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Rumination prospectively predicts executive functioning impairments in adolescents

Samantha L. Connolly[a,*], **Clara A. Wagner**[a], **Benjamin G. Shapero**[a], **Laura L. Pendergast**[a], **Lyn Y. Abramson**[b], and **Lauren B. Alloy**[a]

Samantha L. Connolly: samantha.connolly@temple.edu; Clara A. Wagner: clara.wagner@temple.edu; Benjamin G. Shapero: benjamin.shapero@temple.edu; Laura L. Pendergast: laura.pendergast@temple.edu; Lyn Y. Abramson: lyabrams@wisc.edu; Lauren B. Alloy: lalloy@temple.edu

[a]Department of Psychology, Temple University, 1701 North 13th Street, Philadelphia, PA 19122, United States

[b]Department of Psychology, University of Wisconsin–Madison, 1202 West Johnson Street, Madison, WI 53706, United States

Abstract

Background and objectives—The current study tested the resource allocation hypothesis, examining whether baseline rumination or depressive symptom levels prospectively predicted deficits in executive functioning in an adolescent sample. The alternative to this hypothesis was also evaluated by testing whether lower initial levels of executive functioning predicted increases in rumination or depressive symptoms at follow-up.

Methods—A community sample of 200 adolescents (ages 12–13) completed measures of depressive symptoms, rumination, and executive functioning at baseline and at a follow-up session approximately 15 months later.

Results—Adolescents with higher levels of baseline rumination displayed decreases in selective attention and attentional switching at follow-up. Rumination did not predict changes in working memory or sustained and divided attention. Depressive symptoms were not found to predict significant changes in executive functioning scores at follow-up. Baseline executive functioning was not associated with change in rumination or depression over time.

Conclusions—Findings partially support the resource allocation hypothesis that engaging in ruminative thoughts consumes cognitive resources that would otherwise be allocated towards difficult tests of executive functioning. Support was not found for the alternative hypothesis that lower levels of initial executive functioning would predict increased rumination or depressive symptoms at follow-up. Our study is the first to find support for the resource allocation hypothesis using a longitudinal design and an adolescent sample. Findings highlight the potentially detrimental effects of rumination on executive functioning during early adolescence.

*Corresponding author. Tel.: +1 215 204 6852; fax: +1 215 204 5539.

Conflicts of interest
The authors declare no conflicts of interest.

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Keywords

Rumination; Executive functioning; Adolescence; Depression

1. Introduction

Major depressive disorder (MDD) is a common and debilitating mental illness with an estimated lifetime prevalence in the United States of 16.2% (Kessler, Merikangas, & Wang, 2007). It is particularly important to study the onset of depression during adolescence as the majority of adults with MDD experience their first depressive episode during this critical period of development (Kim-Cohen et al., 2003). Although rates of depression may be as low as 1% in children up to age 11, a dramatic spike in onset occurs during adolescence, with lifetime prevalence rising to an estimated 5% by age 15 and 20% by age 18 (Hankin et al., 1998).

Individuals with depression often report decreased concentration and memory, and cognitive difficulties are an established symptom of MDD (American Psychiatric Association [*DSM-IV-TR*], 2000; Gotlib & Joormann, 2010). Indeed, depression has been linked to impaired performance on cognitive tasks involving non-emotionally-valenced stimuli; deficits have been found in samples of depressed adults across all domains of executive functioning (EF) including attentional switching, updating and monitoring working memory, and selective attention (Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lonnqvist, 2008; Gotlib & Joormann, 2010; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Wagner, Doering, Helmreich, & Lieb, 2011). Findings in adolescent samples have been mixed. Unipolar depression in adolescence has been linked to poorer performance on neutral tests of sustained attention (Maalouf et al., 2011; Wilkinson & Goodyer, 2006), selective attention (Wilkinson & Goodyer, 2006), and attentional switching (Gunther, Konrad, De Brito, Herpertz-Dahlmann, & Vloet, 2011; Wilkinson & Goodyer, 2006), as well as working memory (Klimkeit, Tonge, Bradshaw, Melvin, & Gould, 2011; Matthews, Coghill, & Rhodes, 2008). However, some studies of EF in depressed adolescents have found no difference between depressed and non-depressed youth (Favre et al., 2009; Gunther, Holtkamp, Jolles, Herpertz-Dahlmann, & Konrad, 2004), suggesting that further research is necessary.

Cognitive impairments observed in depressed individuals may be related to cognitive vulnerabilities. Rumination, a cognitive vulnerability for depression, is characterized by recurring, perseverative thoughts about the symptoms, causes, and future repercussions of one's depression (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Smith & Alloy, 2009). Rumination has been found to predict the onset (Just & Alloy, 1997), duration (Roberts, Gilboa, & Gotlib, 1998), and number (Spasojevic & Alloy, 2001) of depressive episodes in adult samples. Rumination was also a significant predictor of depressive symptoms (Abela & Hankin, 2011; Nolen-Hoeksema et al., 2008; Roelofs et al., 2009) and episodes (Abela & Hankin, 2011) in studies of adolescents and children.

Rumination also has been linked to impaired cognitive processing on neutral tasks (Wisco & Nolen-Hoeksema, 2008). Dysphoric adults instructed to ruminate displayed inhibition impairments on the Stroop task (Philippot & Brutoux, 2008), as well as poorer short-term problem-solving abilities and impaired concentration (Lyubomirsky, Kasri, & Zehm, 2003; Lyubomirsky & Nolen-Hoeksema, 1995); the latter two effects did not emerge in nondysphoric participants, or when dysphoric participants were instructed to engage in distraction techniques. In addition to studies of rumination induction, trait rumination also has been associated with cognitive impairments on neutral tasks. Adults scoring higher in rumination were worse at inhibiting a previous task's instructions when presented with a new task; this result was independent of depression score (Whitmer & Banich, 2007). In addition, rumination has been linked to difficulties in attentional switching and mental flexibility in studies examining depressive symptoms in adults (Altamirano, Miyake, & Whitmer, 2010; Davis & Nolen-Hoeksema, 2000; De Lissnyder, Koster, Derakshan, & De Raedt, 2010). Findings of switching deficits complement the conceptualization of rumination as involving difficulties disengaging from depressive cognitions, resulting in repetitive, maladaptive thought patterns (Davis & Nolen-Hoeksema, 2000). In addition, tasks requiring attentional switching and inhibition may be particularly cognitively demanding, in accord with hypotheses that the detrimental effects of rumination on EF may only emerge when under significant cognitive load (Levens, Muhtadie, & Gotlib, 2009). Rumination also has been associated with working memory deficits (Berman et al., 2011; Meiran, Diamond, Toder, & Nemets, 2011). Only one study has examined the relationship between trait rumination, depression and EF in an adolescent sample; whereas attentional switching impairments were linked to MDD, there was no significant relationship between switching and trait rumination (Wilkinson & Goodyer, 2006). In sum, findings from adult and adolescent studies suggest a link between depression and cognitive impairment, particularly with regards to attentional processes and working memory on neutral tasks. Rumination has been associated with similar EF impairments in adults in domains such as attentional switching, inhibition, and working memory, and may in part be responsible for the deficits observed in relation to depression (Gotlib & Joormann, 2010; Hertel, 1998; Levens et al., 2009; Watkins & Brown, 2002).

