitudinal study through the Center for Antisocial Drug Dependence (CADD) at the University of Colorado and a separate study of executive functions and self-regulation (for additional

information, see Rhea, Gross, Haberstick, & Corley, 2006, 2013). Participants completed measures of depression, intelligence, and rumination at approximately age 23 (*M* = 22.8, SD = 1.27), as well as measures of intelligence at age 16 (*M* = 16.52, *SD* = 0.75). This sample was 92.4% white, with 5.2% of participants being multiracial, 1.2% not reported, .9% American Indians, and .3% Pacific Islander. All research protocols were approved by the Institutional Review Board at the University of Colorado Boulder.

Measures and General Procedure

The Diagnostic Interview depression symptoms and diagnoses were collected via phone interview as a part of the CADD study. Measures of rumination and IQ were collected as a part of a larger battery in the laboratory as a part of the self-regulation and executive functions study.

Rumination. Rumination was measured using the 10-item version of the Ruminative Response Scale (RRS; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). The RRS measures the frequency of participants' self-focused past or presently oriented thoughts when they "feel down, sad, or depressed" (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Questions such as "I think, why do I always react this way?" (Treynor, Gonzalez, & Nolen-Hoeksema, 2003) are ranked from 1 (*almost never*) to 4 (*almost always).* The 10-item modified version of the RRS excludes questions in the original RRS that overlapped with depression symptoms. The modified RRS consists of two subscales: brooding (RRS-B), which focuses on passive negative self-thought, and reflection (RRS-R), which focuses on active analysis of negative emotions (Burwell & Shirk 2007). Previous literature has demonstrated the reliability of this scale (Parola et al., 2017), for the brooding (α = .832) and reflection (α = .744) scales.

Depression symptoms. Depression symptoms were assessed using two different measures. The Center for Epidemiological Studies –Depression scale (CESD; Radloff, 1977)

consists of 20 questions about the frequency of depression symptoms in the past week, such as "I could not 'get going'" or "I enjoyed life." These questions were rated by frequency of a symptom from 1: *rarely or none of the time (less than one day)* to 4: *most or all of the time (5-7 days*).

The second measure was the Diagnostic Interview Schedule-IV (DIS-IV). This fully structured clinical interview was used to assess for lifetime symptoms and diagnoses of the major disorders in the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-4; American Psychiatric Association, 1994). We created a symptom count measure of the symptoms and diagnoses endorsed on the DIS-IV, in which no symptoms were scored as zero, some symptoms but no diagnosis was scored as one, and a diagnosis of depression was scored as a two. Scoring with these parameters was done to create a distribution with the least biased parameter estimates (Derks, Dolan, & Boomsma, 2004).

Intelligence. At approximately age 23, twins completed a short form of the Raven's Advanced Progressive Matrices (RPM; Raven, 1976). This form contained 18 items from the full 35-item multiple choice questionnaire and measures nonverbal fluid intelligence. An example of an RPM problem might consist of a geometric analogy puzzle with a missing piece, with eight options. Participants had 20 minutes to complete as many of the 18 items as possible, and scores were the proportion of correct answers (out of 20; split-half reliability = .78).

Intelligence at age 16 was measured using the Wechsler Adult Intelligence Scale III (Wechsler, 1997). This measure was used to assess verbal intelligence in addition to performance intelligence. The eleven subtests of the WAIS were vocabulary, similarities, arithmetic, digit span, information, comprehension, picture completion, digit symbol, block design, picture arrangement, and object assembly (Friedman et al., 2008). Reliability (internal consistency)

estimates reported by Weschler (1997) were .97 for the verbal IQ composite and .93 for the performance IQ composite.

Statistical Analysis

After visually inspecting the data for univariate outliers, we used a square root transformation of the CESD scale to improve normality. Descriptive statistics for continuous variables are shown in Table 1. All models were run in Mplus 7.4 (Muthén & Muthén, 1998-2015). The means and variance-adjusted weighted least squares estimation method, which uses pairwise deletion for participants with missing data on one or more measures, was used for the models that included the ordinal depression measure. Robust maximum likelihood estimation, which treats missing data as missing at random and uses all available data to compute parameter estimates, was used for all other models. Participants were twin pairs, so all analyses used the Mplus TYPE=COMPLEX option to obtain chi-square statistics and standard errors corrected for family nonindependence. An alpha level of .05 was used for all analyses.

