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Can't Take My Eyes Off of You: Eye Tracking Reveals How Ruminating Young Adolescents Get Stuck

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Abstract

Rumination, a cognitive process that involves passively, repetitively focusing on negative feelings and their meaning, is a transdiagnostic risk factor for psychopathology. Research with adults has suggested that attentional control difficulties may underlie rumination, but questions remain about the nature of these processes. Furthermore, the relationship between attentional control and rumination in youth has received little empirical examination. In the present study, 92 youth (ages 9–14; 72% girls; 74% Caucasian) reported on their trait rumination and internalizing symptoms. They also completed a 1,500 ms emotional-faces dot-probe task while their eye movements were measured to examine overt visual attention with high temporal precision. Youth's rumination was associated with greater dwell on emotional faces but not with initial orientation. These findings suggest that rumination is associated with increased attention to emotional information during the later stages of selective attention rather than earlier orienting to emotional cues. Implications for prevention and treatment of psychopathology are discussed.

Rumination is a mode of cognitive processing that involves repetitively and passively focusing on, and brooding about, one's negative emotions. For example, someone prone to rumination who experienced an awkward social interaction would repeatedly dwell on her memories of the details and feelings of the interaction and continue to question her role in the situation. Rather than actively problem solving or moving beyond the situation to focus on other issues, ruminators take a passive approach, which leaves them prone to experiencing more negative affect associated with prior experiences (Lyubomirsky & Nolen-Hoeksema, 1995). Not surprisingly, rumination predicts depression, anxiety, binge eating, alcohol abuse, and self-injurious behavior (Nolen-Hoeksema & Watkins, 2011; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Current formulations suggest that rumination involves difficulty with attentional control, which may explain why ruminators get stuck in negative mind-sets (Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Linville, 1996;

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Whitmer & Gotlib, 2012). Previous research examining attentional control and rumination has focused primarily on adult samples despite evidence that rumination is operative in the development of psychopathology by adolescence (Rood, Roelofs, Bogels, Nolen-Hoeksema, & Schouten, 2009). In the present study, we examine aspects of selective attention involving emotional information in youth and their relationship to rumination.

RESEARCH ON COGNITIVE CONTROL AND RUMINATION

Poor cognitive control is frequently suggested as a reason ruminators cannot turn off their perseverative thinking patterns (for a review, see Whitmer & Gotlib, 2012). Indeed, individuals who ruminate describe their thoughts as intrusive and difficult to stop (Papageorgiou & Wells, 2001). Consistent with this view, nonclinical samples of adults with a tendency to ruminate show difficulty with set shifting, one indicator of cognitive control (Altamirano, Miyake, & Whitmer, 2010; Davis & Nolen-Hoeksema, 2000; Whitmer & Banich, 2007). Similar effects emerged in a task requiring adults with remitted depression to switch between angry and neutral faces (Demeyer, De Lissnyder, Koster, & De Raedt, 2012). In addition to switching difficulties, ruminators have difficulty inhibiting information (e.g., irrelevant emotional words) in working memory, another indicator of cognitive control (Hertel & Gerstle, 2003; Joormann, 2006; Joormann & Gotlib, 2008).

One difficulty interpreting these studies is that cognitive control is a broad, multicomponent process. Broader deficits with cognitive control could be the result of more discrete or specific problems. For example, there is some evidence that aspects of basic attentional control may not operate typically among ruminators (e.g., Daches, Mor, Winquist, & Gilboa-Schechtman, 2010; Koster et al., 2011; Linville, 1996; Whitmer & Gotlib, 2012). In a study examining eye movements during a task where participants were cued to look away from a target, high-ruminating adults were slower than low-ruminating adults to look away, reflecting impaired inhibition of visual attention (De Lissnyder, Derakshan, De Raedt, & Koster, 2011). Relatedly, depressed adults had more sustained pupil dilation to emotional tasks (reflecting higher attentional load), which was positively correlated with rumination (Siegle, Steinhauer, Carter, Ramel, & Thase, 2003). Increasing attentional control among depressed adults through an intervention also resulted in decreased self-reported rumination (Siegle, Ghinassi, & Thase, 2007; Siegle et al., 2014).