However, the nature of the relationship between depression, rumination, and executive functioning is not well understood. Resource allocation theory posits that the negative thoughts of depression and rumination deplete limited cognitive abilities that would otherwise be directed towards task-relevant processes (Gotlib & Joormann, 2010; Levens et al., 2009; Watkins & Brown, 2002). According to this theory, valuable cognitive resources are allocated towards irrelevant depressive and ruminative thought processes. Indeed, depression and rumination have been associated with increased attention towards, and difficulty disengaging from, negative information, as put forward in the affective interference hypothesis (Gotlib & Joormann, 2010; Siegle, Ingram, & Matt, 2002). In line with this hypothesis, EF deficits observed in depressed and ruminative individuals may be more indicative of difficulties in cognitive control and attentional redirection than of global processing deficits (Gotlib & Joormann, 2010; Siegle et al., 2002). At the same time, although engaging in depressive and ruminative thoughts may deplete cognitive resources that would otherwise be directed towards relevant tasks, it is also possible that underlying cognitive impairments could be the cause of depressive and ruminative styles, or that these negative thought patterns and EF impairments interact (Gotlib & Joormann, 2010; Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Levens et al., 2009).

Unfortunately, there is a lack of longitudinal research attempting to better understand the direction of the relationship between rumination, depression, and EF impairment. Zetsche and Joormann (2011) found that impaired inhibition of negatively-valenced stimuli predicted increased rumination and depressive symptoms in adults at six-month follow-up; however, this study did not include non-emotional stimuli. De Lissnyder et al. (2012) utilized both emotional and non-emotional stimuli in a longitudinal study examining the relationship between EF, stress, and rumination in college students. They found that baseline emotional set-switching impairments moderated the effect of a stressful life event on subsequent brooding rumination, with higher levels of initial set-switching impairment resulting in higher rumination levels following the experience of a stressor. Interestingly, only emotional set-switching impairments significantly moderated the effect of stress on rumination; non-emotional switching impairments did not. Although these findings tentatively suggest that impaired processing of emotional information may play a role in the development of rumination, the relationship between rumination and non-emotional cognitive processing remains unclear.

Several prospective studies have linked rumination and depression in adolescence to lower levels of effortful control (EC), an aspect of temperament encompassing overall self-regulatory and attentional abilities (Hilt, Armstrong, & Essex, 2012; Verstraeten, Vasey, Raes, & Bijttebier, 2009). Associations have been found between low EC, rumination, and depressive symptoms both concurrently (Verstraeten et al., 2009) and prospectively (Hilt et al., 2012; Verstraeten et al., 2009), suggesting that lower levels of EC may predict greater rumination and that higher EC may serve as a protective factor against depressive symptoms, although null results also have been reported (Mezulis, Simonson, McCauley, & Vander Stoep, 2011). Findings from studies of EC suggest that the direction of the relationship between underlying cognitive abilities and rumination may be opposite to that proposed by the resource allocation hypothesis, underlining the need for additional longitudinal research. Additionally, the temperamental construct of effortful control in these studies is often measured by self-report, and does not address specific domains of executive functioning, which may be best examined using behavioural methods. To our knowledge, no prospective studies of rumination, depression, and behavioural indices of executive functioning have been conducted in an adolescent sample.

From a developmental perspective, it is particularly important to investigate the relationship between rumination, depression, and EF during adolescence. Adolescence is characterized by dramatic rises in depression (Hankin et al., 1998) and increases in rumination (Jose & Brown, 2008). Cognitive styles such as rumination have been hypothesized to undergo consolidation during this period (Alloy & Abramson, 2007), and the association between rumination and depressive symptoms has been found to increase in stability (Rood, Roelofs, Bögels, Nolen-Hoeksema, & Schouten, 2009). In addition, adolescence is characterized by the ongoing maturation of the prefrontal cortex and executive functioning abilities (Alloy & Abramson, 2007; Cicchetti & Rogosch, 2002; Jacobs, Reinecke, Gollan, & Kane, 2008; Steinberg, 2008), which continue to develop into mid-adolescence or beyond (Luna &

Sweeney, 2004; Steinberg, 2008). Importantly, EF domains have been found to follow unique developmental trajectories and develop at different rates, with some coming online by early adolescence and others continuing to develop into adulthood (for reviews see Anderson, 2002; Diamond, 2002; Luna, Garver, Urban, Lazar, & Sweeney, 2004; Spear, 2010; Steinberg, 2008). Although studies examining developmental changes in performance on tests of EF over short time increments during adolescence are relatively rare, there is evidence that development may occur rapidly in some domains. For example, children age 11–12 have been found to differ from children age 13–15 on tests of working memory (Conklin, Luciana, Hooper, & Yarger, 2007), and 15 year-olds have shown superior performance relative to 11 year-olds on aspects of the Wisconsin Card Sorting Test, a complex test requiring cognitive flexibility (Huizinga & van der Molen, 2007). Performance on a variety of tasks, including those assessing switching abilities, has been found to differ in children between ages 11 and 15 (Huizinga, Dolan, & Van der Molen, 2006).

Within this developmental context, a complex interplay between depression, rumination, and executive functioning is likely to occur. Consistent with the resource allocation hypothesis, it is possible that increases in rumination and depression occurring during adolescence may interfere with normative development of executive skills. Thus, adolescents who ruminate may fail to achieve expected gains in executive function over time. These adolescents may exhibit weaker EF relative to their same-aged peers as a result of habitual rumination. An alternative possibility is that relative weaknesses in executive functions may emerge during the transition to adolescence, when some adolescents may experience lags in cognitive development relative to their same-aged peers. Adolescents with relative weaknesses in EF may subsequently experience greater difficulty engaging in self-regulation and the redirection of attentional resources, thus leading to increases in rumination.