Results

Preliminary Analyses

Zero order correlations for all variables, separated by sex, are presented in Table 2. We examined the correlations separately by sex due to well documented effects of sex on rumination, which indicate women score higher than men (Johnson & Whisman, 2013). Results indicated that the CESD was significantly associated with total rumination for both men (r = .48, p < 0.001) and women (r = .47, p < 0.001). Brooding had a stronger association with CESD scores (r = .50, p < 0.001; r = .52, p < 0.001) than did reflection (r = .37, p < 0.001; r = .32, p < 0.001) for both men and women, respectively. Brooding was not significantly related to IQ in men (r = –.01, p = 0.899) or women (r = .03, p = 0.561), whereas reflection showed a significant

association with IQ in women (r = .16, p = 0.001) but not men (r = .07, p = 0.258). Brooding was not significantly associated with verbal or performance IQ; however, reflection was significantly associated with both verbal (r = .25, p < 0.001) and performance IQ (r = .13, p = 0.015) for women, and verbal IQ for men (r = .18, p = 0.001). The correlation between CESD scores and performance IQ was significant for women (r = –.14, p = 0.037) but not for men (r = –.04, p = 0.547) while CESD and verbal IQ was not significantly associated with women (r = –.07, p = 0.223) or men (r = –.04, p = 0.547).

Due to the incongruence of findings on rumination in previous studies (Nolen-Hoeksema & Daivis, 2000; Penney et al., 2015) and differences in associations between ruminative subtypes and depression (Treynor, Gonzalez, & Nolen-Hoeksem, 2003), we decided to keep subtypes of rumination separate in our study. A full scale measure of IQ was also included due to its frequent appearance in previous studies (Davis & Nolen-Hoeksema, 2000; Lyubomirsky & Nolen-Hoeksema, 1993). Models were run using measures of rumination and depression both separately and together to examine their associations with IQ. We then examined whether the associations between rumination, depression, and IQ differed when performance compared to verbal IQ was used as the independent variable. Due to the similarities between sexes in preliminary findings, analysis was collapsed over sex in the following and used as a covariate in addition to age.

Association between total rumination and IQ. We predicted that rumination and IQ would be negatively associated when we do not account for depression. To test this hypothesis, we conducted a regression analysis with RPM as the independent variable and the total RRS score as the dependent variable. As visualized in Table 3, total rumination had a significant and positive association with RPM (β = .08, p = .029). We found sex was not significantly associated

with IQ (β = .04, *p* = .417); older individuals had lower IQ scores (β = —.13, *p* = .003), but inclusion of age did not change the significance of these findings.

Association between ruminative subtypes and IQ. With the inclusion of ruminative subtype in a path analysis regression model where RPM was the independent variable and both ruminative subscales (brooding and reflection) score were the dependent variables, we found a marginally significant negative association between brooding and RPM (β = —.08, *p* = .081), and a significant positive association between reflection and RPM (β = .17, *p* < .001). This pattern implies that the association between RPM and RRS differs across subtypes of rumination. These findings can be found on Table 3. Results indicate age (β = —.13, *p* = .003), but not sex (β = .03, *p* = .435), was a significant covariate. Older individuals have lower IQ scores on the RPM than younger individuals. A chi-square difference test was conducted between the association of IQ and reflection and the association of IQ and brooding, $\Delta\chi 2$ (1) = 9.86, *p* = .002. This indicates that we were unable to constrain the association between IQ and reflection to be equal to the association between IQ and brooding.

Association between depression and IQ. To test the hypothesis that depression would be negatively associated with IQ we conducted a regression analysis twice: first with the CESD as a continuous measure of depression and then with the DIS-IV as an ordinal measure of depression. Results indicated a negative association between the CESD and IQ (β = —.12, *p* = .001). When we used the DIS-IV as the measure of depression the association between depression and IQ was not significant (β = —.03, *p* = .319). The CESD and DIS-IV, respectively, were not significantly associated with sex (β = .02 , *p* = .697; β = .02 , *p* = .649) but were negatively associated with age (β = —.12, *p* = .007; β = —.13, *p* = .004).