Taken together, these studies suggest that there may be specific impairments related to later stages of selective attention. In other words, the attentional difficulties that ruminators have seem to be related more to difficultly disengaging attention than to initial allocation of attention (see reviews by Koster et al., 2011; Whitmer & Gotlib, 2012). If this is the case, then interventions aimed at improving attentional control by targeting disengagement might be better for ruminating individuals than interventions focused on training attention to orient toward specific stimuli. Of interest, although rumination in the context of depression has been found to be specifically associated with difficulty disengaging from negative stimuli, nonclinical samples of adult ruminators have demonstrated difficulty disengaging from a variety of stimuli including those both positive and negative in valence (see Whitmer & Gotlib, 2012).

Although several studies have examined attentional control and rumination among adults, few studies have examined attentional processes and rumination in younger samples; thus, it is unclear whether findings from the adult literature can be applied to youth. Some research with adolescent samples has shown a relationship between effortful control and rumination (e.g., Hilt, Armstrong, & Essex, 2012; Verstraeten, Vasey, Raes, & Bijtteibier, 2009), and one study showed that rumination was associated with difficulty inhibiting negative emotional information on a switching task (Hilt, Leitzke, & Pollak, 2014). However, studies on specific attentional processes associated with rumination in younger samples are generally lacking. Because rumination is associated with psychopathology by adolescence (Hilt, Cha, & Nolen-Hoeksema, 2008; Muris, Roelofs, Meesters, & Boomsma, 2004; Nolen-Hoeksema, Stice, Wade, & Bohon, 2007; Rood et al., 2009), it is important to study attentional control among youth. If attentional control difficulties are associated with rumination among young, nonclinical samples, then targeting these processes could prevent the development of psychopathology.

One way to measure selective attention is through dot-probe tasks. In a dot-probe task, stimuli appear side by side and then disappear. Next, participants indicate where a dot is presented, which is in the location of one of the previous stimuli. Reaction times (RTs) are used to infer selective attention, with faster RTs suggesting greater attention to the stimuli preceding the dot.

The dot-probe task has been associated with attention biases among adults with affective disorders (Mogg & Bradley, 2005), and limited research has used this task to examine attention in relation to rumination. Two studies with depressed adults found that rumination was associated with an attentional bias for negative stimuli (sad words or pictures; Donaldson, Lam, & Mathews, 2007; Joormann, Dkane, & Gotlib, 2006). Studies with youth also suggest that rumination is associated with greater attention to emotional faces (vs. neutral) following a negative mood induction (Romens & Pollak, 2012) or to neutral faces (vs. happy) following a laboratory stressor (Hilt & Pollak, 2013).

Although these studies bolster support for selective attention being involved in rumination, RT indices of attention from the dot-probe task cannot distinguish whether ruminators initially orient toward a particular type of stimulus, have enhanced maintenance of attention, or have difficulty disengaging from certain stimuli (Koster, Crombez, Verschuere, & DeHouwer, 2004; Weierich, Treat, & Hollingsworth, 2008). This is because the dot-probe task infers attention from a single point in time—when individuals press the button to indicate the location of the dot. The stimulus presentation time typically used in studies that find a depression-related bias is at least 1,000 ms (Wisco, 2009). This allows ample time for multiple fixations, as fixations are usually defined as looking within a specific location for at least 100 ms, with the average length being 300 ms (Henderson & Hollingworth, 1998). Thus, we might expect that attentional biases on the dot-probe reflect where individuals are looking during the end of the trial, which could, but may not necessarily be, the same place they are looking throughout the trial.

One way to examine how rumination may be associated with early versus later stages of selective attention processes is through eye tracking. Eye tracking allows for direct

measurement of eye gaze (i.e., overt attentional processes) and can be used to precisely measure the amount of time individuals look at a particular stimulus throughout the duration of a trial. This provides a dynamic assessment of early, rapid, overt attentional processes.