In the current study, we employed a longitudinal design to test whether higher levels of rumination and depressive symptoms at baseline would prospectively predict impaired executive functioning abilities on neutral tests of attention and memory in adolescents. According to the resource allocation hypothesis, habitually engaging in ruminative or depressive thoughts will deplete cognitive resources that would otherwise be directed towards neutral EF tasks. The current study sought to test this hypothesis against the alternate possibility that lowered executive functioning abilities may predict increases in rumination or depressive symptoms at follow-up. These questions were explored using a range of behavioural measures of EF previously demonstrated to be associated with rumination and/or depressive symptoms, including selective attention, sustained attention, attentional switching, divided attention, and working memory. We chose to examine multiple EF domains, given evidence that rumination and depression may exhibit dissociable patterns of association with EF measures (Altamirano et al., 2010). The current study expands on previous research by: 1) examining both the resource allocation hypothesis and its alternative using a prospective design and 2) utilizing an adolescent sample and behavioural measures of executive functioning. By employing measures of EF that controlled for age, we sought to examine the effects of rumination and depression on cognitive functioning over time while accounting for normative cognitive development occurring during adolescence.

2. Method

2.1. Participants and procedure

Participants were recruited as part of the Temple University Adolescent Cognition and Emotion (ACE) Project, a prospective longitudinal study of the emergence of depression in adolescence (Alloy et al., 2012). Adolescents and their primary female caregivers (91% were adolescents' biological mothers) were recruited from the Philadelphia School District (PSD) and other Philadelphia area public and private middle schools. Two recruitment methods were utilized. First, with the permission of the PSD, letters were mailed to the parents of African American and Caucasian male and female students, ages 12 and 13. Project staff members then made follow-up phone calls inviting families to participate. Second, study advertisements were placed in Philadelphia area newspapers, allowing parents to call and express interest in participating. Prior to inclusion in the study, phone screening interviews were completed to ensure eligibility. Eligible adolescents were 12 or 13 years old and self-identified as Caucasian, African American, or Biracial. Adolescents' primary female caregivers had to be willing to participate. Families were excluded if the adolescent and/or caregiver did not read or speak English well enough to complete study tasks, or if either the adolescent or caregiver had a severe psychiatric, developmental, medical, or learning disorder that would prevent adequate study participation. However, adolescents and/or caregivers with mild learning disabilities or cognitive impairments were eligible to participate provided that they could complete all study assessments.

Eligible mothers and adolescents were invited to complete the Time 1 assessment (T1), divided into two 3-h sessions. Prior to the T1 assessment, written informed consent was obtained from mothers and written assent was obtained from adolescents. During T1, mothers completed a demographic questionnaire and adolescents completed self-report measures of depressive symptoms (Children's Depression Inventory (CDI); Kovacs, 1992) and rumination (Children's Response Styles Questionnaire (CRSQ); Abela, Vanderbilt, & Rochon, 2004). Adolescents also completed behavioural tasks assessing attention (Test of Everyday Attention – Children (TEA-Ch); Manly, Robertson, Anderson, & Nimmo-Smith, 1999) and working memory (Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV) Digit Span; Wechsler, 2003). Adolescents completed these measures again at a follow-up assessment approximately one year later, referred to hereafter as Time 2 (T2). Mothers and adolescents were reimbursed for their participation after each assessment.

The current study includes the 200 adolescents (*M* age at T1 = 12.41 years old; SD = .63) who have completed both T1 and T2 assessments (*M* time to follow-up = 15.12 months, SD = 3.21 months). Of note, T2 also was divided into two separate sessions; as the T2 WISC Digit Span measure was conducted at a different session than the remaining T2 measures, some participants included in the current sample had not yet completed the Digit Span at both T1 and T2, lowering the sample size for these analyses (*N* = 172). The study sample was 56.5% female, 51.3% African American and 45.2% Caucasian. Participants varied in socioeconomic status; 27.5% had annual family incomes below $30,000, 45% had incomes between $30,000 and $75,000, and 27.5% reported incomes above $75,000. In addition, 51.3% of adolescents in the sample qualified for a subsidized school lunch, a measure of financial need that accounts for the number of dependents being supported by a given family income.

2.2. Measures

2.2.1. Children's Depression Inventory (CDI; Kovacs, 1992)—The CDI is a 27-item self-report measure of depressive symptoms during the past two weeks designed for youth ages seven to 17. Ratings range from zero to two for each question and are summed to create a total score ranging from zero to 54, with higher scores indicating higher depressive symptom levels. The CDI has demonstrated good reliability and validity (Klein, Dougherty, & Olino, 2005) and displayed a coefficient alpha of .86 in the current study, indicating strong internal consistency.

2.2.2. Children's Response Styles Questionnaire (CRSQ; Abela et al., 2004)—The CRSQ is a 25-item self-report measure of trait rumination. Participants indicated the manner in which they respond to feelings of sadness. The CRSQ has three subscales: rumination, distraction, and problem-solving. The current study employed the rumination subscale, which consists of 13 items referencing self-focused responses to sad mood. Ratings vary on a four-point scale and responses are summed to yield a total rumination score, with higher scores representing a greater tendency to ruminate when experiencing depressed mood. Past research employing the CRSQ has indicated good validity and moderate internal consistency (Abela et al., 2004). In the current sample, the coefficient alpha was .85, indicating strong internal consistency.

2.2.3. Test of Everyday Attention – Children (TEA-Ch; Manly et al., 1999)—The TEA-Ch was developed to assess attentional domains of executive functioning in youth ages six to 16. It consists of a series of activities designed to measure sustained attention, selective attention, attentional switching, and divided attention. The TEA-Ch has demonstrated both convergent and discriminant validity (Manly et al., 2001). To prevent practice effects, distinct versions of each TEA-Ch subtest (Version A and Version B) were administered at T1 and T2.

2.2.3.1. Selective attention: Sky Search (SS) is a timed test of selective attention requiring participants to search for targets (20 pairs of matching spaceships) among distracters (108 pairs of nonmatching spaceships). It includes a secondary motor control condition free of distracters to control for individual differences in psychomotor speed. The score utilized in the current study is an overall selective attention score (SS Attention Score), calculated by subtracting the ratio of targets found to time elapsed in the motor control condition from the same ratio in the distracter condition.

