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Cognitive Control and Rumination in Youth: The Importance of Emotion

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Abstract

Rumination involves the tendency to passively dwell on negative emotions along with their meanings and consequences. Susan Nolen–Hoeksema demonstrated the role of rumination in the development of several forms of psychopathology and suggested that cognitive control may be one factor that makes some individuals more prone to ruminate than others. Studies with adults have consistently found that rumination is associated with cognitive control difficulties, especially related to switching and inhibiting emotional information. Because rumination predicts psychopathology by adolescence, the present study examined whether ruminating youth would show similar cognitive control difficulties. Fifty–two adolescents completed two tasks from the Cambridge Neuropsychological Test Automated Battery and reported on their depressive symptoms and tendency to ruminate. There was no effect of rumination on a task measuring general cognitive flexibility. However, rumination was associated with difficulty inhibiting negative information when switching from negative to positive blocks on an Affective Go/No–go task. Results suggest both similarities and differences compared to adult studies and are discussed in terms of clinical implications for the prevention and treatment of psychopathology.

Keywords

rumination; adolescence; cognitive control; executive processes; depression; CANTAB; emotion regulation

Introduction

Susan Nolen–Hoeksema first investigated rumination, the tendency to passively dwell on negative emotions along with their meanings and consequences, as a mechanism to explain the preponderance of depression in women (Nolen–Hoeksema, 1987; 1991). Later, she and others demonstrated that rumination was in fact a transdiagnostic risk–factor implicated in many forms of psychopathology (Nolen–Hoeksema & Watkins, 2011). In addition to establishing the role of rumination in the development of psychopathology, Nolen–Hoeksema investigated processes that might explain why some people are more prone to

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ruminate than others. One such process that was identified was cognitive control (Davis & Nolen–Hoeksema, 2000). Since Davis and Nolen–Hoeksema's demonstration that adults who ruminate make more perseverative errors on a general cognitive task, several other studies have suggested that adults who ruminate also have difficulty with cognitive flexibility (e.g., Hertel & Gerstle, 2003; Whitmer & Banich, 2007). Despite this large body of research, little work has examined cognitive control in the context of rumination among younger individuals. Rumination is operative in childhood and reliably predicts depression by adolescence (Rood, Roelofs, Bogels, Nolen–Hoeksema, & Schouten, 2009); therefore, examining cognitive control among young adolescents who ruminate offers an important opportunity to investigate this putative mechanism before severe psychopathology is likely to have developed.

Rumination and Cognitive Control among Adults

Studies with adults have shown that rumination is associated with perseverative errors that likely reflect difficulties with executive functioning (e.g., Davis & Nolen–Hoeksema, 2000; Watkins & Brown, 2002). Theories of rumination suggest that the ruminative process may result from a weakened inhibition system that allows these intrusive thoughts into working memory (e.g., Linville, 1996). In support of this, a study comprising an unselected sample of adults showed that ruminators' cognitive control problems appear to be related to a specific difficulty inhibiting a previous set (Whitmer & Banich, 2007, Experiment 1). Another study showed that while ruminators made more errors on a goal–shifting task, they actually made fewer errors on a Stroop task that involves goal maintenance (Altamirano, Miyake, & Whitmer, 2010). These findings point to the possibility that ruminators may have difficulty with attentional inhibition, because inhibition of a previous set is required in order to shift to a new set. Further evidence that these difficulties may involve trouble with attentional inhibition come from a study where ruminators showed difficulty inhibiting orientation towards an abrupt cue during an eye tracking task (De Lissnyder, Derakshan, De Raedt, & Koster, 2011).

Studies of depressed or dysphoric individuals have also found that rumination is associated with cognitive control difficulties, mostly related to inhibition and set switching. In these studies, inducing rumination (through instructions for self– and emotion–focused thinking, e.g., *Think about why you feel the way you do*) resulted in worse performance on cognitive tasks. Among depressed individuals, this type of rumination induction resulted in worse performance on a switching task compared to those induced to distract (Whitmer & Gotlib, 2012). In another study, a rumination induction resulted in a stereotyped counting response among depressed participants during a random number generation task (Watkins & Brown, 2002). Finally, another study found that induced rumination resulted in worsened performance on the Stroop task among dysphoric participants (Philippot & Brutoux, 2008).

Taken together, these studies suggest that rumination is associated with cognitive control difficulties that may be specifically related to difficulty in inhibition or set switching. Inhibition and switching are related executive functions (e.g., Arbuthnott & Frank, 2000), as inhibition of a previous set is required to switch to a new set; however, these two processes are distinguishable. It is noteworthy that these studies all involved tasks with neutral (i.e.,

non– emotional) stimuli. Because rumination involves a passive, perseverative focus on negative emotions, one might expect cognitive control difficulties to be more pronounced on tasks with negatively–valenced stimuli.

