IS CHILDREN'S PARTICIPATION IN ACTIVITIES RELATED TO EXECUTIVE FUNCTION DEVELOPMENT?

by

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ABSTRACT

Recent research suggests that basic cognitive skills are plastic in nature and can be significantly impacted by one's environment. Specifically, it has been hypothesized that formal activity participation can both directly and indirectly influence executive function development and related developmental outcomes. In the current study, we examined associations between parents' reports of their children's activity participation, children's feelings of social belonging and support, executive function skills, and depressive symptoms. The children were recruited through partnerships with two elementary schools (N = 151; 8–12 years of age). The statistical analyses included correlations, hierarchical regression, and a series of mediation path analyses. The final models statistically demonstrated a significant relationship between children's participation in activities and depressive symptoms through processes of social belonging and support and executive function. Children who participated in a greater number of activities reported a greater sense of social belonging and support from peers, demonstrated better executive function skills (working memory only), and reported fewer depressive symptoms. Children from families who reported greater annual incomes reportedly participated in a greater number and wider breadth of activities. Our findings add to the existing literature by showing that common, everyday childhood activities, not just those specifically designed to enhance development, are beneficially related to positive aspects of development.

This project is dedicated to both my mother and father, who have devoted their lives and careers to bettering the lives and futures of children. Together, they have fostered and continue to inspire my passion for learning, teaching, and giving back.

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INTRODUCTION

Youth participation in organized school and community-based activities has been directly linked to both short- and long-term positive developmental outcomes (Eccles & Gootman, 2002), including decreased risk-taking behavior (e.g., substance abuse), and increased self-esteem, GPA, leadership qualities, physical and mental health, and academic aspirations (e.g., Barber, Eccles, & Stone, 2001; Otto, 1976). Diamond (2012) recently proposed a model that highlights the direct and less studied, indirect, routes through which programs or activities impact the development of executive functions (EFs) and the developmental outcomes they have been linked to through research. She theorized that such positive outcomes are due to the enhanced development of executive function through participation in activities that contribute to increased feelings of joy and accomplishment, physical fitness, feelings of social belonging and support, and to building children's confidence and self-efficacy (Diamond, 2012). See Figure 1.

Recent research supports the idea that childhood participation in complex activities helps foster social development and cognitive skills, such as executive functions. However, the majority of literature has focused on creating and testing formal programs or interventions that directly promote social skills and executive function. Very little research has looked at whether the activities children commonly engage in directly and indirectly impact social and cognitive development. Understanding if and how participation in regular, commonly engaged in activities relate to these developmental

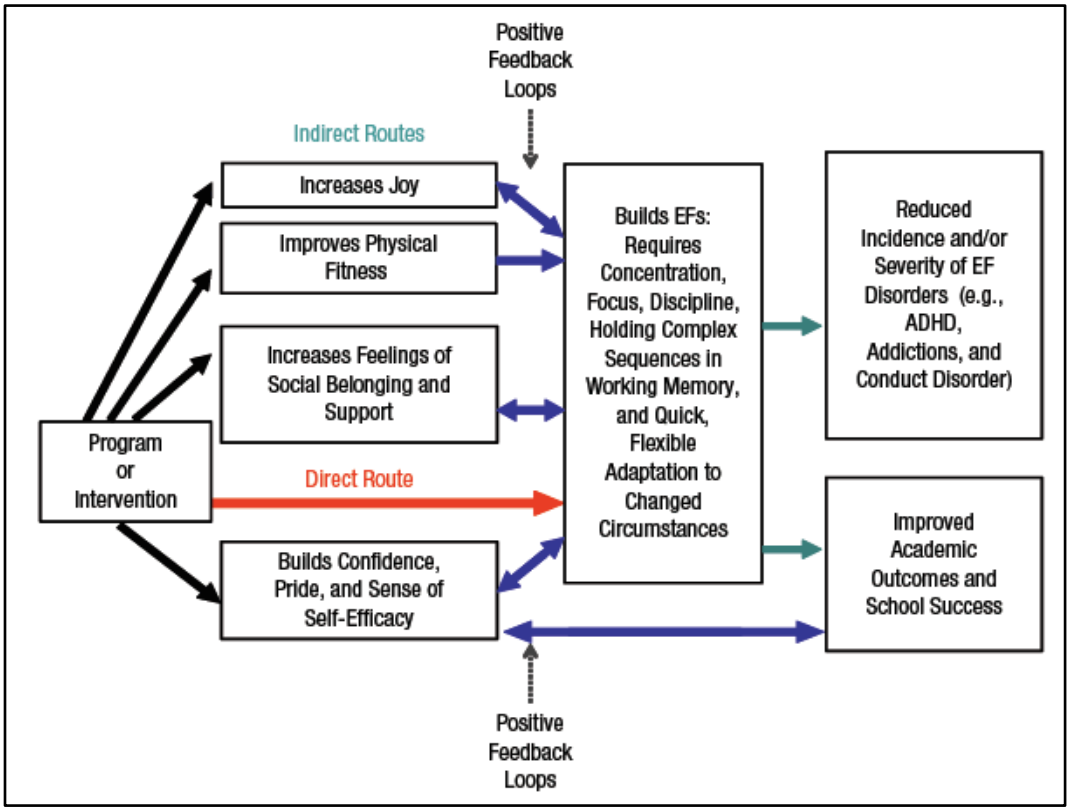

Figure 1: Diamond Theoretical Model

processes and outcomes is important because cognitive skills, specifically executive functions, have been empirically linked to better psychological functioning (e.g., Diamond, 2013; Fairchild, van Goozen, Stollery, Aitken, & Savage, 2009; Taylor-Tavares et al., 2007), favorable academic outcomes (Blair, 2002; Blair & Diamond, 2008), and improved health (Crescioni et al., 2011; Miller, Barnes, & Beaver, 2011; Riggs, Spruijt-Metz, Sakuma, Chou, & Pentz, 2010), as well as overall job success (Bailey, 2007) and quality of life (Brown & Landgraf, 2010; Davis, Marra, Najafzadeh, & Lui-Ambrose, 2010). Using Diamond's work as a guiding framework, the current study was an exploratory investigation of the direct and indirect links from children's

participation in activities, such as organized sports, performing arts, and clubs, to their perceived feelings of social belonging and support, executive function skills, and depressive symptoms.