Association between rumination and IQ controlling for depression. We used multiple regression to test our hypothesis that rumination would be positively associated with RPM after controlling for our continuous measure of depression symptoms (CESD). The other measure of depression included in this study, the DIS-IV, was excluded from depression analysis due less information in the categorical scoring of no symptoms, some symptoms but no diagnosis, or a diagnosis of depression. The previously positive association between RPM and total rumination ($\beta = .08$, $p = .029$) became stronger after controlling for CESD scores ($\beta = .18$, $p < .001$). This indicates that higher levels of rumination are more strongly associated with higher IQ scores after controlling for depression. The significant negative association between RPM and CESD noted previously ($\beta = —.12$, $p = .001$) also became stronger when controlling for total rumination ($\beta = —.21$, $p < .001$). This indicates that higher levels of depression are more strongly associated with lower IQ scores when controlling for total rumination.

A multiple regression, shown in Table 4, was also used to see if these associations between rumination and RPM differed with the inclusion of ruminative subtypes. Because prior work suggests that brooding rumination is significantly associated with depression but reflection is not (Treynor, Gonzalez, & Nolen-Hoeksema, 2003), we wanted to analyze the association of reflection independently from both brooding and depression. The dependent variable of the first model was RPM and the independent variables were reflection and depression. Results indicated a significant and positive association between reflection and RPM when controlling for depression ($\beta = .19$, $p < .001$) which supports the idea that rumination may not be associated with low IQ. We also used a separate model with brooding where the dependent variable was RPM and the independent variables were brooding and depression. Like reflection, brooding showed a significant and positive association with RPM after controlling CESD ($\beta = .11$, $p = .012$).

Another model was conducted to analyze the potential effects of shared variance between reflection and brooding when controlling depression in the relation of rumination and RPM. The independent variables of this model were brooding, rumination, and depression whereas the dependent variable was RPM. Controlling for CESD, RPM was significantly positively associated with reflection ($\beta = .18$, $p < .001$), which confirms the association in the model above. This model also indicated brooding was not significantly associated with RPM ($\beta = .01$, $p = .796$) after controlling for CESD. This indicates the two scales of the RRS may have differential effects on intelligence not only impacted by controlling depression but also when controlling the other scale. In this model, reflection rumination was significantly associated with higher IQ, although brooding scores were not significantly associated with IQ. This differs from the model above in which brooding had a significant positive association with IQ after controlling for CESD.

Differential associations between IQ type and rumination. Next, we examined whether the associations between rumination and IQ differed when we distinguished between verbal and performance IQ. We hypothesized that reflection rumination, but not brooding rumination, would be positively associated with both types of intelligence and more strongly associated with verbal intelligence.

Initial models analyzed brooding and reflection, separately from depression to determine the associations with both verbal IQ and performance IQ. Before controlling for depression, regression analysis indicated that verbal IQ had a significant positive association with reflection ($\beta = .29$, $p < .001$) and significant negative association with brooding ($\beta = —.12$, $p = .005$). Performance IQ showed a similar positive association with reflection ($\beta = .18$, $p < .001$) and

negative association with brooding (β = —.14, p = .006). The CESD had a significant negative relation with both verbal IQ (β = —.09, p = .026) and performance IQ (β = —.09, p = .011).

A chi-square difference test indicated we were unable to constrain the association between verbal IQ and reflection to equal the association between performance IQ and reflection, $\Delta\chi 2$ (1) = 12.63, p < .001, which suggests that verbal IQ and performance IQ have significantly different associations with reflection. The second test equated the association between verbal IQ and brooding to the association between performance IQ and brooding, $\Delta\chi 2$ (1) = 0.89, p = .765, which indicates that there is no significant difference in these associations.