Rumination and Cognitive Control Over Emotional Information Among Adults

Several studies have examined the relationship between rumination and cognitive control among adults using tasks that include emotional stimuli. These studies tested the hypothesis that ruminators would perform worse on tasks requiring the inhibition of negative information. Two studies of depressed adults found support for this hypothesis. In one study, rumination was associated with difficulty removing task–irrelevant negative words from working memory in a modified Sternberg task (Joormann & Gotlib, 2008), and in the other, rumination was associated with a lack of inhibition of negative information during a negative affective priming task (Joormann & Gotlib, 2010).

Studies with non–clinical samples of adults have also found that rumination is associated with poor cognitive control over emotional information. One study of unselected college students showed that those reporting high levels of rumination were not successful at inhibiting irrelevant emotional words in an affective priming task (Joormann, 2006). Another study of unselected college students found that rumination was associated with an impaired ability to refresh target words when emotional words were also presented (Bernblum & Mor, 2010). These effects have been demonstrated with a variety of tasks including a Working Memory Selection Task (Zetsche, D'Avanzato, & Joormann, 2012), where participants have to update working memory by discarding no–longer relevant material, an Affective Shift Task (De Lissnyder, Koster, Derakshan, & De Raedt, 2010) where participants have to perform an odd–face–out decision based on a cue presented prior to the stimuli, and an Internal Shift Task (De Lissnyder, Koster, & De Raedt, 2012) where participants have to keep track of either gender or emotion during the presentation of faces.

Taken together, these studies show that rumination is associated with difficulty inhibiting emotional information, especially negative information. Because studies have largely looked at either general cognitive control or cognitive control over emotional information, it is difficult to know whether cognitive control problems among ruminators are more pronounced on tasks involving emotional stimuli. Studies that include different types of trials (i.e., neutral and emotional) suggest that rumination is in fact associated with greater cognitive control difficulties related to processing emotional information relative to neutral information (e.g., De Lissnyder et al., 2010, 2011; Demeyer, De Lissnyder, Koster, & De Raedt, 2012).

It is also noteworthy that these effects appear to be specific to rumination and not depression level. While poor cognitive control has been found to predict levels of depression after one year among remitted depressed adults, this effect was fully mediated by rumination (Demeyer et al., 2012). Additionally, several other studies have found that effects for rumination hold when controlling for depression level (e.g., Bernblum & Mor, 2010; De Lissnyder et al., 2010), and some studies did not find cognitive control effects for depression

level, but did for rumination (e.g., Zetsche et al., 2012, De Lissnyder et al., 2012). Thus, studies conducted to date with adults from both clinical and unselected samples suggest that rumination is specifically associated with cognitive control impairments that involve inhibition, especially of negative emotional information.

The Importance of Studying Youth

Although a large literature has emerged suggesting a relationship between rumination and cognitive control, few studies have examined this among younger samples. Doing so is important for several reasons. Adolescence is a period of marked development of psychopathology, in particular depression (Twenge & Nolen–Hoeksema, 2002), and the relationship between rumination and cognitive control may be instrumental in furthering the understanding of this development. Studies of youth who self–reported on their tendency to ruminate show a reliable relationship between rumination and depression by adolescence (Rood et al., 2009). In addition to depression, several other forms of psychopathology linked to rumination are especially prominent in adolescence. These include both anxiety (McLaughlin & Nolen–Hoeksema, 2011) and escapist behaviors such as eating disorders, substance abuse, and self–injury (Hilt, Cha, & Nolen–Hoeksema, 2008; Nolen–Hoeksema, Stice, Wade, & Bohon, 2007). Understanding the relationship between rumination and cognitive control in youth may provide an earlier look into the progression of these disorders.

There is also good reason to be cautious about generalizing adult findings to youth. In a study investigating age– related differences in emotion regulation, young adolescents were less successful at regulating their responses to social stimuli than were adults, suggesting that adolescents may have differential abilities in appraising social and emotional information relative to adults (Silvers, McRae, Gabreli, & Gross, 2012). Additionally, although adult studies of depression find fairly consistent cognitive biases, studies of youth have been more mixed (e.g., Neshat– Doost, Moradi, Taghavi, Yule, & Dalgleish, 2000). These examples suggest that conclusions about the relationship between cognitive control and rumination among youth should be based on empirical evidence using youth samples.

To date, we are aware of few studies directly examining the relationship between cognitive control and rumination among youth. A few studies done by our group have examined attentional biases and rumination among children and adolescents. One found that performance on a measure of attention in preschool predicted rumination in adolescence under certain contexts (Hilt, Armstrong, & Essex, 2012). Another study found that rumination moderated the impact of child maltreatment on attention biases toward sad faces on a dot–probe task such that high–ruminating maltreated children demonstrated a bias toward sad faces while low–ruminating maltreated children did not (Romens & Pollak, 2012). Recently, we also showed that young adolescents who ruminated following an interpersonal stressor were characterized by an attention bias away from happy faces on a dot–probe task (Hilt & Pollak, 2013). Because attention is a component of cognitive control, these studies provide preliminary evidence that rumination is related to cognitive control among youth. However, studies examining the relationship between rumination and general

cognitive flexibility and control over inhibition of emotional information and switching is lacking.