Activities, Social Belonging, and Social Support

A large proportion of kids' social interactions occur in the context of the organized activities they regularly engage in. Activities such as team sports, music lessons or band, and scouts are inherently social in nature. Therefore, along with increasing joy, confidence, and physical fitness, participation in these types of activities promotes social development by providing on-going opportunities to utilize and practice learned social skills as children support and interact with one another (Diamond, 2012). Two important social benefits that children gain by participating in activities with peers are feelings of social belonging and social support (Eime, Young, Harvey, Charity, & Payne, 2013).

Participation in activities provides continuous opportunities for children to build positive peer networks, thereby increasing potential sources of social belonging and support. Hammond, Bibok, and Carpendale (2010) emphasized that childhood activities provide social settings that have the potential to promote or interfere with normative development, as they often have to work together as a group or team in order to be successful. Interacting with others on a team for a common goal contributes to feelings of social belonging. For example, investigators of one study explored how adolescents' participation in extracurricular activities was related to their social adjustment during their transition into high school (Bohnert, Aikins, & Arola, 2013). They found that youth

who continued to participate in team sports and other academic activities in high school reported having more friends. Similarly, Poulin and Denault (2013) examined 8th graders' friendships within the context of organized activities. They reported an interesting difference between two different types of activities; youth reported their friends who participated in individual sports as being more academically minded, but friends who were part of a team sport as more supportive, but having a greater number of problem behaviors.

Overall, a reoccurring theme in existing literature appears to be that childhood or youth participation in activities conveys significant social benefits including an increased number of friendships, which directly contributes to perceived feelings of social belonging and support. In the current study, we explored both the number of activities each child participated in and the breadth of activities reported to examine whether the number of activities alone would predict positive developmental outcomes or if being involved in a breadth of activities (e.g., sports, civic engagement, clubs, music) was the best predictor of positive outcomes.

Activities and Executive Function

Many activities, like those already mentioned, involve complicated rules and environments that challenge and promote cognitive development by requiring children to employ specific executive function skills. Executive function (EF) is a broad umbrella term that is commonly used to describe basic, higher-order cognitive skills that allow children to control goal-oriented and socially appropriate behavior (Blair & Diamond, 2008; Landry & Smith, 2010). Executive functions are dependent on the protracted

development of the cortical networks in the prefrontal cortex (PFC) of the brain (Best & Miller, 2010; Crone, 2009; Diamond, 2002; Huizinga, Dolan, & van der Molen, 2006). During childhood, the prefrontal cortex goes through several key periods of development and as a result, children develop the necessary EF skills to master simple tasks early in life. Executive functions continue to develop throughout childhood and adolescence, achieving relatively stable, adult capacity in young adulthood, when the PFC reaches maturity. Executive functions have consistently displayed relative plasticity; they can be altered by short, single bouts of physical exercise, interventions, and practice (e.g., Etnier & Chang, 2009).

Researchers like Diamond, Barnett, Thomas, and Munro (2007) have agreed there are three essential components of EF that are necessary for prime self-regulation and success in life: 1) inhibitory control - one's ability to resist distractions, unwanted thoughts or memories, and selectively attend to relevant information; 2) working memory - the ability to hold information in mind and mentally use or manipulate such information to complete a task; and 3) cognitive flexibility - the ability to shift attention or adjust to change. Other researchers have supported the use of these three specific components of EF because they can be fairly clearly defined and operationalized. They have been measured with widely accepted tasks, and they predict performance on highly complex and involved EF tasks, like the Wisconsin Card Sorting Task (Diamond, 2013; Huizinga, Dolan, & van der Molen, 2006; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000) and higher-order cognitive processes including constructive memory processes (Tsethlikai & Greenhoot, 2006; Tsethlikai, 2010) and verbal skills (Tsethlikai, 2011). Furthermore, these three components of EF have "provided useful insights into the nature

and organization of individual differences in EFs," (Miyake & Friedman, 2012, p. 9). Thus, for the current study, we treat EF as a multifaceted construct defined by the related but distinct skills of inhibitory control, working memory, and cognitive flexibility.

Recent research suggests that the types of activities youth participate in directly impact the development of executive functioning (Hammond, Bibok, & Carpendale, 2010) by challenging and exercising the areas of the brain associated with the skills needed to inhibit irrelevant stimuli, keep a variety of rules in mind, focus on a common goal, and flexibly switch attention between different tasks. For example, participation in sports may contribute to enhanced inhibitory control by requiring a child to actively practice different aspects of inhibition, including emotion inhibition, behavioral inhibition, and cognitive inhibition (Diamond, 2013). Researchers have postulated that working memory and inhibitory control are closely related and develop alongside one another (Diamond, 2013). In fact, some researchers have argued that working memory capacity and inhibition are one ability instead of two distinct skills (Redick, Heitz, & Engle, 2007). These two abilities are closely tied because in order to hold relevant information in mind and work with it (Working Memory), the brain must also successfully inhibit irrelevant or interfering stimuli/information (Inhibition) (Diamond, 2013). It is important to promote skills like working memory because it is strongly related to outcomes such as creativity and analogical reasoning (Diamond, 2013). Working memory is especially relevant for activity participation because it enables an individual to keep the rules of a game and socially acceptable behavior in mind during an interaction. Finally, cognitive flexibility builds on both inhibition and working memory (Diamond, 2013) reaching adult level capacity during adolescence (Huizinga, Dolan, &

van der Molen, 2006). Specifically, flexibility is key in being able to see situations from different perspectives, be they spatial or interpersonal. It also allows for creativity and being able to think outside the box, which is a necessary skill for successfully adapting to changing environments and demands (Diamond, 2013).

Recently published studies have consistently reported a positive relationship between physical activity (also referred to as aerobic exercise) and cognitive functioning (see Etnier & Chang, 2009 or Tomporowski, Davis, Miller, & Naglieri, 2008 for a review). This area of research was spurred when researchers reported that physical activity was a significant predictor of frontal lobe activation in aging populations (Kramer, Humphrey, Larish, & Logan, 1994). Thus, some researchers hypothesized that exercise would be particularly beneficial in activating functions that involve the PFC, such as EF. Empirical research looking at the relationship between exercise and cognitive functioning has mainly focused on adults and acute bouts of physical activity (see Tomporowski, 2003 for a review), chronic exercise in children (e.g., Etnier & Chang, 2009), or the significant relationships between physical activity and improved EF skills in specific populations such as the elderly, children diagnosed with ADHD (Gapin & Etnier, 2010), and overweight children (Davis, Tomporowski, McDowell, Austin, Miller, Yanasak, & Naglieri, 2011). There has been very little focus on the routine physical activities in a normative sample of children.

