Executive Function, Coping, and Depressive Symptoms in Adolescent Offspring of Depressed and Non-Depressed Mothers

Meghan M. Howe

Vanderbilt University

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Abstract

The present study examined the concurrent associations among executive functioning, coping, maternal depression history, and depressive symptoms in adolescents. The sample included 82 adolescents between the ages of 12 and 15 and their mothers, recruited to represent a range of maternal depression history. Results indicated that adolescents of mothers with a history of depression were more depressed than adolescents of mothers without a history. In the full sample, significant relations were found between measures of coping and depressive symptoms, executive function and depressive symptoms, and executive function and coping. The association between executive function and depressive symptoms was accounted for secondary control coping. Findings suggest that better EFs, coupled with increased secondary control coping, may protect against depressive symptoms in adolescents with and without a history of exposure to maternal depression.

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Depression is a significant mental health problem in the U.S. and worldwide (Moussavi et al., 2007). The lifetime prevalence rate of major depressive disorder (MDD) is estimated to be 16% in the United States, however, cohort longitudinal studies show that lifetime rates of the disorder may be as high as 40% (Moffit et al., 2007). One of the most striking findings about depression is that it runs in families (Hammen, Shih, & Brennan, 2004). It is estimated that approximately 15 million children live with a parent who has experienced at least one episode of major depressive disorder (MDD) during their children's lifetime (National Research Council and Institute of Medicine, 2009). Having a depressed parent remains one of the most potent risk factors for developing depression. Compared to children in the general population, children who live with depressed parents are at 3 to 4 times greater risk for developing depression and other psychopathology (NRC/IOM, 2009). Additionally, depression in children of depressed parents is shown to have an earlier onset, longer duration and greater recurrence rates (Hammen, Burge, Burney, & Adrian, 1990). To prevent the onset of depression and other symptoms and diagnoses of psychopathology in children of depressed parents it is essential to understand the processes through which exposure to parental depression increases children's risk.

Mechanisms of Transmission

Goodman and Gotlib (1999) proposed a developmentally sensitive model to explain the processes through which maternal depression adversely affects child outcomes. The model proposes four mechanisms through which risk for depression is transmitted from mother to child: "(a) heritability of depression; (b) innate dysfunctional neuroregulatory mechanisms; (c) negative maternal cognitions, behaviors, and affect; and (d) the stressful context of the children's lives"

(Goodman & Gotlib, 1999, p.460). The first mechanism of transmission is that children of depressed mothers directly inherit a genetic vulnerability to depression. However, despite the strong evidence that depression runs in families (Moffit et al., 2007), a specific candidate gene or set of genes for depression has yet to be identified. As a second mechanism, Goodman and Gotlib (1999) posit that children of depressed mothers are born with dysfunctional neuroregulatory mechanisms due to adverse prenatal experiences. In theory, maternal depression during pregnancy causes the fetus to develop abnormally which directly impairs neuroregulatory mechanisms (Goodman & Gotlib, 1999). However, this mechanism only applies to offspring born to mothers who experienced a clinically significantly episode of MDD during pregnancy. In the third mechanism Goodman and Gotlib (1999) focus on the disrupted interpersonal processes between depressed mothers and their children. Depression in mothers is characterized by negative cognitions, behaviors, and affect. Goodman and Gotlib (1999) hypothesized that modeling the negative cognitions, behaviors and affect exhibited by their mothers puts children at greater risk for depression.

Exposure to chronic stress. Goodman and Gotlib's (1999) final mechanism of transmission of risk is that the stress of living with a depressed mother significantly contributes to the development of depression in their children. Maternal depressive symptoms create a chronically stressful environment for youth. Exposure to high levels of chronic stress increases risk for multiple forms of psychopathology, including depression (e.g., Hammen, Kim, Eberhart, & Brennan, 2009). Chronic, early life stress has also been shown to have adverse effects on children/adolescents' brain development and cognition. The brain regions affected by stress are responsible for coordinating cognitive processes known as executive functions which underlie the ability to effectively cope with stress. Thus, the effect of chronic stress on children of

depressed parents is twofold: chronic stress exposure directly increases risk for psychopathology and chronic stress undermines the ability to cope with stress by impairing executive functions.

There is strong evidence that children of depressed parents are exposed to high levels of chronic and episodic stress. Depression causes disruptions in parenting that lead to stressful parent-child interactions. Specifically, depressed parenting is characterized by parental withdrawal (e.g., avoidance) and/or parental intrusiveness (e.g., irritability, and over involvement in children's lives) (Fear et al., 2009; Gruhn et al., 2016; Jaser et al., 2005; Langrock et al., 2002). Increased inter-parental conflict also contributes to the stress of living with a depressed parent. When one or both partners are depressed, marital relationships are often characterized as tense, disharmonious, and hostile (Bruce & Kim, 1992; Fear et al., 2009; Gotlib & Beach, 1995). Children of mothers with a history of recurrent MDD experience more chronic interpersonal stress than children of never depressed mothers (Feurer, Hammen & Gibb, 2016; Hammen, Brennan, & Shih, 2004). Additionally, children of depressed parents report higher levels of stress than other children at-risk for increased stress exposure. Compared to children of mothers with bipolar disorder and children of chronically medically ill mothers, children of mothers with MDD experience the highest levels of chronic stress across time (Adrian & Hammen, 1993). Children of mothers with a history of MDD also generate higher levels of episodic stress than children of nondepressed mothers (Adrian & Hammen, 1993; Feurer et al., 2016).