2.2.3.2. Sustained attention: Score! is an auditory test of sustained attention in which participants listen to an audio recording of identical tones presented at irregular intervals across ten trials of varying length. Participants are instructed to count silently and to report the number of tones they hear during each trial. Score! yields an overall accuracy score (Score! Correct Trials).

2.2.3.3. Attentional switching: The Creature Counting (CC) subtest consists of seven trials in which participants count pictures of creatures along a winding path, alternating between counting forwards and backwards as indicated by the presence of an up or down arrow, respectively, at various points along the path. This task assesses attentional switching and the inhibition of previous counting direction. The current study employed a measure of switching accuracy (CC Correct Trials).

2.2.3.4. Divided attention: Sky Search Dual Task (SS DT) is a cross-modal dual task measuring divided attention. After completion of the Sky Search and Score! subtests, participants are instructed to simultaneously perform both tasks, circling matching spaceship pairs and ignoring distracters while also counting the number of tones heard and providing a total count at the end of each Score! trial. This task yields an accuracy score based on the proportion of attempted counting trials correctly identified and the number of visual search targets correctly circled.

2.2.4. Wechsler Intelligence Scale for Children – Fourth Edition-Digit Span (WISC-IV; Wechsler, 2003)—The Digit Span subtest of the WISC-IV measures auditory verbal working memory in youth ages six to 18. Participants listen to and then repeat a series of numbers read aloud by the experimenter (Digit Span Forwards). This task is intended to measure sustained attention and short-term memory abilities. Participants subsequently listen to a series of numbers presented by the experimenter and then repeat them aloud in reverse order (Digit Span Backwards), a task thought to measure the maintenance and manipulation of information in one's working memory. A total score is calculated which takes into account performance on both Digit Span subtests (Digit Span Total Score).

2.2.5. Demographic questionnaire—A demographic questionnaire was completed by female caregivers at the T1 assessment. Participants responded to multiple choice questions regarding their relationship with the adolescent (e.g., biological mother, stepmother, grandmother), marital status, household income, highest education level for each of the adolescent's parents, and the adolescent's eligibility for a subsidized school lunch. In addition, caregivers provide their own age, race, and ethnicity, and that of their child.

2.3. Statistical analysis

All TEA-Ch variables were converted from raw scores to scaled scores based on age and gender norms (M = 10, SD = 3 for all scaled scores) (Manly et al., 1999). The use of scaled scores allows for more standardized comparisons of participants and differing TEA-Ch subtests over time. Scaled scores are based on a normal distribution, helping to eliminate differences between measures and better isolate the EF constructs of interest. The WISC-IV Digit Span Total Score was also converted to a scaled score (M = 10, SD = 3) based on participant age (Wechsler, 2003).

t-Tests were conducted to identify time point differences in depressive symptoms, rumination, and EF scores. Pearson correlations were used to examine the relationship between depressive symptoms, rumination, and EF variables within and across time points. Our primary study aims was addressed using hierarchical linear regressions to test the resource allocation hypothesis against its alternative that lower initial levels of EF would predict increases in rumination and/or depressive symptoms.

In the first set of regressions testing the resource allocation hypothesis, EF scores served as dependent variables. All regressions controlled for the amount of time elapsed between T1 and T2. Of note, age was not controlled for, as all EF scaled scores were normed based on age. Regressions did not control for gender, as TEA-Ch variables were normed based on gender, and no significant gender differences were found in the degree of change of the WISC-IV Digit Span Total Score at follow-up.[1] For regressions testing whether T1 rumination predicted a change in EF, the T1 EF variable of interest, time to follow-up, and T1 and T2 depressive symptoms were entered in Step 1, T2 rumination were entered in Step 2, and T1 rumination was entered in Step 3. In regressions testing whether T1 depressive symptoms were predictive of EF change, the T1 EF variable of interest, time to follow-up, and T1 and T2 rumination were entered in Step 1, T2 depressive symptoms was entered in Step 2, and T1 depressive symptoms was entered in Step 3. T2 measures of rumination and depressive symptoms were included in order to test the full model, addressing the possibility that there were persistent correlations between EF, rumination, and depressive symptoms across time points.

The second set of regressions examined the alternative hypothesis that baseline EF levels may predict change in T2 rumination and depressive symptoms at follow-up. T2 rumination and depressive symptoms served as dependent variables. All regressions controlled for time elapsed between T1 and T2. Age at T1, race, and socioeconomic status were not found to significantly predict change in rumination or depressive symptoms at follow-up and were not included as controls.[2] In regressions predicting to T2 rumination, Step 1 included T1 rumination, T1 and T2 depressive symptoms, and time to follow-up. The T2 EF variable of interest was entered in Step 2, and the T1 EF variable of interest was entered in Step 3. When predicting to T2 depressive symptoms, Step 1 included T1 depressive symptoms, T1 and T2 rumination, and time to follow-up. The T2 EF variable of interest was entered in Step 2, and the T1 EF variable of interest was entered in Step 3.

3. Results

3.1. Time point differences and correlations for main study variables

All main study variable means and standard deviations for the overall sample at T1 and T2 are presented in Table 1. T1 depressive symptoms and rumination were significantly higher than T2 levels (CDI, $t(197) = 4.56$, $p < .001$; CRSQ Rumination, $t(190) = 2.25$, $p < .05$). Although selective attention and attentional switching showed significant increases at T2, sustained attention and divided attention displayed significant decreases. Bivariate correlations of study variables across time points are displayed in Table 2. Depressive

[1]In addition, in cases where SES and race were significant predictors of change in a given EF variable from T1 to T2, we reran regression analyses controlling for these variables. Controlling for SES and race did not alter the significance of our findings. Results are therefore presented controlling only for time in order to increase consistency in the covariates included in our regressions testing both models. The results of these additional analyses are available upon request.

[2]Being female was found to significantly predict increases in rumination at T2. Analyses including gender as a covariate are not displayed here in order to increase consistency across regressions testing both models. However, controlling for gender did not alter the significance of our findings. The results of these analyses are available upon request.

symptoms were positively correlated with rumination within both time points (*r*s > .38, *p*s < .001). T1 CDI was also correlated with T2 rumination ($r = .31$, $p < .001$); T1 rumination was correlated with T2 CDI at the trend level ($r = .14$, $p < .06$). T1 rumination was significantly correlated with lower selective attention and attentional switching at T2 (SS Attention Score, CC Correct Trials; *r*s > |−.17|, *p*s < .05). CDI was not correlated with EF measures at either time point (*r*s < |−.10|, *p*s > .10).