It is possible that not all physical activity is equally beneficial, but that certain types of exercise may have stronger benefits for EF development (Best, 2010). Research has suggested that the most effective type of physical activity not only involves aerobic movement, but also cognitive engagement. Team sports are a good example of a

cognitively engaging activity because they require constant adaptation to changing contexts (Best, 2012). Exergames are competitive virtual games that also involve physical exercise. Two different studies found exergaming to be a significant contributor of improved EF (Best, 2012; Staiano, Abraham & Calvert, 2012). Interestingly, Best (2012) found that an acute bout of physical activity through exergaming immediately improved children's EF scores, which suggests that not only does plasticity exist in shaping the development of EFs during childhood but also that EFs are highly responsive to environmental stimulation. Replicating this finding, Staiano, Abraham, and Calvert (2012) found that in comparison to a control group, children who participated in the 10-week exergaming program displayed improvement in EF scores.

Another possible way that activities can continually challenge children's executive function skills is through participation in numerous activities. Participating in a greater number of activities provides children with more opportunities to utilize and strengthen their EF skills. In addition to being cognitively engaging, in order for activities to be beneficial for EF, they must be repeatedly practiced and become more difficult over time (Diamond & Lee, 2011; Diamond, 2012) otherwise the necessary skills become rote and automatic. When children regularly participate in an activity, it is usually because they enjoy doing the activity, thereby increasing the likelihood that they will practice (Diamond, 2012). In the current study, we examined both the sheer number of activities children reportedly participated in and their breadth of activity participation.

Social Belonging, Social Support, and Executive Function

Until recently, the development of EF has been thought of as a purely cognitive, neurobiological process (Dick & Overton, 2010). However, researchers have begun hypothesizing that EF, like brain development, is a very dynamic process that relies on biological, cultural, and social factors (Dick & Overton, 2010). Specifically, some have suggested that social experiences and social interactions are not only causal in the developmental of social competence but that they are influential in the development of EFs (Hammond, Bibok, & Carpendale, 2010; Sokol, Müller, Carpendale, Young, & Iarocci, 2010). In fact, one group of authors have proposed that perhaps the mechanism by which team sports and similarly complex activities might enhance EF has more to do with the fact that they are social in nature rather than that they are cognitively or physically challenging (Hammond, Bibok, & Carpendale, 2010).

Although EF skills necessary for basic tasks develop early in life, the level of EF skills needed to master more complex tasks, such as understanding a peer's perspective or the ability to negotiate with peers, continues to develop and improve throughout middle childhood and adolescence. It is these complex tasks that are of interest as they aid in the ability to form and maintain relationships and friendships, which are of extreme importance during this sensitive developmental period (Choudhury, Blakemore, & Charman, 2006).

Good EF skills are necessary for positive social skills and interactions, which contribute to peer competence and in turn enhance one's likelihood of experiencing belonging and support. Hughes and Ensor (2008) have suggested a bidirectional relationship between EF and negative social skills as measured by problem behaviors due

to research supporting that EF skills, in particular inhibitory control, facilitate children's ability to regulate their behavior.

Increases in social competence seen with age could be due to older children's more advanced cognitive skills that allow for more insight into the peer's behavior. Tsethlikai (2010) and Tsethlikai and Greenhoot (2006) demonstrated that children with better basic cognitive skills were better able to understand and integrate a fictional friends' perspective than children with poorer skills. This suggests that children's developing cognitive skills likely contributed to their ability to understand the minds of others such that they could think beyond their own experiences and learn from the experiences of others. This is critical for the development of feelings of social belonging and support because understanding other's perspectives and motives is particularly important in the process of friendship building. Thus, children's social development is important to consider when studying basic cognitive skills.

Developmental Outcomes

The previous sections helped to establish empirically supported associations between childhood participation in activities, feelings of social belonging and support, and executive function. Research has also supported that each of these variables are related to a host of social, academic, and psychological outcomes. Although Diamond's model does not propose a direct association between activities and outcomes, a number of other studies have examined how different types of activities directly predict positive developmental outcomes. For example, Barber, Stone, and Eccles (2005) looked at how high school students' participation in activities, during four waves of data collection, was

related to various outcomes. Importantly, this study found that involvement in such activities was related to various positive outcomes such as self-esteem, physical and mental health, and academic aspirations. Participation in a greater number of activities, regardless of type, was related to more positive outcomes although participation in just one activity was still better than none. The authors also examined the breadth of participation and found that participation in a greater number of types of activities (e.g., team sports and performing arts) was more strongly related to positive outcomes than participating in just one type of activity.

As it has been called a "basic human need," research has repeatedly found social belonging and support to be strongly associated with many positive developmental processes and life outcomes. Recently, investigators found that for 7th – 11th graders, peer social support was a significant predictor of school engagement (Wang & Eccles, 2012). Another study reported that greater adolescent social support was significantly related with fewer social adjustment problems (East, Hess, & Lerner, 1987). Aspects of development that contribute to school engagement and positive social adjustment, such as belonging and support, are important to study because copious amounts of literature have established that a lack of social belonging and social connectedness are directly related to more severe clinically related outcomes such as loneliness (Cacioppo & Patrick, 2008) and depression (Choenarom, Williams, & Hagerty, 2005; Hagerty & Williams, 1999).

In addition, executive functioning is related to a broad spectrum of outcomes including enhanced self-regulation, through reductions in problem behaviors (Hughes & Ensor, 2008), improved academic and social readiness to attend school (Blair, 2002; Blair & Diamond, 2008), and increased overall life success as demonstrated by job security,

health, and well-being (Miyake & Friedman, 2012; Moffit, Arseneault, Belsky, Dickson, & Hancox, 2011). As Diamond (2012) suggested in her model, when EF skills, specifically working memory, inhibition, and cognitive flexibility, are compromised for any reason, be that social or physical, it can result in EF-related disorders such as addiction (Baler & Volkow, 2006), ADHD (e.g., Diamond, 2005; Lui & Tannock, 2007), and depression (Taylor-Tavares et al., 2007).

One psychological outcome that activity participation, social belonging, and executive function have all been empirically linked to is symptoms of depression (Barber, Stone, & Eccles, 2005; Choenarom, Williams, & Hagerty, 2005; Hagerty & Williams, 1999; Taylor-Tavares et al., 2007). Childhood depression is especially important to study and understand because it is a psychological disorder of increasing concern (Crick & Dodge, 1994; Kovacs, 2003) that involves social, cognitive, and long-lasting effects (Lima, do Nascimento, de Carvalho, de Abreu, Neto et al., 2013). The prevalence of youth diagnoses has climbed in recent years to rates as high as 15 and 20% (Possel, Seemann, Ahrens, & Hautzinger, 2006). In addition, individuals who experience depression early in life have a greater risk for experiencing depression as well as other comorbid mental illnesses as adults (Lima et al., 2013).

