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Preschool Executive Control and Internalizing Symptoms in Elementary School

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Abstract

Depression and anxiety are prevalent and impairing forms of psychopathology in children and adolescents. Deficits in early executive control (EC) may contribute to the development of these problems, but longitudinal studies with rigorous measurement across key developmental periods are limited. The current study examines EC in preschool as a predictor of subsequent depression and anxiety symptoms in elementary school in a community sample (N=280). Child participants completed a battery of nine developmentally-appropriate tasks designed to measure major aspects of EC at age 5 years, 3 months. Children later participated in an elementary school follow-up phase, during which they completed validated norm-referenced self-report questionnaires of depression and anxiety symptoms in fourth grade. Results indicate that poorer preschool EC was significantly associated with both greater depression and anxiety symptoms in elementary school, controlling for baseline depression and anxiety symptoms in preschool and other relevant variables. These findings suggest that poor EC may be an important risk factor for the development of internalizing psychopathology in childhood. Given emerging evidence for the modifiability of EC, particularly in preschool, EC promotion interventions may hold promise as a potential target in psychopathology prevention.

Keywords

executive control; preschool; depression; anxiety; elementary school

Depression and anxiety are among the most prevalent forms of psychopathology in children and are associated with substantial psychosocial impairment (CDC 2013). Effective prevention and treatment of these problems requires identification of modifiable factors that confer individual risk, particularly early in development before the onset of clinical symptoms. Deficits in executive control (EC) a set of cognitive abilities for directing attention and behavior (Garon, Bryson, and Smith 2008) has emerged in recent years as one

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such potential risk factor (Han et al. 2016; Kertz, Belden, Tillman, and Luby 2016; Koster, De Lissnyder, Derakshan, and De Raedt 2011; Luciana 2016). Conceptualizations of child EC typically encompass the related abilities of working memory, inhibitory control and flexible shifting (Espy 2016; Garon et al. 2008), and previous research has found that these abilities in preschool (a critical period for EC development) are best represented by a unitary EC construct (Espy 2016; Fuhs & Day 2011; Nelson et al. 2016; Wiebe, Sheffield, Nelson, Clark, Chevalier and Espy 2011; Willoughby, Blair, Wirth and Greenberg 2012). Although studies documenting associations between EC (also known as "executive function" or "EF") and internalizing psychopathology are available in both the pediatric and adult literatures, research on early EC as a predictor of later child depression and anxiety symptoms is limited. Specifically, studies in this area have been limited by cross-sectional or short-term longitudinal designs, EC measurement limitations, and lack of attention to key developmental periods. To address these limitations and advance understanding of a potentially important factor underlying internalizing psychopathology, the current study examines EC *in preschool* as a predictor of depression and anxiety symptoms in late *elementary school*, using developmentally-appropriate and validated measures.

Considerable research exists documenting an association between deficits in child EC and disruptive behavior problems such as attention-deficit/hyperactivity disorder (ADHD) and conduct problems (Espy, Sheffield, Wiebe, Clark, and Moehr 2011; Hughes and Ensor 2011). In fact, EC impairment is featured prominently in leading theories of ADHD etiology (e.g., Barkley 1997; Barkley 2012), and the empirical literature has generally provided support for the role of EC deficits in children with ADHD (see Pauli-Pott and Becker 2011, and Willcutt, Doyle, Nigg, Faraone, and Pennington 2005 for reviews). However, much less research has examined links between EC and internalizing problems in children, despite the high prevalence of such problems (CDC 2013; Merikangas et al. 2010) and compelling reasons to believe significant associations might exist.

EC and Internalizing Problems

Research with adults has documented executive dysfunction in individuals with clinical depression (Snyder 2013). Although smaller than the corresponding adult literature, some studies have also found significant impairments in specific EC abilities for children and adolescents with depression compared to healthy controls (see Wagner, Mueller, Helmreich, Huss, and Tadic 2015 for review). In particular, studies have shown relative deficits for depressed youth in working memory (Brooks, Iverson, Sherman, and Roberge 2010; Klimkeit, Tonge, Bradshaw, Melvin, and Gould 2011), inhibition (Brooks et al. 2010; Maalouf et al. 2011), shifting (Günther, Konrad, De Brito, Herpertz-Dahlmann, and Vloet 2011; Micco et al. 2009), and sustained attention (Cataldo, Nobile, Lorusso, Battaglia, and Molteni 2005; Günther et al. 2011; Han et al. 2012). A limited number of studies have explored associations between child or adolescent EC (and related abilities) and internalizing symptoms over time, suggesting links with depression (Kertz et al. 2016), anxiety (Han et al. 2016; Kertz et al. 2016), and internalizing symptoms more generally (Riggs, Blair, and Greenberg 2003). In a particularly rare long-term investigation spanning 7.5 years, Kertz and colleagues (2016) found that preschool deficits in shifting and inhibition (as measured by the parent report Behavior Rating Inventory of Executive Function-

Preschool Version [BRIEF-P]; Gioia, Espy, and Isquith 2003), which are specific aspects of EC, significantly predicted increases in subsequent depression and anxiety symptoms. Despite these significant findings, some caution is warranted; results in the literature have been mixed, with other studies failing to find significant EC-depression associations in both cross-sectional (Favre et al. 2009; Wagner, Alloy, and Abrahamson 2015) and short-term longitudinal (Connolly et al. 2014) investigations.