The Present Study

To address these gaps in the literature, we sought to explore the relationship between rumination and cognitive control among an adolescent sample. We chose two different tasks. Both tasks rely upon cognitive control, but one of the tasks taps general flexibility in this control, whereas the other relies upon the inhibition of emotional information. If adolescents are similar to adults, we predicted that those with a greater tendency to ruminate would perform worse than low ruminators on the first task involving flexibility of cognitive control. We also predicted that adolescents with greater ruminative tendencies would demonstrate difficulties in inhibiting negative emotional information, particularly when switching sets. We expected these effects to hold controlling for depression, suggesting a specificity for rumination.

Method

Participants and Procedure

Fifty–two youth (76% girls) participated in the present study. Participants were recruited via advertisements and posters for a study on emotions in youth. They ranged in age from 9 years, 5 months to 16 years, 2 months (M = 12.91, SD = 1.31). We choose this age range because youth can reliably self–report by age 9, and to generally capture the developmental period before the sharp increase in depression typically emerges (Hankin et al., 1998; Twenge &Nolen–Hoeksema, 2002). Racial–ethnic distribution was 79% Caucasian, 11% African–American, 8% Asian–American, and 2% Hispanic. Annual family income was reported by a parent and ranged from less than 5,000 U.S. dollars to greater than $200,000 (median = $80,000 – 90,000).

The study was approved by the Institutional Review Board at the University of Wisconsin–Madison. Informed consent was obtained from the child's parent and assent was obtained from all youth. Parents provided demographic information. Participants completed cognitive control tasks followed by self–report measures during a single visit to the laboratory. They were compensated with a small prize.

Measures

Cognitive control tasks

Participants completed selected tasks from the Cambridge Neuropsychological Test Automated Battery (CANTAB; Cambridge Cognition, Cambridge, United Kingdom), a computerized battery that has been used in many studies of youth. Youth first completed two brief practice tasks to familiarize them with the touch screen and press pad. Next, they completed a non–emotional shifting task to measure general cognitive flexibility followed by an affective go/no–go task to measure inhibition of emotional information.

Intra–Extra Dimensional Set Shift

The Intra–Extra Dimensional Set Shift test (IED) is a computerized analogue of the Wisconsin Card Sorting Test and was used to examine general cognitive control during a non–emotional task. The dimensions include color– filled shapes and white lines, with simple stimuli including only one of these dimensions and complex stimuli including both. Participants are presented with two color–filled shapes and must indicate the correct response by touching it on the screen. The correct response is learned through feedback, and after six correct responses, the rule and/or stimuli change. Shifts are intra–dimensional first (i.e., only color–filled shapes) and then switch to extra– dimensional (ED, i.e., white lines).

Affective Go/No–go

The Affective Go/No–go (AGN) is a task that requires maintenance and inhibition of emotional information. This task involves trials where a word is presented in the center of the screen for 300 ms followed by a 900 ms interstimulus interval, during which time participants press a bar for correct targets (i.e., positive words during positive trials or negative words during negative trials). In each block, some trials involve distractors (i.e., negative words during positive trials, or positive words during negative trials). Participants are told to respond as fast as possible without making mistakes. The task consists of 2 practice blocks followed by eight recorded blocks (2 positive, 2 negative, 2 positive, and 2 negative) consisting of 18 trials each. In addition to valence, blocks vary according to shift (e.g., a positive block following a negative block or vice versa) or non–shift (e.g., a positive block following a positive block). Response time is recorded for correct trials (i.e., mean correct latency) along with omission errors (i.e., failing to respond for a correct target word) and commission errors (i.e., responding to a distractor word). We were only interested in commission errors for the present study. Responses that occurred within the first 100 ms for any trial were excluded. Due to technical difficulties, 3 participants' data were not recorded for this task.

Rumination

We assessed rumination using the 13–item rumination subscale from the Children's Response Style Questionnaire (CRSQ; Abela, Brozina, & Haigh, 2002). For each item, youth are asked to rate how often they respond in that way when they feel sad on a 4–point Likert scale (0 = almost never, 1 = sometimes, 2 = often, 3 = almost always). Sample items include: Think about a recent situation wishing it had gone better and *Think "Why can't I handle things better?"* Items were totaled and divided by the number of items to form an average rumination score. The reliability and validity of the CRSQ, as well as its subscales, have been demonstrated in several studies (e.g., Abela et al., 2002; Abela, Aydin, & Auerbach, 2007). Although the rumination scale typically used with adults comprises two factors (brooding and reflection; Treynor, Gonzales, & Nolen–Hoeksema, 2003), the CRSQ rumination scale comprises a single rumination factor (Abela et al., 2007). We modified the directions slightly to ask children to respond based on what they do when they feel sad *or stressed* in order to examine rumination as a response to distress, in line with current conceptualizations (Nolen–Hoeksema, Wisco, & Lyubomirsky, 2008) and as has been done

with other studies of youth (e.g., Burwell & Shirk, 2007). The CRSQ rumination scale demonstrated excellent reliability in this study (α = .87).