Current Study

Prior research has looked primarily at formal programs or interventions. However, the current study was unique because it explored whether participation in common childhood activities like sports, arts, and clubs were related to children's feelings of

perceived social belonging and support, executive function skills, and depressive symptoms using Diamond's model as the guiding framework.

The current study had three main goals. The first goal was to explore whether number of activities, breadth of activities, feelings of social belonging and support, executive function skills, and depressive symptoms were related. The second goal was to examine the unique sources of variances in depressive symptoms among the predictor variables of interest. The final, and third, goal was to use the current data to explore Diamond's hypothesized model using Hayes process mediation techniques.

METHOD

Participants and Procedure

One hundred fifty-one children (46 boys, 105 girls), ages 8 – 12 years old (*M*= 9.77, *SD*=1.34), participated in this study. The participants were primarily Caucasian (87%) with a median annual income of $70,000. The children were recruited through partnerships with two local elementary schools. With the help of school principals, administrative staff, and teachers, packets were distributed to 3rd, 4th, and 5th graders, with instructions to have them take the packets home for their parents to complete and return to the school if they wanted to participate. Consent forms and parent demographic questionnaires were sent home once we received permission to contact the parents and an interview was scheduled. The majority of the participants were seen after school in a room provided by the school but a few were seen at their home or in the lab. The children gave verbal and written assent before each session began and they received a copy of their consent form. Participants then completed assessments of perceived social/peer support, executive function, and the Children's Depression Inventory. Upon completion of the interview, children received $10 and some small toy gifts for participating. Parents were also compensated $10 for their time and for filling out the demographic questionnaires.

Measures

Socio-Economic Status

Parents/Guardians were given a short questionnaire to assess their economic status. They were asked to report their household annual income using a scale that ranged from less than $5,000 to over $200,000. The highest number in the reported range was recorded. The questionnaire also asked about their occupation status and educational attainment.

Activities

Parents were asked in an open-ended question to report their child's extracurricular activities and regular family activities. First, all reported activities were coded into the following groups: physical activities (e.g., team sports, hiking, riding bikes), performing arts (e.g., playing a musical instrument, singing in a choir), and clubs (e.g., cub scouts, chess club) (Barber, Stone, & Eccles, 2005). Each child's reported activities were then counted and summed to create a numeric variable representing each child's sheer number of activities (Activities) (range: 0 – 11).

Another count variable was created to represent each child's breadth of participation (Breadth) (range: 0-3). Only 1 child was reported as not participating in any activities, thus the breadth score for this individual was 0. A score of 1 meant a child reportedly participated in just one type of activity (N=22); a 2 meant participation in two different types of activities (N=64) and a 3 meant the child's parent reported s/he participated in at least one physical activity, one performing art activity, and one club (N=64). Parents of 132 children reported his/her child participated in at least one physical

activity, 89 reported in at least one performing arts activity, and 121 parents reported his/her child participated in club activities.

Feelings of Social Belonging and Support

Activities and Feelings is a commonly used measure of children's perceptions of loneliness and social adequacy versus inadequacy, and self-evaluations of peer rankings (adapted by Vandell for the NICHD Study of Early Child Care and Youth Development from the original questionnaire developed by Asher, Hymel, & Renshaw in 1948). The questionnaire consists of 24 items including statements like, "*It's hard to get other kids to like me*," and "*I don't have anyone to play with*," and 8 positive items, such as "*I get along with other kids*." The measure also includes 8 filler items like, *"I watch TV a lot"* or *"I like music"* to offset any potential negative emotions children might feel. Children responded using a 5-point scale with answer choices of *not at all, hardly ever true, sometimes true, most of the time true,* and *always true.* The 8 negative items were reverse coded so that higher scores indicated greater feelings of social belonging, social adequacy, and higher levels of self-perceived peer status. All 16 principal item responses were summed to create an indicator of peer acceptance (AF). The raw items used to create this score had high internal reliability (16 items, Cronbach's alpha = .89).

Kids in My Class at School is an 18-item self-report measure of perceived social support from peers at school (10 items; *"Are there kids at your school who tell you you're good at doing things"*), victimization (4 items; *"Do any of the kids at school pick on you"*), and participation in physical and verbal bullying behaviors with classmates (4 items; *"Do you say mean things to other kids at school?"*). Vandell adapted this measure

for the NICHD Study of Early Child Care and Youth Development from three questionnaires developed by Gary Ladd and colleagues (e.g., Kochenderfer & Ladd, 1996; Ladd, Kochenderfer, & Coleman, 1996, 1997). Like *Activities and Feelings*, this measure had a 5-point likert scale, which asked children to respond using *never, hardly ever, sometimes, most of the time,* and *always.* For the current study, we summed the responses to the items inquiring about perceived social support and victimization, but not bullying behavior, to create an indicator of perceived social belonging and support at school (KAS). The raw items used to create this score had high internal reliability (14 items, Cronbach's alpha = .87).

Executive Function

Two types of assessments were used to measure EF: behavior-rating-based and performance-based measures.

Behavior-rating-based EF assessment. The Behavioral Rating Inventory of Executive Function (BRIEF) (developed by Gerard, Isquith, Guy, & Kenworthy) parent form was administered to all parents to assess behavioral indicators of EF. The BRIEF is an assessment of executive function related behaviors at home for youth ages 5–18. The measure consists of 86 items that relate to 8 clinical domains of executive functioning: Inhibit (10 items), Shift (8 items), Emotional Control (10 items), Initiate (8 items), Working Memory (10 items), Plan/Organize (12 items), Organization of Materials (6 items), and Monitor (8 items). Each item asks parents to rate their child's problems with behaviors on a 3-point likert scale of: *never, sometimes,* or *often,* scored as 1, 2, and 3, respectively. Thus, higher scores are indicative of more problem behaviors. Although the

entire BRIEF was administered, given the interests of the current study, we only looked at the following three subscales: Inhibit, Shift, and Working Memory. Items in each of the three subscales were summed and used as three separate indicators of children's EF skills based on their parents' behavioral ratings. An example of an item on the Inhibit subscale would be, "*blurts things out,"* and the raw items used to create this score had high internal reliability (10 items, Cronbach's alpha was .91). An example of an item on the Shift subscale would be, "*is disturbed by change of teacher or class,"* and the raw items used to create this score had high internal reliability (8 items, Cronbach's alpha was .82). Working Memory was assessed by items such as, "*when given three things to do, remembers only the first or last,"* (10 items, Cronbach's alpha was .92).

