2018

Neurocognitive Correlates of Rumination Risk in Children: Comparing Competing Model Predictions

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NEUROCOGNITIVE CORRELATES OF RUMINATION RISK IN CHILDREN: COMPARING COMPETING MODEL PREDICTIONS

By

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A Dissertation submitted to the
Department of Psychology
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

2018

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Rumination has been identified as a transdiagnostic risk factor associated with the development and maintenance of multiple psychological symptoms in children and adolescents. Additionally, a growing body of literature has linked individual differences in rumination to impairments of executive control, including difficulties associated with updating, inhibition, and shifting abilities. Yet, few studies have examined these neurocognitive correlates together in preadolescent children. The goal of the current study was to test competing model predictions regarding the unique relations between two forms of rumination, sadness and anger, and each executive function based on two theoretical frameworks, the attentional scope model and the multiple systems model. Differential associations between each form of rumination and each executive function were examined via multiple regression analyses. One hundred and fifty-nine children, aged 8-13, completed self-report measures of sadness and anger rumination as well as a battery of neurocognitive tasks assessing updating, inhibition, and shifting abilities. Results indicated that sadness rumination was associated with poorer updating and shifting abilities but unrelated to inhibition. Anger rumination was positively associated with updating abilities and not significantly associated with either shifting or inhibition. Together, these findings offer partial support for the attentional scope and multiple systems models for sadness rumination. Our finding that sadness and anger rumination were associated with different neurocognitive correlates highlights the importance of differentiating between sadness and anger rumination. These findings also suggest that current conceptual models of rumination may not provide an adequate account of neurocognitive correlates of anger rumination. This study adds to the limited extant literature examining associations between rumination and executive functions in preadolescent children.

CHAPTER 1

INTRODUCTION

A growing body of literature has implicated rumination as a transdiagnostic risk factor for the development and maintenance of multiple psychological symptoms in children and adolescents (McLaughlin & Nolen-Hoeksema, 2011; Rood, Roelofs, Bogels, Nolen-Hoeksema, & Schouten, 2009; Watkins, 2009). Rumination refers to the tendency to mentally perseverate on the symptoms, causes, and consequences of one's negative mood, which in turn perpetuates a sustained state of negative affect (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Identifying factors that influence why some individuals ruminate is important given its stability over time and its association with a host of adverse outcomes (Nolen-Hoeksema et al., 2008). For example, rumination has been associated with concurrent and future elevations in depressive symptoms (e.g., Hilt, McLaughlin, & Nolen-Hoeksema, 2010; Rood et al., 2009), aggressive behavior (Caprara, Paciello, Gerbino, & Cugini, 2007; Harmon, Stephens, Repper, Driscoll, & Kistner, 2017; McLaughlin, Aldao, Wisco, & Hilt, 2014; Peled & Moretti, 2007; Smith, Stephens, Repper, & Kistner, 2016; Vasquez, Osman, & Wood, 2012), and future alcohol abuse and binge eating (Nolen-Hoeksema, Stice, Wade, & Bohon, 2007).

Growing research suggests that individual differences in rumination may be linked to individual differences in cognitive control processes (e.g., Davis & Nolen-Hoeksema, 2000). More recently, rumination has been linked to impairments in executive functions (e.g., Whitmer & Gotlib, 2013). While there are multiple conceptualizations about which core processes comprise executive functioning (e.g., central executive; Baddeley, 1998), the current study focuses on the three-factor model outlined by Miyake and colleagues (2000). Specifically, this model emphasizes three core executive functions that are interrelated, yet distinguishable processes:

updating and monitoring working memory, inhibiting prepotent responses, and shifting between tasks or mental sets (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). Updating and monitoring working memory (henceforth, referred to as "updating") consists of the ability to monitor and code incoming information that is task-relevant, replacing information that is no longer relevant with this newer information (Morris & Jones, 1990). Inhibition consists of the ability to deliberately override prepotent response tendencies or interference from previously relevant information and unwanted thoughts and emotions (Miyake et al., 2000). The third executive function, shifting, involves the ability to flexibly switch between tasks, operations, and mental sets by disengaging from an irrelevant task set and subsequently engaging in a relevant task set (Monsell, 1996). Shifting may also involve the ability to perform a new operation despite interference or negative priming (Miyake et al., 2000). This three-factor framework has received substantial support in both adult (e.g., Miyake et al., 2000; Miyake & Friedman, 2012) and child samples (e.g., St Clair-Thompson & Gathercole, 2006). Moreover, these three executive functions are most often studied in relation to rumination (Vălenaş & Szentágotai-Tătar, 2017).

Recently, two conceptual models of rumination have emerged, with disparate predictions regarding the neurocognitive correlates of trait rumination. The first model, the *attentional scope model,* posits that trait ruminators exhibit key characteristics of a constricted attentional scope, including difficulties updating working memory and inhibiting no-longer-relevant information (Whitmer & Gotlib, 2013). According to this model, when individuals with a constricted attentional scope experience negative mood, mood-congruent thoughts are activated. This further limits the array of thoughts accessible in the already limited working memory. Because of the difficulties processing and replacing new information, these thoughts remain accessible in working memory which increases the likelihood that this negative information will become repetitive (Whitmer &

Gotlib, 2013). According to the authors, these difficulties hold regardless of current mood suggesting that difficulties related to updating and inhibition should be evident among high ruminators even when not in a negative mood (Whitmer & Gotlib, 2013). Examples of decreased working memory abilities among ruminators include larger sorting costs for negative words (Joormann, Levens, & Gotlib, 2011), slower processing of information held in working memory (Bernblum, & Mor, 2010), and difficulty removing task-irrelevant negative words from working memory (Joormann & Gotlib, 2008). Evidence linking rumination to deficits in inhibition include difficulties disengaging from task-irrelevant information (Whitmer & Banich, 2007), forgetting emotional material (Joormann & Tran, 2009), inhibiting content from long-term memory (Whitmer & Banich, 2010), and slower antisaccade latencies (De Lissnyder, Derakshan, De Raedr, & Koster, 2010).

On the other hand, the *multiple systems model,* which draws substantially from the literature on aggression, posits that the tendency to ruminate is related to difficulty inhibiting or disengaging from anger-related thoughts and switching attention and thoughts from anger-related stimuli (Denson, 2013). While inhibiting previous information is necessary for switching between mental sets, the two processes are distinguishable (e.g., Arbuthnott & Frank, 2000; Miyake et al., 2000). Within the framework of the multiple systems model, anger rumination, at the cognitive level, activates specific responses across psychological and biological levels, which influences executive control and increases risk of aggression (Denson, 2013). As such, anger rumination is posited to influence executive control and vice versa (Denson, 2013). Few studies have directly examined associations between anger rumination and executive function; therefore, much of the cognitive bases of this model are drawn from studies assessing executive function within the realm of depression. Among studies that have examined anger rumination directly, significant associations have been observed between higher levels of rumination and poor performance on measures of

inhibition (e.g., Ding, Yang, Qian, & Gordon-Hollingsworth, 2015; Whitmer & Banich, 2010). Associations between higher levels of rumination and poorer shifting abilities, evidenced by larger shift costs between tasks, have also been found (e.g., Ding et al., 2015; Whitmer & Banich, 2007).

While both the attentional scope and multiple systems models emphasize inhibition as a key neurocognitive correlate of rumination risk, they differ in their predictions regarding associations with other core executive functions (Miyake & Friedman, 2012); whereas the attentional scope model focuses on individual differences in updating, the multiple systems model points to shifting as critical to regulating rumination. Therefore, questions remain regarding which executive functions are associated with rumination. The current study is the first to examine all three of these executive functions together in children to test these shared (inhibition) and competing (updating vs. shifting) predictions head-to-head, with implications for model refinement and treatment development.

At the same time, a limitation of both models is that their foundational research has focused almost exclusively on one type of negative affect. That is, the attentional scope model is primarily drawn from literature focused on rumination in response to depression or sad mood (sadness rumination; Whitmer & Gotlib, 2013). On the other hand, the multiple systems model is based on literature focused on anger (anger rumination; Denson, 2013). However, recent evidence suggests that rumination towards both forms of negative affect are worthy of study in youth. Specifically, anger rumination has been shown to predict both internalizing and externalizing symptoms, over and above the role of sadness rumination (Harmon et al., 2017). Yet, despite evidence that both sadness and anger rumination are cognitive factors associated with the development of emotional and behavior problems in children, few studies have examined both forms of rumination together (e.g., Gilbert, Cheung, Irons, & McEwan, 2005; Harmon et al., 2017; Peled & Moretti, 2007, 2010).