Associations between IQ type and rumination controlling depression. A multiple regression was used to examine rumination and depression as predictors of verbal IQ and performance IQ. Because rumination had been positively associated with verbal IQ in past literature (Penney et al, 2015), and earlier models indicated reflection was positively associated with both IQ scales, we wanted to see if separating rumination by subtype strengthened association with performance or verbal IQ. Regression path analysis was used with separate models for brooding and reflection. The dependent variables of the first model were verbal IQ and performance IQ, and the independent variables were reflection and depression. The positive associations between reflection and verbal IQ (β = .29, p < .001) as well as performance IQ (β = .14, p = .001) remained. Significant negative associations emerged for CESD and verbal IQ (β = —.18, p < .001) as well as CESD and performance IQ (β = —.14, p < .001) when controlling for reflection.

The second model used the dependent variables of verbal IQ and performance IQ, and the independent variables of brooding and depression. Although the associations of performance IQ and brooding remained nonsignificant (β = .01, p = .728), a positive association of brooding with

verbal IQ emerged (β = .12, *p* = .014). The CESD was negatively associated with both verbal (β = —.15, *p* = .001) and performance IQ (β = —.01, *p* = .008) when controlling for brooding rumination.

Another regression analysis was conducted using brooding and reflection in the same model. The dependent variables of this model were verbal IQ and performance IQ, and the independent variables were reflection, brooding and depression. After controlling for CESD, verbal IQ was positively associated with reflection (β = .31 *p* < .001), but not significantly associated with brooding (β = —.04, *p* = .369). Similarly, performance IQ was positively associated with reflection (β = .18, p < .001) and not significantly associated with brooding (β = —.08, *p* = .109) when controlling for CESD. Both verbal IQ (β = —.17, *p* < .001) and performance IQ (β = —.12, *p* = .002) were significantly negatively associated with CESD when controlling for rumination.

Discussion

The present study examined the association between rumination and IQ to determine whether ruminative subtype, IQ subtype, or overlap with depression might explain why some studies report a positive association between rumination and IQ and others report a negative association (e.g., Lyubomirsky et al, 2003; Penney et al, 2015). We found a positive association between rumination and IQ, but this relationship differed across the brooding and reflection subscales of the RRS. Specifically, we found that reflection had a consistent positive association with IQ. In contrast, brooding had a marginally significant negative association with IQ before controlling for depression, and this relation became insignificant after controlling for depression and when analyzing reflection separately from brooding.

Brooding rumination is not significantly associated with intelligence

Our findings indicate that after controlling for depression and using both subscales of rumination in analysis with IQ, brooding was not significantly associated with IQ. Although a positive relationship emerged for the association of brooding alone with verbal IQ, this did not remain after the addition of the other rumination scale and was not true for performance IQ. Although there may be a unique relation of brooding and verbal IQ, it also only occurs under specific conditions.

Reflective rumination is positively associated with intelligence

After controlling for depression symptoms, reflection remained significantly positively associated with RPM scores, whereas the association between brooding and RPM scores was not significant. Examination of the association between two forms of IQ (performance and verbal) with ruminative subtypes indicated that verbal IQ was more strongly related to reflection than performance IQ, though both were significant positive relationships, and that this association did not change when depression symptoms were included as a covariate. This association between reflection and verbal IQ is similar to the positive findings of Penney et al (2015), and further build upon this work by distinguishing the potentially positive effects of reflective rumination compared to brooding rumination.

Rumination is differentially related to performance and verbal intelligence

Reflection was more strongly related to verbal IQ than performance IQ and this association did not change when depression was controlled. Brooding was negatively associated with both verbal and performance IQ, however these associations were no longer statistically significant after controlling for depression. Due to the lack of significance in this finding, our evidence implies the negative effects of brooding rumination on IQ cannot be uniquely attributed to brooding but may reflect brooding's shared variance with depression.

This finding shows support for the AR hypothesis. The AR hypothesis theorizes that when complex problems arise, depression is triggered to allocate mental resources towards that problem. This hypothesis also proposes rumination has positive utility for problem solving as it allows for more thorough analysis, and despite the compromised lab performance sometimes seen for problem solving, rumination enhances overall analysis of the problem which trigged depression (Andrews & Thomson, 2009). This hypothesis is potentially supported by our positive findings of the positive association between reflection and IQ, which may indicate utility of reflection. The indication that rumination and depression together have negative implications, rather than rumination alone may also be supported by our finding that once depression is controlled, the effects of brooding on intelligence are no longer significant. This evidence may indicate that shared variance between rumination and depression might not have an independent association with intelligence above and beyond depression.