Performance-based EF assessments. The remaining EF assessments were performance-based measures of EF skills administered to the children.

Two tests of working memory were collected. The Backward Digit Span asked children to repeat a series of digits backwards (Alloway, Gathercole, Willis, & Adams, 2004; Gathercole, Pickering, Ambridge, & Wearing, 2004). Correctly reported numbers were counted and used as the child's Digit Span, with a total of 14 possible points.

The Sentence Recall Task asked children to read groups of sentences aloud and to replace the last word of each sentence (which was missing) with a word of their choosing that meaningfully completed the sentence (Towse, Hitch, & Hutton, 1998). After every group of sentences, with the number of sentences increasing from 2 sentences in the first group to 7 sentences in the last group, the children were asked to recall the words they used to complete each sentence after reading all of the sentences in each group. The total

number of correctly recalled words across all sets was counted as the child's Reading Span, with a total of 42 possible points.

A test of retrieval inhibition was collected using the categorized block cued directed-forgetting task (Wilson, Kipp, & Daniels, 2003). In this task, children were asked to remember a list of fruits and vegetables. After the interviewer read the list to the child, they were told that that list was just for practice and they could forget the words and just remember the next set of words. The next list included words that were all items of furniture. After a 30-second distraction task, each child was prompted to remember only the words they were told to remember (the second list). The number of words the children said that came from list 1 (fruits and vegetables) were subtracted from the number of words recalled from list 2 (furniture) to assess Recall Inhibition, such that higher scores indicated better retrieval inhibition.

The Wisconsin Card Sorting Task (WCST) Revised and Expanded provides an assessment of the ability to flexibly switch attention from one dimension of an object to another (Heaton, Chelune, Talley, Kay, & Curtiss, 1981, 1993). Specifically, the WCST assesses an individual's ability to keep in mind an appropriate problem-solving strategy when environmental conditions change. For the task, each child was presented with four stimulus cards that had varying shapes, colors, and numbers of items on them. A deck of 128 additional cards were presented face down and the child was required to flip over each card one at a time and attempt to match it to one of the four original stimulus cards with no directions given to them as to how to proceed (by shape, color, or number of items). The children must figure out what the matching rule is and once they successfully match 10 times using this rule, the rule is then changed without them knowing and the

child must determine what the new matching rule is. The three matching rules switched six times or until the child ran out of response cards. There are a number of ways to score the child's cognitive flexibility. For this study, we used the number of perseverative errors, as it is one of the more commonly used indicators (calculated by adding up the number of times the child continued to use a rule that had already been changed).

Depressive Symptoms

Depressive symptoms were measured by self-report using the Children's Depression Inventory (CDI). The CDI is a measure that has been widely used in research to tap into a child's emotional state (Children's Depression Inventory, CDI; Kovacs, 1992). The 27-item measure consists of five subscales: negative self-esteem (belief that you are not good at anything), interpersonal problems (difficulty making and keeping close relationships), anhedonia (inability or decreased ability to experience joy), ineffectiveness (lack of motivation or inability to complete tasks), and negative mood (irritability or anger). For each item, children were told to pick the answer that best describes them from one of three options: *Once in a while, many times,* or *often.* All items were scored on a scale of 0 – 2; however, for positively worded items (e.g., *I am lov*ed."), a response of *often* was given a score of 0 and for negatively worded items (e.g., *"I do things wrong."*), a response of *often* was given a score of 2, so that higher scores indicated more depressive symptoms. A response of *many times* always received a score of 1, regardless of the item. All 27 items were summed to create a single composite score indicator of depressive symptoms. The raw items used to create this score had high internal reliability (27 items, Cronbach's alpha = .87).

RESULTS

Preliminary Analyses

The data were first screened for univariate and multivariate outliers and violations of assumptions using IBM SPSS. Upon examining casewise diagnostics, it was determined that there were no extreme outliers in the dataset. Evaluation of the regression assumptions of normality of sampling distributions, linearity, homogeneity of slopes was satisfactory for most variables. For the few variables that appeared to be slightly skewed, nonparametric Spearman correlations were also analyzed. To increase power, all analyses included age, activity participation, social belonging and support, executive function, and depressive symptoms as continuous variables. Descriptive statistics are presented in Table 1.

Analyses

Correlations

To meet the first aim of the study, we first examined the correlations among gender, child's age, annual family income, number of activities, breadth of activities, both indicators of social belonging and support, all measures of executive functioning, and the CDI (see Table 2).

Gender was not significantly correlated with any of the variables of interest. Children's age was not correlated with either number or breadth of activity participation.

Table 1

Means and Standard Deviations for Age, Annual Income, Activities, Feelings of Social Belonging and Support, Executive Function, and Depressive Symptoms

Variable	*M*	*SD*	Range
Age	9.77	1.34	8 – 12
Annual Income	86096	52254	5000 – 200000
Number of Activities	4.58	2.34	0 – 11
Breadth of Activities	2.26	.728	0 – 7
Activities and Feelings	67.33	9.41	29 – 80
Kids in My Class at School	78.99	8.43	45 – 90
Social Belonging and Support Composite	127.41	15.4	54 – 150
BRIEF – Inhibit	14.9	4.53	10 – 30
BRIEF – Shift	12.45	3.33	8 – 23
BRIEF – Working Memory	16.39	4.97	10 – 30
Backwards Digit Span	5.11	1.72	2 – 12
Reading Span	12.45	6.17	0 – 36
Recall Inhibition	5.42	2.07	0 – 10
WCST Perseverance Errors	10.17	8.34	0 – 41
Depressive Symptoms	5.88	5.86	0 – 37

Table 2

Intercorrelations among Gender, Age, Annual Income, Activity Participation, Feelings of Social Belonging and Support, Executive Function, and Depressive Symptoms