Effects of stress on brain development and function. Chronic exposure to stress, and particularly stress that occurs early in development, can cause maladaptive structural and functional changes in the developing brain (Chocyk et al., 2013). Due to ethical concerns, most of the empirical evidence for the adverse effects of stress on the developing brain comes from animal models. McEwen and colleagues have provided foundational evidence that prolonged

stress exposure results in the simplification of dendrites in the hippocampus and the medial prefrontal cortex (mPFC) (e.g., Eiland, Ramroop, Hill, Manley, & McEwen, 2012). The PFC continues to develop into the second decade of life which makes it especially vulnerable to the adverse effects of chronic stress (Hanson et al., 2012). For example, Radley, Arias, and Sawchenko (2006) observed that rats exposed to chronic stress through repeated restraint resulted in a significant decrease in dendritic spine density and length in pyramidal neurons in the mPFC. Similarly, Eiland et al. (2012) found that exposing juvenile rats to chronic stress led to the simplification of dendrites in the hippocampus and mPFC and concurrent hypertrophy of dendrites in the amygdala. The few empirical studies conducted with human subjects have also shown support for the adverse effects of chronic stress on brain development. In a neuroimaging study, Frodl, Reinhold, Koutsouleris, Reiser, and Meisenzahl (2010) found that left hippocampal white matter volume as significantly reduced in depressed men who had experienced high levels of childhood stress. In a neuroimaging study of healthy children, Hanson et al. (2012) neuroimaging demonstrated that clusters of decreased white mater volume in the PFC near the forceps minor was associated with increased life stress.

Effects of chronic stress on development of executive functions. The adverse effects of chronic stress are most pronounced in brain regions responsible for executive functions. Executive functions (EF) refers to a set of higher-order cognitive processes that coordinate and control lower level processes to regulate the dynamics of human behavior and cognition (Miyake & Friedman, 2012). Executive functions are different from more automatic cognitive processes (e.g., motor control) in that they are conscious, controlled, self-directed behaviors. The broad concept of EF is comprised of dissociable subcomponents such as working memory, inhibition, cognitive flexibility/problem solving, and attentional control (e.g., Miyake, Friedman, Emerson,

Witzki, & Howerter, 2000; Diamond & Lee, 2011) that are united by a common EF factor (Miyake & Friedman, 2012). Executive functions are often referred to as frontal lobe tasks because of their heavy reliance on the prefrontal cortex (e.g., Baddeley, 1996; Fuster, 2000). It is noteworthy that prolonged exposure to stress has a negative effect on EF and cognitive control through the disruption of functioning in the PFC (Radley, Morilak, Viau, & Campeau, 2015). The effect of stress on the PFC and executive function has been demonstrated in recent neuroimaging studies. Using a community sample of children, Hanson et al. (2012) found that decreased PFC volumes were associated with increased cumulative life stress and impaired working memory. The effect of stress on working memory was stronger for cumulative life stress than for acute stress in the past year. In a study of mothers with and without a history of depression and their children, Reising et al. (in press) found that adolescents with depressed mothers demonstrated differential activation in the PFC while performing a working memory task compared to adolescents without depressed mothers.

Depression and Executive Function

Cognitive impairment is an important characteristic of major depressive disorder. The *Diagnostic and Statistical Manual of Mental Disorders* (5th edition, DSM-5) lists "diminished ability to think or concentrate, or indecisiveness, nearly every day" (American Psychiatric Association, 2013) as a defining symptom of MDD. A growing body of research has begun to examine association between depression and EF impairment.

In a comprehensive meta-analysis (*N*=113), Snyder (2013) aimed to determine whether measures of EF are indeed reliably impaired in patients with MDD compared to healthy controls. Snyder (2013) reviewed studies that compared patients with MDD to healthy age-matched controls on the following EF components: inhibition, shifting, updating, verbal working memory,

visuospatial working memory, planning, and verbal fluency. Snyder (2013) also included processing speed and vocabulary measures in the analysis as these tasks likely require EF involvement. Patients with MDD performed significantly worse than healthy controls on all measures of EF. Measures of verbal working memory, processing speed and vocabulary are highly relevant to the current study as they are likely implicated in the successful utilization of complex coping strategies.

Snyder (2013) found that patients with MDD scored significantly lower than healthy controls on the verbal working memory composite score (d= 0.45, k= 39). The most commonly reported measures of verbal working memory were the digit span forward and backward tests. Patients with MDD were significantly impaired on both the digit span forward (d= 0.39, k= 27) and backward test (d= 0.55, k= 23). The digit span backward test is a particularly good measure of working memory/updating in that it requires short-term maintenance and manipulation of information. The successful completion of processing speed measures, such as the digit-symbol substitution task, requires the integration of multiple cognitive abilities including working memory and sustained attention (van Hoof, Jogems-Kosterman, Sabbe, Zitman, & Hulstijn, 1998). Patients with MDD were significantly slower on the digit-symbol substitution task compared to healthy controls (d= 0.55, k= 0.55). While vocabulary is not traditionally a component of executive function, it is theorized to relate to executive function components such as verbal working memory or verbal fluency. Patients with MDD scored lower on vocabulary measures than healthy controls (d= 0.14, k= 36). The effect sizes for vocabulary increased with symptom severity. Overall, Snyder (2013 found that patients with MDD performed significantly worse across all domains of EF compared to healthy controls. However, the analysis primarily included studies with adult samples (M= 46 years). Thus, the findings may not extend to

children/adolescents with MDD.

Based on the strong body of evidence that MDD is associated with broad impairments in EF in adults, Wagner, Müller, Helmreich, Huss, and Tadić (2015) conducted a similar meta-analysis to examine this association in children and adolescents. Wagner et al. (2015) identified 17 eligible studies that compared children/adolescents in a current episode of MDD to healthy controls on various domains of EF. Six of the studies focused on children/adolescents' performance on measures of working memory. The reported measures included the digit forward task (k= 3), n-back task (k= 1), digit symbol coding (k= 1), and spatial working memory (k= 1). Children and adolescents with MDD performed significantly worse than healthy controls on all measures of working memory. The effect of MDD on executive functions was not limited to measures of working memory; children and adolescents with current MDD showed significant impairments on all executive functions indices excluding selective attention. Depression appears to be associated with broad cognitive impairments as early as childhood/adolescence.

The direction of the relation between executive function impairment and depression is less understood. One potential explanation is that cognitive skills suffer as a result of being depressed. It is also plausible that poorer executive functions precede and increase risk for depression. If impaired executive functioning increases risk for depression, then it is reasonable to theorize that better executive functions may serve as a source of resilience for those at risk for depression. In a recent study, Davidovich et al. (2016) found that better executive functioning buffered the effect of current parental depression on children' (ages 9-17) depressive symptoms. Specifically, adolescents who performed better on measures of inhibitory control and cognitive flexibility experienced fewer depressive symptoms controlling for age, IQ, and gender (Davidovich et al., 2016). Davidovich and colleagues provide preliminary evidence that better

executive functions may serve as a protective factor for those highly at risk for depression.