Importantly, Peled and Moretti (2007, 2010) examined the structure of sadness and anger rumination and determined that they were distinct, yet correlated constructs. Studies assessing both sadness and anger rumination have highlighted the unique and shared emotional and behavioral correlates of each form of rumination. For example, Peled and Moretti (2007, 2010) found that sadness rumination uniquely predicted depression and anger rumination uniquely predicted aggression in samples of adolescents and young adults. In contrast, Harmon and colleagues (2017) found that anger rumination, but not sadness rumination, uniquely predicted both aggressive and depressive symptoms in preadolescent youth, suggesting that anger rumination may be a bigger risk in the development of internalizing and externalizing psychopathology in youth. Because few studies have examined both sadness and anger rumination in the same study, it is unclear whether sadness and anger rumination differentially relate to executive function impairments in children.

Another limitation is that studies examining neurocognitive correlates of rumination have focused almost exclusively on adults. Examining the relation between rumination and executive functioning in preadolescent children is important given that both processes undergo significant developmental changes as children transition into adolescence (e.g., Boll & Bryant, 1988; Jose & Brown, 2008) and provide potential opportunities for clinical intervention. Only a handful of studies have assessed associations between rumination and executive functions in children and adolescents (e.g., Connolly et al., 2014; Hilt, Leitzke, & Pollak, 2014; Wagner, Alloy, & Abramson, 2015; Wilkinson & Goodyer, 2006), with mixed results. Examining these associations in preadolescent children is important given that rumination is operative during this developmental period and increases significantly as children develop toward the adolescent period (Jose & Brown, 2008) where the primary outcomes of rumination (e.g., increased depressive symptoms) begin to fully

manifest (Cohen et al., 1993; Kofler et al., 2011). Examining these associations in preadolescent children provides an opportunity to identify neurocognitive correlates associated with psychological risk during its earliest period of development and may provide a framework for interventions targeting ruminative thought in youth.

Among studies that have examined the relation between executive functions and rumination in children and adolescents, all have focused on sadness rumination and findings are mixed regarding areas of impairment. Unlike the adult literature, only a few studies have examined rumination's associations with working memory, inhibition, and shifting in samples of children and adolescents. For instance, only one study has examined the association between rumination and inhibition in youth (Hilt, Leitzke, & Pollak, 2014). Results of this study indicated a significant association between rumination and difficulty inhibiting negative information. However, results examining relations between rumination and shifting are mixed, with one study showing a significant association between rumination and shifting (Dickerson, Ciesla, & Zelic, 2017), but others failing to find such an association (Connolly et al., 2014; Hilt et al., 2014; Wagner et al., 2015; Wilkinson & Goodyer, 2006). Additionally, studies have failed to find links between rumination and working memory maintenance/manipulation (Connolly et al., 2014; Wagner et al., 2015). To our knowledge, no study has examined sadness rumination in relation to working memory updating or examined these primary executive functions in relation to anger rumination in youth. As such, conclusions regarding current associations between rumination and executive function abilities in children are limited.

Our understanding is further limited because most studies have relied primarily on traditional neuropsychological measures that have been criticized for suboptimal construct validity relative to modern tests of executive functioning from the cognitive literature (e.g., Snyder, Miyake, & Hankin,

2015). These traditional neuropsychological tests have been criticized for lacking sensitivity because they were designed to detect gross neurological impairments rather than capture individual differences in specific aspects of executive functioning (e.g., Sonuga-Barke, Sergeant, Nigg, & Willcutt, 2008; Synder, Miyake, & Hankin, 2015). Another concern regarding studies of executive functions is the issue of task impurity. As previously noted, many commonly used executive function tasks lack construct validity and may elicit and measure multiple executive and non-executive processes as executive functions manifest themselves by operating on other cognitive processes (e.g., Burgess, 1997; Miyake et al., 2000; Phillips, 1997). To address this concern, the measures of executive function used in the current study were selected based on strong construct validity evidence (Synder, Miyake, & Hankin, 2015).

The current study addresses these limitations and is the first to test model-driven predictions regarding neurocognitive correlates of rumination in preadolescent children using a well-validated executive function framework. Based on theoretical frameworks outlined by the attentional scope and multiple systems models, it is hypothesized that sadness and anger ruminative tendencies would be associated with poor inhibition. Given the scarcity of research examining rumination in relation to working memory updating and shifting in preadolescent children, no specific hypotheses are offered. Finding that ruminative tendencies predict updating but not shifting abilities would provide support for the attentional scope model (Whitmer & Gotlib, 2013), whereas finding that ruminative tendencies predict shifting and not updating would provide support for the multiple systems model (Denson, 2013). No specific hypotheses are offered regarding potential differential associations between sadness and anger rumination with each executive function given the paucity of research examining both forms of rumination together. Additionally, we hypothesized that boys would report greater anger rumination (e.g., Harmon et al., 2017). While

patterns of sex differences in sadness rumination have been observed in adolescent and adult samples, such that adolescent girls and women report greater sadness ruminative tendencies (e.g., Peled & Moretti, 2010; Rood et al., 2009), these patterns are less clear in preadolescent children (e.g., Harmon et al., 2017; Rood et al., 2009). Finally, we conducted exploratory analyses to examine the extent to which processes common to both sadness and anger rumination (i.e., their interaction) are associated with each executive function.

CHAPTER 2

METHODS

Participants

The means and standard deviations of study variables are presented in Table 1. The sample comprised 159 children, aged 8-13 years (mean age = 10.38, SD = 1.34; 53.5% male), recruited by or referred to the university-based Children's Learning Clinic (CLC) through community resources (e.g., self-referral, pediatricians, community mental health clinics, school personnel). The CLC is a research-practitioner training clinic that conducts developmental research and provides comprehensive diagnostic services. Its client base consists of children with suspected learning, behavioral or emotional problems, as well as typically developing children (those without a suspected psychological disorder) whose parents agreed to have them participate in developmental/clinical research studies. The lower age limit for the sample was selected because several of the research protocols require a 2nd grade or higher word recognition level for successful completion. The upper age limit corresponds to developmental distinctions between child and adolescent samples, including developmental differences in psychological symptom prevalence, brain anatomy, and cognitive skills (e.g., Boll & Bryant, 1988). This sample was ethnically diverse: 59.1% Caucasian (N = 94), 13.8% African American (N = 22), 11.9% Multiracial (N = 19), 10.1% Hispanic (N = 16), and 5% Asian/Pacific Islander (N = 8). The mean income for the sample was 47.18 (SD = 12.35; Hollingshead, 1975). Exclusion criteria included: 1) children with gross neurological, sensory, or serious motor impairment, or a history of seizure disorder, psychosis, or intellectual disability; and 2) children taking medications other than psychostimulants (e.g., selective serotonin reuptake inhibitors) used to treat attention-deficit/hyperactivity disorder due to the unknown impact of these medications on the cognitive

functions of interest. Children meeting exclusion criteria were excluded prior to the start of the study via the initial phone screen. Only one child was excluded after the phone screen due to an intellectual disability that was missed during the initial phone screen. Medication was withheld at least 24 hours for children taking psychostimulants.

The sample included children who were referred to the CLC for a comprehensive psychoeducational and diagnostic evaluation as well as children from local families who voluntarily enrolled in a university-based registry for families interested in participating research studies. Of the total sample, one hundred children and their parents completed the comprehensive evaluation. Children who completed the comprehensive evaluation presented with the following symptoms: Attention-Deficit/Hyperactivity Disorder (ADHD; 58%), anxiety (19%), learning disability (17%), conduct problems (10%), autism spectrum disorder (6%), and depression (3%). To improve generalizability, children with comorbidities were included. Comorbidities reflect clinical consensus best estimates (Kosten & Rounsaville, 1992). Psychostimulants were withheld for 27 children (27%). The clinically-referred sample also comprised 35 consecutive case-control referrals (19 girls) of neurotypical children who screened positive for normal developmental histories and nonclinical parent/teacher ratings.