Although studies have suggested possible connections between EC and child internalizing symptoms, this literature has been limited in important ways. First, the majority of studies in this area have employed cross-sectional designs, which preclude any examination of directionality. Even when longitudinal designs have been used, they have usually included only relatively short-term follow-ups that may not allow adequate time for new internalizing symptoms to unfold (e.g., Connolly et al. 2014, Han et al. 2016; Riggs et al. 2003; see Kertz et al. 2016 for a rare exception). Second, the extant literature on EC and internalizing symptoms in children has been plagued by important measurement limitations, particularly in the assessment of EC. Specifically, studies have relied on either questionnaires to measure EC-related constructs (e.g., Kertz et al. 2016) or relatively limited testing batteries that do not assess the full scope of child EC. The field has made important strides in the performance-based measurement of early EC (see Espy 2016), but rigorous and comprehensive measurement remains rare in the current EC-internalizing problems literature. Third, previous research has given insufficient attention to the overlap between EC and foundational cognitive abilities, which are more general abilities that are drawn upon in completing executive tasks (e.g., language abilities, visual/spatial perception, processing speed; Nelson et al. 2016). Most studies either do not account for foundational cognitive abilities in examining EC-internalizing associations or, if they do, use overly simplistic approaches such as simply controlling for IQ. A bifactor modeling approach employed by Espy and colleagues (Espy 2016; Nelson et al. 2016), which accounts for shared and separate variance associated with EC and foundational cognitive abilities, could hold substantial advantages in explicating the unique contributions of EC to emerging internalizing symptoms. In such a model, foundational cognitive abilities is modeled as a general factor across both EC and non-EC tasks, and EC is modeled as a specific factor drawn from only EC tasks, thus isolating EC-specific variance. To our knowledge, such an approach has yet to be used in an investigation of EC predicting children‘s depression and anxiety symptoms. The current study addresses all three of these limitations in a longitudinal study spanning approximately five years, with a comprehensive and rigorous EC battery in preschool, and sophisticated bifactor modeling of EC and foundational cognitive abilities.

Conceptual Framework

A strong conceptual framework guides the current investigation of early EC as a predictor of later internalizing symptoms. Consistent with the “impaired disengagement hypothesis” (Koster et al. 2011), deficits in EC are believed to contribute to internalizing psychopathology through impairments in attentional control. Specifically, individuals with poor EC may have substantial difficulty disengaging from negative thought patterns particularly negative self-referent thoughts which leads to rumination, a known contributor to depression (Aldao, Nolen-Hoeksema, and Schweizer 2010). Similarly, EC deficits may

make it difficult to disengage from threatening stimuli, resulting in attentional bias toward anxiety-provoking environmental cues and risk for anxiety symptoms (Dudeney, Sharpe, and Hunt 2015). Poor EC may also undermine a child's ability to exert "top-down" control over unpleasant emotions and redirect behavior to support more positive affect (e.g., through seeking pleasurable activities or appropriate social support). Further, EC deficits are associated with poor academic achievement (Blair and Razza 2007; Bull, Espy, Wiebe, Sheffield, and Nelson 2011; Clark, Sheffield, Wiebe, and Espy 2013; Espy et al. 2004), which in turn can contribute to emerging internalizing problems. Overall, deficits in EC may create a vulnerability to negative emotionality and compromised coping, which increase the long-term risk of significant depression and anxiety symptoms.

Our conceptualization of EC and internalizing symptoms in childhood is also informed by developmental research on these constructs. Substantial theory and empirical studies indicate that preschool is a critical period in the development of EC and the prefrontal cortex (PFC), which supports these emerging abilities (Clark et al. 2016; Espy 2016; Moriguchi and Hiraki 2013). On the other hand, elementary school represents an important time for studying the emergence of internalizing problems as rates of depression and anxiety increase across childhood and into adolescence (CDC 2013; Merikangas et al. 2010). Based on these important developmental considerations, the current study spans the preschool and elementary school periods to examine how early EC abilities predict the development of internalizing symptoms later in childhood.

It is important to note that we use the term *executive control* (EC) as synonymous with *executive function* but distinct from the related construct of *effortful control*. EC is a construct drawn from the neuropsychology literature representing modular cognitive processes which underlie an individual's ability to direct attention and behavior, whereas effortful control is an aspect of temperament with less direct focus on cognitive processes. Because some research has documented associations between effortful control and internalizing symptoms (e.g., Wang, Chassin, Eisenberg, and Spinrad 2015), we consider effortful control (as well as other constructs associated with internalizing problems) as a covariates to determine the unique predictive value of early EC for subsequent internalizing symptoms.