Limitations and Future Directions

One potential limitation of the present study is that although we examined a fluid IQ measure (RPM) in addition to rumination and depression at age 23, our measures of verbal and performance IQ were administered at age 16. This decision was made because we did not have a measure of verbal and performance IQ at age 23. Despite this age gap, the persistence of significant results may suggest high stability of this association between verbal IQ, performance IQ, and rumination. However, it may be beneficial in future work to replicate these findings using measures of concurrent rumination, depression, performance IQ, and verbal IQ. Another future direction could be examining these questions across the lifespan, given prior work documenting cognitive decline and a decrease in rumination in older adulthood (Craik & Bialystok, 2006). In studying cognition through age, Craik and Bialystok (2006) assert the best

measure of general knowledge is through measurement of fluid intelligence, or comprehension and cognitive task ability, in conjunction with crystalized intelligence, which includes implementation of learning and judgment.

Another limitation of this study may be the limited definition of intelligence. Although fluid intelligence and crystalized intelligence have some common features there are aspects of fluid intelligence and crystalized intelligence not captured by performance IQ and verbal IQ. The differential effects of rumination on intelligence presented in this study demonstrate the need to include other measures of intelligence that may be associated with rumination, such as crystalized and fluid.

It may also be useful in future research to expand upon types of rumination. In the present study, we saw the unique effects of the subtypes of depression rumination: brooding and reflection. A study by du Pont et al. (2017) demonstrated anger rumination to be discernable from depression rumination despite sharing common variance; finding them to be differently associated with psychopathology. These findings indicate there may be a reason to include other types of rumination in addition to depression rumination.

Future studies could investigate how the subtypes of rumination relate to other aspects of higher cognition. Specifically, including executive functions, such as a measure of set shifting like the Wisconsin Card Sorting Test (Davis & Nolen-Hoeksema, 2000) or a measure of attentional bias like the Dot-Probe Task (Joormann, Dkane, Gotlib, 2006), may be beneficial due to the frequent use in studies of problem solving. The inclusion of processing speed as a covariate may also yield interesting findings due to its proposed effects on both depression and aspects of performance such as reaction time and trail making (Cannity, 2013). The significant negative association between depression and processing speed (Sackeim et al., 1992) may

explain our finding that performance IQ is significantly negatively associated with brooding rumination but that this association is insignificant after depression is controlled. Because literature regarding rumination and performance IQ seems more limited than literature on verbal IQ, including a measure of processing speed may capture further differences between reflection and brooding. Further analysis is required to understand the full relationship between processing speed and rumination.

Conclusions

To gain a greater understanding of the association between rumination and intelligence, we examined the association between ruminative subtypes, IQ scales, and the independent association between rumination and IQ after controlling for depression. Our results indicate that although a reflective ruminative mind may be a more verbally intelligent mind, regardless of depression, the intelligence of a brooding mind may be negatively affected due to an increased risk of depression. In an effort to predict and prevent depression whenever possible, it is important to identify discernible patterns for intelligence and rumination that may be used to predict later depression. Although rumination has been used as a predictor for aspects of depression in the past, by being able to discern potentially beneficial rumination not significantly related to depression—reflection—from rumination that when associated with depression has a significant negative relation to intelligence—brooding—rumination may have increased accuracy as a predictor for depression. The association between rumination and intelligence has typically been masked by not controlling for depression. Although previous literature generally demonstrated that rumination has a negative relationship with intelligence, we found a positive association between intelligence and rumination, reflective rumination in particular, that

persisted when we controlled for depression. These results suggest the need to look at rumination and IQ as a multifaceted construct in future research.

Acknowledgements

My sincerest gratitude is first extended to Alta du Pont, clinical graduate student, Department of Psychology and Neuroscience, who imparted invaluable knowledge and guidance during the thesis process. She provided critical evaluation, experience, and support, without which this thesis wouldn't be possible. Thank you for being available and offering thoughtful insight even during nights, weekends, and holidays.