Due to funding constraints, the final 59 participants completed an abbreviated screening evaluation that included parental report of current symptoms, a 1-subtest IQ screener, and detailed developmental, medical, educational, and psychiatric histories. Children who completed the abbreviated evaluation presented with the following symptoms: ADHD (13.6%), anxiety (3.4%), depression (1.7%), and autism spectrum disorder (1.7%). Psychostimulants were withheld for 9 children (15.3%). Children did not differ significantly based on whether they received a full or

abbreviated evaluation in terms of age, ethnicity, or IQ. The abbreviated subgroup had, on average, more girls (M = 1.58 vs. 1.40) and slightly lower socioeconomic status (M= 44.6 vs. 48.69).

Procedure

All children completed a series of questionnaires assessing their tendency to ruminate and a battery of computerized neurocognitive tasks to assess specific executive functions. Research procedures were conducted in one or two 3-hours visits. Neurocognitive tasks were counterbalanced to minimize order effects. The examiner was stationed just out of the child's view to provide a structured setting while minimizing performance improvements associated with examiner demand characteristics (Gomez & Sanson, 1994). All children received preset breaks (5-10 mins) after every 2-3 tasks to minimize fatigue.

Measures

Executive Functions

Executive functions were measured using a battery of neurocognitive tasks selected based on evidence for strong construct validity and demonstrated ability to detect individual differences in various populations, including nonclinical adults (e.g., Miyake et al., 2000), typically developing children (e.g., St Clair –Thompson & Gathercole, 2006), and children with neurocognitive disorders (e.g., Alderson, Rapport, Sarver, & Kofler, 2008; Kofler et al., 2018; Raiker, Rapport, Kofler, & Sarver, 2012). Similar tasks have also been used in previous studies examining rumination in adults (e.g., Ding et al., 2015).

Letter Updating. Updating ability was evaluated using the Letter Updating task (adapted for use with children from Miyake and colleagues' (2000) letter memory task). In this computerized task, letters were presented on the screen one at a time and children were instructed to remember the last three letters presented. To ensure continuous updating of working memory, children were

instructed to rehearse out loud the last three letters by mentally adding the most recent letter and dropping the fourth letter back until the end of each trial (Miyake et al., 2000). Each child completed a practice trial which required that each child complete three correct trials before advancing to the test phase. For the full task, four blocks of 3 trials each were administered. The number of letters presented (4-8 letters per trial, 1200 ms presentation, 2400 ms interstimulus interval) was varied randomly across trials to ensure continuous updating. Children responded by using the mouse to select the last three letters presented. The dependent variable was the mean stimuli recalled correctly per trial with scores ranging from 0-3. Higher scores indicated better updating ability. Internal consistency for this sample was $\alpha = 0.75$.

Stop-signal. The stop-signal task was used to measure inhibition. The protocol was identical to those described in Alderson et al. (2008). Go-stimuli were displayed for 1000 ms as uppercase letters X and O positioned in the center of a computer screen (500 ms interstimulus interval; total trial duration = 1500 ms) and participants were asked to use a game-pad device to indicate which letter appeared on the display (e.g., press the left button after seeing the letter 'X', and the right button after seeing the letter 'O'). Xs and Os appeared with equal frequency throughout the experimental blocks. A 1000 Hz auditory tone (i.e., stop-stimulus) was presented randomly on 25% of trials. Children were instructed to stop responses when they heard the tone. All children completed two practice blocks and 4 consecutive experimental blocks of 32 trials per block (24 go-trials, 8 stop-trials per block). Stop-signal reaction time (SSRT), which reflects the speed of children's inhibition (stop) process, served as the dependent variable. SSRT at each of the four blocks served as the primary indices of inhibition with higher scores reflecting slower inhibition abilities. Psychometric evidence includes high internal consistency and 3-week test-retest reliability (0.72; Soreni, Crosbie, Ickowicz, & Schachar, 2009), as well as convergent

validity with other inhibitory control measures (e.g., Alderson et al., 2008). Internal consistency in this sample was $\alpha = 0.98$.

Global-Local. The Global-Local task was used to measure Shifting. This task is based on the Miyake et al. (2000) local-global task and adapted for use with children. Children were presented with Navon figures (Navon, 1977) which are larger shapes made up of different, smaller shapes presented in one of four quadrants on the computer screen. When stimuli appeared in either of the top two quadrants, children were asked to respond based on the global (larger) shape, disregarding the local (smaller) shapes. When stimuli appeared in either of the bottom two quadrants, children respond based on the local (smaller) shapes, disregarding the global (larger) shape. Children responded via mouse click. Trials with stimuli in the top left or bottom right quadrants involved set shifting (shift trials) because responses required a different rule than the previous trial. Trials with stimuli in the top right or bottom left quadrants did not require shifting because they featured the same rule as the previous trial (non-shift trials). Children completed a total of 60 trials which were divided into 4 consecutive blocks to match the number of outcome variables from the updating and inhibition tasks (Kofler et al., 2018). Fifty percent (50%) of trials require children to shift between rules (global to local, or local to global). To minimize memory demands, visual cues reminding participants of the rule set ("big shape," "small shapes") remained on the screen throughout the task. Children were required to complete three blocks of practice trials before advancing to the full task. During the first practice block, children were required to match shapes to ensure that they could match each shape to the response options. The second practice block included six trials alternating between responding to the global and local shapes (100% correct required for the first two practice trials). The final practice trial included the stimuli rotating (clockwise) through the four quadrants (90% correct

required). The shift cost, or the difference between the average reaction time for the shift trials and the average reaction time for the non-shift trials, served as the dependent variable. Higher reaction times indicated worse performance. Internal consistency in this sample was $\alpha = 0.86$ for the shift trials and $\alpha = 0.90$ for the non-shift trials (Kofler et al., 2018).

Executive Function Dimension Reduction. Given that neurocognitive tasks are not pure measures of their targeted process, it is recommended that researchers use multiple indicators to remove random and unwanted systematic error attributed to non-executive function processes (e.g., time-on-task effects; Miyake et al., 2000; Shipstead, Redick, & Engle, 2010). To be consistent with this recommendation, each neurocognitive task consisted of 4 consecutive experimental blocks, a method used in previous studies examining executive function in youth (e.g., Granvald & Marciszko, 2016; Kofler et al., 2016, 2018; Raiker et al., 2012). In line with recommendations by Willoughby and colleagues (2016, 2017), executive function task data were represented as formative (mean-based scores) rather than reflective indicators (confirmatory factors). Within a formative approach, all pairwise covariances are freely estimated, with mean-based scores reflecting a broader summation of the abilities assessed rather than just their shared association. This approach has been recommended to capture individual differences and patterns of developmental change in executive functions in children (Willoughby, Blair, & The Family Life Project Investigators; 2016; Willoughby, Kuhn, Blair, Samek, & List, 2017).

Mean-based scores were created for each executive function construct by computing Bartlett maximum likelihood weighted averages based on the intercorrelations among task performance scores (DiStefano, Zhu, & Mîndrilă 2009). This process allows for the extraction of common construct-specific variance by estimating and removing error associated with measurement, time-on-task effects, other executive processes, and tasks-specific nonexecutive processes (e.g., short-term

memory load), therefore producing estimates that are the most likely to represent "true" measures of each construct, and hence control against concerns of task impurity (Conway et al., 2005; DiStefano et al., 2009; Rabbitt, 1997). In the current study, the twelve task performance variables (i.e., 3 tasks with 4 blocks each) were reduced to three component estimates. A three-component model was specified a priori (Miyake et al., 2000) to derive separate estimates for updating, inhibition, and shifting. Orthogonal components were specified to derive independent factors and maximally control for task impurity (e.g., Kofler et al., 2016, 2018). The ratio of participants (159) to factors (3) was deemed acceptable (Hogarty, Hines, Kromrey, Ferron, & Mumford, 2005).

Mean-based scores for each executive function were created via principle component analysis (PCA) using the Statistical Package for the Social Science (SPSS) version 24.0. Prior to performing the PCA analysis, the correlation matrix was examined to assess the suitability of the data for component analysis. Examination of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Olkin value was .68, consistent with the recommended value (Kaiser, 1970) and Bartlett's Test of Sphericity (Barlett, 1954) reached statistical significance, supporting the factorability of the correlation matrix. The three-component solution explained a total of 47.1% of the variance. Loadings for each performance variable on each executive function component are presented in Table 1. By design, the intercorrelations among the varimax-rotated updating, inhibition, and shifting components were r = .00. These three executive function component scores (z-scores) were used in all analyses. As previously noted, higher scores reflect better updating but worse inhibition and shifting abilities.