Depressive symptoms and rumination displayed moderate retest reliability, with positive correlations between T1 and T2 scores (CDI $r = .38$, $p < .001$; CRSQ Rumination $r = .44$, $p < .001$). Divided attention and working memory also showed positive retest correlations between T1 and T2 (SS Dual Task Score $r = .24$, $p < .01$; Digit Span Total Score $r = .56$, $p < .001$), whereas the remaining EF measures did not display significant retest correlations (*r*s < |.01|, *p*s > .05).

3.2. Hierarchical linear regressions

3.2.1. Test of the resource allocation hypothesis—Results of regressions testing T1 rumination as a predictor of change in EF are displayed in Table 3. It was found that T2 rumination was a significant predictor of lower T2 selective attention when entered into Step 2 (SS Attention Score; $\beta = -.18$, R^2 change = .03, $p < .05$). When T1 rumination was entered into the regression model in Step 3, the relationship between T2 rumination and selective attention was no longer significant ($\beta = -.12$, $p > .10$). T1 rumination was a marginally significant predictor of decreases in selective attention at T2; the addition of T1 rumination to the model resulted in a trend-level increase in the explanatory power of the regression equation ($\beta = -.16$, R^2 change = .02, $p < .09$). These findings suggest that the significant relationship between T2 rumination and decreased T2 selective attention was in part explained by T1 rumination levels, in that higher levels of baseline rumination predicted poorer selective attention performance at follow-up at the trend level. Increased rumination at T1 was also predictive of decreases in attentional switching performance at T2 (CC Correct Trials; $\beta = -.28$, R^2 change = .05, $p < .001$). T1 rumination did not predict changes in sustained attention, divided attention, or working memory scores at follow-up (βs < |−.15|, R^2 change values < .01, *p*s > .10).

T1 and T2 CDI were not correlated with EF measures at either time point. However, hierarchical regressions indicated that T1 CDI was a marginally significant predictor of increases in sustained attention and attentional switching at T2 when controlling for T2 CDI and T1 and T2 rumination (Score! Correct Trials, CC Correct Trials; βs > .16, R^2 change values > .02, *p*s = .05–.10, Table 3). Given that T1 CDI was not significantly correlated with these EF variables (see Table 2), post-hoc analyses were conducted in which T1 and T2 rumination and T2 CDI were removed from the model to examine whether T1 CDI alone predicted increases in T2 sustained attention or attentional switching at follow-up, controlling for the complementary EF values at T1. T1 CDI standardized coefficients substantially decreased and no longer predicted change in EF at the trend level (βs < .08, R^2 change values < .01, *p*s > .20). Therefore, it is likely that these findings of T1 CDI predicting increases in T2 EF domains when testing the full model are spurious, resulting from the strong correlations between T1 and T2 rumination and depression variables.

3.2.2. Test of the alternative hypothesis—The second set of regressions tested whether differences in T1 measures of EF were predictive of change in rumination or depressive symptoms at follow-up. No T1 or T2 EF variables predicted T2 rumination or depression scores (see Table 4). However, it was possible that strong relationships between rumination and depression scores may have dampened the potential effects of EF in predicting change in either of these measures at follow-up. Therefore, post-hoc regressions were conducted in which 1) CDI variables were removed from regressions predicting to T2 rumination and 2) rumination variables were removed from regressions predicting to T2 depression. Effects of T1 EF variables remained nonsignificant (βs < |−.11|, R^2 change values < .01, *p*s > .10).

T1 rumination and T2 CDI significantly predicted rumination at follow-up (βs > .33, *p*s < .001); these effects remained significant when taking into account time between sessions and the T1 and T2 values of the EF variable of interest. For regressions employing T2 depressive symptoms as the dependent variable, T2 rumination and T1 CDI scores significantly predicted T2 depressive symptoms (βs > .33, *p*s < .001); these effects remained significant when taking into account time between sessions and the T1 and T2 values of the EF variable of interest. T1 rumination was predictive of decreases in depressive symptoms at follow-up, contrary to prediction (βs > |−.16|, $p < .05$). However, a post-hoc regression found that T1 rumination was not significantly related to change in depressive symptoms when not including other covariates ($\beta = -.03$, $p > .10$), suggesting that the negative correlation reported above may again have been the result of strong relationships between T1 and T2 rumination and depression variables. Gender was not a significant predictor of increased depressive symptoms at follow-up.

4. Discussion

The current study examined whether baseline rumination or depressive symptoms were predictive of deficits in executive functioning (EF) at a 15-month follow-up in an adolescent sample. Baseline (T1) rumination levels were found to prospectively predict decreases in attentional switching, and in selective attention at the trend level, at follow-up (T2); T1 depressive symptoms did not predict meaningful change in EF values at T2. These findings provide partial support for the resource allocation hypothesis, which posits that engaging in ruminative or depressive thoughts depletes cognitive resources that would otherwise be allocated to challenging tests of neutral EF. Support was not found for the alternative hypothesis that lower levels of initial EF would predict increased rumination or depressive symptoms at follow-up. Our study is the first to find support for the resource allocation hypothesis employing a longitudinal design and an adolescent sample.

Findings of a relationship between rumination and decreased attentional switching align with previous research linking rumination in adults to poorer concurrent performance on neutral cognitive tasks involving switching and mental flexibility (Altamirano et al., 2010; Davis & Nolen-Hoeksema, 2000; De Lissnyder et al., 2010; Levens et al., 2009; Whitmer & Banich, 2007). Switching deficits are consistent with the conceptualization of rumination as involving deficiencies in redirecting attention away from depressive cognitions, leading to repetitive, maladaptive thought patterns (Davis & Nolen-Hoeksema, 2000). Our finding that

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rumination predicted marginally significant decreases in selective attention at follow-up complements previous research reporting that rumination induction led to a decreased ability to ignore distracting information and attend to the task at hand (Philippot & Brutoux, 2008; Watkins & Brown, 2002). However, other studies have found a lack of relationship between trait rumination and selective attention, or conversely, an improved ability to ignore irrelevant distracters and attend to relevant stimuli, suggesting that more research on the relationship between selective attention and rumination is needed (Altamirano et al., 2010; Whitmer & Gotlib, 2012; Zetsche, D'Avanzato, & Joormann, 2012; Zetsche & Joormann, 2011).