I am also deeply grateful to Dr. Naomi Friedman, assistant professor, Department of Psychology and Neuroscience, Institute of Behavioral Genetics, who inspired me to begin the thesis process and encouraged me along the way. She motivated me and provided all the resources necessary to conduct this research.

I would like to thank my committee members and the various people who have assisted me in my writing. Without this help, I wouldn't have learned as much from this process or enjoyed it as much as I have. I also thank NIH grants MH063207 and AG046938 for providing the data used in this thesis.

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Table 1
Descriptive Statistics of Rumination, Depression, and IQ Measures by Sex

Measure	*n*	Mean	SD	Min	Max	Skewness[a]	Kurtosis[a]
Males							
RRS-B	350	1.89	0.57	1.00	4.00	0.53	0.12
RRS-R	350	1.95	0.67	1.00	4.00	0.29	-0.83
RRS	350	2.91	0.55	2.00	5.00	0.35	-0.23
CESD	347	2.94	1.38	0.00	6.78	0.09	0.07
RAVEN23	346	0.63	0.20	0.11	1.00	-0.51	-0.33
WAIS16	324	103.25	11.17	70.00	142.00	0.09	0.15
VIQ16	324	104.30	13.04	73.00	140.00	0.14	-0.04
PIQ16	324	101.45	11.32	72.00	136.00	0.15	-0.036
Females							
RRS-B	400	2.05	0.64	1.00	4.00	0.52	-0.24
RRS-R	401	2.13	0.70	1.00	4.00	0.33	-0.53
RRS	400	3.09	0.59	2.00	5.00	0.33	-0.32
CESD	369	3.08	1.39	0.00	6.63	0.10	-0.28
RAVEN23	399	0.62	0.19	0.11	1.00	-0.27	-0.54
WAIS16	384	102.91	11.47	74.00	138.00	0.37	0.33
VIQ16	384	103.19	12.97	75.00	143.00	0.46	0.21
PIQ16	384	101.96	10.85	74.00	136.00	0.22	0.08

Note. min = minimum; max = maximum; RRS-B, Ruminative Responses Scale-Brooding. RRS-R, Ruminative Responses Scale-Reflection. CESD, Center for Epidemiologic Studies Depression Scale. RAVEN23, Raven's Progressive Matrices at age 23. WAIS16, Wechsler Adult Intelligence Scale at age 16. VIQ16, Verbal IQ scores on WAIS at age 16. PIQ16, Performance IQ scores on the WAIS at age 16.
[a]Skewness and kurtosis reflect the distributions of the square root transformed scores for CESD and the scaled scores for WAIS16, VIQ16, and PIQ16

Table 2

Zero-order Rumination, Depression, and Intelligence Correlations by Sex

Males	1	2	3	4	5	6	7	8	9
1. RRS-B									
2. RRS-R	.57*								
3. RRS	.87*	.91*							
4. CESD	.50*	.37*	.48*						
5. MDD	.27*	.28*	.31*	.29*					
6. RAVEN23	−.01	.07	.04	−.16*	−.08				
7. WAIS16	−.01	.15*	.09	−.01	.01	.58*			
8. VIQ16	−.00	.18*	.11*	−.11	.03	.50*	.91*		
9. PIQ16	−.01	.06	.03	−.03	−.04	.48*	.76*	.44*	
Females	1	2	3	4	5	6	7	8	9
1. RRS-B									
2. RRS-R	.56*								
3. RRS	.87*	.89*							
4. CESD	.52*	.32*	.47*						
5. MDD	.36*	.36*	.41*	.41*					
6. RAVEN23	.03	.16*	.11*	−.11*	−.07				
7. WAIS16	.03	.23*	.15*	−.11	−.03	.58*			
8. VIQ16	.07	.25*	.19*	−.07	.00	.51*	.95*		
9. PIQ16	−.05	.13*	.05	−.14*	−.07	.53*	.83*	.55*	

Note. RRS-B = Ruminative Responses Scale – Brooding. RRS-R = Ruminative Responses Scale – Reflection. RRS = Ruminative Response Scale. CESD = Center for Epidemiologic Studies Depression Scale. MDD = Major Depressive Disorder. RAVEN23 = Raven's Progressive Matrices at age 23. WAIS16 = Wechsler Adult Intelligence Scale at age 16. VIQ16 = Verbal IQ scores on WAIS at age 16. PIQ16 = Performance IQ scores on the WAIS at age 16.
* $p < .05$.