Rumination

Children's Response Styles Scale. Trait sadness rumination was assessed using the Children's Response Styles Scale (CRSS), a 20-item self-report questionnaire of children's

tendency to ruminate or distract in response to sad mood. Children were asked to rate the frequency with which they engage in rumination (i.e., "I think, 'Why can't I stop feeling this way?' ") or distracting behaviors (i.e., "I do something I really like to do") on an 11-point Likert scale, ranging from 0 ("never") to 10 ("always"). The Rumination subscale was used for analysis and consists of 10 items. The CRSS was demonstrated to be a reliable and valid measure of response styles in children (Ziegert & Kistner, 2002). Internal consistency for this sample was $\alpha = .86$. Total scores were used for analysis with possible scores ranging from 0-100. Higher scores indicate higher ruminative tendencies.

Children's Anger Rumination Scale. Trait anger rumination was assessed using the Children's Anger Rumination Scale (CARS), a 19-item self-report questionnaire of children's tendency to ruminate in response to anger (i.e., "I think a lot about other times when I was angry"). Children will be asked to rate their response on a 4-point Likert-scale, ranging from 1 ("almost never") to 4 ("almost always"). Total scores were used. The CARS was adapted from the Anger Rumination Scale (Sukhodolsky, Golub, & Cromwell, 2001) to be developmentally appropriate and has been shown to be a reliable and valid measure of anger rumination in children and adolescents (Smith et al., 2016). Internal consistency for this sample was $\alpha = .87$. Total scores were used for analysis with possible scores ranging from 19-76. Higher scores indicate higher ruminative tendencies.

Socioeconomic Status (SES)

SES was assessed via procedures outlined in Hollingshead (1975). Scores are based on caregiver(s)' education and current occupation and range from 8-66, with higher scores indicating a higher socioeconomic status.

Data Analyses

Multivariate regression analyses were conducted to assess the unique relations between sadness and anger rumination and each executive function, controlling for age and sex. Separate regression models were created to assess the unique contribution of sadness and anger rumination on each outcome variable (updating, inhibition, shifting). Exploratory analyses were conducted to examine whether specific executive functions were associated with processes common to sadness and anger rumination (i.e., the sadness x anger rumination interaction) and the extent to which results differed as a function of age and sex (i.e., age and sex were examined as two-way interactions with each form of rumination).

CHAPTER 3

RESULTS

Preliminary Analyses

Prior to the analyses, all variables were examined for missing values, normality, skewness and kurtosis, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity. The Missing Value Analysis (MVA) in SPSS 24.0 revealed that 0.43% of cases (n=13) had missing data. To estimate the pattern of missing values, Little's (1988) Missing Completely at Random (MCAR) test was conducted and revealed a MCAR missing data pattern, χ^2 (108) = 121.78, p = .17. Missing data were accounted for using an expectation maximization (EM) algorithm that included all variables used in the regression models (Tabachnick & Fidell, 2013). Inspection of histograms, Q-Q plots, and skewness and kurtosis were used to evaluate the distributions of all study variables for violations of the assumption of normality. Examination of skewness and kurtosis values revealed that all variables were within the acceptable range (skewness = +/- 2; kurtosis = +/-7). Based on recommendations outlined by Tabachnick and Fidell (2013), outliers +/- 3 standard deviations from the mean were winsorized relative to other values within that measure. This process affected 0.48% of data points. Mahalanobis distances suggested that there were no multivariate outliers.

A priori power analysis for a multiple regression with 4 predictors was conducted using the software package, GPower version 3.1.9.2 (Faul, Erdfelder, Lang, & Buchner, 2014). Using an alpha of .05 and power of .80, our sample size of 159 is powered to detect small-to-medium effects of f^2= .08 or larger. Thus, the study is adequately powered to test the effects of interest.

Descriptive Statistics

Simple correlations between demographic variables, rumination variables, and each executive function component score are detailed in Table 2. In accord with prior research (e.g.,

Linares, Bajo, & Pelegrina, 2016; Ikeda, Okuzumi, & Kokubun, 2014, respectively), age was significantly correlated with the updating (r = .20, p = .01) and inhibition factors (r = -.39, p < .001), suggesting better updating and inhibitory abilities with age. An age-related association was not observed for shifting abilities (r = -.05, p = .54). Sex (coded as 2 = girls, 1 = boys) was significantly correlated with the inhibition factor (r = .16, p =.04), suggesting slower inhibition abilities among girls in the study sample. However, this association was no longer significant when the effects of age were controlled for (r = .15, p =.06). Consistent with previous studies (Harmon et al., 2017; Peled & Moretti, 2007, 2010), sadness and anger rumination were positively correlated (r = .48, p < .001). However, sadness rumination was not significantly correlated with updating (r = -.05, p = .55), inhibition (r = -.04, p = .59), and shifting (r = .12, p = .14). Similarly, anger rumination was not correlated with updating (r = .09, p = .23), inhibition (r = .10, p = .22), and shifting (r = -.04, p = .66). Intercorrelations among updating, inhibition, and shifting factors were r = .00, p = 1.0 by design. Mean scores and standard deviations for each study variable are included in Table 3.

Neurocognitive Correlates of Sadness and Anger Rumination

Results from each regression analysis are displayed in Table 4.

Updating. The results of the regression indicated the model explained 9% of the variance in updating abilities, R^2 = .09, F (4, 154) = 3.58, p < .01. It was found that better developed working memory updating was associated with lower sadness rumination (β = -.18, p = .047), higher anger rumination (β = .20, p = .03), and older age (β = .25, p < .01). There were no detectable sex differences in updating abilities (β = .11, p = .15).

Inhibition. The results of the regression indicated the model explained 17.3% of the variance in inhibition abilities, R^2 = .17, F (4, 154) = 8.06, p < .001. Neither sadness rumination (β

= -.05, p = .54) nor anger rumination was associated with inhibition (β = .08, p = .37). Better developed inhibition abilities were associated with older age (β = -.36, p < .01). There were no detectable sex differences in inhibition abilities (β = .14, p = .06).

Shifting. The results of the regression indicated the model explained 4.4% of the variance in shifting abilities, R^2 = .04, F (4, 154) = 1.75, p = .14. Shifting difficulties were associated with higher sadness rumination (β = .21, p = .03). Shifting was not associated with anger rumination (β = -.14, p = .12). There were no detectable age (β = -.10, p = .24) or sex (β = -.11, p = .17) differences in shifting abilities.

Exploratory Analyses

In an exploratory fashion, the moderating effects of age and sex were examined for each regression model. Results indicated neither age nor sex moderated associations between anger and sadness rumination and each executive function, and that anger and sadness rumination did not interact to predict any executive function (all p > .30). As such, results from the multiple regression analysis are presented without interactions in Table 3. Additionally, exploratory analyses were conducted to examine associations when an oblique rather than orthogonal rotation was specified for each executive function component. Similar results were observed when executive function factor scores were allowed to covary. Thus, only results for the orthogonal components were presented above.

CHAPTER 4

DISCUSSION

The current study sought to test competing model predictions regarding the neurocognitive correlates of rumination in a preadolescent sample. This was accomplished by examining the applicability of two theoretical frameworks, the attentional scope model and the multiple systems model. To our knowledge, this is the first study to examine these competing frameworks in preadolescent children. Differential associations between multiple forms of rumination and executive functions were explored by examining both sadness and anger rumination given prior evidence that both forms of rumination are related but distinct constructs (Harmon et al., 2017; Peled & Moretti, 2007, 2010). To date, no study has examined the association between anger rumination and executive functions, or simultaneously examined all three primary executive functions in studies of rumination in youth.

Findings from this study offer partial support for the attentional scope and multiple systems models, but only for sadness rumination. That is, sadness rumination was associated with worse updating and shifting abilities as predicted by the attentional scope and multiple systems models, respectively. In contrast, sadness rumination was not associated with inhibition difficulties, which was inconsistent with both theoretical models. Neither model was supported for anger rumination, which was associated with *better* updating abilities. Together, this study provides novel insights into the differential neurocognitive correlates associated with sadness and anger rumination in youth. It also highlights the importance of differentiating between anger and sadness rumination given their moderate intercorrelation and distinct neurocognitive correlates. Possible explanations for these findings and implications regarding the associations between rumination and executive function in children are considered next.