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Gender	---														
2. Age	.10	---													
3. Annual income	.02	**.19***	---												
4. Number of Activities	.03	.02	**.29****	---											
5. Breadth of Activities	.06	.13	**.27****	**.58****	---										
6. Activities and Feelings	-.001	.14	.109	**.25****	**.17***	---									
7. Kids in My Class at School	.022	.08	.039	.16	**.21***	**.60****	---								
8. BRIEF – Inhibition	-.15	**-.24****	-.09	**-.24****	**-.23****	**-.26****	**-.23***	---							
9. BRIEF – Shift	.03	-.03	-.03	**-.19***	-.15	**-.21****	-.03	**.47****	---						
10. BRIEF – Working Memory	-.096	-.09	-.097	-.12	**-.22****	**-.25****	**-.17***	**.62****	**.55****	---					
11. Backwards Digit Span	.12	**.35****	.08	.08	.06	.08	.11	.08	-.04	-.02	---				
12. Reading Span	.02	.14	.06	.05	.003	.12	.13	-.13	-.04	-.11	**.19***	---			
13. Recall Inhibition	.14	**.27****	.11	**.18***	**.20***	**.202***	**.17***	**-.23****	**-.23****	-.12	**.22****	**.24****	---		
14. WCST Perseverance Errors	-.07	**-.23****	-.03	.05	-.01	.094	.08	.16	**.16***	.03	-.12	**-.23****	-.14	---	
15. Depressive Symptoms	-.05	**-.19***	-.12	**-.18***	-.13	**-.62****	**-.45****	**.29****	.14	**.32****	-.08	**-.17***	-.16	-.11	---

*$p < .05$. ** $p < .01$.

However, as expected, age was significantly correlated with several of the executive function measures, including the BRIEF inhibition subscale, $r = -.24$, $p = .003$, backwards digit span, $r = .35$, $p = .000$, recall inhibition, $r = .27$, $p = .001$, and WCST perseverative errors, $r = -.23$, $p = .004$. Older children demonstrated better EF skills than younger children. Interestingly, age was also correlated with depressive symptoms, such that younger children reported experiencing significantly more depressive symptoms, $r = -.19$, $p < .05$. Annual family income was correlated with both number of activities, $r = .29$, $p = .000$, and breadth of activities, $r = .27$, $p = .001$, indicating that participants from families with higher annual incomes reportedly participated in a greater number of activities, and a wider breadth of activities, than those with lower annual incomes.

The correlation analyses revealed that there were many significant associations between activity participation, social belonging and support, executive function, and depressive symptoms. Activity participation was significantly correlated with social belonging and support. Children whose parents reported they participated in a greater number of activities self-reported greater levels of feelings of social belonging and support as measured by *Activities and Feelings*, $r = .2$, $p < .01$. The same was true for breadth of activities, it was also correlated with both *Activities and Feelings,* $r = .17$, $p < .01$, and *Kids in My Class,* $r = .21$, $p < .05$. Both activity measures were also correlated with the performance-based EF measure recall inhibition. Again, this was a positive correlation such that better inhibition was associated with greater number of activities, $r = .18$, $p < .05$, and breadth of activities, $r = .20$, $p < .05$. The two activity variables (number and breadth) differed on which BRIEF subscales they were correlated with. Number of

activities was correlated with BRIEF inhibition, $r = -.24$, $p < .01$, and shifting, $r = -.19$, $p < .05$, whereas breadth was correlated with the BRIEF inhibition, $r = -.23$, $p < .01$, and working memory, $r = -.22$, $p < .01$. A greater number of reported activities and wider breadth were related with fewer behavior-based EF problem behaviors. Finally, only number of activities was related with depressive symptoms, $r = -.18$, $p < .05$. Participation in more activities was associated with fewer self-reported depressive symptoms. Since depressive symptoms was the outcome variable of interest in the current study, only number of activities, not breadth, was used in further analyses.

Children's feelings of social belonging and support were significantly correlated with several assessments of executive function both behavior- and performance-based. Both *Activities and Feelings* and *Kids in My Class at School* were also correlated with depressive symptoms, $r = -.62$, $p < .01$ and $r = -.45$, $p < .01$, respectively. The two indicators of social belonging and support, *Activities and Feelings* and *Kids in my Class* were significantly correlated with each other, $r = .60$, $p < .01$. Therefore, the responses for the items from both questionnaires were all summed together to create one single indicator of social belonging and support to use in further analyses. The raw items used to create this score had extremely high internal reliability (30 items, Cronbach's alpha = .92).

Finally, the executive function variables varied greatly by assessment. More of the behavior-based EF measures (BRIEF) were significantly correlated with activity participation, social support, and depressive symptoms than the performance-based EF measures. The BRIEF – shift subscale was not correlated with breadth, kids in my class, or the CDI. Thus, only the BRIEF – inhibition and BRIEF – working memory subscales

were used in the next set of analyses. Recall inhibition was the only performance-based measure that was correlated with number of activities, $r = .18$, $p < .05$, and *Activities and Feelings,* $r = .25$, $p < .01$. Similarly, only Reading Span was significantly correlated with depressive symptoms, $r = -.17$, $p < .05$. Therefore, recall inhibition and reading span were the only performance-based measures that were analyzed in the next step.

Hierarchical Regression

Next, we used a stepwise hierarchical regression approach to explored unique sources of variance in depressive symptoms including the variables that were identified as significant correlates. Since age was significantly correlated with depressive symptoms, we controlled for age in the first step. See Table 3.

In the first step, age alone accounted for a nonsignificant 2% of the variance in children's self-reported depressive symptoms, $F(1,141) = 3.26$, $p = .073$. In the second step, we examined the amount of variance explained by the total number of activities children reportedly participated in over and above the 2% variance accounted for by age. Total number of activities accounted for a significant proportion of the variance (3%) in depressive symptoms after controlling for age, $R^2 = .052$, $\Delta F(2,140) = 4.41$, $p = .038$. Children whose parents reported them as participating in a greater number of activities reported experiencing fewer depressive symptoms.

The next step revealed that children's feelings of perceived social belonging and support accounted for a significant proportion of variance (33%) in depressive symptoms after controlling for age and the number of reported activities, $R^2 = .381$, $\Delta F(3,139) = 73.76$, $p = .000$. This finding indicated that children who perceived themselves as having

Table 3

Hierarchical Regression on Depressive Symptoms by Age, Number of Activities, Feelings of Social Belonging and Support, BRIEF – Inhibit, BRIEF – Working Memory, and Recall Inhibition

Step and Predictor Variable	ΔR^2	B	SE	β	sr^2 at Step 7
Step 1	.023				
Age		-.66	.36	-.15	.004
Step 2	.030*				
Number of Activities		-.42	.20*	-.17*	.0003
Step 3	.328***				
Social Belonging and Support		.22	.026***	.60***	.265***
Step 4	.004				
BRIEF – Inhibit		.09	.09	.07	.0007
Step 5	.017				
BRIEF – Working Memory		.19	.10	.16	.016
Step 6	.000				
Recall Inhibition		-.06	.20	-.02	.000
Step 7	.011				
Reading Span		-.10	.07	-.11	.011

Note. B and β (standardized regression coefficient) values are at the point of entry into the model; sr^2 is the squared semipartial correlation, which represents the amount of variance added to R^2 by each independent variable at the point that it enters the equation. * $p < .05$. ** $p < .01$. *** $p < .001$.

a greater sense of social belonging and more social support reported significantly fewer depressive symptoms.