Table 3

Multiple Regressions Predicting IQ with Ruminative Subtypes

	Independent variables				
Dependent Variables	Total RRS	Reflection	Brooding	Sex	Age
Raven23	0.08[.04]*			0.04[.04]	-0.13[.04]**
		0.17[.04]***	-0.08[.05]+	0.03[.04]	-0.13[.04]**
		0.12 [.04]***		0.04 [.04]	-0.13[.04]**
			0.01 [0.04]	0.03[.04]	-0.13[.05]**
VIQ16	0.16[.04]***			0.06[.05]	-0.10[.05]*
		0.29[.05]***	-0.12[.05]**	0.06[.05]	-0.09[.04]*
			0.04[.04]	0.05[.05]	-0.10[.05]*
		0.22[.04]***		0.07[.05]	-0.09[.04]*
PIQ16	0.04[.04]			-0.02[.05]	0.01[.05]
		0.18[.05]***	-0.14[.05]**	-0.02[0.5]	0.01[0.05]
			-0.04[.04]	-0.03[.05]	0.01[.05]
		0.10[.04]*		-0.01[.05]	0.01[.05]

Note. RRS-B = Ruminative Responses Scale-Brooding. RRS-R = Ruminative Responses Scale-Reflection. CESD = Center for Epidemiologic Studies Depression Scale. RAVEN23 = Raven's Progressive Matrices at age 23. VIQ16 = Verbal IQ scores on WAIS at age 16. PIQ16 = Performance IQ scores on the WAIS at age 16. Raven23 was measured in one analysis model while PIQ16 and VIQ16 were measured together in a separate model. Standardized model results and standard error in brackets. *p ≤ 0.05. +p≤ 0.10. **p ≤ 0.01. ***p ≤ 0.001.

Table 4

Multiple Regressions Predicting IQ with Ruminative Subtypes and Depression

	Independent Variables					
Dependent Variables	Total RRS	RRS-R	RRS-B	CESD	Sex	Age
Raven23	0.18[.04]***			-0.21[0.4]***	0.04[.04]	-0.12[.04]**
		0.18[.04]***	0.01[.05]	-0.19[.04]***	0.04[.04]	-0.12[.04]**
		0.19[.04]***		-0.19[.04]***	0.04 [.04]	-0.12[.04]**
			0.11 [0.04]*	-0.18[.04]***	0.03[.04]	-0.12[.05]**
VIQ16						
		0.31[.05]***	-.04[.05]	-.17[.04]***	0.07[.05]	-0.09[.04]*
			0.12[.05]*	-.14[.04]***	0.05[.05]	-0.09[.05]*
		0.29[.04]***		-0.18[.04]***	0.07[0.05]	-0.09[.04]
PIQ16						
		.18[.05]***	-.08[.05]	-.12[.04]**	-0.01[.04]	0.03[.04]
			0.01[.04]	-0.01[.04]**	-0.03[.05]	0.03[.05]
		0.14[.04]***		-0.14[.04]***	-0.01[.04]	0.03[.05]

Note. *Note*. RRS-B = Ruminative Responses Scale-Brooding. RRS-R = Ruminative Responses Scale-Reflection. CESD = Center for Epidemiologic Studies Depression Scale. RAVEN23 = Raven's Progressive Matrices at age 23. VIQ16 = Verbal IQ scores on WAIS at age 16. PIQ16 = Performance IQ scores on the WAIS at age 16. Raven23 was measured in one analysis model while PIQ16 and VIQ16 were measured together in a separate model. Standardized model results and standard error in brackets.

*p ≤ 0.05. +p≤ 0.10. **p ≤ 0.01. ***p ≤ 0.001.