Coping and Executive Function

One way that executive function may increase/decrease risk for depression is by disrupting the cognitive processes needed to cope with stress. The ability to effectively cope with stress is particularly important for children of depressed parents, who are exposed to unusually high levels of stress at home (e.g., Feurer, Hammen & Gibb, 2016; Hammen, Brennan, & Shih, 2004). Coping is defined as "conscious volitional efforts to regulate emotion, cognition, behavior, physiology and the environment in response to stressful events or circumstances" (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001, p.89). Confirmatory factor analyses support a three-factor model of volitional coping responses: primary control coping, secondary control coping, and disengagement coping (Connor-Smith, Compas, Wadsworth, Thomsen, & Saltzman, 2000). Primary control coping responses are direct efforts to influence the source of a stressor or one's emotional response to it (e.g., problem solving, emotional expression, emotion regulation). Secondary control coping responses are efforts to adapt to sources of stress such as cognitive reappraisal, positive thinking, acceptance, and distraction. Disengagement coping includes efforts to avoid the source of stress and/or one's emotional response to it (e.g., denial, avoidance, wishful thinking) (Connor-smith et al., 2000). The factor structure of the RSQ has been supported in confirmatory factor analytic studies with children and adolescents from a wide range of ethnic and cultural backgrounds coping with a variety of stressors (e.g., Compas et al., 2006; Connor-Smith et al., 2000; Wadsworth et al., 2004; Yao et al., 2010).

Executive functions are theorized to the be the foundation on which the ability to select and utilize adaptive coping strategies rests. Working memory is a specific executive function that underlies both primary and secondary control coping strategies (Connor-Smith et al., 2000). The

ability to hold onto several different thoughts in short-term memory while attempting to modify them is also integral to primary control coping skills such as problem solving. Furthermore, neuroimaging studies (e.g., Ochsner, Bunge, Gross, & Gabrieli, 2002) have demonstrated that using cognitive reappraisal coping strategies (i.e., secondary control coping) corresponds with increased activation in prefrontal brain regions linked to working memory. In addition to working memory, executive functions such as inhibitory control and cognitive flexibility also facilitate successfully engaging adaptive coping skills (Compas, 2006).

The empirical evidence for a direct relation between executive function and coping is currently limited. However, the initial studies do indicate promising evidence for the association between executive function and coping. For example, in a study of children with acute lymphocytic leukemia Campbell et al. (2009), found that executive function components (working memory, cognitive flexibility, and self-monitoring) were positively associated with primary control and secondary control coping, and were negatively associated with disengagement coping. Better selective attention was related to increased use of secondary coping skills in a study of youth with functional abdominal pain (Hocking et al., 2011). Working memory has been shown to positively associate with secondary control coping skills such as cognitive reappraisal (Andreoitti et al., 2013). There is also recent evidence (e.g., Evans, Kouros, Samanez-Larkin, & Garber, 2016) that executive functions predict the use of coping skills over time. Specifically, better working memory performance at baseline predicted increased use of primary control and secondary control coping strategies approximately five months later (Evans et al., 2016). Overall there is emerging evidence that executive functions underlie the complex cognitive processes required to successfully cope with stress. Consequently, executive function impairment is likely to disrupt the complex, cognitive

processes necessary for selecting and utilizing coping strategies in response to stress (Compas, 2006).

Coping and Depressive Symptoms

The capacity to effectively cope with stress has important implications for increasing risk or protecting against depression (Compas et al., 2010). The inability to employ effective coping skills in response to stressors is a potent risk factor for internalizing problems such as depression (Compas et al., 2001, 2014). Greater use of disengagement coping responses (i.e., avoidance, denial, wishful thinking) is associated with increased depressive symptoms in children and adolescents. Conversely, the utilization of primary and secondary control coping responses is associated with fewer emotional problems and may protect against depressive symptoms (Connor-Smith et al., 2000; Evans et al., 2016; Jaser et al., 2008, 2011). Previous studies of children coping with parental depression have consistently shown strong evidence that secondary control coping is negatively associated with depressive symptoms (Dunbar et al., 2013; Fear et al., 2009; Jaser et al., 2005, 2008, 2011; Langrock et al., 2002). Additionally, family cognitive-behavioral interventions designed to teach children/adolescents secondary control coping skills have significantly lowered depressive symptoms (e.g., Compas et al., 2010, 2015).

The Present Study

Based on the evidence that parental depression, executive function, and coping have significant roles in determining adolescent risk for depression, this study examined the relations between these factors and their collective influence on adolescent depressive symptoms. The concurrent and long-term associations among executive function, coping, and depressive symptoms have previously been tested in undergraduates (Andreoitti et al., 2013; Morris, Evans, Rao, & Garber, 2015), adults with multiple sclerosis (Grech et al., 2016), and in school-aged

children (Evans et al., 2016). The most consistent findings were that coping, at least partially, mediated the association between executive function and depressive symptoms. This study provides one of the first examinations of the associations among executive function, coping, and depressive symptoms in adolescents of mothers with and without a history of depression.

The following hypotheses are tested: (1) Mothers with a history of depression will report higher levels of current depressive symptoms than mothers without a history of depression. (2) Parent and adolescent-self reports of adolescents' depressive symptoms will be positively associated with current maternal depressive symptoms. (3) Offspring of mothers with a history of depression will report higher levels of anxious/depressed, withdrawn/depressed, and affective problem symptoms on child-self and parent reports; report lower use of primary and secondary control coping and greater use of disengagement coping; and score lower on tests of executive function. (4) For the whole sample, greater use of primary and secondary control coping will be associated with fewer depressive symptoms, whereas greater use of disengagement coping will be associated with increased depressive symptoms as reported by mothers and adolescents. (5) In the whole sample, impaired performance on measures of executive function will be associated with less use of primary and secondary control coping and greater use of disengagement coping, and more depressive symptoms as reported by mothers and adolescents. (6) In the whole sample, secondary control coping and executive function will be significant, individual predictors of adolescent depressive symptoms. (7) Executive function will indirectly predict depressive symptoms through secondary control coping in the whole sample.