Depressive symptoms

Youth completed the Children's Depression Inventory (CDI; Kovacs, 1992), a 27–item self–report measure of depressive symptoms that has been standardized on children and adolescents aged 7–17 years. Each item consists of three statements (e.g., I am sad once in a while, I am sad many times, I am sad all the time) representing different levels of severity of a specific symptom of depression (e.g., depressed mood) or a consequence of depressive symptoms (e.g., social rejection). Items are assigned a numerical value from 0 (symptom absent) to 2 (symptom present and severe), and higher scores indicate higher levels of depression. The CDI has sound psychometric properties, including internal consistency (Reynolds, 1994), test–retest reliability, and discriminant validity (Kovacs, 1992). Internal consistency for the present sample was good (α = .82).

Results

After examining variables for normality, we used a square root transformation to normalize rumination scores, which were positively skewed. For the IED, we conducted a regression analysis for stages completed and one for errors with rumination and depression scores as predictors. For the AGN, we used a mixed ANOVA model to predict commission errors, with two continuous between–subjects factors (Rumination and Depression scores) and two within–subjects factors (Valence: positive, negative and Shift: shift, non–shift). We predicted a 3–way Rumination X Valence X Shift interaction. Means and standard deviations are presented in Table 1.

General Cognitive Control

To examine the relationship between rumination and general cognitive control during a non–emotional task, we examined rumination as a predictor of IED outcomes, controlling for depression. Because the task involves switching rules throughout, if youth are similar to adults, we would predict higher rumination to be associated with fewer stages completed and more errors. Neither of the models was significant (see Table 2). The overall pattern provided no evidence for a relationship between rumination and cognitive control on this non–emotional task.

Cognitive Control Over Emotional Information

Next we examined whether rumination was associated with cognitive control during an emotional task by examining performance on the AGN (see Table 3). Because of theory and previous research, we were most interested in examining evidence for difficulty with inhibition. Commission errors involve responding to positive words during negative blocks or responding to negative words during positive blocks, and we expected this to offer the most direct evidence for inhibition difficulty. General inhibition problems would involve more commission errors across blocks. Negative inhibition problems would involve more commission errors on positive blocks (when negative words are distractors). General

switching problems would involve commission errors on shift blocks. Therefore, we examined whether rumination was associated with difficulty inhibiting negative information in the context of switching which would involve more commission errors on positive shift blocks compared to positive non–shift blocks.

There was a significant Rumination X Valence X Shift interaction, $F(1, 46) = 6.42$, $p = .015$, $\eta_p^2 = .12$. We followed up this 3–way interaction by creating rumination variables at one SD above and below the mean and testing the mixed ANOVA model to examine the 2–way interaction between Valence and Shift. There was no Valence X Shift interaction for rumination at 1 SD below the mean, $F(1, 46) = .93$, $p = .339$; however, there was a significant Valence X Shift interaction for rumination at 1 SD above the mean, $F(1, 46) = 4.70$, $p = .035$. Because we predicted that rumination would be associated with difficulty inhibiting negative information in the context of switching, we compared commission errors on positive non–shift blocks (requires inhibiting negative information without switching) to positive shift blocks (requires inhibiting negative information following a negative block). This analysis revealed a significant effect for Shift, $F(1, 46) = 4.72$, $p = .035$, where higher rumination was associated with more commission errors on positive shift blocks ($M = 5.16$, $SE = .58$) than positive non–shift blocks ($M = 4.98$, $SE = .60$). There was no effect of Shift within negative blocks, $F(1, 46) = .69$, $p = .412$, suggesting the inhibition difficulty was specific to negative stimuli interfering when switching from a negative block to a positive block.

Discussion

Because rumination is associated with psychopathology by adolescence, yet research on cognitive control and rumination has generally focused only on adults, the goal of the present study was to examine whether young ruminators would display similar cognitive control difficulties as has been documented among adult ruminators. In line with the adult literature, rumination among youth was associated with cognitive control difficulty during an emotional task, i.e., rumination was associated with difficulty inhibiting negative emotional information when switching from negative to positive blocks. However, contrary to findings among adults, rumination among youth was not associated with difficulty on a general (i.e., non–emotional) test of cognitive flexibility.