Consistent with previous studies (De Lissnyder et al., 2010; Whitmer & Banich, 2007), rumination was a significant predictor of poorer EF abilities controlling for baseline depressive symptoms. This suggests a unique link between rumination and EF impairments that may underlie the relationship between depression and cognitive deficits observed in some studies. Previous literature has suggested that the detrimental effects of rumination on EF only emerge under conditions of high interference (Levens et al., 2009). In line with this hypothesis, the tests of selective attention and switching that displayed near significant or significant decreases in the current study consume a considerable amount of cognitive resources; the selective attention task requires the inhibition of distracters, whereas the attentional switching task demands shifting between tasks and inhibiting the previous direction of counting. Baseline rumination was not predictive of poorer working memory or sustained or divided attention. Although working memory deficits previously have been linked to ruminative response styles (Berman et al., 2011; Meiran et al., 2011), these findings were obtained in samples of clinically depressed patients and may not generalize to trait rumination in nonclinical samples. It is also possible that the working memory task utilized in the current study did not involve the degree of complexity required in some TEA-Ch subtests. This decreased cognitive demand may also help explain the lack of findings within the sustained attention domain, where participants were instructed to count the number of tones heard and were not presented with distracter stimuli. The TEA-Ch divided attention task combined the selective and sustained attention tests into one exercise. While this may be thought to increase cognitive load, this task was a combination of tests that participants had previously completed. Therefore, participants had the ability to practise these tasks individually prior to integrating them, which may have decreased the divided attention task's difficulty. In addition, more effective tests of divided attention may require the allocation of cognitive resources to unique tasks within the same cognitive modality, versus the integration of a visual test of selective attention and an auditory test of sustained attention employed in the current study, which may not cause as much interference (Huestegge & Hazeltine, 2011; Levens et al., 2009).

Contrary to hypotheses, depressive symptoms did not predict any meaningful changes in EF measures at follow-up. Although depressive symptoms were found to predict marginally significant increases in sustained attention and attentional switching at T2, which opposed predictions, post-hoc analyses revealed that these relationships were likely spurious and the result of strong correlations between T1 and T2 rumination and depression variables included in the regression model. Our lack of depression findings may be due to our large community-based sample in which depressive symptoms were measured using a self-report questionnaire and mean depression levels were low; in fact, both depressive symptoms and rumination scores significantly decreased at follow-up. A sample of older adolescents may have revealed significant effects of depression, as the documented spike in depression levels has been shown to occur later in adolescence (Hankin et al., 1998).

The considerable correlation between T1 and T2 rumination levels found in the current study suggests that rumination can exhibit relatively stable, trait-like qualities during adolescence (Alloy & Abramson, 2007; Jacobs et al., 2008). Given findings that rumination can serve as a vulnerability factor for the development of future depression (Abela & Hankin, 2011), EF deficits observed as a result of ruminative response styles in early adolescence may foreshadow the emergence of even greater impairments if cognitively vulnerable teens experience depression later in the life course. In the current study, rumination at T1 was not found to predict increases in depressive symptoms at follow-up. Likewise, males and females did not differ in change in depressive symptoms at follow-up. However, being female was predictive of greater increases in rumination at T2, complementing findings of the emergence of gender differences in rumination during adolescence (Alloy & Abramson, 2007). It is possible that a longer follow-up period may have been necessary to capture increases in depression likely to arise in females and those who ruminate in mid-adolescence.

Support was not found for the alternative hypothesis that lower EF abilities at T1 would be predictive of increases in rumination or depression at follow-up. Although this relationship has been supported in studies examining measures of effortful control (EC), an aspect of temperament involving self-regulation and attention (Hilt et al., 2012; Verstraeten et al., 2009), it has not yet been extended to behavioural measures of EF. Indeed, operationalizations of effortful control vary considerably from the EF measures employed in the current task. EC measures range from self-reports of individuals' impulsivity and distractibility to behavioural tasks in which time spent attending to a target stimulus was coded in toddlers (Hilt et al., 2012; Mezulis et al., 2011; Verstraeten et al., 2009). Therefore, it is likely that EF variables in the current study are measuring considerably different constructs from those in EC studies. Further longitudinal research employing behavioural measures of EF in adolescents and adults is necessary to better understand the viability of this alternative hypothesis regarding EF, rumination, and depression.

Scaled scores were used for all EF measures in order to better control for normative developmental increases in EF with age. Findings thus reflect the interplay between individual differences in rumination, depression and executive functions in early adolescence, controlling for normative age-related change. It should be noted that whereas measures of divided attention and working memory displayed retest reliability between time points, the remaining EF measures did not. Whereas the current study measured test-retest reliability for TEA-Ch measures at a 15-month follow-up, retest stability values reported by the test's creators were calculated over a 6–15 day follow-up; therefore, the reliability of TEA-Ch measures over a longer time period is less clear (Manly et al., 1999). Additionally, all average TEA-Ch scaled scores exhibited either significant increases or decreases from T1 to T2. This is unexpected given that scaled scores control for age and would thus reflect performance relative to same aged, same gendered peers, and would be expected to remain relatively stable over time. Although one possible explanation of observed increases in EF over time would be practice effects, an alternate version of the TEA-Ch was used at follow-up, rendering this interpretation unlikely. It is also unclear why certain EF domains experienced significant decreases in average scaled scores over time. However, it is important to note that TEA-Ch scaled scores were normed cross-sectionally, with means calculated from distinct samples of adolescents of different ages (Manly et al., 1999). Further research employing longer follow-up periods is necessary to better understand the stability of EF scaled scores within individuals.

The current study is the first to test the resource allocation hypothesis using 1) a prospective design and 2) an adolescent sample, allowing for a better understanding of the directionality of the relationship between rumination, depressive symptoms, and EF during this critical period of development. Few studies have examined the relationship between rumination and EF prospectively in adults (De Lissnyder et al., 2010; Zetsche & Joormann, 2011), and none have done so in adolescent samples, with the exception of studies of EC (Hilt et al., 2012; Verstraeten et al., 2009). The longitudinal design of the current study is also ideal for studying the effects of trait rumination over time. As opposed to rumination induction studies in which participants are instructed to ruminate at the time EF is assessed, the measure of rumination employed in the current study is a self-report questionnaire assessing adolescents' habitual response style when experiencing depressed moods. Trait rumination may differ qualitatively from rumination induced in a laboratory setting and may represent a more generalized response to sad mood. The deleterious effects of trait rumination on adolescents' cognitive abilities may emerge over time and be best detected through statistical measures of change, as utilized in the current study.