The Current Study

The current study presents a theoretically-grounded and rigorous investigation of associations between preschool EC abilities and internalizing symptoms (both depression and anxiety) in late elementary school. Specifically, this study utilizes a developmentally-appropriate and comprehensive battery of EC abilities in preschool, along with longitudinal measurement of internalizing symptoms with well-validated norm-referenced measures. Further, to better understand the unique contributions of early EC specifically versus foundational cognitive abilities, we employ a bifactor modeling approach (Espy 2016). The study had two a priori hypotheses. First, we hypothesized that poorer preschool EC would significantly and uniquely predict greater depression symptoms in fourth grade, controlling for baseline depression symptoms in preschool and other relevant covariates. Second, we hypothesized that poorer preschool EC would also significantly and uniquely predict greater

anxiety symptoms in fourth grade, controlling for baseline anxiety symptoms in preschool and other relevant covariates. This study builds on previous literature exploring EC and internalizing symptoms in children and elucidates the unique predictive power of early EC after accounting for overlap with foundational cognitive abilities. The findings could provide a foundation for considering EC in pediatric depression and anxiety prevention, and inform interventions targeting early EC development to promote long-term mental health.

Method

Participants

The participants were 280 children (47.86% female) and their mothers who were recruited for participation in a longitudinal study focusing on early EC development and subsequent behavioral and emotional outcomes. Families were recruited through flyer distribution in a small Midwestern city while the target child was in preschool. The larger study was designed to describe typical cognitive development, so children with a *diagnosed* developmental, behavioral, or language disorder *at the time of initial recruitment* were excluded. Children who were diagnosed with development or language delays subsequent to enrollment (by parent report) were also excluded. Because one of the goals of the broader longitudinal study was to examine the impact of early EC development on the emergence of later psychopathology symptoms, children who were diagnosed with a behavioral or emotional disorder after initial enrollment were *not* excluded. The exclusion of children with diagnosed disorders at enrollment but not at subsequent time points is ideal for the current study‘s investigation of emerging depression and anxiety symptoms later in childhood. The ethnic and racial makeup of the sample was representative of the city and region from which it was drawn (57.86% European American, 14.64% Hispanic, 4.29% African American, . 71% Asian, and 22.50% multiracial). The sample was also oversampled for families with greater sociodemographic risk and included 56.43% receiving public medical assistance (which requires an income of less than $32,319 for a family of four in the state where the study was conducted at this time of this writing) by parent report at the time of enrollment. For comparison, 21.3% of the United States population received public assistance from one or more programs (e.g., Medicaid, Supplemental Nutrition Assistance Program) between 2009 and 2012 (U.S. Census Bureau 2015). See Table 1 for sample descriptive statistics.

Procedures

All participating children completed testing sessions in the laboratory at age 5 years, 3 months. Sessions included an extensive battery of developmentally-appropriate and individually-administered neuropsychological tasks designed to assess the main components of EC (see *Measures*). Children were also administered a brief battery of standardized tests to assess foundational cognitive abilities. Mothers completed ratings of child behavioral and emotional symptoms using well-validated norm-referenced measures during the 5 years, 3 months visit. To examine the associations between preschool EC and later psychopathology symptoms, an elementary school follow-up phase was conducted and included assessments of child depression and anxiety symptoms using well-validated self-report instruments in third or fourth grade. The vast majority of children completed self-report measures in fourth grade (which was the final assessment point in elementary school and therefore the target

time point for measuring emerging depression and anxiety symptoms); a small subset (n=18; 6.43% of the sample) did not have measures in fourth grade (due to the end of project funding prior to their fourth grade year), so their third grade measurement was used as the final available measure. Fourth (or third) grade was considered an ideal time to measure symptoms of child depression and anxiety given increasing child awareness of internalizing symptoms that facilitates valid self-report measures of these constructs at this age (Kovacs 2011; Lowe 2015; Reynolds and Richmond 2008; Timbremont, Braet, and Dreesen 2004). Further, by using the latest available elementary school assessment, this allowed for a substantial delay from the baseline preschool measurement (average time lapse between preschool EC assessment and elementary school depression/anxiety assessment = 4.7 years) to allow psychopathology symptoms to unfold. Informed consent was obtained from all adult participants, and assent was obtained from all child participants. All procedures were approved by the Institutional Review Board of the University of Nebraska-Lincoln.

Intensive efforts were made to maintain contact with participating families across the longitudinal study to ensure a high retention rate. Out of the 288 children who participated at 5 years, 3 months, 280 participated in the follow-up study in elementary school (97.22%).