Although studies of adult ruminators have documented cognitive control impairments on both neutral and emotional tasks, results appear to be stronger for tasks involving emotional information (e.g., De Lissnyder et al., 2010, 2012). We predicted that rumination among youth would be associated with difficulty inhibiting negative information when switching from a negative to a positive block, and results supported this. Specifically, rumination was associated with incorrectly responding to negative distractors during positive blocks that followed negative blocks, suggesting that youth who ruminate more experience more interference from negative information, especially when shifting. This task involved updating the contents of working memory with each shift, and rumination was associated with interference when shifting from a block where negative information is maintained in working memory to one where positive information is maintained in working memory. This may help explain why rumination (which involves keeping negative information in working

memory) is difficult to disengage from. This finding is consistent with adult studies showing an association between rumination and reduced inhibition of negative information (e.g., Joormann & Gotlib, 2008, 2010). It is noteworthy that this is the first study we are aware of that specifically examined the relationship between rumination and cognitive control in a young adolescent sample, and the size of the effect was medium to large in magnitude according to Cohen's conventions.

While previous research with adults has demonstrated that rumination is associated with worse performance on general, non–emotional goal–shifting tasks (e.g., Altamirano et al., 2010; Davis & Nolen–Hoeksema, 2000), the current study found no such differences. There are several explanations for this discrepancy: differences in tasks used to assess cognitive control, differences between youth and adults, or other differences in the samples. The task we used, the Intra–Extra Dimensional Set Shift, is considered an analog to the Wisconsin Card Sorting Test, used by Nolen–Hoeksema and Davis. Thus, although the tasks are different, this explanation is unlikely to account for the different findings. In addition to age differences, the sample in our study may have a more restricted range of rumination scores compared to adult studies because of our method of participant selection. We recruited an unselected sample rather than choosing participants based on particularly high or low rumination scores (e.g., Davis & Nolen–Hoeksema, 2000). Thus, the lower levels of rumination reported in our sample could possibly account for the lack of association between rumination and general cognitive control; however, some studies of adults have found that rumination was related to general cognitive control difficulties even among participants without extreme levels of rumination (e.g., Whitmer & Banich, 2007, Experiment 2).

If the lack of association between rumination and general cognitive control is accounted for by participants' younger age or developmental level, it may point to a potential direction of effects. For example, persistent rumination may gradually decrease cognitive control abilities. Experimental studies with adults have demonstrated that induced rumination depletes cognitive resources (e.g., Watkins & Brown, 2002). Cognitive control is also reduced following depressive episodes (e.g., Vanderhasselt & De Raedt, 2009). Thus, it is possible that the general cognitive control impairments observed in adult ruminators could be due to "scars" from previous rumination and/or experiences with low mood. On the other hand, Nolen–Hoeksema posited that cognitive control processes confer a proneness to rumination, suggesting a different direction of effects (Davis & Nolen–Hoeksema, 2000). In support of this, Demeyer et al. (2012) found that cognitive control impairments predicted increased rumination and depressive symptoms one year later. Additionally, a birth–cohort study found that sustained attention on a general cognitive control task during preschool was associated with rumination in adolescence (Hilt et al., 2012). Based on the limited experimental and prospective research conducted to date, it appears that the relationship between cognitive control and rumination may be bi–directional. Perhaps the association between rumination and difficulty with cognitive control over negative emotional information among youth in the present study will predict more pervasive cognitive control problems in the future. This line of inquiry will be an important avenue for future research.

Importantly, our findings related to cognitive control over emotional information appear to be specific to rumination, and not depression levels. By co–varying depression scores in our analyses, we saw that there was no effect of depression symptom level on performance in the Affective Go/No–go task. The specificity regarding rumination in the current study may help to explain why rumination is a transdiagnostic risk–factor implicated in the development of several different emotional disorders, not just depression (Nolen–Hoeksema et al., 2008). While the effects of rumination and cognitive control on the development of depression has been demonstrated among adults (e.g., Demeyer et al., 2012), the question remains whether cognitive control and rumination confer unique or synergistic effects in the development of depression and other forms of psychopathology among adults and youth.

It is also important to consider limitations of this study when interpreting findings. As noted above, our sample may have been limited by a restricted range of rumination scores which could have limited power to detect effects on the general cognitive control task. The age–range of our sample was rather large (7 years), yet we did not have sufficient power to examine possible age–related effects (e.g., whether effects for older adolescents are stronger or more similar to adults). Also, because this study was an initial examination of patterns of general cognitive control and control over emotional information in youth who ruminate, we chose one task to assess each rather than include a fine–grained analysis of different types of inhibition difficulties (Zetsche et al., 2012). Following up from this study, it will be important to use paradigms and methods that allow for a more detailed examination of the relationship between rumination and cognitive control over emotion among youth. Finally, it is important to note the generalizability of findings may be limited to non–clinical youth, and future work should examine cognitive control among clinical samples of youth as well.

Whether difficulties in cognitive control over emotion precede or follow the development of ruminative tendencies, targeting them may offer an important avenue for the prevention and treatment of psychopathology. Rumination's role in the development of several forms of psychopathology suggest that targeting it or other closely related processes could have a large public health impact. Studies that increase cognitive control through direct training (e.g., Siegle, Ghinassi, & Thase, 2007) and mindfulness techniques (e.g., Ramel, Goldin, Carmona, & McQuiad, 2004) have shown a reduction in both rumination and depression. Additionally, cognitive bias modification (CBM) studies have shown promise in reducing depression, and especially anxiety (Hallion & Ruscio, 2011). It would be interesting to see if one mechanism of CBM is reduction in rumination.