The next two steps analyzed the unique variance accounted for by two different BRIEF subscales, inhibition and working memory, over and above age, number of activities, and social belonging and support. Neither of the two subscales accounted for a significant proportion of variance in depressive symptoms. BRIEF – Inhibition accounted for less than 1% of the variance, R^2 = .385, ΔF(4,138) = .995, p = .32, and BRIEF – Working Memory only explained an additional 2% of the variance in depressive symptoms, R^2 = .402, ΔF(5,137) = 3.84, p = .052.

In the 6th step, we included recall inhibition to determine if the performance-based EF measure accounted for any unique variance in depressive symptoms above and beyond the behavior-based EF measures. As it turned out, recall inhibition did not account for a significant amount of variance (0%) in depressive symptoms, R^2 = .403, ΔF(6,136) = .089, p = .765.

In the final 7th step, we included reading span because it was correlated with depressive symptoms in the correlation analyses. Reading span accounted for a non-significant 1% of unique variance in depressive symptoms above and beyond all other measures in the model, R^2 = .413, ΔF(7,135) = .2.46, p = .119.

Overall, the regression analyses revealed that the indicators of social belonging and support accounted for the most unique variance in depressive symptoms (33%). There was a slightly significant added benefit for those who participated in a greater number of activities (3%). Surprisingly, although not statistically significant in the analyses, both working memory measures (BRIEF – working memory and reading span)

accounted for small proportions of variance, 2% and 1%, respectively, whereas the two inhibition indicators each accounted for 0% of the unique variance in depressive symptoms. This finding indicates that there was a slight, but nonsignificant, added benefit for those with greater working memory, as children whose parents reported them as having fewer behavior-based working memory problems, and demonstrated better working memory as assessed by the sentence recall tasks, reported experiencing fewer depressive symptoms.

Hayes Mediation Model

The final aim of the current study was to test Diamond's (2012) theoretically proposed model. Only variables that were found to account for at least 1% unique variance in depressive symptoms were used in the final model building approach. These variables included number of activities, feelings of social belonging and support, BRIEF – working memory, and reading span.

Based on Diamond's theory, two mediation models were tested (see Figures 2 and 3) in which we examined the predictor of number of activities on depressive symptoms through mediators of social belonging and support and executive function (specifically working memory). The hypothesized mediation models were tested using Hayes Process syntax for SPSS (Hayes, 2013). Hayes' process analysis uses an ordinary least squares path analytical framework for estimating direct and indirect effects of variables in multiple mediator models. Since age was significantly correlated with executive function and depressive symptoms, both tested models controlled for age (as a covariate). Bias corrected bootstrapping procedures were used to create confidence intervals for

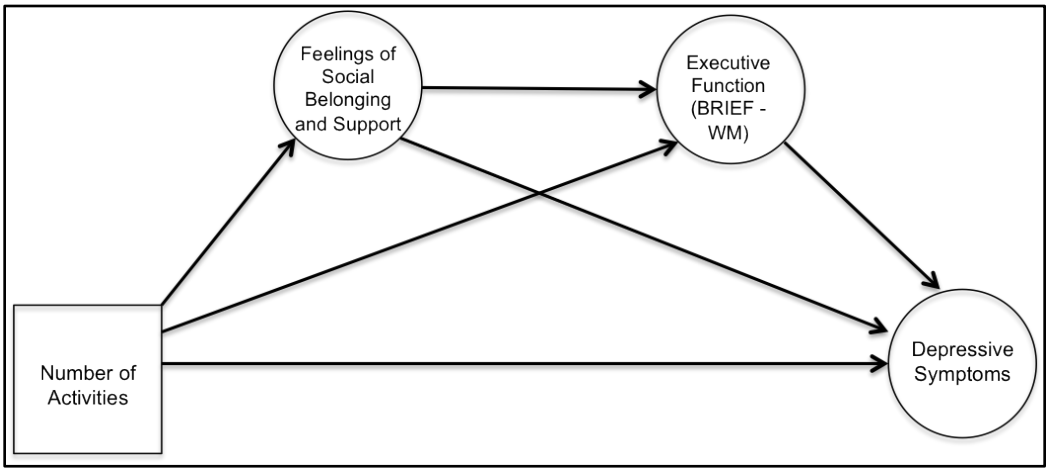

Figure 2: Hypothesized model for the relationship between number of activities and depressive symptoms as mediated by social belonging and support and working memory (BRIEF – working memory).

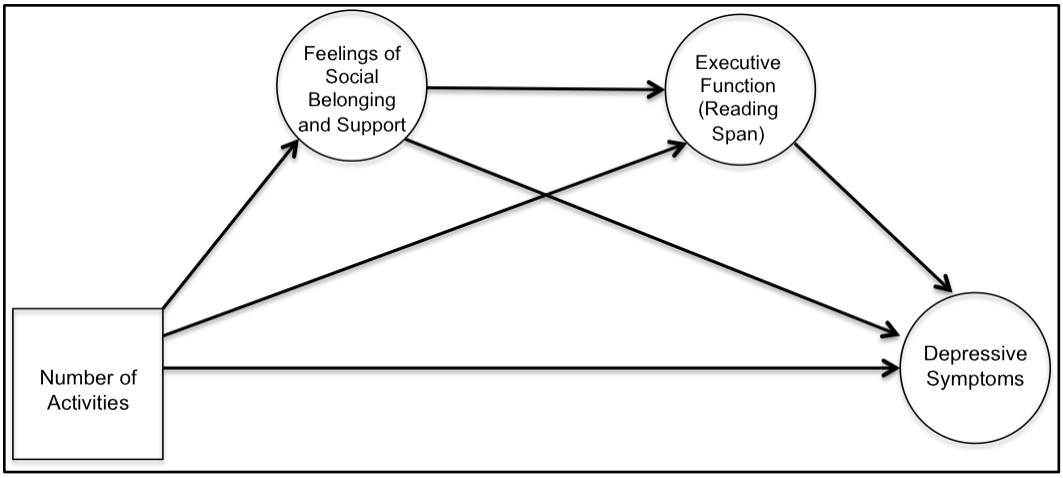

Figure 3: Hypothesized model for the relationship between number of activities and depressive symptoms as mediated by social belonging and support and working memory (reading span).

inferences of indirect effects.