THE PRESENT STUDY

In the present study, we employed eye tracking to measure overt selective attention during an emotional-faces dot-probe task with a community sample of youth. We hypothesized that rumination would be associated with greater attention to emotional stimuli and explored whether this occurred earlier or later in the selective attention process. We expected that rumination would be associated with longer time dwelling on emotional faces once attention was allocated to them, suggesting a possible difficulty in disengaging from the stimuli rather than initially orienting toward emotional stimuli. Because depression and anxiety have been associated with biased attention on dot-probe tasks (see Mogg & Bradley, 2005), we measured symptom levels of these constructs. Understanding the attentional control patterns associated with rumination has important implications for the treatment and prevention of psychopathology. If ruminators do get stuck on emotional cues, devoting undue attentional resources, they might miss other critical information in the environment that could help them disambiguate situations, suggesting that a critical intervention component should involve helping ruminators to disengage attention.

METHOD

Participants

Ninety-two youth (72% 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 1 month to 14 years 3 months ($M = 11.34$, $SD = 1.46$). We chose this age range in order to understand rumination during the developmental period before the sharp increase in depression typically emerges (Hankin et al., 1998; Twenge & Nolen-Hoeksema, 2002). Racial-ethnic distribution was 74% Caucasian, 12% African American, 10% Asian American, 1% Native American, and 3% Other. Annual family income was reported by a parent and ranged from less than $5,000 to greater than $200,000 ($Mdn = \sim \$80,000$). Informed consent was obtained from the child's parent, and assent was obtained from all youth.

Measures

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, Aydin, & Auerbach, 2007; Abela et al., 2002). Although the Rumination scale typically used with adults comprises two

rumination factors (brooding and reflection; Treynor, Gonzales, & Nolen-Hoeksema, 2003), the CRSQ rumination scale used in this study 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 et al., 2008) and as has been done with other studies of youth (e.g., Burwell & Shirk, 2007). The CRSQ rumination scale demonstrated good reliability in this study ($\alpha = .86$).

Depression symptoms—Youth completed the Children's Depression Inventory (Kovacs, 1992), a 27-item self-report measure of depressive symptoms that has been standardized on children and adolescents 7 to 17 years of age. 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 Children's Depression Inventory has sound psychometric properties, including internal consistency (Reynolds, 1994), test–retest reliability, and discriminant validity (Kovacs, 1992). Internal consistency for the present sample was excellent ($\alpha = .90$).

Anxiety symptoms—Youth completed the Multidimensional Anxiety Scale for Children (March, Parker, Sullivan, Stallings, & Conners, 1997), a 39-item screening questionnaire for anxiety problems in children and adolescents between the ages of 8 and 19. For each item, participants indicate how true it is for him or her on a 4-point Likert scale, ranging from 0 (*never true*) to 3 (*very true*). The Multidimensional Anxiety Scale for Children has demonstrated excellent internal consistency along with adequate convergent and divergent validity (March et al., 1997). Internal consistency in the present sample was excellent ($\alpha = .90$).

Dot-probe task—An emotional-faces dot-probe task (Romens & Pollak, 2012; adapted from Joormann, Talbot, & Gotlib, 2007) was used to examine attentional patterns related to facial expressions of emotion. Face stimuli were selected from the MacArthur Network Face Stimuli Set (http://www.macbrain.org/resources.htm; Tottenham, Borscheid, Ellersten, Marcus, & Nelson, 2002; Tottenham et al., 2009). This stimuli set consists of color photographs of 646 different facial-expression stimuli displayed by a variety of models of each sex and varying ethnicities. Models were selected based on reliability scores across emotion types (Tottenham et al., 2009), and the task included 19 models from the set with approximately equal representations of sex and ethnicity that each displayed a neutral, happy, sad, and angry expression. Each stimulus was displayed twice, resulting in 38 trials for each emotion type (happy, sad, and angry) for a total of 114 trials. The task was presented with E-Prime 2.0 (Psychology Software Tools; Pittsburgh, PA). The size of each picture on the screen was approximately 18.2 × 23.1 cm. The pictures in each pair were approximately 28 cm apart (measured from their centers). The task was presented on an IBM-compatible computer and a Tobii color monitor with eye-tracking capability. Each trial began with a fixation cross for 1,000 ms, followed by presentation of the face pair

(emotional and neutral) for 1,500 ms. After offset of the face pair, a small dot appeared in the center of the location where one of the faces had been. The dot remained on the screen until the participant responded with a key press to indicate the location of the dot. Faces appeared in the right and left positions equally, as did the dot. Participants were instructed to press a button on a computer keyboard corresponding to the location of the dot on the screen. Participants first completed 10 practice trials and were told that it was important to respond as fast as they can without making mistakes.