In addition to these strengths, multiple dimensions of EF were assessed including selective, sustained, and divided attention, attentional switching, and working memory, and scores were normed for gender and/or age. Whereas the majority of studies of EF, rumination, and depression employ tasks assessing one or two EF domains, the current design allows for a more fine-grained analysis of specific facets of executive functioning that may be affected by ruminative or depressive thought processes. The study included a diverse sample of adolescents, and regressions differentiated between the roles of rumination and depressive symptoms in relation to EF deficits.

Nonetheless, the current study has several limitations. Only one follow-up period occurred an average of 15 months after initial assessment, measuring changes as adolescents transitioned from approximately 12–13 years old. It is possible that an interval longer than 15 months would be needed to best detect impairment in EF ability due to rumination or depressive symptoms. In addition, multiple time points would have allowed for the assessment of participants in more advanced stages of adolescence and may have better demonstrated the rise in depression thought to occur slightly later in development (Hankin et al., 1998). As the current study utilized a community sample of adolescents in which depressive symptoms were measured through a self-report questionnaire and depression levels were low, results do not extend to more severe populations. It would be important for future research to explore the relationship between EF, rumination, and depression among adolescents with MDD diagnoses.

An additional limitation of reported findings is the lack of comparison between measures of executive functions and intelligence within the current sample. Despite this limitation, there is reason to believe that findings still represent associations with specific EF deficits, namely in selective attention and attentional switching, rather than more global cognitive impairment. From a theoretical perspective, one could argue that the distinction between executive functioning and fluid intelligence is not meaningful (for discussion, see Friedman et al., 2006). Empirically, there is mixed support for the relation between performance on tests of EF and IQ. In adults, there is evidence for separable but interrelated executive functions, not all of which are equally associated with IQ (Friedman et al., 2006). Specifically, switching and inhibition were found to no longer be significantly associated with IQ when taking into account the relation between IQ and working memory updating (Friedman et al., 2006). In children, some studies have failed to obtain evidence for correlations between measures of EF and IQ (Welsh, Pennington, & Groissier, 1991), whereas others reported that the majority of variance in measures of EF attributable to IQ was accounted for by the working memory index (Arffa, 2007). Although we were unable to examine whether our findings remained significant when controlling for overall IQ, we were able to examine the relationship between TEA-Ch measures and working memory (WISC-IV Digit Span Total Score). In its normative sample, TEA-Ch measures were not significantly correlated with Wechsler Intelligence Scale scores with the exception of attentional switching accuracy, which was moderately correlated with WISC scores ($r = .30$). This finding suggests that attentional switching accuracy is related to but separable from IQ and that WISC scores are generally not good predictors of performance on the TEA-Ch (Manly et al., 1999). In the current sample, working memory was not significantly correlated with selective attention or attentional switching within either time point, suggesting that our significant findings represented change in EF over time and not overall IQ. In addition, participants in the current study were screened prior to testing, and adolescents with severe developmental or learning disorders were excluded. Consistent with this criteria, only one participant in the current sample was found to have more than two EF scores across both time points falling more than two standard deviations below the scaled score mean of 10 (T1 and T2 sustained attention, T2 divided attention scaled scores < 4). Removing this participant from analyses did not alter the significance of findings that T1 rumination predicted decreases in selective attention and attentional switching at follow-up. Collectively, these characteristics of the study sample suggest that main findings cannot be attributed to global cognitive deficits among participants.

The current study also was limited by its use of solely neutral and not emotional EF tasks. Although we found support for the resource allocation hypothesis that rumination is predictive of subsequent deficits on tests of neutral EF, this does not preclude the possibility that EF impairments involving emotional information may be predictive of future depression and rumination, as proposed by the affective interference hypothesis (Siegle et al., 2002). Indeed, attentional biases towards emotional, and particularly negative, information have been found to prospectively predict depressive and ruminative thought processes in adults (De Lissnyder et al., 2010; Zetsche & Joormann, 2011). Considering these findings, the affective interference and resource allocation hypotheses together may best reflect the relationship between ruminative thought processes and EF; ruminators' attention towards and difficulty disengaging from emotional information may deplete cognitive resources and result in poorer subsequent performance on tests of neutral EF (Gotlib & Joormann, 2010). These attentional biases towards emotional information, which are hypothesized to exist as vulnerability factors for the future development of rumination and depression, may emerge during adolescence as EF abilities mature (Alloy & Abramson, 2007; Jacobs et al., 2008). Therefore, in future research, it would be important to assess whether 1) biases towards emotional stimuli are predictive of future rumination and depression in adolescents, and 2) whether these biases are related to poorer performance on tests of neutral EF.

In sum, the current study found partial support for the hypothesis that habitually engaging in ruminative thoughts would consume valuable cognitive resources and result in poorer performance over time on challenging tests of neutral EF in an adolescent sample. Adolescents with higher levels of baseline rumination displayed decreases in selective attention and attentional switching accuracy scores at an approximately 15-month follow-up, high-lighting the potentially detrimental effects of rumination on EF during early adolescence. Higher baseline depressive symptoms were not predictive of meaningful changes in EF at follow-up, and support was not found for the alternative hypothesis that lower levels of initial EF would predict increases in rumination or depression over time. It will be necessary for future work to expand on the complex relationship between the consolidation of cognitive vulnerabilities, rising depression levels, and changes in EF during the crucial developmental period of adolescence.

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Table 1

Mean scores, standard deviations, and *t*-tests for all T1 and T2 measures.

	Time 1		Time 2		*t*
	M	SD	*M*	SD	
Executive functioning					
Selective attention SS Attention Score	10.10	2.63	10.93	2.75	−3.03**
Sustained attention Score! Correct Trials	9.64	3.05	8.63	3.20	3.18**
Attentional switching CC Correct Trials	9.83	3.07	11.18	2.91	−4.41***
Divided attention SS Dual Task Score	7.56	2.41	6.79	3.16	3.08**
Working memory Digit Span Total Score	9.95	3.00	9.72	3.54	.98
Depressive symptoms					
CDI	7.04	6.26	4.92	5.42	4.56***
Response style					
CRSQ Rumination	24.88	7.47	23.62	7.47	2.25*

Note. SS = Sky Search; CC = Creature Counting; CDI = Children's Depression Inventory; CRSQ = Children's Response Styles Questionnaire.

*** $p < .001$,

** $p < .01$,

* $p < .05$.