Measures

Preschool Executive Control—Preschool EC was assessed using a 9-task battery that was administered to each child at age 5 years, 3 months during individual sessions in the laboratory. The tasks were designed to cover the major areas that make up EC, including working memory, inhibitory control, and flexible shifting (Espy 2016). Each task is briefly described in Table 2. A more comprehensive description of each task and supporting psychometric information is available in James, Choi, Wiebe, and Espy (2016). Tasks assessing working memory included *Nine Boxes* (adapted from Diamond, Prevor, Callender, and Druin 1997), *Delayed Alternation* (Espy, Kaufman, and Glisky 1999; Goldman, Rosvold, Vest, and Galkin 1971), and *Nebraska Barnyard* (adapted from *Noisy Book*; Hughes, Dunn, and White 1998). Inhibitory control was assessed using *Big-Little Stroop* (adapted from Kochanska, Murray, and Harlan 2000), *Go/No-Go* (adapted from Simpson and Riggs 2006), *Shape School - Inhibit Condition* (Espy 1997; Espy, Bull, Martin, and Stroup 2006), and a *modified Snack Delay* task (adapted from Kochanska, Murray, Jacques, Koenig, and Vandegeest 1996; Korkman, Kirk, and Kemp 1998). Tests of flexible shifting included *Shape School - Switching Condition* (Espy 1997; Espy et al. 2006) and *Trails - Switching Condition* (modified from Espy and Cwik 2004). All tasks showed excellent psychometric properties at age 5 years, 3 months, including ample variability, excellent inter-rater reliability (where appropriate), and minimal missing data. Extensive previous psychometric work has demonstrated that the factor structure of EC in preschool is best represented as a unitary construct (Fuhs & Day 2011; Wiebe et al. 2011; Willoughby et al. 2012). Similarly, rigorous factor analyses with the current battery at this age have found that a unitary EC construct with all nine tasks loading directly onto a latent EC factor provides the most parsimonious structure for modeling EC (Espy 2016; Nelson et al. 2016). Therefore, the current study retains this unitary representation, and structural model fit statistics were evaluated to confirm its appropriateness (see *Analyses*).

Preschool Foundational Cognitive Abilities—Foundational cognitive abilities (FCA) were assessed in preschool using the Woodcock-Johnson-III Brief Intellectual Assessment (WJ-III; Woodcock, McGrew, and Mather 2001). Specifically, children were administered tests of Verbal Comprehension, Concept Formation, and Visual Matching. The Verbal Comprehension test measured four aspects of language development, including picture vocabulary, synonyms, antonyms, and verbal analogies. Concept Formation measured visual/spatial perception by requiring children to identify the object that did not belong in a category and explain why the selected object was different. Visual Matching assessed processing speed by requiring children to point to two matching shapes in a row of shapes. These tests were specifically selected to represent a range of foundational abilities with reliable subtests (alphas ranging from .91 to .94; Woodcock, McGrew, and Mather 2001) available for preschoolers (see James et al. 2016 for a detailed discussion).

In addition to the three WJ-III subtests, the latent FCA construct included the nine EC tasks. Because EC tasks require FCA to some degree, the nine EC tasks loaded onto the FCA latent factor. Children completed both the executive task battery and the three separate measures of FCA (WJ-III subtests) that did not include strong executive demands (e.g., discrete tests of vocabulary, visual/spatial perception, or motor speed) in order to simultaneously examine how EC and FCA were differentially associated with internalizing symptoms.

Elementary School Depression Symptoms—Child depression symptoms in elementary school were assessed using the Child Depression Inventory (CDI-2, Kovacs 2011), a 28-item self-report measure of depression symptoms for children ages 7 to 17 years. Children reported on symptoms over the previous two months by rating items on a 3-point Likert scale. Scores were compared to a normative sample with separate norms based on age. Research demonstrates that the CDI-2 is internally consistent, with alphas ranging from .67 to .91, and is able to effectively discriminate youth with major depression symptoms from healthy controls and those with other forms of psychopathology (Bae 2012). Internal consistency of the CDI-2 in the current study was good (α =.80). For the main analyses, the continuous depression *T*-score was used as the outcome variable of interest. For the supplemental analyses examining at-risk/clinical cut-off scores, a *T*-score of 60 was used to differentiate children with at-risk/clinical levels of depression symptoms from those with symptoms in the normal range. In this sample, 12 children (4.3%) had depression scores in the at-risk/clinical range.

Elementary School Anxiety Symptoms—Child anxiety symptoms in elementary school were assessed using the short form of the Revised Child Manifest Anxiety Scale, second edition (RCMAS-2; Reynolds and Richmond 2008). The RCMAS-2 is a 10-item self-report measure of anxiety symptoms for children ages 6 to 19 years. Children answered questions about anxiety symptoms by circling either *Yes* or *No* for each question. Recent research has demonstrated that the short form has good internal consistency (α =.79), has demonstrated measurement invariance across gender, and correlates significantly with other measures of anxiety in elementary school and high school respondents (Lowe 2015). Internal consistency of the RCMAS-2 in the current study was good (α =.77). For the main

analyses, the continuous anxiety *T*-score was used as the outcome variable of interest. For the supplemental analyses examining at-risk/clinical cut-off scores, a *T*-score of 60 was used to differentiate children with at-risk/clinical levels of anxiety symptoms from those with symptoms in the normal range. In this sample, 31 children (11.2%) had anxiety scores in the at-risk/clinical range.

Elementary School Externalizing Symptoms—Because poor EC has been associated with externalizing symptoms such as oppositional behaviors and hyperactivity (e.g., Espy et al. 2011; Hughes and Ensor 2011), and because child internalizing and externalizing symptoms tend to be correlated (Achenbach, Howell, Quay, and Conners 1991), measures of these symptoms were also collected at the elementary school time point. Specifically, parents completed the ODD and ADHD-Hyperactivity subscales of the Conners 3rd Edition Parent Ratings Scale (CPRS-3; Conners 2008). Each subscale is comprised of four-point Likert scale items, with high scores corresponding to diagnostic criteria for ODD and ADHD. These subscales have shown excellent internal consistency (αs = .91 and .92, respectively), and the CPRS-3 has demonstrated high classification accuracy (Conners 2008). *T*-scores for each scale were included as outcome measures in the main analyses and at-risk/cut-off scores (T score 60) were used in supplemental analyses. In this sample, 70 children (27.6%) had at-risk/clinical ODD symptoms and 96 children (37.8%) had at-risk/clinical hyperactivity symptoms.