Attention bias scores based on RT were computed for sad, angry, and happy as described by Mogg and Bradley (2005): 1/2 [RpLe—RpRe) + (LpRe—LpLe)] where R = right position, L = left position, p = probe, and e = emotional face. Scores would be zero by chance; thus, scores greater than zero indicate greater attention toward the emotional face relative to neutral, whereas scores less than zero indicate greater attention toward the neutral face relative to the emotional face. RTs from incorrect trials were excluded along with RTs less than 150 ms and greater than 2 standard deviations above each individual's average. Less than 5% of the data were excluded based on these criteria.

Eye movement was recorded via eye tracking using E-Prime Extensions for Tobii (Psychology Software Tools; Pittsburgh, PA). Fixations were defined as at least 100 ms of looking within a 50-pixel radius. Fixations toward emotional stimuli initiated prior to stimulus onset were excluded. Areas of interest were defined as the area of each face and the gray space immediately around it to form a rectangle around each face stimulus. To measure initial allocation of attention, we computed the average proportion of trials where the first fixation was on the emotional face as opposed to the neutral face for sad, angry, and happy trials. Based on chance, these scores would equal .5, so numbers greater than .5 indicate more first fixations on the emotion face and numbers less than .5 indicate more first fixations on the neutral face. We also computed total time continuously dwelling on each stimulus type once a fixation first occurred (in millliseconds, averaged across trials).

Procedure

Participants completed self-report measures at home during the week of their lab visit. During the lab visit, participants sat down in front of a 21-in. (53.3-cm) Tobii 2150 eye tracker screen (1600 × 1200 screen resolution), which uses binocular pupil tracking and samples at a rate of 50 hz, at a distance of approximately 27.5 in. (70 cm). This is a non-invasive eye-tracking procedure because participants can sit comfortably (i.e., no chin rest is required) and their gaze patterns are monitored from cameras concealed just below the computer screen. This eye-tracking procedure is robust to head movement, which is particularly helpful when studying youth. Eye movements were calibrated using a 5-point calibration-accuracy test in which participants were instructed to visually follow a moving circle to five different points on the computer screen while their eye positions were recorded and mapped. Following calibration, participants completed the dot-probe task and other activities (not related to the present study). At the end of the lab session, participants received $10 and a prize. The study was approved by an Institutional Review Board at the University of Wisconsin–Madison.

Data Analytic Plan

We predicted that rumination would be associated with greater attention to emotional information in the later stages of selective attention processing (i.e., longer dwell) but not related to initial allocation of attention. First, to compare our results to previous research, we examined whether rumination was associated with differences in RT scores, which would suggest selective attention differences but not differentiate among stages of selective attention. Next, we examined eye-tracking data related to initial allocation of attention and dwell in order to examine attention to emotional information at early and later stages of selective attention.

We planned to test our hypothesis with mixed analysis of variance (ANOVA) models to predict three dependent variables from rumination scores: manual RT scores, initial allocation of attention, and dwell. Because age and gender differences have been related to rumination and psychopathology (Nolen-Hoeksema et al., 2008; Rood et al., 2009), we also examined these factors and their interactions with rumination in our analyses. In addition, because rumination has been strongly associated with depression and anxiety (see Nolen-Hoeksema et al., 2008), we measured symptom levels of depression and anxiety and included them in our analyses. First, however, we tested models without additional covariates given that rumination without depressive and anxiety symptoms may not be an ecologically valid construct and power to detect effects with additional predictors would be limited.

Our models included continuous predictors (rumination, along with depression and anxiety symptoms and age) and gender. The RT and initial allocation of attention models included one within-subjects factor: trial type (sad, angry, and happy; all relative to neutral). The dwell model included two within-subjects factors: face type (emotional faces, neutral faces) and trial type (sad, angry, happy). We predicted a Rumination × Face Type interaction, with rumination predicting longer dwell on emotional faces. We also explored whether this was qualified by a three-way Rumination × Face Type × Trial Type interaction, which might suggest differences between negative and positive emotional stimuli (as suggested by Koster et al., 2011).