Our finding that elevated sadness rumination was associated with updating difficulties replicates previous findings observed in the adult literature, including larger sorting costs (e.g., Joormann, Levens, & Gotlib, 2011), slower "refreshing" (e.g., Bernblum, & Mor, 2010), and difficulty removing emotion-laden information in working memory (e.g., Joormann & Gotlib, 2008) among those with a proclivity for sadness rumination. To our knowledge, the current study is the first to examine sadness rumination in relation to updating abilities in children. Consistent with the attentional scope model, this finding indicates that difficulty retrieving new memories and replacing thoughts in working memory is also characteristic of sadness rumination in youth, providing partial evidence for a downward extension of this model. Furthermore, our finding that sadness rumination was associated with shifting difficulties offers partial support of a downward extension of the multiple systems model, such that children who ruminate to sadness are characterized by difficulty quickly switching their attention and thoughts away from negative-stimuli. However, this association is inconsistent with the null findings observed in the majority of previous studies conducted among children (Connolly et al., 2014; Hilt et al., 2014; Wagner et al., 2015; Wilkinson & Goodyer, 2006). A possible explanation for this inconsistency may reflect differences in the measures used to assess shifting abilities. For instance, the neurocognitive measures used in the current study were selected based on strong construct validity evidence, however, several of the previous studies (Connolly et al., 2014; Wagner et al., 2015; Wilkinson & Goodyer, 2006) examined these relations used traditional neuropsychological measures (i.e., Test of Everyday Attention-Children) that may assess gross neuropsychological functioning rather than shifting specifically (e.g., Snyder, Miyake, & Hankin, 2015).

The most surprising finding in our study was that neither sadness nor anger rumination were associated with the ability to inhibit prepotent responses. Instead, these findings suggest

that it is the inability to replace negative thoughts and shift between mental sets, and not the inability to suppress an automatic response, that is associated with ruminative tendencies. One possibility for the observed differences between this and previous studies regarding inhibitory control (e.g., Ding et al., 2015; Hilt et al., 2014; Whitmer & Banich, 2010) may be that the current study accounted for task impurity by controlling for concurrent updating and shifting processes. These processes, namely maintaining competing rule sets and flexibly going back and forth between rule sets, are likely involved in successful performance on inhibition tasks (e.g., the Go/No-Go task). Future studies should use measures consistent with recommendations from the cognitive literature that may best capture these specific cognitive abilities. Alternatively, differences may be due to variations in how inhibition is operationalized across studies (Vălenaş & Szentágotai-Tătar, 2017). Inhibition is not a unitary construct but is often used interchangeably to described various processes, including the inhibition of external vs. internal distractions (i.e., cognitive inhibition), inhibition of prepotent responses (e.g., Aker, Harmer, & Landrø, 2014; Friedman & Miyake, 2004; Nigg, 2000), and/or processes associated with cancelling an in-progress action vs. stopping oneself from beginning a prepotent but unwanted behavior (i.e., behavioral inhibition; e.g., Alderson, Rapport, & Kofler, 2007). The inhibition task used in the current study (i.e., stop-signal) assessed behavioral inhibition; however, inhibition may be best measured by tasks that are consistent with the cognitive framework of rumination. That is, individuals who ruminate may be most likely have difficulty suppressing thoughts or no-longer-relevant information, rather than difficulty stopping a prepotent behavioral response (e.g., Whitmer & Gotlib, 2013). However, this seems unlikely given literature demonstrating that thought suppression is ineffective for managing unwanted thoughts or memories (e.g., Kircanski, Craske, & Bjork, 2008; Pettit et al., 2009). Future studies should include tasks assessing multiple forms of

inhibition, such as the ability to inhibit no-longer-relevant information as well as the ability to inhibit external distractors.

Contrary to both conceptual models, this study found that anger rumination was associated with *better* updating abilities. The direction of this finding was surprising particularly given the negative association between sadness rumination and updating. This finding suggests that anger ruminators, compared to sadness ruminators, are better able to process and sort information necessary for achieving an immediate goal. It also suggests that tendencies to ruminate in response to anger may be associated with factors other than executive function difficulties. However, given that no study, to our knowledge, has examined trait anger rumination in relation to updating abilities, hypotheses regarding this relation should be considered tentative. While further investigation is needed to better understand differential associations between sadness and anger rumination, this finding adds to the evidence that these two forms of rumination are in fact different.

The differential neurocognitive correlates observed between sadness and anger rumination underscores the importance of examining multiple forms of rumination concurrently. For instance, Harmon and colleagues (2017) found that controlling for both sadness and anger rumination revealed unique behavioral correlates (i.e., anger rumination and not sadness rumination was uniquely associated with children's depressive symptoms). These associations were unobserved in previous studies as most studies focused on only one type of rumination. Similarly, different results were observed in the current study when examining simple correlations between sadness and anger rumination and each executive function compared to when the two were included in the same model. Not controlling for the other form of rumination increases the possibly of overlooking significant and unique results. In light of the large body of

research examining rumination in relation to executive function, only one has examined sadness and anger rumination in the same study. For instance, Whitmer and Banich (2007) found different neurocognitive correlates between sadness and anger rumination among adults, specifically, that sadness rumination was associated with inhibitory deficits and anger rumination associated with shifting difficulties. However, this study did not examine sadness and anger rumination concurrently. Given that this was the first study to concurrently assess executive function correlates of sadness and anger rumination in children, future research is necessary to replicate and investigate these associations further.

There are several possibilities that may account for different findings between sadness and anger rumination. One possibility is that working memory may serve different purposes for sadness and anger rumination. For instance, within the attentional scope framework, because ruminators are characterized by a narrowed attentional scope, the process of rumination is rather automatic when negative mood is experienced. Therefore, an adequate ability to update negative thoughts with less negative thoughts is necessary to actively break the cycle of repetitive thought within the context of sadness rumination. However, for anger rumination, the process may be less automatic and more cognitively demanding which would require better updating abilities to maintain task-relevant information (e.g., the task here being "to stay mad"). Also, because anger rumination is often the result of a provocation, children with better updating abilities may be more capable of maintaining an angry experience through constant mental rehearsal in hopes of future retaliation (e.g., Denson, 2013).

There are several factors unique to the study design that should be examined when considering alternative explanations for the differences observed between this and previous studies. One possibility is the emotional-valence of previous neurocognitive tasks. For instance,

Joormann and Tran (2009) found that high sadness ruminators had more difficulty forgetting positive and negative to-be-forgotten words while others have noted significant associations between rumination and reduced inhibition of negative material (De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Hilt et al., 2014; Joormann & Gotlib, 2010). Additionally, sadness rumination has been associated with intrusions from task-irrelevant negative material (Joormann & Gotlib, 2008), difficulty removing task-irrelevant negative material (Joormann & Gotlib, 2008) and larger sorting costs for negative words (Joormann et al., 2011). Interestingly, these associations were not observed for positive (Joormann & Gotlib, 2008; Joormann et al., 2011) or neutral material (Joormann & Gotlib, 2008) and only among depressed participants and not controls (non-depressed high ruminators; Joormann & Gotlib, 2008). However, within the framework of the attentional scope model, high ruminators should demonstrate a constricted attentional scope regardless of the type of information presented to them (Whitmer & Gotlib, 2013). That is, a negative mood should lead to negative cognitive biases while the absence of negative mood should lead to positive cognitive biases. Consistent with previous studies with youth (Connolly et al., 2014; Wagner et al., 2015; Wilkinson & Goodyer, 2006), the neurocognitive tasks administered in the current study were non-emotional. Together, these findings suggest that the difficulties observed among high ruminators may be a byproduct of processing emotional (negative) stimuli rather than difficulties associated with broader cognitive abilities.

It is also important to consider differences in the measures used to assess sadness and anger rumination as an alternative explanation for our findings. Given that the study focused on children rather than adults, measures were selected that were developmentally sensitive. The measures of sadness and anger rumination used in this study were adapted from the well-

validated measures frequently used in the adult literature (i.e., Response Styles Questionnaire; RSQ; Butler & Nolen-Hoeksema, 1994; Anger Rumination Scale, ARS; Sukhodolsky et al., 2001, respectively). Importantly, however, both adapted rumination measures have been found previously to be reliable and valid indicators of children's tendencies to ruminate in response to sadness (Ziegert & Kistner, 2002) and anger (Smith et al., 2016). Additionally, sadness and anger rumination were significantly correlated in our sample ($r = .48$, $p < .001$) and the magnitude of this association is very similar to what Harmon et al. (2017) found in their study of similarly aged children. While we cannot completely rule out this explanation for discrepant results, it does not seem likely for the reasons noted above.