Method

Participants

The current sample consisted of 82 adolescents and their mothers. Adolescents ranged in age from 12-15 years old (*M*= 13.28 years). Mothers were between the ages of 32 and 62

(*M*=43.35 years). 40.2% of the adolescents in the sample were female. These participants were recruited to take part in a larger study (*N*=162) of mothers, with diverse histories of major depressive disorder, and their children ages 9-15. In the selected subsample of participants, 45% of mothers had experienced an episode of MDD during their child's lifetime (*n*=37). The subsample of participants did not significantly differ from the larger sample on maternal depression history.

Of the mothers in the current sample, 67.1% were Caucasian, 28.0% were African American, 1.2% were Asian American, 1.2% were Native American, and 1.2% were more than one race or other ethnic background. Of the adolescents in the current sample, 65.9% were Caucasian, 26.8% were African American, 1.2% were Asian American, and 4.9% identified as more than one race or other ethnic background. The majority of mothers (59.8%) were married or living with a partner, 29.2% divorced or separated, 8.5% never married, and 2.4% widowed. The annual household income rates for the sample ranged from $13,000 to more than $200,000 (*M*= 80,162.16). Maternal education levels ranged from some high school to graduate education (*M* = 15.66 years). See Table 1 for full sample demographic information.

Measures

Maternal depression history and symptoms. Mothers were interviewed by extensively trained graduate students using the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID; First, Spitzer, Gibbon, & Williams, 2001) to determine current or previous history of major depressive disorder. The SCID is a semi-structured clinical interview used to assess current and prior psychiatric diagnoses according to DSM criteria. In the current study the SCID was used to determine the absence or presence of a maternal depressive episode during the child's lifetime. The Beck Depression Inventory-II (BDI-II; Beck, Steer, Ball, & Ranieri, 1996)

was used to measure maternal depressive symptoms over the past two weeks. The BDI-II is a widely used self-report measure of depressive symptoms with established internal reliability (α=0.91) and validity in differentiating levels of depression severity (Beck et al. 1996).

Adolescent depressive symptoms. The Youth Self-Report (YSR; Achenbach & Rescorla, 2001) was used to assess adolescents' views of their own depressive symptoms. The YSR is a 112-item self-report designed to measure youth's behavioral and emotional problems over the past 6 months. It is demonstrated to have excellent reliability and validity (Achenbach & Rescorla, 2001). The Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) was used to assess mothers' views of their child's depressive symptoms. The CBCL is a 118-item self-report instrument designed to measure parent reports of their youth's emotional and behavioral problems over the past 6 months. It is also shown to have excellent reliability and validity (Achenbach & Rescorla, 2001). Responses on the YSR and the CBCL are scored on eight empirically-based syndrome scales and six DSM-orientated scales. Since the current study is specifically interested in adolescents' depressive symptoms, the anxious/depressed, withdrawn/depressed, and DSM affective problems scales were selected for analysis. Normalized *T*-scores are used in all data analysis for the present study, with higher *T*-scores representing higher depressive symptoms.

Coping. The Family Stress version of the Responses to Stress Questionnaire (FS-RSQ; Connor-Smith et al., 2000) was used to measure how adolescents coped with family related stress over the past six months. Parents and adolescents completed the parent-report and the self-report versions, respectively. The RSQ is divided into two sections. The first section assesses how often 12 stressful events have occurred over the past 6 months. The respondent uses a 4-point Likert scale of 0 (*never),* 1 (*a few times*), 2 (*many times),* or 3 (*almost every day)* to report

how frequently he or she experiences each of the stressful events. The second section contains 57-items designed to measure how the adolescent responded to the stressful events. The RSQ has been shown to be a reliable and valid measure of children and adolescents' responses to stress (Connor-Smith et al., 2000). Confirmatory factor analyses of the RSQ have demonstrated five factors: primary control engagement coping, secondary control engagement coping, disengagement coping, involuntary engagement and involuntary disengagement (Benson et al., 2011; Compas et al., 2006; Connor-Smith et al., 2000; Wadsworth et al., 2004; Yao et al., 2010). The present study focuses on voluntary coping responses: primary control, secondary control and disengagement coping. Proportion scores were used for all analyses to control for response bias (Vitaliano et al., 1987). Proportion scores were calculated by dividing the total score for each factor (e.g., secondary control coping) by the total score for all RSQ coping and stress response items (Connor-Smith et al., 2000).

Executive function. Adolescents completed the Coding and Digit Span forward and backward subtests of the Wechsler Intelligence Scale for Children- Fourth Edition (WISC-IV; Wechsler, 2003) as measures of executive function. The digit span backward test is a commonly used measure of working memory (e.g., Snyder, 2013). Processing speed tasks, such as the WISC-IV Coding, have been shown to relate to measures of working memory and executive function (e.g., Jacobson et al., 2011). The adolescents also completed the Wechsler Abbreviated Scale of Intelligence (WASI; Psychological Corporation, 1999) Vocabulary subtest. There is recent evidence that vocabulary impairment is indirectly related to depressive symptoms through secondary control coping (Prussien et al., 2017).

Procedure

Mothers and their children, ages 9-15 years old, were recruited to take part in a larger

study on mothers, children, and emotions that included mothers with and without a history of major depressive disorder. Prior to enrolling in the study, mothers completed a brief phone screen interview to confirm that they or their child met the inclusion criteria. Mothers were excluded from the study if they had ever been diagnosed with schizophrenia, schizoaffective disorder, bipolar I or bipolar II disorder. Children with developmental disorders, schizoaffective disorder or schizophrenia were ineligible to participate in the study. The study also required that both mom and child spoke English. If the participants met the inclusion criteria, then the mother-child dyads came into the lab to complete in-person interviews and tasks after previously completing at-home surveys. After the lab session, both mother and child were given monetary compensation for their time.