RESULTS

Descriptive Statistics

Means, standard deviations, and correlations with rumination are presented in Table 1. It is noteworthy that rumination is correlated with proportion of first fixation on happy faces and with dwell on happy faces. Also, the pattern of correlations for dwell suggests that rumination is not associated with dwell on neutral faces but is positively related to dwell on emotional faces, albeit with small magnitude and nonsignificant relationships except for happy faces. RT scores appear small (which is not surprising given the nonclinical sample), and one-sample t tests show that none were significantly different from zero, on average; for angry, $t = -1.02$, $p = .312$; for sad, $t = 1.87$, $p = .065$; for happy, $t = -1.70$, $p = .092$.

It is also important to note that symptom scores reflect the unselected nature of the sample. T scores for depressive symptoms ranged from 35 to 71, with three participants scoring

above the clinical cutoff of 65. *T* scores for anxiety symptoms ranged from 27 to 80, with two participants scoring above the clinical cutoff of 65.

Hypothesis Testing

We predicted that rumination would be associated with greater attention to emotional information in the later stages of selective attention as indicated by longer dwell, rather than during initial allocation of attention, as indicated by proportion of first fixations.

Reaction time scores—Although RT scores cannot distinguish between earlier and later stages of selective attention processes, we included this analysis to ensure that our results can be compared to extant data. In the model without additional covariates, there was neither a main effect of trial type nor a significant Trial Type × Rumination interaction. There was a marginal main effect of rumination, suggestive of rumination being associated with relatively greater attention to emotional faces (see Table 2). The addition of covariates (i.e., depressive and anxiety symptoms, age and gender) did not change the pattern of results. In addition, there were no main effects or significant Rumination × Age or Rumination × Gender effects.

Eye tracking: Initial allocation of attention (early stage selective attention)—There was no significant effect of rumination, or Trial Type × Rumination interaction in the model without covariates, but there was a main effect of trial type (see Table 3). Examination of means (Table 1) suggests that the proportion of first fixations on angry faces relative to neutral was higher than the proportions for sad and happy. The addition of covariates eliminated this effect, and no additional significant main effects or interactions with age or gender emerged.

Eye tracking: Dwell (later stage selective attention)—In the model without additional covariates, there was a main effect for face type that was qualified by a significant Face Type × Rumination interaction (see Table 4). Rumination was significantly correlated with dwell time on emotional faces ($r = .20$, $p = .05$) but not on neutral faces ($r = .11$, $p = .28$), suggesting that rumination is associated with longer dwell on emotional faces. The addition of covariates in the model reduced the power to detect this effect ("observed power" dropped from .54 to .06). No other effects emerged with the addition of covariates and age and gender interaction terms.

DISCUSSION

The goal of the present study was to examine selective attention for emotional stimuli and its relationship to rumination among young adolescents. We found that rumination was marginally associated with greater RT scores on an emotional faces dot-probe task. We were able to distinguish among early and later processes of selective attention using eye tracking and found that this attentional pattern was not due to greater facilitation of attention toward emotional stimuli; rather, the attentional pattern associated with rumination appears to occur in later stages of selective attention processing. Rumination predicted greater dwell on emotional faces after a first fixation, suggesting that rumination may be involved with difficulty disengaging attention from emotional information in youth.

The magnitude of the attention bias was small, and this may be due to the nonclinical nature of the sample. Previous research showing a RT bias associated with rumination using an emotional dot-probe task has focused primarily on depressed adults (Donaldson et al., 2007; Joormann et al., 2006) or has used a negative mood induction (e.g., Romens & Pollak, 2012). We chose to examine our hypothesis in a nonclinical sample without a negative mood induction for several reasons. Because rumination poses a risk for various forms of psychopathology, we did not want to examine it in the context of a particular disorder. Relatedly, although sad mood inductions have often been employed in the context of a sad bias on the dot-probe, we did not induce a negative mood, as we wanted our findings to be generalizable to rumination, not just in the context of depression. The effect size for the Face × Rumination interaction in predicting dwell time in the present study was medium in magnitude. We might expect an even larger effect in a clinical sample with higher rumination scores.