In conclusion, the current study found evidence that rumination is associated with difficulties in cognitive control over emotional information among a sample of youth. Just as rumination increases negative mood, negative mood, in turn, increases rumination (e.g., Nolen–Hoeksema et al., 2007). Difficulty with cognitive control over emotional information may underlie this vicious cycle. Because these difficulties are already apparent by adolescence in a non–clinical sample, early prevention efforts would be optimal. Identifying youth with specific cognitive risk factors such as rumination or poor cognitive control over emotional information and studying how these factors relate to the emergence of psychopathology throughout development may enhance our understanding of the optimal points and timing of appropriate and effective preventive interventions. This study adds to

the growing literature largely inspired by Susan Nolen–Hoeksema's impressive body of work regarding the ruminative process and extends findings on cognitive control to a younger sample than has been previously studied. Because both similarities and differences emerged relative to adult findings, it is important to consider the relationship between rumination and cognitive control within a developmental context.

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References

Abela JRZ, Brozina K, Haigh EP. An examination of the response styles theory of depression in third- and seventh-grade children: A short-term longitudinal study. Journal of Abnormal Child Psychology. 2002; 30:515–527. http://dx.doi.org/10.1023/A:1019873015594. [PubMed: 12403154]

Abela JRZ, Aydin CM, Auerbach AP. Responses to depression in children: Reconceptualizing the relation among response styles. Journal of Abnormal Child Psychology. 2007; 35:913–937. http://dx.doi.org/10.1007/s10802-007-9143-2. [PubMed: 17549619]

Altamirano LJ, Miyake A, Whitmer AJ. When mental inflexibility facilitates executive control: Beneficial side effects of ruminative tendencies on goal maintenance. Psychological Science. 2010; 21:1377–1382. http://dx.doi.org/10.1177/0956797610381505. [PubMed: 20798398]

Arbuthnott K, Frank J. Executive control in set switching: Residual switch cost and task-set inhibition. Canadian Journal of Experimental Psychology. 2000; 54:33–41. http://dx.doi.org/10.1037/h0087328. [PubMed: 10721237]

Bernblum R, Mor N. Rumination and emotional-related biases in refreshing information. Emotion. 2010; 10:423–432. http://dx.doi.org/10.1037/a0018427. [PubMed: 20515230]

Burwell RA, Shirk SR. Subtypes of rumination in adolescence: Associations between brooding, reflection, depressive symptoms and coping. Journal of Clinical Child and Adolescent Psychology. 2007; 36:56–65. http://dx.doi.org/10.1080/15374410709336568. [PubMed: 17206881]

Davis RN, Nolen-Hoeksema S. Cognitive inflexibility among ruminators and non-ruminators. Cognitive Therapy & Research. 2000; 24:699–711. http://dx.doi.org/10.1023/A:1005591412406.

De Lissnyder E, Derakshan N, De Raedt R, Koster EHW. Depressive symptoms and cognitive control in a mixed antisaccade task: Specific effects of depressive rumination. Cognition and Emotion. 2011; 25:886–897. http://dx.doi.org/10.1080/02699931.2010.514711. [PubMed: 21824026]

De Lissnyder E, Koster EHW, De Raedt R. Emotional interference in working memory is related to rumination. Cognitive Therapy and Research. 2012; 36:348–357. http://dx.doi.org/10.1007/s10608-011-9352-4.

De Lissnyder E, Koster EHW, Derakshan N, De Raedt R. The association between depressive symptoms and executive control impairments in response to emotional and non-emotional information. Cognition and Emotion. 2010; 24:264–280. http://dx.doi.org/10.1080/02699930903378354.

Demeyer I, De Lissnyder E, Koster EHW, De Raedt R. Rumination mediates the relationship between impaired cognitive control for emotional information and depressive symptoms: A prospective

study in remitted depressed adults. Behaviour Research and Therapy. 2012; 50:292–297. http://dx.doi.org/10.1016/j.brat.2012.02.012. [PubMed: 22449892]

Hankin BL, Abramson LY, Moffitt TE, Silva PA, McGee R, Angell KE. Development of depression from preadolescence to young adulthood: Emerging gender differences in a 10-year longitudinal study. Journal of Abnormal Psychology. 1998; 107(1):128–140. http://dx.doi.org/10.1037/0021-843X.107.1.128. [PubMed: 9505045]

Hallion LS, Ruscio AM. A meta-analysis of the effect of cognitive bias modification on anxiety and depression. Psychological Bulletin. 2011; 137:940–958. http://dx.doi.org/10.1037/a0024355. [PubMed: 21728399]