Consistent with previous studies, sex differences were not observed for sadness rumination (e.g., Abela, Vanderbilt, & Rochon, 2004; Broderick & Korteland, 2004; Harmon et al., 2017). Similarly, sex differences were not observed for anger rumination. The absence of sex-related differences is inconsistent with a recent study where boys reported significantly higher rates of anger rumination relative to girls (Harmon et al., 2017). To our knowledge, only two studies have examined anger rumination in a mixed-sex sample within this age group (Harmon et al., 2017; Peled & Moretti, 2007). Given that few studies have examined anger rumination in preadolescent youth, the extent to which anger rumination differs by sex is not fully understood. Additionally, sadness and anger rumination did not differ with age. Prior research is mixed regarding whether rumination increases (e.g., Hempel & Petermann, 2005) or decreases with age (Harmon et al., 2017). Longitudinal studies are necessary to determine developmental trends in anger and sadness rumination.

There are several strengths and limitations of the current study that should be noted. First, this study addressed a current gap in the literature focused on understanding the relationship

between rumination and executive function. The sample included a mixed sample of typically-developing and clinically referred children which allowed for the examination of effects across a broader range of ruminative tendencies and executive function abilities. Additionally, this study assessed independent associations between multiple forms of rumination (i.e., sadness and anger) and executive function, including being the first study to examine the relation between anger rumination and executive function in youth. One limitation of the current study is that it assessed only cross-sectional associations between measures of rumination and executive functions. Therefore, it is unclear if rumination is predicting impairments of executive function or vice versa. This is important in light of evidence suggesting that the relation between executive function and rumination is bidirectional (e.g., Denson, 2013). Longitudinal studies are necessary to examine how these patterns evolve over time as children continue in their cognitive development. Additionally, this study did not screen for concurrent psychological symptoms. Therefore, the pattern of results may reflect the influence of a third variable, such as trauma, depression, or anger. Future studies should account for the influence of such variables. Furthermore, as noted above, this study examined the relation between rumination and executive function using non-emotional stimuli. However, inconsistent findings across emotional tasks suggests that using emotional stimuli may confound results and possibly underestimate executive function abilities due to evoking non-executive function impairments. Future studies using an experimental, dual-dissociation paradigm (low/high executive function demands x negative/positive/neutral stimuli) are warranted to assess whether negative stimuli reduce task performance for ruminators generally or specifically on high executive function tasks within this age group.

Conclusion

The current study sought to understand executive control difficulties among children who ruminate. Few studies have examined the relation between rumination and three primary forms of executive function in preadolescent children. This study provides a unique contribution to this growing literature by being the first to examine these associations together across two forms of rumination, sadness and anger. Together, these findings add to a growing body of literature suggesting that sadness and anger rumination are distinct constructs and are associated with unique neurocognitive (e.g., Whitmer & Banich, 2007) and behavioral correlates (e.g., Harmon et al., 2017). Regarding existing models of rumination, two associations (sadness rumination-poor updating/shifting) offered partial support to both the attentional scope and multiple systems models. Other associations did not offer support for either model, suggesting different rumination-executive function relations in children than those observed in the adult literature.

Table 1. *Loadings of Performance Variables on Executive Function Components*

	Updating	Inhibition	Shifting
Letter Updating Block 1	**.64**	-.24	-.15
Letter Updating Block 2	**.70**	-.08	.08
Letter Updating Block 3	**.73**	-.11	-.07
Letter Updating Block 4	**.75**	-.05	-.08
Stop-Signal Block 1	-.02	**.77**	.10
Stop-Signal Block 2	-.01	**.75**	.08
Stop-Signal Block 3	-.26	**.62**	-.14
Stop-Signal Block 4	-.11	**.61**	-.09
Global-Local Block 1	-.14	-.01	**.59**
Global-Local Block 2	.12	-.17	**.59**
Global-Local Block 3	-.08	.15	**.76**
Global-Local Block 4	-.25	-.19	-.17

Notes. Component loadings are based on varimax rotation. Loadings equal or greater than .32 shown in bold.

Table 2. *Intercorrelations of Study Variables with Executive Function Component Scores*

		1	2	3	4	5	6	7	8
1.	Age	--							
2.	Sex	-.06	--						
3.	SES	.11	.01	--					
4.	Sadness	.11	.09	-.08	--				
5.	Anger	-.12	.03	-.03	.48***	--			
6.	Updating	.20*	.09	.12	-.05	.09	--		
7.	Inhibition	-.39***	.16*	-.07	-.04	.10	.00	--	
8.	Shifting	-.05	-.09	-.11	.12	-.04	.00	.00	--

Note. All means and standard deviations are presented in raw scores. SES = socioeconomic status; Sadness = sadness rumination; Anger = anger rumination; Updating = updating component; Inhibition = inhibition component; Shifting = shifting component; *$p < .05$, **$p < .01$, ***$p < .001$

Table 2. *Demographic Characteristics and Intercorrelations with Executive Function Mean Scores*

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Age	10.38 (1.34)	--																		
2. Sex	--	-.06	--																	
3. SES	47.20 (12.35)	.11	.01	--																
4. Sadness	41.83 (21.89)	.11	.09	-.08	--															
5. Anger	35.46 (11.01)	-.12	.03	-.03	.48***	--														
6. Updating	2.05 (.58)	.27**	.06	.14	-.06	.07	--													
7. LU Block 1	2.09 (.76)	.29***	.01	.18*	-.11	-.04	.70***	--												
8. LU Block 2	2.01 (.80)	.16	.06	.08	.01	.10	.71***	.32***	--											
9. LU Block 3	2.04 (.81)	.20*	.01	.03	-.07	.09	.75***	.38***	.37***	--										
10. LU Block 4	2.06 (.82)	.15	.10	.12	-.01	.04	.75***	.37***	.37***	.42***	--									
11. Inhibition	340.98 (52.34)	-.39***	.14	-.07	-.06	.07	-.28***	-.26**	-.19*	-.19*	-.17*	--								
12. SS Block 1	322.37 (70.68)	-.33***	.14	-.02	-.08	.06	-.14	-.16*	-.09	-.11	-.05	.75***	--							
13. SS Block 2	351.27 (75.04)	-.29***	.18*	-.04	.01	-.01	-.16*	-.22**	-.09	-.11	-.05	.72***	.41***	--						
14. SS Block 3	344.62 (77.83)	-.24**	.07	-.12	-.07	.09	-.28***	-.25**	-.18*	-.25**	-.14	.70***	.43***	.29***	--					
15. SS Block 4	345.54 (77.79)	-.27**	.00	-.03	-.03	.08	-.19	-.09	-.17*	-.07	-.23**	.66***	.32***	.34***	.22**	--				
16. Shifting	349.69 (446.36)	-.00	-.13	-.05	.02	-.09	-.12	-.08	-.06	-.08	-.18	-.01	.09	.01	-.04	-.07	--			
17. GL Block 1	428.70 (654.23)	-.03	.04	-.07	.11	-.10	-.10	-.12	.01	-.06	-.11	-.04	.09	-.02	.01	.03	.57***	--		
18. GL Block 2	304.23 (822.39)	.04	-.09	-.03	-.00	-.02	.08	.11	.02	.05	.07	-.11	-.03	-.03	-.15	-.09	.65***	.14	--	
19. GL Block 3	391.81 (857.79)	-.08	-.15	-.11	.07	.02	-.16*	-.18*	-.03	-.12	-.13	.08	.12	.13	-.01	-.01	.51***	.19*	.18*	--
20. GL Block 4	273.41 (952.67)	.06	-.05	.08	-.11	-.09	-.09	-.01	-.12	-.04	-.09	-.02	.03	-.06	.03	-.07	.50***	.11	.10	-.22**

Note. All means and standard deviations are presented in raw scores. Updating, inhibition, and shifting component scores are presented as mean scores. SES = socioeconomic status; Sadness = sadness rumination; Anger = anger rumination; Updating = updating component; Inhibition = inhibition component; Shifting = shifting component; LU = letter updating; SS = stop-signal; GL = global-local; *$p < .05$, **$p < .01$, ***$p < .001$