Data Analysis

Descriptive statistics for demographic variables were produced using SPSS. Independent sample t-tests were conducted in SPSS to determine if mothers with a history of depression reported more depressive symptoms on the BDI-II than mothers without a history of depression (Hypothesis 1). Bivariate Pearson correlations were calculated in SPSS to determine if adolescent depressive symptoms, as reported on the YSR and CBCL, were positively associated with increased maternal depressive symptoms on the BDI-II (Hypothesis 2). T-tests were then conducted in SPSS to determine adolescents' depressive symptoms, coping responses, and executive function significantly differed because of maternal depression history (Hypothesis 3). Next, bivariate Pearson correlations were calculated in SPSS to examine the strength and the direction of the associations between measures of adolescents' depressive symptoms, coping, and executive function (Hypotheses 4, 5, & 6). Finally, a multiple linear regression was run in SPSS to determine if the association between executive function and depressive symptoms was

accounted for by secondary control coping (Hypothesis 7).

Results

Descriptive Statistics

Means and standard deviations for maternal depressive symptoms, adolescent depressive symptoms, reports of coping with family stress, and measures of executive function are reported in Table 2. Consistent across parent and adolescent self-reports of adolescent depressive symptoms, the mean *T*-scores for the entire sample are close to one-half standard deviation above the normative mean of 50. This reflects a moderate elevation in depressive symptoms for the entire sample of adolescents. Means and standard deviations for adolescents with and without a history of maternal depression are also reported in Table 2.

Hypothesis 1

In support of Hypothesis 1, mothers with a history of depression experienced more depressive symptoms ($M = 12.89$, $SD = 8.99$) than mothers without a history ($M = 6.98$, $SD = 8.52$) over the past two weeks; $t\ (80) = 3.05$, $p = .003$.

Hypothesis 2

As hypothesized, mother and adolescent-self reports of adolescents' depressive symptoms on the CBCL and YSR, respectively, were significantly and positively related to current maternal depressive symptoms as reported on the BDI-II. All six of the correlations examined were significant and ranged in magnitude from $r = .31$ to $r = .46$. Bivariate correlations are reported in Table 3.

Hypothesis 3

Independent samples *t*-tests were performed to determine whether maternal depression history was significantly related to adolescents' depressive symptoms, coping, and executive

function. Results are reported in Table 2. The adolescents exposed to maternal depression scored significantly higher on the Youth Self-Report withdrawn/depressed scale (M = 57.92, SD = 8.65) than adolescents never exposed to maternal depression (M = 54.60, SD = 5.86); t (80) = -2.06, p = .042. Adolescents with and without a history of maternal depression did not significantly differ on the YSR anxious/depressed or affective problems scales. Maternal depression history was significantly related to mothers' reports of adolescents' depressive symptoms. Adolescents exposed to maternal depression scored significantly higher on the anxious/depressed, withdrawn/depressed, and affective problems CBCL scales.

Adolescents' self-reported primary control, secondary control and disengagement coping did not significantly differ based on their exposure to maternal depression. However, on parent reports of adolescent coping, mothers with a history of depression reported that their adolescents used significantly less primary control coping (t (79) = 2.21, p = .030), less secondary control coping (t (79) = 4.65, p <.001), and more disengagement coping (t (79) = -2.96, p =.004) coping.

Adolescents' scores on the WASI-Vocabulary, WISC-IV Coding, and WISC-IV Digit Span tests did not significantly differ based on their exposure to maternal depression.

Hypothesis 4

Bivariate correlations between adolescents' coping and depressive symptoms are reported in Table 3. Each of the nine correlations between adolescents' self-reports of coping and depressive symptoms was significant in the expected direction. The correlations ranged in magnitude from r = .34 to r = .52. The hypothesis was supported for all three types of coping such that depressive symptoms were negatively associated with primary and secondary control coping and positively associated with disengagement coping. Similarly, within maternal reports of adolescents' coping and symptoms, eight of nine correlations were significant with the ninth

approaching significance. The significant correlations ranged in magnitude from $r = .27$ to $r = .58$. Finally, of the 18 cross-informant correlations, 13 were significant. Adolescent self-reports of primary and secondary control coping were negatively associated with mother reports of adolescents' depressive symptoms on the CBCL withdrawn/depressed and affective problems scales. The correlations ranged in magnitude from $r = -.23$ to $r = -.40$. Adolescent self-reports of disengagement coping were positively associated with mother reports of adolescents' depressive symptoms on the CBCL withdrawn/depressed and affective problems scales, $r = .38$ and $r = .27$, respectively. For the correlations between mother reports of adolescents' coping and adolescent self-reports of depressive symptoms, two were negative and significant for primary control coping, three were negative and significant for secondary control coping, and two were positive and significant for disengagement coping. The significant correlations ranged in magnitude from $r = .23$ to $r = .40$. In summary, there is consistent evidence across and within informant for the negative association between primary control coping and depressive symptoms, similarly for secondary control coping, and for the positive association between disengagement coping and depressive symptoms.

Hypothesis 5

Of the 18 correlations between three measures of executive function and parent and adolescent self-reports of coping, two were significant. Higher scores on the WISC-Digit Span test were positively related to adolescents' self-reported use of primary control ($r = .33$, $p = .003$) and secondary control ($r = .29$, $p = .010$) coping. Lower scores on executive function measures were not significantly related to greater disengagement coping.

Of the 18 correlations between three measures of executive function and parent and adolescent self-reports of adolescent depressive symptoms, two were significant and one

approached significance. The association between the YSR anxious/depressed scale and the WISC-IV Digit Span test was significant and negative (r = -.27, p = .015). Scores on the CBCL affective problems scale were negatively correlated with performance on the WISC-IV Coding test (r = -.22, p = .047). In this sample, the correlation between the CBCL anxious/depressed scale and the WISC-IV Coding test approached significance (r = -.22, p = .051).

Hypothesis 6

Secondary control coping and executive function were hypothesized to be significant, individual predictors of adolescent depressive symptoms. Adolescents' self-reports of secondary control coping use were negatively correlated with self- and mother reports of depressive symptoms. The correlations ranged in magnitude from r = -.38 to r = -.50. Similarly, mothers' reports of adolescents' secondary control coping use were negatively correlated with self- and mother reports of adolescent depressive symptoms. The correlations ranged in magnitude from r = -.23 to r = -.57. Increased secondary control coping was a significant predictor of fewer depressive symptoms in this sample of adolescents.