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Table 2

Bivariate correlations between executive functioning, depressive symptoms, and rumination.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	T1 selective attention (SS Attention Score)	–	.09	−.10	−.19**	.04	.02	−.05	.00	−.08	−.05	−.03	.16*	−.03	−.04
2	T1 sustained attention (Score! Correct Trials)		–	.22**	.18*	.27***	−.05	.07	−.06	−.01	−.01	.14†	.16*	−.05	.08
3	T1 attentional switching (CC Correct Trials)			–	.12	.14	.00	−.02	−.02	.05	.00	.14†	.10	.04	.04
4	T1 divided attention (SS Dual Task Score)				–	.19*	−.05	.06	.09	.12	.09	.24**	.04	−.10	.08
5	T1 working memory (Digit Span Total Score)					–	−.10	.02	.03	.05	.06	.22**	.56***	−.07	.03
6	T1 depressive symptoms (CDI)						–	.47***	−.08	.07	.01	−.07	.03	.38***	.31***
7	T1 response style (CRSQ Rumination)							–	−.17*	−.05	−.21**	.08	.10	.14†	.44***
8	T2 selective attention (SS Attention Score)								–	.14	.13	−.17*	−.06	−.05	−.17*
9	T2 sustained attention (Score! Correct Trials)									–	.20**	−.09	−.01	−.03	−.03
10	T2 attentional switching (CC Correct Trials)										–	−.01	.10	−.07	−.11
11	T2 divided attention (SS Dual Task Score)											–	.07	−.05	.08
12	T2 working memory (Digit Span Total Score)												–	.08	.12
13	T2 depressive symptoms (CDI)													–	.38***
14	T2 response style (CRSQ Rumination)														–

Note. SS = Sky Search; CC = Creature Counting; CDI = Children's Depression Inventory; CRSQ = Children's Response Styles Questionnaire.

*** $p < .001$,

** $p < .01$,

* $p < .05$,

† $p < .10$.

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Table 3

Hierarchical regressions of T2 executive functioning on T1 rumination and depressive symptoms.

	Dependent variables: T2 executive functioning measures									
	T2 selective attention SS Attention Score		T2 sustained attention Score! Correct Trials		T2 attentional switching CC Correct Trials		T2 divided attention SS Dual Task Score		T2 working memory Digit Span Total Score	
Predictors	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2
Rumination										
Step 1										
T1 EF variable of interest	.008	.014	−.004	.009	−.009	.029	$.234^{**}$	$.062^{*}$	$.561^{***}$	$.320^{***}$
T1 CDI	−.053		.079		.032		−.046		.011	
T2 CDI	−.005		−.043		−.111		.004		.102	
Time between sessions	.102		.058		$-.159^{*}$		.044		−.043	
Step 2										
T2 CRSQ Rumination	$-.182^{*}$	$.027^{*}$	−.055	.002	−.093	.007	.104	.009	.025	.001
Step 3										
T1 CRSQ Rumination	$-.159^{\dagger}$	$.016^{\dagger}$	−.145	.013	$-.279^{**}$	$.048^{**}$	.082	.004	.116	.009
Depressive symptoms										
Step 1										
T1 EF variable of interest	−.005	$.053^{*}$	.004	.009	−.014	$.060^{*}$	$.229^{**}$	$.066^{*}$	$.552^{***}$	$.320^{***}$
T1 CRSQ Rumination	−.135		−.073		$-.197^{*}$		.038		.097	
T2 CRSQ Rumination	−.106		.000		−.017		.057		.022	
Time between sessions	$.125^{\dagger}$		.073		−.110		.040		−.072	
Step 2										
T2 CDI	.045	.002	.000	.000	−.070	.004	−.049	.002	.098	.008
Step 3										
T1 CDI	.054	.002	$.155^{\dagger}$	$.015^{\dagger}$	$.175^{\dagger}$	$.020^{\dagger}$	−.101	.007	−.040	.001

Note. SS = Sky Search; CC = Creature Counting; CDI = Children's Depression Inventory; CRSQ = Children's Response Styles Questionnaire.

$^{***}p < .001$,

$^{**}p < .01$,

* $p < .05$,

† $p < .10$.

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Table 4

Hierarchical regressions of T2 rumination and depressive symptoms on T1 executive functioning.

	Selective attention		Sustained attention		Attentional switching		Divided attention		Working memory	
	SS Attention Score		Score! Correct trials		CC Correct Trials		SS Dual Task Score		Digit Span Total Score	
Predictors	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2
Dependent variable: T2 rumination										
Step 1										
T1 CRSQ Rumination	$.397^{***}$	$.309^{***}$	$.406^{***}$	$.319^{***}$	$.407^{***}$	$.321^{***}$	$.388^{***}$	$.284^{***}$	$.414^{***}$	$.323^{***}$
T1 CDI	.007		.008		.006		.003		−.017	
T2 CDI	$.329^{***}$		$.340^{***}$		$.337^{***}$		$.319^{***}$		$.362^{***}$	
Time between sessions	.040		.044		.036		.024		.040	
Step 2										
T2 EF variable of interest	−.090	.008	−.001	.000	.007	.000	.073	.005	.009	.319
Step 3										
T1 EF variable of interest	.006	.000	.052	.003	.030	.001	.067	.004	.052	.317
Dependent variable: T2 depressive symptoms										
Step 1										
T1 CDI	$.385^{***}$	$.290^{***}$	$.361^{***}$	$.287^{***}$	$.357^{***}$	$.286^{***}$	$.352^{***}$	$.266^{***}$	$.340^{***}$	$.288^{***}$
T1 CRSQ Rumination	$-.177^{*}$		$-.200^{*}$		$-.186^{*}$		$-.163^{*}$		$-.165^{*}$	
T2 CRSQ Rumination	$.338^{***}$		$.356^{***}$		$.354^{***}$		$.327^{***}$		$.390^{***}$	
Time between sessions	$-.146^{*}$		$-.168^{**}$		$-.170^{**}$		$-.164^{*}$		$-.136^{*}$	
Step 2										
T2 EF variable of interest	.020	.000	−.037	.001	−.097	.009	−.030	.001	.063	.004
Step 3										
T1 EF variable of interest	−.056	.003	−.048	.002	.017	.000	−.077	.006	−.094	.006

Note. SS = Sky Search; CC = Creature Counting; CDI = Children's Depression Inventory; CRSQ = Children's Response Styles Questionnaire.

*** $p < .001$,

** $p < .01$,

* $p < .05$,

† $p < .10$.