Control Variables—To determine the unique predictive value of early EC for psychopathology symptoms in elementary school, a series of control variables were also assessed and included in the analyses. Baseline symptoms of *depression and anxiety in preschool* were assessed via parent report on two separate subscales from the Child Behavior Checklist for Ages 1½–5 (CBCL/1½–5; Achenbach and Rescorla 2001; Ebesutani et al. 2010): the Depressive Problems scale and Anxiety Problems scale. These scales consist of items measured on a three-point Likert scale. The Depressive Problems *T*-score and Anxiety Problems *T*-score were included in the model as control variables. Baseline *externalizing symptoms in preschool* were assessed via parent report on two separate subscales from the CBCL/1½–5: the ADHD scale and the Oppositional Defiant Disorder (ODD) scale. These scales consist of items measured on a three-point Likert scale. *T*-scores were included in the model as control variables.

Child *effortful control* was assessed using the effortful control scale of the Child Behavior Questionnaire (CBQ; Rothbart et al. 2001), which includes items measured on a 7-point Likert scale and completed by mothers at the preschool time point. *Early stressful life events* in the family were assessed via mothers‘ report on the Negative Life Events scale of the Life Stressors and Social Resources Inventory (LISRES; Moos & Moos 1994). The scale includes 200 items that assessed life stressors across eight domains (physical health, home and neighborhood, finances, work, spousal/partner relationship, relationships with children, extended family relationships, and relationships with friends and social groups) which combined to form an index of negative life events in the prior year. The response format varied across the items including a yes/no format and four- and five-point Likert scales.

Family socioeconomic status (SES) was assessed using mothers' report. Specifically, we used years of maternal education, a commonly-used indicator for SES with particular relevance to a study of child EC (Hackman, Gallop, Evans and Farah 2015) and psychopathology symptoms (Sonego, Llacer, Galan, and Simon 2013), as a proxy for family SES. A wide range of maternal education was reported in the sample (5.4% had less than a high school education, 15.4% had a high school degree or equivalent, 7.5% had attended some college courses, 33.9% had an associate's degree or equivalent, 24.6% had a bachelor's degree or equivalent, and 13.2% had graduate-level education), and the mean education was 14.5 years (SD = 2.23). Finally, *family history of internalizing disorders* was assessed using two questions included as a part of the standard background survey completed by the caregiver. Specifically, the caregiver was asked if the mother, father, or grandparents had ever been diagnosed with and/or treated for depression and/or anxiety.

Statistical Methods

In the bifactor model, the nine executive tasks were set to load on both the EC and FCA latent variables, whereas the WJ-III subtests were allowed to load exclusively on the FCA latent variable. Thus, EC is the specific factor and FCA is the general factor in the bifactor model. Consistent with the bifactor modeling approach (Espy 2016), the EC and FCA latent variables were not allowed to correlate, making them orthogonal. The residual error terms for the two Shape School indicators (i.e., from the Inhibit and Switching conditions) were allowed to correlate, because the two indicators are different conditions of the same task and are similar in stimuli and response format. The bifactor model was estimated in Mplus version 7 (Muthen and Muthen 1998–2015) using maximum likelihood.

First, the measurement model that estimated the fit of the bifactor EC and FCA latent variables was specified (i.e., not including the outcome or control variables). Second, after estimating the fit of the bifactor latent structure, a predictive model was estimated that included the bifactor EC and FCA as predictors of depression (CDI-2) and anxiety (RCMAS-2) symptoms in elementary school. In order to examine the distinct role of EC and FCA on emerging depression and anxiety symptoms, the model controlled for the following covariates: baseline anxiety symptoms, baseline depression symptoms, elementary school ADHD-Hyperactivity symptoms, elementary school ODD symptoms, preschool effortful control, child sex, maternal education, the LISRES Negative Life Events scale, parent-report of family history of depression, and parent-report of family history of anxiety. Finally, supplemental analyses were conducted to examine whether EC predicted at-risk/clinical levels of anxiety and depression using the at-risk/clinical cutoff scores. Thus, a model including anxiety and depression outcome variables that were coded into binary cut-off scores such that *0 = below the at-risk/clinical cutoff* and *1 = above the at-risk/clinical cutoff* was examined. The supplemental model included the same control variables as the predictive model.

Results

Structural Model

Consistent with previous research (Espy 2016), the measurement model representing the bifactor structure in the current study demonstrated excellent fit, RMSEA = .03, CFI = .99, TLI = .98, SRMR = .04.