Table 4. *Multiple Regression Analyses Examining Concurrent Associations*

	Updating			**Inhibition**			**Shifting**		
	b	***SE***	**B**	***b***	***SE***	**β**	***b***	***SE***	**β**
Age	.19	.06	.25**	-.27	.06	-.36***	-.07	.06	-.10
Sex	.22	.16	.11	.28	.15	.14	-.22	.16	-.11
Sadness Rumination	-.01	.00	-.18*	-.00	.00	-.05	.01	.00	.21*
Anger Rumination	.02	.01	.20*	.01	.01	.08	-.01	.01	-.14

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

APPENDIX A

INSTITUTIONAL REVIEW BOARD
PROJECT APPROVAL MEMORANDUM

Office of the Vice President For Research
Human Subjects Committee
P O Box 3062742
Tallahassee, Florida 32306-2742
(850) 644-8673 · FAX (850) 644-4392

APPROVAL MEMORANDUM (for change in research protocol)

Date: 02/16/2017

To: Sherelle Harmon

Address: 4301

Dept: PSYCHOLOGY DEPARTMENT

From: Thomas L. Jacobson, Chair

Re: Use of Human subjects in Research

Project entitled: Neurocognitive mechanisms underlying rumination risk in children

The application that you submitted to this office in regard to the requested change/amendment to your research protocol for the above-referenced project has been reviewed and approved.

Please be reminded that if the project has not been completed by 07/12/2017, you must request renewed approval for continuation of the project.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Human Research Protection. The Assurance Number is IRB00000446.

Cc: Janet Kistner, Advisor
HSC NO. 2017.20357

APPENDIX B

INSTITUATIONAL REVIEW BOARD
PROJECT RENEWAL MEMORANDUM

The Florida State University
Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673, FAX (850) 644 4392

RE-APPROVAL MEMORANDUM

Date: 6/15/2017

To: Sherelle Harmon

Address: 4301
Dept.: PSYCHOLOGY DEPARTMENT

From: Thomas L. Jacobson, Chair

Re: Re-approval of Use of Human subjects in Research Neurocognitive mechanisms underlying rumination risk in children

Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by 6/13/2018, you must request renewed approval by the Committee.

If you submitted a proposed consent form with your renewal request, the approved stamped consent form is attached to this re-approval notice. Only the stamped version of the consent form may be used in recruiting of research subjects. You are reminded that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report in writing, any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

Cc: Janet Kistner, Advisor
HSC No. 2017.21265

Office of the Vice President For Research
Human Subjects Committee
P O Box 3062742
Tallahassee, Florida 32306-2742
(850) 644-8673 · FAX (850) 644-4392

RE-APPROVAL MEMORANDUM

Date: 05/17/2018

To: Sherelle Harmon

Address: 4301

Dept: PSYCHOLOGY DEPARTMENT

From: Thomas L. Jacobson, Chair

Re: Use of Human subjects in Research

Re: Re-approval of Use of Human subjects in Research:
Neurocognitive mechanisms underlying rumination risk in children

Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by 05/16/2019, you are must request renewed approval by the Committee.

If you submitted a proposed consent form with your renewal request, the approved stamped consent form is attached to this re-approval notice. Only the stamped version of the consent form may be used in recruiting of research subjects. You are reminded that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report in writing, any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chairman of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

Cc:
HSC NO. 2018.24956

APPENDIX C

PARENT CONSENT FORM

Parents' or Guardians' Permission for Your Child to be in a Research Study

As the parent or guardian, you are being asked to give permission for your child to be in this study.

Participant's Name_____

Principal Investigator:	Sherelle Harmon, M.S., LCSW FSU Department of Psychology 1107 W. Call Street Tallahassee, FL 32306 Phone: (850) 644-1538
Supervised by:	Janet Kistner, Ph.D., Licensed Psychologist FSU Department of Psychology 1107 W. Call Street Tallahassee, FL 32306 Phone: (850) 644-1538 Michael Kofler, Ph.D., Licensed Psychologist Director, Children's Learning Clinic FSU Department of Psychology 1107 W. Call Street Tallahassee, FL 32306 Phone: (850) 645-7423
Sponsor:	Florida State University Department of Psychology

What is the purpose of this form?

This form will help you decide if you want your child to be in the research study. You need to be informed about the study before you can decide if you want to be in it. You do not have to be in the study if you do not want to. You should have all your questions answered before you give your permission or consent to be in the study.

Please read this form carefully. If you want your child to be in the study, you will need to sign this form. You will get a copy of this form.

Who is funding this study?

This study is being funded by the Florida State University Department of Psychology.

Why is this research being done?

The purpose of this study is to better understand the role of executive functioning in the relationship between children's thoughts, feelings, and behaviors. Executive functions are brain processes that help us guide our behavior, and include working memory (holding information in our mind and processing that information), inhibition (monitoring our behavior and stopping it when it isn't accomplishing our goals), and cognitive flexibility (keeping multiple ideas in mind and shifting between them).

Your child is being asked to be in this study because you have expressed interest in participating in research of this type at Florida State University.

Up to 150 people will be in this study at FSU.

How long will this study take?

Participation in this study will require up to two visits over a 1-month period of time. Each visit will last about 3 hours.

What will happen if you are in the study?

SCREENING:

You have already completed screening for this study by telephone interview**.** You are now being invited to participate in this study.

VISITS 1 and 2:

If you agree to participate, you will sign this consent form before any study related procedures take place.

The following will occur during these visits:

- You will complete a packet of questionnaires.

- You will receive a packet of questionnaires to give to your child's teacher. This would be whichever teacher knows your child the best.

- We will ask your child to complete a number of tasks:
    - Written tasks such as working math problems, and copying nonsense shapes on paper.
    - Learning tasks, such as being asked to define words and identify patterns.
    - Computer tasks such as learning pairs of numbers, or recalling words presented on the screen.
    - Other tasks which involve using memory or rapid decision-making to meet a goal, such as pressing a space bar on the computer when certain images appear.

These visits will last about 3 hours. Your child will receive breaks after every one or two tasks, so that he/she will never be working on a task for more than 10 or 15 minutes. During the breaks, your child will be offered a snack, or engage in active play, such as indoor basketball with research staff.

We will ask your child to wear 4 actigraphs during these visits. Actigraphs are watch-like devices that contain a sensor that records movement. We will place an actigraph on each of your child's wrists and both ankles. There will also be an actigraph attached to the chair. Because we want to record your child's usual activity level, unchanged by awareness of the purpose of the actigraph, we will tell your child only that the actigraph is a "special watch". One of these actigraphs will also record your child's heart rate and temperature. This actigraph is similar to popular watches that athletes wear to measure their heart rate during exercise. We will be happy to demonstrate these "special watches" for you.

If you want to know about the results before the study is done:

During the study your study leader will let you know of any test results that may be important to your child's health. In addition, as the research moves forward, your study leader will keep you informed of any new findings that may be important for your child's health or may help you decide if you want to continue in the study. The final results of the research will not be known until all the information from everyone is combined and reviewed. At that time you can ask for more information about the study results.

Some of the tests in this study are investigational. The purpose of these tests is NOT to diagnose any abnormality your child may have. Because the test is investigational there is no way for the study leader to understand if the results are "normal" or "abnormal." However, if any test results are concerning, your study leader will let you know. One of the actigraphs measures physiological (biological) variables such as heart beats per minute and skin temperature, which will help us better understand your child's attention and reactions to our games. This device does not record data comparable to an electrocardiogram (EKG) or other medical procedures, so it will not tell us whether your child has a heart condition or any other medical abnormality.

What are the risks of being in this study?
Risks and side effects related to the study include:

Your child may become tired or frustrated while working on some of the tasks. We schedule frequent breaks between tasks, and our research team members are trained to interact with children in a cheerful and supportive manner. If your child shows evidence of becoming overly frustrated, we will end the task and take a 10-minute break. Continued participation at the visit will only proceed if your child indicates that he/she is willing and ready to proceed with the tasks.

There is a very small risk that someone could see your child's private information.