Two measures of executive function significantly predicted adolescent depressive symptoms. The Digit Span test was negatively associated with symptoms on the YSR anxious/depressed scale (r = -.27, p = .015). The Coding test was negatively associated with symptoms on the CBCL affective problems scale (r = -.22, p = .047).

Hypothesis 7

Based on findings from the bivariate correlation analyses, the WISC-IV Digit Span test and the YSR anxious/depressed scale were selected as measures of executive function and depressive symptoms, respectively. The multiple regression model with secondary coping and WISC-IV Digit Span predicting YSR anxious/depressed T-scores was significant, F (2, 77) =

10.51, $p < .001$, adj. $R^2 = .19$. There was a significant main effect for secondary control coping ($\beta = -.40$, $p < .001$). The main effect for the WISC-IV Digit Span as a measure of executive function was no longer significant when secondary control coping was included in the model. This regression was also run with the interaction between secondary control coping and WISC-IV Digit Span included, but this interaction was not significant. The association between the WISC-IV Digit Span as a measure of executive function and depressive symptoms was accounted for by secondary control coping.

Discussion

The current study examined the associations among risk and protective factors for depression in a sample of adolescents with and without a history of maternal depression. The results of this study showed further evidence for the associations between measures of coping and symptoms of depression, executive function and symptoms of depression, and coping and executive function.

Hypothesis 1

In support of Hypothesis 1, mothers with a history of depression scored significantly higher on the BDI-II than mothers without a history. This finding is consistent with previous literature on maternal depression (e.g., Jaser et al., 2008; Goodman et al., 2011) and it supports the hypothesis that mothers with a history of depression continue to experience milder levels of symptomology despite not being in a current episode. Mothers with a history of depression reported minimal to mild depressive symptom levels ($M = 12.99$, $SD = 8.99$). This finding is not surprising given that only five mothers reported being currently depressed at the time of the study. Despite the relatively low levels of symptoms reported, there is evidence that stressful parent-child interactions persist even when parents are out of episode and are not experiencing

high levels of depressive symptoms (Langrock et al., 2002). This is highly important given that chronic exposure to stressful events, especially the stress associated with depressed parenting, is theorized to mediate the association between maternal depression and forms of child psychopathology, including depression (Goodman and Gotlib, 1999).

Hypothesis 2

As predicted, higher maternal depressive symptoms were positively associated mother and adolescent self-reports of adolescent depressive symptoms. Evidence for the association between current mother and adolescent depressive symptoms has been inconsistent (e.g., Jaser et al., 2008; Langrock et al., 2002). The inconsistencies are likely due to the tendency to compare mother reports of their adolescent's depressive symptoms with mother self-reports on the BDI-II. In the present study, we improve upon previous findings by comparing maternal BDI-II scores with self-reports of adolescent depressive symptoms to eliminate potential shared method variance.

Hypothesis 3

The hypothesis that adolescents' depressive symptoms, coping responses, and executive functions would differ based on maternal depression history was partially supported. Maternal depression history was related to higher depressive symptoms on both parent and adolescent-self reports. This finding is consistent with previous literature showing a significant relationship between maternal depression and risk for psychopathology, including depression, in youth (e.g., Goodman et al., 2011; Watson et al., 2012). It is noteworthy that the whole sample of adolescents consistently scored close to half a standard deviation above the normative mean of 50 across parent and adolescent-self reports of adolescent depressive symptoms. This moderate

elevation in symptoms is likely related to the 13-15-year-old age range of this sample as depressed moods are relatively common during adolescence (Hankin & Abramson, 2001).

Adolescents' self-reports of coping did not differ based on exposure to maternal depression. In comparison, mother reports of their adolescent's coping responses differed by maternal depression history in the expected direction for all three coping factors. Mothers with a history of depression reported that their adolescents used significantly less primary and secondary control coping and greater disengagement coping compared to adolescents without a history of maternal depression. These results expand upon previous evidence that mothers with a history of depression report that their children/adolescents use less primary control coping (e.g., Langrock et al., 2002). The hypothesis that adolescents with a history of maternal depression would use less primary and secondary control coping and greater disengagement coping is supported for mothers' reports of how their adolescents cope with stress but is not supported for adolescents' self-reports of coping. One possible explanation for inconsistency between parent and adolescent self-reports of coping is that mothers with a history of depression viewed their adolescents more negatively. However, given that the average BDI score for mothers with a history of depression was low ($M = 12.99$), it is unlikely that current depressive symptoms caused mothers to view their adolescents as being more negative.

Contrary to the hypothesis, adolescents with and without a history of maternal depression did not differ on measures of executive function. This replicates findings from previous cross-sectional study of maternal depression and executive function (Davidovich et al., 2016). However, this finding is inconsistent with previous evidence that maternal depression is a significant predictor of children's executive function over a four-year period (Hughes et al., 2013). One possible explanation for the lack of findings is that the current level of maternal

depressive symptoms was relatively mild. Of the 37 mothers with a history of depression, only five were currently depressed at the time of the study. It is possible that maternal depressive symptoms were not severe enough to affect adolescents' performance on measures of executive function. Although executive functions have traditionally been perceived as being stable, trait-like characteristics (Miyake & Friedman, 2012), other studies have shown that these cognitive processes are sensitive to current levels of stress (Quinn & Joorman, 2015). Therefore, it is plausible that in this sample adolescents of with and without histories of maternal depression experienced similar levels of stress and thus did not significantly differ on measures of executive function.

Hypothesis 4

Hypothesis 4 was strongly supported with consistent evidence across and within informant for the negative association between primary control coping and depressive symptoms, similarly for secondary control coping, and for the positive association between disengagement coping and depressive symptoms. Greater use of primary control and secondary control coping may serve as a protective factor against depressive symptoms in adolescents with and without a history of maternal depression. This finding has previously been illustrated across samples of adolescents and young adults (e.g., Connor-Smith et al., 2000; Compas et al. 2010, Dunbar et al., 2013; Morris et al., 2015). The positive association between disengagement coping and depressive symptoms adds to the body of evidence that greater use of disengagement coping may increase risk for depression (e.g., Compas et al., 2001; Dunbar et al., 2013; Morris et al., 2015).