Predictive Model

In the bifactor model including all covariates (baseline effortful control, baseline anxiety symptoms, baseline depression symptoms, baseline ADHD symptoms, baseline ODD symptoms elementary school ADHD symptoms, elementary school ODD symptoms, maternal education, child sex, the LISRES Negative Life Events scale, parent-report of family history of depression, and parent-report of family history of anxiety), preschool EC significantly predicted depression symptoms, with poorer EC associated with greater depression symptoms, $b = -2.59$, $\beta = -.25$, $SE = .10$, $t = -2.54$, $p = .011$. EC also significantly predicted anxiety symptoms, such that children with poorer EC had greater anxiety symptoms, $b = - -3.66$, $\beta = -.28$, $SE = .09$, $t = -2.98$, $p = .003$. FCA did not significantly predict depression symptoms ($b = -1.26$, $\beta = -.02$, $SE = .07$, $t = -.29$, $p = .771$) or anxiety symptoms ($b = -4.78$, $\beta = -.06$, $SE = .07$, $t = -.89$, $p = .374$). The only control variable that significantly predicted elementary school anxiety was child sex, such that girls had more anxiety symptoms than boys, $b = -2.70$, $\beta = -.15$, $SE = .07$, $t = -2.22$, $p = .026$. No control variables were associated with elementary school depression in the model. See Figure 1 for a depiction of the predictive model results.

Supplemental Analyses

In a parallel model examining at-risk/clinical cut-off scores for elementary school anxiety and depression, preschool EC did not significantly predict at-risk/clinical levels of depression symptoms (log odds = −2.45, $SE = 1.34$, $t = -1.84$, $p = .066$), but did significantly predict anxiety symptoms (log odds = −.92, $SE = .47$, $t = -1.98$, $p = .048$), with lower EC scores associated with greater likelihood of at-risk/clinical levels of anxiety symptoms. FCA did not significantly predict at-risk/clinical levels of depression (log odds = .50, $SE = 7.64$, $t = .07$, $p = .948$) or anxiety symptoms (log odds = 2.47, $SE = 3.69$, $t = .67$, $p = .502$). None of the control variables significantly predicted at-risk/clinical levels of depression or anxiety.

Discussion

Although previous studies have suggested links between EC and child internalizing symptoms, the current study makes important contributions in extending this literature. Specifically, this study is among the first to examine EC during the critical period of preschool as a predictor of subsequent child depression and anxiety symptoms in a longitudinal study spanning several years. This study also accounted for several covariates in the analyses, strengthening the finding that early EC accounts for unique variance in predicting subsequent depression and anxiety symptoms. Further, the rich measurement of early EC using a developmentally-appropriate battery of tasks covering the major aspects of

the EC construct is an important improvement from previous studies, including the rare longitudinal investigations in the child EC-internalizing problems literature (e.g., Kertz et al. 2016). Finally, the current study employed a sophisticated bifactor modeling approach to determine the relative contributions of early EC and foundational cognitive abilities to later depression and anxiety symptoms.

The main results of the current study are consistent with *a priori* expectations and with theory suggesting a potentially important role for EC in regulation of mood. Poor EC may contribute to emerging depression or anxiety symptoms in a variety of ways. One potential pathway could be through problems with attentional control, in particular difficulty disengaging from negative stimuli and thoughts, as suggested by the "impaired disengagement hypothesis" (Koster et al. 2011). Similarly, strong EC may be critical in moderating experiences of negative emotions and intentionally directing both internal thoughts and external behavior toward improving mood. Consequently, poor EC may result in "unchecked" negative emotionality, which can contribute to emerging mood problems. Further, it is possible that the academic consequences of poor EC could mediate associations with subsequent mood and anxiety symptoms. Existing literature documents links between early EC deficits and poor academic achievement (Blair and Razza 2007; Bull et al. 2011) and classroom behavior (Nelson et al. 2017; Nesbitt, Farran, and Fuhs 2015; Neuenschwander, Röthlisberger, Cimeli, and Roebers 2012). In turn, school difficulties could be a source of frustration, apprehension about academic activities, and negative self-image. Future research should explore these potential mechanisms linking sub-optimal EC and internalizing risk to improve understanding of exactly how EC deficits contribute to later psychopathology.

The current study also reinforces the importance of EC development early in life. The finding that EC in preschool predicted both depression and anxiety symptoms later in elementary school suggests that a child's tools for managing mood may develop long before significant internalizing symptoms emerge. Studies spanning even longer periods of development are needed to document the long-term mental health implications of poor early EC. If in fact early EC deficits confer long-term psychopathology risk, important implications for prevention and treatment could follow. A growing literature suggests that EC is modifiable, particularly early in life and for those with deficits (Diamond and Lee 2011; Hillman et al. 2014; Holmes, Gathercole, and Dunning 2009; Tamm, Nakonezny, and Hughes 2014; Zelazo and Carlson 2012). Therefore, interventions to promote better early EC development, and to remediate deficits as early as preschool, could strengthen psychopathology prevention programs for at risk youth. Similarly, targeted intervention to improve EC abilities among youth presenting with internalizing disorders could bolster existing evidence-based treatments. Helping children to better direct their attention and behavior could be a valuable skill for reducing mood and anxiety (and perhaps other psychopathology) symptoms throughout the lifespan.