Although some theoretical conceptualizations suggest that rumination should be associated only with attentional difficulties related to *negative* information (e.g., Koster et al., 2011, who predicted that difficulty inhibiting negative information underlies rumination), we did not find this. Results from the mixed ANOVA model suggest that the association between rumination and attention to emotional information was not valence specific, and the pattern of correlations suggests that this effect may have been driven by longer dwell time on happy faces. These findings are consistent with findings from other recent studies demonstrating cognitive control difficulties for positive and negative emotional information among ruminators (e.g., Joormann & Tran, 2009; see Whitmer & Gotlib, 2012, for a review). For example, our findings are consistent with a study that found poststressor rumination was associated with difficulty disengaging from sad, angry, and happy faces among dysphoric individuals on an exogenous cuing task (LeMoult, Arditte, D'Avanzato, & Joormann, 2013). The present findings are also consistent with another dot-probe study with youth that found greater attention to emotional faces associated with rumination among maltreated children following a sad mood induction (Romens & Pollak, 2012).

The finding that rumination was associated with longer looking at emotional faces other than just sad, as is typically seen in depression, is informative. It could help to explain why rumination is associated with many different forms of psychopathology (Nolen-Hoeksema & Watkins, 2011). For example, rumination is associated with anxiety (e.g., Muris et al., 2004), and anxious individuals have displayed difficulty disengaging from threatening stimuli such as angry faces (e.g., Buckner, Maner, & Schmidt, 2010). The finding that rumination was associated with selective attention for happy faces does run counter to a previous study that found rumination to be associated with relatively greater attention to neutral faces during happy dot-probe trials (Hilt & Pollak, 2013). However, the previous study examined state rumination in response to an interpersonal stressor rather than a general tendency to ruminate as was examined in the present study, and it also used RT scores only, not eye tracking. Taken together, results from the present study suggest that rumination may involve a general difficulty with prolonged processing of emotional information, not one specific to sad emotion.

A strength of the present study was the ability to distinguish among earlier and later subcomponents of selective attention through the use of eye tracking. Rumination was not related to initial allocation of attention in the mixed ANOVA model. However, once the face was attended to, rumination was associated with longer dwell on emotional faces relative to neutral ones, suggesting that rumination is associated with differential patterns of attention during the later stages of selective attention. It is noteworthy that rumination was associated with a greater proportion of first fixations on happy faces, relative to neutral, at the bivariate level, suggesting that early stages of selective attention could also be relevant. One limitation of the dot-probe task is that it is not able to distinguish between maintenance and disengagement processes (Koster et al., 2004). Paradigms with a specific incentive to disengage would better be able to isolate disengagement (e.g., Sánchez, Vázquez, Marker, Le Moult, & Joormann, 2013; Sears, Thomas, LeHuquet, & Johnson, 2010) and should be a focus of future work related to rumination.

This pattern of results contributes to the larger literature on attentional control difficulties among individuals who ruminate and extends these findings in two important ways. First, by using eye tracking to distinguish between earlier and later selective attention processes, this study supported the idea that rumination may be specifically associated with differences in later stages of selective attention. This complements research that has focused on the role of attentional control in rumination and further suggests specific processes of selective attention that could be targeted in prevention and treatment. Second, this study extends research on the association between selective attention and rumination to a younger sample than has previously been examined. Now that a preliminary body of evidence suggests that attentional control difficulties are associated with rumination by early adolescence (also see Hilt et al., 2014; Romens & Pollak, 2012), we can examine the development of attentional control and rumination prospectively with younger samples to help understand the temporal relationships between these two processes. In addition, because rumination is associated with the development of psychopathology by adolescence (e.g., Rood et al., 2009), a greater understanding of this correlate could offer an avenue for prevention in the form of attention training.

This study should be interpreted within the context of its limitations. In addition to the limitation of the task just discussed, some participants showed signs of boredom or fatigue completing the task. In future research with youth, it may be helpful to design a more engaging and motivating task to assess attention. In addition, because we used a single task to assess attention, we cannot be sure whether attentional patterns among youth who ruminate are specific to emotional or more general stimuli. However, in another study of youth, rumination was associated with attentional patterns on an affective task but not a general cognitive task (Hilt et al., 2014). It will be important for future research to examine additional tasks with varying stimuli to better understand the extent of attentional patterns among youth who ruminate. Finally, we lacked the power to detect effects with additional covariates in the models (e.g., anxiety and depressive symptoms), suggesting that future research should attempt to recruit larger samples or groups with higher and lower symptom levels to understand the effects of internalizing symptoms in the relationship between rumination and attention.