Hypothesis 5

The hypothesis that executive function impairment would be associated with less use of primary and secondary control coping and greater use of disengagement coping, and more

depressive symptoms as reported by mothers and adolescents was partially supported. Higher scores on the WISC-Digit Span test, as a measure of working memory, were positively related to adolescents' self-reported use of primary control (r = .33, p = .003) and secondary control (r = .29, p = .010) coping. Working memory likely plays a key role in the successful utilization of complex coping strategies such as problem solving and cognitive reappraisal. It is noteworthy that we examined several correlations, many of which were not significant. However, the significant findings are consistent with previous literature on the association between working memory and adaptive coping strategies (e.g., Andreoitti et al., 2013; Campbell et al., 2009). Adolescents' use of disengagement coping was not related to performance on measures of executive function.

The association between adolescents' executive function and depressive symptoms was also partially supported. Higher scores on the WISC-IV Coding and Digit Span tests were associated with fewer depressive symptoms as reported by parents and adolescents, respectively. Many of the correlations that were tested proved to be non-significant, but the it is noteworthy that the significant findings are consistent with previous research on working memory and depressive symptoms (e.g., Wagner et al., 2015; Evans et al., 2016). The significant association of the Coding and Digit Span tests with depressive symptoms highlights that better executive functions may be an important source of resilience for adolescents at risk for depression.

Hypothesis 6

In support of the sixth hypothesis, secondary control coping and the WISC-IV Digit Span test were related to adolescents' depressive symptoms. Greater working memory capacity, and greater use of secondary control coping were independently related to lower levels of depressive symptoms on the YSR. The individual associations of working memory, as a component of

executive function, and secondary control coping with adolescent depressive symptoms support previous findings showing the importance of these processes as both risk and protective factors for depression (e.g., Compas et al., 2001; Snyder, 2013; Wagner et al., 2015). Additionally, the significant individual associations support the further examination of how executive function and secondary control coping jointly contribute to adolescents' depressive symptoms.

Hypothesis 7

As hypothesized, the association between the Digit Span test, as a measure of executive function, and adolescents' depressive symptoms was accounted for by secondary control coping. This finding suggests that one of the ways executive function is related to symptoms is because it's associated with difficulties in coping which has the strongest, proximal effect on symptoms. This result is consistent with previous studies of adolescents which have shown that executive function is indirectly related to depressive symptoms and behavioral problems through secondary control coping (e.g., Campbell et al., 2009; Evans et al., 2016). However, it is possible that the effect of coping on depressive symptoms in this study was partially accounted for by shared-method variance. Both coping and depressive symptoms were measured with adolescent self-report measures which allowed for the possibility that the strength of the effect was driven by shared-method variance.

Study Strengths and Limitations

One main strength of this study was the inclusion of mothers with varying histories of depression. This allowed for a sample of adolescents with a range of risk for depression. Additionally, this study utilized excellent, multi-informant measures of coping and depressive symptoms. Most importantly, this study used objective behavioral measures of executive function. Previous studies on coping, executive function, and depressive symptoms (e.g.,

Andreoitti et al., 2013; Campbell et al., 2009; Evans et al., 2016) have used self-report measures to create composite measures of executive function. Using composite measures has allowed for shared method variance among executive function, coping, and depression in previous studies. By using objective measures of executive function, the current study provides some of the strongest evidence for the associations of executive function with coping and depressive symptoms. The cross-sectional design of the current study is a limitation as conclusions cannot be made about causality of significant associations. Additionally, shared method variance between adolescents' self-reports of coping and depressive symptoms could be driving some of the significant associations found.

Conclusions and Future Directions

Future research may build upon the results of this study in several ways. First, additional longitudinal studies are needed to examine the associations between coping and executive function as independent and joint predictors of depressive symptoms. In addition, chronic exposure to stress, particularly stress that occurs in childhood, is theorized to have adverse effects on the cognitive processes needed to successfully cope with stress. Future studies examining the associations between executive function and coping could benefit from including a measure of stress. Finally, primary control coping was found to be significantly associated with the Digit Span test and depressive symptoms. Although it was not a focus of the current study, there is preliminary evidence that executive function may indirectly predict depressive symptoms through primary control coping. The observed associations among primary control coping, executive function, and depressive symptoms should be examined in future studies.

In summary, the results of this study show support for the associations between measures of coping and depressive symptoms, coping and executive function, and executive function and

depressive symptoms in adolescents with a range of risk for depression. Additionally, the present findings are consistent with extensive evidence showing that children/adolescents of mothers with a history of depression are at greater risk for developing depression and other forms of psychopathology (e.g., Goodman et al., 2011; Watson et al., 2012). The protective roles of high executive function and adaptive coping for all adolescents in the sample highlights two viable avenues for intervention. Adolescents with and without a history of exposure to maternal depression may benefit from intervention programs that aim to improve executive functions and teach adaptive coping skills.

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Table 1.

Demographic Characteristics of Sample

	Mothers ($N = 82$)	Adolescents ($N = 82$)
Age [mean (SD)]	43.35 (5.96)	13.38 (1.00)
Sex [*n* (% female)]	82 (100)	33 (40.2)
Ethnicity [*n* (%)]		
Not Hispanic or Latino	76 (92.7)	73 (89.0)
Hispanic or Latino	3 (3.7)	4 (4.9)
Unknown or Missing	3 (3.7)	5 (6.1)
Race [*n* (%)]		
Caucasian	55 (67.1)	54 (65.9)
African-American	23 (28.0)	22 (26.8)
Asian-American	1 (1.2)	1 (1.2)
American-Indian/Native Alaskan	1 (1.2)	0 (0.0)
More than one race or "other"	1 (1.2)	4 (4.9)
Missing	1 (1.2)	1 (1.2)
Annual Family Income [*n* (%)]		
$10,000-29,999	12 (14.6)	
$30,000-49,999	9 (11.0)	
$50,000-69,999	15 (18.3)	
$70,000-89,999	13 (15.9)	
$90,000-149,999	23 (28.0)	
≥ $200,000	4 (4.9)	
Unknown	6 (7.3)	
Education [*n* (%)]		
Some high school	1 (1.2)	
Graduated high school	6 (7.3)	
Some college or technical school	26 (31.7)	
Graduated college (4-year degree)	31 (37.8)	
Graduate education (above a 4-year degree)	18 (22.0)	
Marital Status [*n* (%)]		
Married/Living with Partner	49 (59.8)	
Divorced or Annulled	19 (23.3)	
Separated	5 (6.1)	
Never Married	7 (8.5)	
Widowed	2 (2.4)	