Hertel PT, Gerstle M. Depressive deficits in forgetting. Psychological Science. 2003; 14:573. http://dx.doi.org/10.1046/j.0956-7976.2003.psci_1467.x. [PubMed: 14629688]

Hilt LM, Armstrong JM, Essex MJ. Early family context and development of adolescent ruminative style: Moderation by temperament. Cognition and Emotion. 2012; 26:916–926. http://dx.doi.org/10.1080/02699931.2011.621932. [PubMed: 22077906]

Hilt LM, Cha CB, Nolen-Hoeksema S. Nonsuicidal self-injury in young adolescent girls: Moderators of the distress-function relationship. Journal of Consulting and Clinical Psychology. 2008; 76:63–71. http://dx.doi.org/10.1037/0022-006X.76.1.63. [PubMed: 18229984]

Hilt LM, Pollak SD. Characterizing the ruminative process in young adolescents. Journal of Clinical Child and Adolescent Psychology. 2013; 42:519–530. http://dx.doi.org/10.1080/15374416.2013.764825. [PubMed: 23477416]

Joormann J. Differential effects of rumination and dysphoria on the inhibition of irrelevant emotional material: Evidence from a negative priming task. Cognitive Therapy and Research. 2006; 30:149–160. http://dx.doi.org/10.1007/s10608-006-9035-8.

Joormann J, Gotlib IH. Updating the contents of working memory in depression: Interference from irrelevant negative material. Journal of Abnormal Psychology. 2008; 117:182–192. http://dx.doi.org/10.1037/0021-843X.117.1.182. [PubMed: 18266496]

Joormann J, Gotlib IH. Emotion regulation in depression: Relation to cognitive inhibition. Cognition and Emotion. 2010; 24:281–298. http://dx.doi.org/10.1080/02699930903407948. [PubMed: 20300538]

Kovacs, M. Manual for Children's Depression Inventory. Multi-Health Systems, Inc.; North Tonawanda, NY: 1992.

Linville, P. Attention inhibition: Does it underlie ruminative thought?. In: Wyer, RS., Jr.; Martin, LL.; Tesser, A., editors. Ruminative thoughts: Advances in social cognition. Vol. 9. Lawrence Erlbaum; Hillsdale, NJ: 1996. p. 121-133.

McLaughlin KA, Nolen-Hoeksema S. Rumination as a transdiagnostic factor in depression and anxiety. Behaviour Research and Therapy. 2011; 49:186–193. http://dx.doi.org/10.1016/j.brat.2010.12.006. [PubMed: 21238951]

Neshat-Doost HT, Moradi AR, Taghavi MR, Yule W, Dalgleish T. Lack of attentional bias for emotional information in clinically depressed children and adolescents on the dot probe task. Journal of Child Psychology and Psychiatry. 2000; 41:363–368. http://dx.doi.org/10.1111/1469-7610.00620. [PubMed: 10784083]

Nolen-Hoeksema S. Sex differences in unipolar depression: Evidence and theory. Psychological Bulletin. 1987; 101:259–282. http://dx.doi.org/10.1037/0033-2909.101.2.259. [PubMed: 3562707]

Nolen-Hoeksema S. Responses to depression and their effects on the duration of the depressive episode. Journal of Abnormal Psychology. 1991; 100:569–582. http://dx.doi.org/10.1037/0021-843X.100.4.569. [PubMed: 1757671]

Nolen-Hoeksema S, Stice E, Wade E, Bohon C. Reciprocal relations between rumination and bulimic, substance abuse, and depressive symptoms in female adolescents. Journal of Abnormal Psychology. 2007; 116:198–207. http://dx.doi.org/10.1037/0021-843X.116.1.198. [PubMed: 17324030]

Nolen-Hoeksema S, Wisco BE, Lyubomirsky S. Rethinking rumination. Perspectives on Psychological Science. 2008; 3:400–424. http://dx.doi.org/10.1111/j.1745-6924.2008.00088.x.

Nolen-Hoeksema S, Watkins ER. A heuristic for developing transdiagnostic models of psychopathology explaining multifinality and divergent trajectories. Perspectives on Psychological Science. 2011; 6:589–609. http://dx.doi.org/10.1177/1745691611419672.

Philippot P, Brutoux F. Induced rumination dampens executive processes in dysphoric young adults. Journal of Behavior Therapy and Experimental Psychiatry. 2008; 39:219–227. http://dx.doi.org/10.1016/j.jbtep.2007.07.001. [PubMed: 17698028]

Ramel W, Goldin PR, Carmona PE, McQuiad JR. The effects of mindfulness meditation on cognitive processes and affect in patients with past depression. Cognitive Therapy and Research. 2004; 28:433–455. http://dx.doi.org/10.1023/B:COTR.0000045557.15923.96.