The present study, along with previous studies with adults, showed that ruminators get very focused on certain stimuli. Although this can be adaptive in situations that require a narrow focus (Whitmer & Gotlib, 2012), there are costs associated with this narrowed attention. In our view, self-focused cognition is a generally adaptive tendency that helps facilitate self-regulation (see also Carver & Scheier, 1998). However, for effective self-regulation, individuals must move to active problem solving after self-reflection. Those who dwell may get stuck in cognitive loops when reflecting on personal situations (i.e., ruminating), preventing successful regulation and leading to psychopathology. Although the cross-sectional nature of our study precludes interpretation of temporal associations, it offers confidence that these constructs are operative in younger participants so that the emergence of attentional patterns and rumination can be examined in relation to the development of psychopathology in future research.

Our findings regarding the attentional patterns among youth who ruminate have important clinical implications. Because rumination was not associated with facilitation of attention but rather predicted dwell on emotional stimuli, attention training that focuses on disengagement of attention might be particularly helpful. Mindfulness meditation helps train attention to the present moment by “letting go” of habitual thought patterns like rumination. It has been successfully shown to reduce rumination with both brief and extensive training (e.g., Hilt & Pollak, 2012; Jain et al., 2007).

Given that rumination is associated with several forms of psychopathology, understanding its mechanisms are important for the prevention and treatment of psychopathology. The present study provided compelling evidence to support the hypothesis that rumination is associated with increased attention to emotional stimuli in the later stages of selective attention. Next steps involve designing paradigms to make the best use of eye-tracking technology to better understand attentional deployment in rumination and testing the temporal relationship between attentional patterns and rumination across development.

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TABLE 1

Means, Standard Deviations, and Bivariate Correlations With Rumination

		M	SD	r
Rumination Scores		10.54	6.94	—
Depressive Symptoms		5.84	5.75	.45**
Anxiety Symptoms		45.41	15.65	.52**
Manual RT Scores	Sad	7.52	38.68	.09
	Angry	−3.98	37.59	.04
	Happy	−6.91	38.99	.13
Proportion First Fixation	Sad	.51	.08	.08
	Angry	.55	.07	−.06
	Happy	.51	.07	.21*
Dwell (ms)	Sad	327.97	103.78	.12
	Angry	352.78	135.93	.07
	Happy	318.83	132.70	.21*
	Neutral (sad)	278.61	110.12	−.02
	Neutral (angry)	269.36	109.20	.00
	Neutral (happy)	286.02	117.01	.04

Note: Manual reaction time (RT) scores are calculated based on Mogg and Bradley (2005). Proportion of first fixation is the average proportion of time that the first fixation was on that (emotional) stimulus versus the paired neutral stimulus. Dwell is the length of continuous gaze on that stimulus type once a fixation has occurred, averaged across trials. ms = milliseconds.

* $p < .05$.

** $p < .01$.

TABLE 2

Results From Mixed Analysis of Variance Model Predicting Reaction Time Scores

Predictors	*F* Value	*p* Value	Partial η^2
Within Subjects			
Trial Type (Sad, Angry, Happy)	1.17	.314	.01
Trial Type × Rumination	.20	.808	.00
Between Subjects			
Rumination	3.13	.080	.03

TABLE 3

Results From Mixed Analysis of Variance Model Predicting First Fixation Proportions

Predictors	*F* Value	*p* Value	Partial η^2
Within Subjects			
Trial Type (Sad, Angry, Happy)	7.55	.001	.08
Trial Type × Rumination	1.56	.210	.02
Between Subjects			
Rumination	1.52	.222	.02

TABLE 4

Results From Mixed Analysis of Variance Model Predicting Dwell Duration

Predictors	*F* Value	*p* Value	Partial η^2
Within Subjects			
Trial Type (Sad, Angry, Happy)	1.65	.199	.04
Trial Type × Rumination	1.25	.291	.03
Face Type (Emotional, Neutral)	5.13	.026	.05
Face Type × Rumination	4.31	.041	.05
Face Type × Trial Type	1.63	.202	.04
Face Type × Trial Type × Rumination	0.25	.782	.01
Between Subjects			
Rumination	1.12	.292	.01