Table 2.
Descriptive Statistics for Maternal Depressive Symptoms, Adolescent Depressive Symptoms, Reports of Coping with Family Stress, and Executive Function in Whole Sample and by Maternal Depression History Group

	Mean (SD)				
	Full (N = 82)	No Maternal Depression History (n = 45)	Maternal depression History (n = 37)	*df*	*t*
Maternal BDI-II	9.64 (9.17)	6.98 (8.52)	12.99 (8.99)	80	3.05**
Adolescent Depressive Symptoms					
YSR Anxious Depressed	55.66 (6.69)	55.20 (5.79)	56.22 (7.69)	80	-.68
YSR Withdrawn Depressed	56.10 (7.39)	54.60 (5.86)	57.92 (8.65)	80	-2.06*
YSR Affective Problems	55.56 (6.09)	54.64 (5.30)	56.68 (6.84)	80	-1.52
CBCL Anxious Depressed	54.80 (7.36)	52.60 (4.63)	57.49 (9.07)	80	-3.15**
CBCL Withdrawn Depressed	55.72 (8.17)	53.53 (4.64)	58.38 (10.52)	80	-2.78**
CBCL Affective Problems	55.61 (7.59)	53.07 (4.78)	58.70 (9.14)	80	-3.39**
Adolescent Coping					
Primary Control Self-Report	.18 (.04)	.18 (.03)	.17 (.04)	80	1.06
Secondary Control Self-Report	.26 (.05)	.27 (.05)	.25 (.05)	79	1.17
Disengagement Self-Report	.16 (.03)	.15 (.03)	.16 (.03)	80	-.94
Primary Control Parent Report	.21 (.04)	.21 (.04)	.19 (.05)	79	2.21*
Secondary Control Parent Report	.26 (.05)	.28 (.04)	.23 (.05)	79	4.65**
Disengagement Parent Report	.15 (.03)	.14 (.02)	.16 (.03)	79	-2.96**
Executive Function					
WASI-Vocabulary	54.60 (9.80)	53.44 (10.34)	56.00 (9.04)	80	-1.18
WISC-IV Coding	9.00 (2.75)	9.27 (2.95)	8.68 (2.48)	80	.97
WISC-IV Digit Span	10.49 (3.08)	10.47 (2.98)	10.53 (3.25)	79	-.09

Note. YSR Youth Self Report, *CBCL* Child Behavior Checklist, *WASI* Wechsler Abbreviated Scale of Intelligence, *WISC-IV* Wechsler Intelligence Scale for Children- Fourth Edition. Adolescent Depressive Symptoms scores are presented as normalized *T*-scores from the CBCL for mothers' reports and from the YSR for adolescents' self-reports. Scores for adolescent coping are presented as proportion scores on the Family Stress version of the RSQ.
$^{*}p < .05$, $^{**}p < .001$

Table 3.

Bivariate Correlations among Maternal Depressive Symptoms, Adolescent Depressive Symptoms, Coping with Family Stress, and Executive Function

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. BDI-II	–															
2. YSR A/D	.36**	–														
3. YSR W/D	.31**	.53**	–													
4. YSR AP	.40**	.71**	.72**	–												
5. CBCL A/D	.44**	.46**	.34**	.35**	–											
6. CBCL W/D	.37**	.33**	.42**	.42**	.58**	–										
7. CBCL AP	.46**	.45**	.45**	.54**	.75**	.80**	–									
8. RSQ CS PC	-.08	-.36**	-.47**	-.44**	-.09	-.28*	-.23*	–								
9. RSQ CS SC	-.21†	-.45**	-.43**	-.50**	-.22†	-.40**	-.38**	.34**	–							
10. RSQ CS D	.19	.34**	.52**	.42**	.11	.38**	.27*	-.77**	-.35**	–						
11. RSQ MC PC	-.25*	-.24*	-.33**	-.21†	-.42**	-.58**	-.49**	.21	.31**	-.22†	–					
12. RSQ MC SC	-.47**	-.30**	-.23*	-.27**	-.52**	-.52**	-.57**	.10	.33**	-.10	.44**	–				
13. RSQ MC D	.13	.26*	.40**	.20†	.21†	.35**	.21**	-.22	-.23*	.29**	-.54**	-.34**	–			
14. WASI Vocab	-.30**	-.05	-.03	-.03	-.07	-.10	-.06	.12	.06	-.13	-.03	.12	-.01	–		
15. WISC-IV C	-.20†	-.12	-.02	-.01	-.22†	-.19	-.22*	.12	-.04	.02	.09	.18	-.16	.32**	–	
16. WISC-IV DS	-.19	-.27*	-.13	-.19	-.03	-.08	-.03	.33**	.29**	-.19	-.01	.06	.01	.47**	.44**	–

Note. BDI-II Beck Depression Inventory II, *YSR* Youth Self Report, *CBCL* Child Behavior Checklist, *A/D* Anxious Depressed Scale, *W/D* Withdrawn Depressed Scale, *AP* DSM Affective Problems Scale, *RSQ* Responses to Stress Questionnaire, *CS PC* Child Self-Report Primary Control Coping, *CS SC* Child Self-Report Secondary Control Coping, *CS D* Child Self-Report Disengagement Coping, *MC PC* Mother Report on Child Primary Control Coping, *MC SC* Mother Report on Child Secondary Control Coping, *MC D* Mother Report on Child Disengagement Coping, *WASI Vocab* Wechsler Abbreviated Scale of Intelligence Vocabulary Test, *WISC-IV C* Wechsler Intelligence Scale for Children-Fourth Edition Coding Test, *WISC-IV DS* Wechsler Intelligence Scale for Children-Fourth Edition Digit Span Backwards Test.

N= 82

$^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .001$