Risks of Videotaping/Audio taping:

- Your child will be videotaped during this study. If you do not want your child to be videotaped, your child will not be able to participate in the study. Discuss any concerns you may have about your child being videotaped with the principle investigator. Taped recordings are stored as computer files on a secure, password protected computer in the Department of Psychology. All of these files are erased from the computer after they are fully analyzed with one exception:

- Video footage of children performing select executive functioning tasks are saved for classroom and professional demonstration purposes at scientific conferences to help professionals and students understand the difficulties experienced by children with working memory problems. Parents may elect not to allow a video of their child to be shown, or elect to allow a video to be shown only if face-blurring technology is used, without penalty and their child may still participate in the study. In these cases, all video images will be destroyed following the analysis of data.

Please select ***one*** of the following options:

- _____ (parent initials) Video footage of my child can be shown at professional conferences, courses, and lectures taught or supervised by Dr. Kofler. My child's face does not need to be blurred. There is a small chance that someone in the audience may recognize my child (note: no personal identifying information of any kind about any child is presented at scientific conferences).

- _____ (parent initials) Video footage of my child can be shown during professional conferences, courses, and lectures taught or supervised by Dr. Kofler, only if her/his face is completely blurred through software application, rendering it impossible to identify the child when observing the video (note: no personal identifying information of any kind about any child is presented during these lectures).

- _____ (parent initials) No video footage of my child can be shown at professional conferences/courses/lectures.

Other unexpected risks:

You may have side effects that we do not expect or know to watch for now. Call the study leader if you have any symptoms or problems.

Could you be helped by being in this study?

We cannot promise that being in this study will help your child. You and your child may benefit from being in this study. A potential benefit to you includes the knowledge that you are contributing to the field of clinical child research.

What are your other choices if you do not join this study?

You do not have to be in this study to participate in research at Florida State University.

If you are an employee of FSU your job will not be affected if you decide not to participate in this study.

If you are a student at FSU, your grades will not be affected if you decide not to participate in this study.

Will you be paid for being in this study?

You will receive a $20 gift card for your participation at the end of your visits. Your child will receive a small gift of a toy from a prize box at the end of each research session.

Will being in this study cost you any money?

All of the procedures in this study will be provided at no cost to you or your health insurance. You will be responsible for the cost of travel to come to any study visit. Parking is available at no charge.

What if you are hurt in this study?

If you are hurt as a result of being in this study, there are no plans to pay you for medical expenses, lost wages, disability, or discomfort. The charges for any medical treatment you receive will be billed to your insurance. You will be responsible for any amount your insurance does not cover. You do not give up any legal rights, such as seeking compensation for injury, by signing this form.

What happens if you leave the study early?

You can change your mind about being in the study any time. You can agree to be in the study now and change your mind later. If you decide to stop, please tell us right away. You do not have to be in this study to get services you can normally get at Florida State University.

Even if you do not change your mind, the study leader can take you out of the study. Some of the reasons for doing so may include

a) Your study leader is concerned about your child's health

e) You do not follow instructions

f) The study is closed for safety, administrative or other reasons

If you decide to stop being in the study, we will ask you to notify the principle investigator at (850) 644-1538.

How will your personal information be shared?

The FSU researchers are asking for your permission to gather, use and share information about you for this study. If you decide not to give your permission, you cannot be in this study, but your child can continue to receive regular medical care at FSU.

If you sign this form, we may collect any or all of the following information about your child:

- Personal information such as name, address, and date of birth.
- Your child's health information.

Who will see your private information?

- The researchers, to make sure they can conduct the study the right way, observe the effects of the study, and understand its results.
- People or groups that oversee the study to make sure it is done correctly.
- The sponsor(s) of this study, and the people or groups it hires to help perform or review this research.
- People who evaluate study results, which can include sponsors, researchers at other sites conducting the same study, and government agencies that provide oversight.

Some of the people outside of FSU who will see your information may not have to follow the same privacy laws that we follow. We ask them to protect your privacy. However, they may release your information to others, and it may no longer be protected by those laws.

The information collected from you might be published in a medical journal. This would be done in a way that protects your privacy. No one will be able to find out from the article that you were in the study.

What if you sign the form but then decide you don't want your private information shared?

You can change your mind at any time. Your permission does not end unless you cancel it. To cancel it, please send a letter to the researchers listed on this form. Then you will no longer be in the study. The researchers will still use information about you that was collected before you ended your participation.

Limits to Confidentiality

Under certain conditions, we are legally and ethically obligated to release information about a child or family whether or not the caregiver approves. These conditions are:

- Suspected abuse (physical, sexual, or neglect) of children, the aged, and the disabled: As psychologists, we are required by law to report suspected abuse to the Florida Department of Children and Families. All citizens of the State of Florida are mandated to report suspected abuse to the Abuse Hotline: 1-800-96-ABUSE.
- Danger to self or others: If a child or caregiver is thought to be at high risk for suicide, then their family and/or the authorities may need to be notified to protect the person. Likewise, in instances where a client threatens serious bodily harm we may have to notify the intended victim and police.
- Court-order: We must release a client's records if a judge issues a court order compelling us to do so.

If confidentiality is broken or your records released because of any of the above three reasons, you will be notified.

Please contact the researchers listed below to:

- Obtain more information about the study
- Ask a question about the study procedures
- Report an illness, injury, or other problem (you may also need to tell your regular doctors)
- Leave the study before it is finished
- Express a concern about the study

Principal Investigator: Sherelle Harmon
Department of Psychology
Florida State University
1107 W. Call St.
Tallahassee, FL 32306
Telephone: (850) 644-1538

What if you have a concern about this study?

You may also report a concern about this study or ask questions about your rights as a research subject by contacting the Institutional Review Board listed below.

Florida State University Institutional Review Board
Human Subjects Office
2010 Levy Avenue, Suite 276-C
Tallahassee, FL 32306-2742
Ph: (850) 644-7900
Fax: (850) 644-4392

When you call or write about a concern, please give as much information as you can. Include the name of the study leader, the IRB Number (at the top of this form), and details about the problem. This will help officials look into your concern. When reporting a concern, you do not have to give your name.

Signatures
What does your signature mean?

Before you sign this form, please ask questions about any part of this study that is not clear to you. Your signature below means that you have received this information and all your questions have been answered. If you sign the form it means that you agree to join the study. You will receive a copy of this signed document.

Parental/ Guardian Permission

By signing below you confirm you have the legal authority to sign for this child.

_____	_____	_____
PARENT/GUARDIAN (SIGNATURE)	PARENT/GUARDIAN (PRINT NAME)	DATE

Consent From Impartial Witness

If this consent form is read to the parent(s) because the parent(s) is blind or illiterate*, an impartial witness not affiliated with the research or study doctor must be present for the consenting process and sign the following statement. The parent may place an X on the Parent Signature line above.*

I agree the information in this informed consent form was presented orally in my presence to the parent(s) guardian(s) and the parent(s)/guardian(s) had the opportunity to ask any questions he/she had about the study. I also agree that the parent(s)/guardian(s) freely gave their informed consent for their child to participate in this trial.

_____	_____	_____
IMPARTIAL WITNESS (SIGNATURE)	IMPARTIAL WITNESS (PRINT)	DATE

FSU Human Subjects Committee approved on 06/15/2017, void after 06/13/2018. HSC #2017.21265

APPENDIX D

CHILD ASSENT FORM

[for the child to read aloud; research staff will assist with the pronunciation and understanding of any words as needed]

I know that I will be visiting the FSU Department of Psychology to answer different questions about my thoughts and feelings and play different games, including some computer games. I will be given lots of breaks during this time. Some of these games will be easy, and some will be more difficult. The people working in the lab will explain all of the games to me and answer any of my questions.

_____ I want to take part in the FSU Department of Psychology research project.

_____ _____

Child's Name Research Staff

_____

Child's Signature

_____

Date

FSU Human Subjects Committee approved on 06/15/2017, void after 06/13/2018. HSC #2017.21265

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BIOGRAPHICAL SKETCH

Sherelle Harmon attended Swarthmore College where she graduated with a Bachelor of Arts degree in Psychology and a minor in Black Studies in 2007. After completing a post-baccalaureate externship at the Devereux Foundation, she pursued a Master of Science degree in Social Work at Columbia University. After graduating, she worked as a research clinician for two years for the ADHD Research Study at Oregon Health & Science University. She also received a Master of Science degree in Psychology from Florida State University in 2014. Sherelle completed her predoctoral internship at the Medical University of South Carolina. She will graduate with her Ph.D. in Clinical Psychology from Florida State University in 2018 and begin a postdoctoral research fellowship at Harvard University.