The current study was strengthened by an analytic approach that accounted for child externalizing symptoms in isolating the associations between EC and internalizing problems. Child internalizing and externalizing symptoms have been found to significantly correlate with each other (Achenbach et al. 1991) and are frequently comorbid among children with

psychopathology. The present study found that early EC was a significant predictor of subsequent depression and anxiety symptoms *controlling for externalizing symptoms* (as well as other constructs such as effortful control, family history, and family stressors). This approach adds confidence that poor EC may uniquely contribute to internalizing psychopathology. Combined with the existing literature documenting associations between EC and externalizing problems in children (Espy et al. 2011; Hughes and Ensor 2011), it appears that EC may be an important precursor to various forms of child psychopathology.

It is important to note that, although poor early EC predicted greater subsequent depression and anxiety symptoms in the main continuous analyses, EC predicted only anxiety and not depression in supplemental categorical analyses examining the presence of *clinical*-level symptoms. This non-significant finding for depression could be due to the relatively low prevalence of clinically-elevated depression symptoms in this sample and to the loss of power inherent in categorical analyses. Given the continuous nature of child psychopathology symptoms and the relevance of even sub-clinical internalizing symptoms in children, the study‘s main findings of significant associations in dimensional analyses remain important. However, some caution is warranted in considering the contributions of EC to actual clinical depression *disorders*, and additional studies are needed to explore this issue in samples with higher prevalence of clinical-level symptoms.

Although the present study makes meaningful new contributions to the child psychopathology literature, some limitations should be noted. First, our analyses included only self-report measures of depression and anxiety. A more comprehensive, multimethod clinical evaluation of internalizing symptoms would have added rigor to the study and should be considered in future research in this area. That said, the self-report scales used to measure child depression and anxiety symptoms are well-established with demonstrated reliability and validity (Bae 2012; Lowe, 2015). Further, the dimensional approach that characterizes both the CDI-2 and RCMAS-2 is consistent with the continuous nature of child internalizing psychopathology symptoms and captures sub-clinical symptoms that could be important for child functioning but may be missed by more clinical categorical diagnostic schemes (Hankin, Fraley, Lahey, and Waldman 2005). Second, the current study established longitudinal associations between EC and internalizing symptoms, but we were not able to examine potential mechanisms. Future research would benefit from a careful examination of factors such as attentional control and academic achievement as possible mediators of the association between EC and internalizing symptoms.

Third, although the current study leveraged a longitudinal design to examine EC as a predictor of later internalizing symptoms, it is likely that the EC-internalizing association is actually bidirectional in nature. The current study captured the effect of early EC on subsequent depression and anxiety symptoms, but those symptoms in turn likely further compromise EC development over time, resulting in an EC-psychopathology cycle of deteriorating functioning over time. Future research should explore the possibility of this more complex interaction using cross-lagged panel designs to elucidate bidirectional effects between EC abilities and internalizing symptoms. Fourth, although the current study followed children into late elementary school when internalizing symptoms tend to be higher than in preschool, it did not extend into adolescence when internalizing psychopathology

symptoms increase markedly. Future research should include assessments in adolescence to examine the potential influences of early EC on depression and anxiety symptoms during the high-risk period of adolescence. Finally, the percentage of children endorsing at-risk or clinical symptoms of depression and anxiety in this study was somewhat lower than expected based on internalizing disorder base rates and the sociodemographic risk distribution of the current sample. Future research should replicate these findings in samples with higher rates of clinical symptoms.

Despite the limitations noted, the current study advances knowledge of early EC deficits as a risk factor for subsequent child depression and anxiety symptoms by examining longitudinal associations across key periods with rigorous measures. Future research should expand on these findings by extending longitudinal designs into adolescence and exploring specific mechanisms by which poor EC impacts later symptoms. Improved understanding of how EC development relates to emerging child psychopathology will inform novel prevention and intervention efforts addressing a potentially important risk factor.

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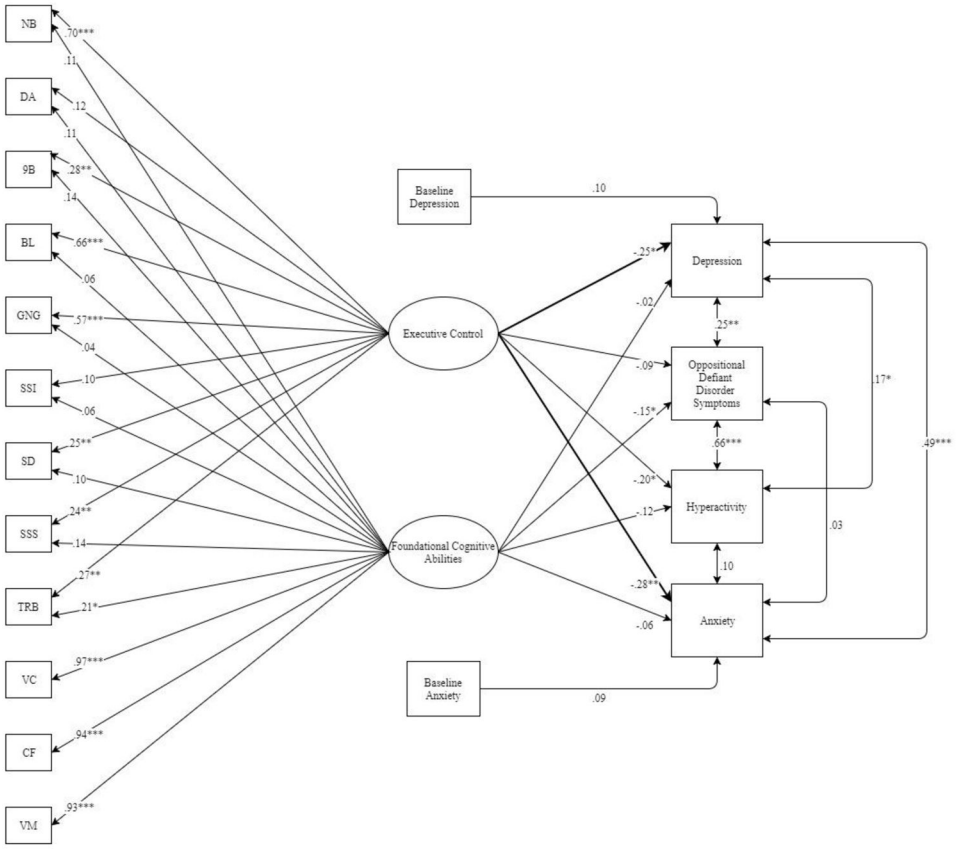