Reynolds, WM. Assessment of depression in children and adolescents by self-report questionnaires.. In: Reynolds, WM.; Johnston, HF., editors. Handbook of depression in children and adolescents. Plenum; New York, NY: 1994. p. 209-244.http://dx.doi.org/10.1007/978-1-4899-1510-8_11

Rood L, Roelofs J, Bogels SM, Nolen-Hoeksema S, Schouten E. The influence of emotion-focused rumination and distraction on depressive symptoms in non-clinical youth: A meta-analytic review. Clinical Psychology Review. 2009; 29:607–616. http://dx.doi.org/10.1016/j.cpr.2009.07.001. [PubMed: 19682781]

Romens SE, Pollak SD. Emotion regulation predicts attention bias in maltreated children at-risk for depression. The Journal Of Child Psychology And Psychiatry. 2012; 53:120–127. http://dx.doi.org/10.1111/j.1469-7610.2011.02474.x.

Siegle GJ, Ghinassi F, Thase ME. Neurobehavioral therapies in the 21st century: Summary of an emerging field and an extended example of cognitive control training for depression. Cognitive Therapy and Research. 2007; 31:235–262. http://dx.doi.org/10.1007/s10608-006-9118-6.

Silvers JA, McRae K, Gabreli JDE, Gross JJ. Age-related differences in emotional reactivity, regulation, and rejection sensitivity in adolescence. Emotion. 2012; 12:1235–1247. http://dx.doi.org/10.1037/a0028297. [PubMed: 22642356]

Treynor W, Gonzalez R, Nolen-Hoeksema S. Rumination reconsidered: A psychometric analysis. Cognitive Therapy and Research. 2003; 27:247–259. http://dx.doi.org/10.1023/A:1023910315561.

Twenge JM, Nolen-Hoeksema S. Age, gender, race, socioeconomic status, and birth cohort difference on the children's depression inventory: A meta-analysis. Journal of Abnormal Psychology. 2002; 111:578–588. http://dx.doi.org/10.1037/0021-843X.111.4.578. [PubMed: 12428771]

Vanderhasselt MA, De. Raedt R. Impairments in cognitive control persist during remission from depression and are related to the number of past episodes: An event related potentials study. Biological Psychology. 2009; 81:169–176. http://dx.doi.org/10.1016/j.biopsycho.2009.03.009. [PubMed: 19482234]

Watkins E, Brown RG. Rumination and executive function in depression: An experimental study. Journal of Neurology, Neurosurgery, and Psychiatry. 2002; 72:400–402. http://dx.doi.org/10.1136/jnnp.72.3.400.

Whitmer AJ, Banich MT. Inhibition versus switching deficits in different forms of rumination. Psychological Science. 2007; 18:546–553. http://dx.doi.org/10.1111/j.1467-9280.2007.01936.x. [PubMed: 17576269]

Whitmer AJ, Gotlib IH. Switching and backward inhibition in major depressive disorder: The role of rumination. Journal of Abnormal Psychology. 2012; 121:570–578. http://dx.doi.org/10.1037/a0027474. [PubMed: 22468767]

Zetsche U, D'Avanzato C, Joormann J. Depression and rumination: Relation to components of inhibition. Cognition and Emotion. 2012; 26:758–767. http://dx.doi.org/10.1080/02699931.2011.613919. [PubMed: 21970297]

Table 1

Means and Standard Deviations

	Means	Standard Deviations
Gender (% girls)	76%	
Age	12.91	1.31
Depressive Symptoms	4.23	4.49
Average Rumination	.72	.57
IED Task		
Number of stages completed	8.49	.80
Total errors	18.89	12.95
AGN Task		
Commissions Non-shift, Positive	4.92	4.17
Commissions Non-shift, Negative	4.80	4.55
Commissions Shift, Positive	5.08	4.07
Commissions Shift, Negative	5.20	4.13

Note. IED = Intra-Extra Dimensional Set Shift; AGN = Affective Go/No-go.

Table 2

Intra-Extra Dimensional Set Shift Regression Outcomes

Outcomes	Model Statistics	Predictors	β	*t*
Stages Completed	Adj. R^2 = .03, p = .184			
		Depressive Symptoms	−.28	−1.66
		Rumination	.27	1.64
Total Errors	Adj. R^2 = −.03, p = .753			−.55
		Depressive Symptoms	−.09	.34
		Rumination	.126	−.55

Table 3

Affective Go/No-go Commission Errors Model

Predictors	***F*-value**	***p*-value**	**Partial η^2**
Depressive Symptoms	1.77	.190	.04
Rumination	.00	.984	.00
Valence	2.94	.093	.06
Valence X Depressive Symptoms	.27	.606	.01
Valence X Rumination	1.82	.184	.04
Shift	1.57	.217	.03
Shift X Depressive Symptoms	1.60	.212	.03
Shift X Rumination	.02	.893	.00
Valence X Shift	3.50	.068	.07
Valence X Shift X Depressive Symptoms	1.96	.168	.04
Valence X Shift X Rumination	6.42	.015	.12