Figure 1.

Bifactor model with preschool executive control and foundational cognitive abilities predicting depression and anxiety symptoms in elementary school.

Note: Control variables included in the model that are not depicted in the figure include maternal education, child sex, preschool effortful control, preschool ODD symptoms, preschool ADHD symptoms, Life Stressors and Social Resources Inventory (LISRES) Negative Life Events scale, parent-report of family history of depression, and parent-report of family history of anxiety.

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

Structural Model Fit: RMSEA = .03, CFI = .99, TLI = .98, SRMR = .04

Predictive Model Fit: RMSEA = .06, CFI = .86, TLI = .83, SRMR = .10

NB = Noisy Book; DA = Delayed Alternation; 9B = 9 Boxes; BL = Big Little Stroop; GNG = Go-No-Go; SSI = Shape School Inhibit; SD = Snack Delay; SSS = Shape School Switch; TRB = Trail Making Test; VC = Verbal Comprehension; CF = Concept Formation; VF = Visual Matching

Table 1

Descriptive Statistics on Sample Demographics and Internalizing Symptom Variables

Variable			**Mean**	***SD***	**Min**	**Max**
Age in Elementary School			9.95	.37	8.25	10.83
Years of Maternal Education			14.50	2.23	8	21
RCMAS-2 (T score)			46.36	8.86	33	68
CDI-2 (T Score)			45.24	7.07	40	84
Gender	***N***	**%**				
Male	146	52.14%				
Female	134	47.86%				
Ethnicity						
European American	162	57.86%				
African American	12	4.29%				
Hispanic	41	14.64%				
Asian	2	.71%				
Multiracial	63	22.50%				
SES At-Risk[†]	***N***	***%***				
Yes	158	56.43%				
No	122	43.57%				

[†]Determined by caregiver report of family receiving public medical assistance.

Table 2

Description of Executive Control Tasks

EC Task	Brief Description	Source
Working Memory		
Delayed Alternation	Participant attempts to find a reward by choosing between two locations. Reward location alternates, so the participant must remember the previous location after a delay.	Espy et al. (1999); Goldman et al. (1971)
Nine Boxes	Nine boxes of different colors and shapes are presented, and the participant is asked to search the boxes for a reward. Participant must remember boxes previously searched to locate the reward in the fewest trials.	Adapted from Diamond et al. (1997)
Nebraska Barnyard	Participant is presented with a 3x3 field of boxes with locations of animal figures. Participant is asked the locations of animal sequences after pictures are removed, requiring the child to remember the locations.	Adapted from Hughes et al. Noisy Book task (1998)
Inhibitory Control		
Big-Little Stroop	Stimuli of small objects embedded within larger objects are presented to the participant. The participant is asked to verbally name the smaller object, requiring the larger object name to be suppressed.	Adapted from Kochanska et al. (2000)
Go/No-Go	Participant is presented with a series of stimuli on screen consisting of either a fish or a shark. The participant is asked to press a button when presented with a fish but to refrain from pressing the button when presented with a shark.	Adapted from Simpson & Riggs (2006)
Shape School Inhibit	Cartoon stimuli are presented on a screen consisting of either a happy or sad face. The participant is asked to verbally name the color of stimulus for happy faces and to refrain from naming the color for sad faces.	Espy (1997); Espy et al. (2006)
modified Snack Delay	The participant is seated at a table near a candy reward. The child is asked to sit still until the tester rings a bell.	Adapted from Konchanska et al. (1996); Korkman et al. (1998)
Flexible Shifting		
Shape School - Switching	Cartoon stimuli of different colors that are either wearing a hat or not wearing a hat are presented. The participant is asked to name the stimulus shape when the cartoon is wearing a hat and name the stimulus color when the cartoon is not wearing a hat.	Espy (1997); Espy et al. (2006)
Trails - Switching	Participant is presented with a page consisting of dog and bone stimuli. The participant is asked to stamp stimuli alternating between dogs and bones.	Adapted from Espy & Cwik (2004)