Both of the final models demonstrated significant direct and indirect pathways between activity participation, social belonging and support, working memory, and depressive symptoms. The first model analyzed accounted for a total of 40% of the variance in depressive symptoms. All direct and indirect associations can be seen in Figure 4. In this model, there were two significant indirect pathways. Perhaps most exciting was the significant indirect pathway between number of activities and depressive symptoms through both mediators of social belonging and support, and the BRIEF – working memory subscale. A bias-corrected bootstrap 95% confidence interval for the hypothesized indirect effect ($a_1 d_{21} b_2$= -.0189), based on 10,000 bootstrap samples, was entirely below zero [-.0635, -.0026]. This finding showed that children who were reported as having participated in a greater number of activities, self-reported greater feelings of social belonging and support, were rated as displaying fewer behavior-based working memory problems, and fewer depressive symptoms. Another significant indirect pathway was found between number of activities and depressive symptoms through just the one mediator – social belonging and support ($a_1 b_1$= -.333, 95% CI [-.66 to -.13]). Number of activities was also related directly to depressive symptoms independent of its effect on social support and EF (c = -.42, p = .038).

The second mediation model accounted for slightly less total variance (39%) in depressive symptoms, yet it still revealed several significant direct and one indirect association between number of activities and depressive symptoms (see Figure 5). While the first model (Figure 4) illustrated that number of activities related to depressive symptoms through both mediators, the second model (Figure 5) did not. However, similar

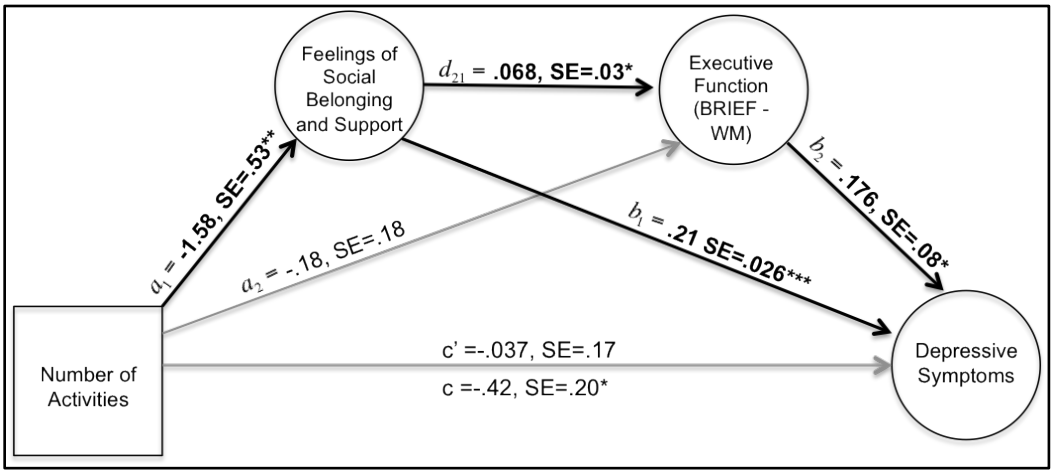

Figure 4: Final Model 1 - Unstandardized regression coefficients for the relationship between number of activities and depressive symptoms as mediated by social belonging and support and executive function as measured by the BRIEF – working memory subscale. Other direct relationships among variables are also shown with unstandardized coefficients. Bolded pathways indicate significant indirect relationships. * $p < .05$. ** $p < .01$. *** $p < .001$.

to the first model, the second did demonstrate a significant indirect relationship between number of activities and depressive symptoms through social belonging and support. This indirect effect ($a_1 b_1$= -.0373) was considered significant because the bias-corrected bootstrap confidence interval was entirely below zero (-.671 to -.133).

Ultimately, these models statistically demonstrated a significant relationship between children's participation in activities and depressive symptoms through processes of social belonging and support and executive function. They supported the idea that children's participation in a greater number of activities was associated with fewer depressive symptoms because activity participation was also associated with greater feelings of social belonging and support and better executive function skills.

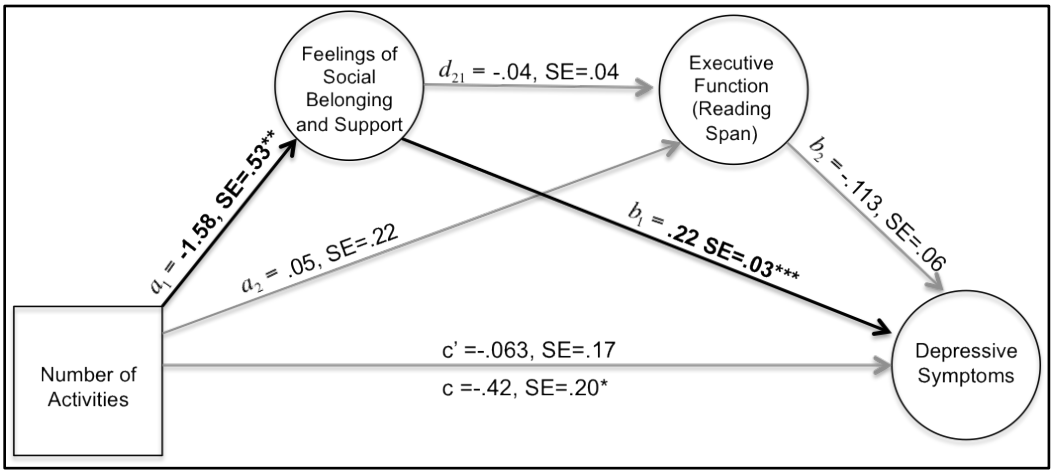

Figure 5: Final Model 2 - Unstandardized regression coefficients for the relationship between number of activities and depressive symptoms as mediated by social belonging and support and executive function as measured by the Reading Span. Other direct relationships among variables are also shown with unstandardized coefficients. Bolded pathways indicate significant indirect relationships. * $p < .05$. ** $p < .01$. *** $p < .001$.

DISCUSSION

The current study was exploratory in nature and had three primary goals. The first goal was to explore possible associations between children's participation in activities, their feelings of social belonging and support, executive function skills, and depressive symptoms. The second goal was to determine sources of unique variability in the outcome variable of depressive symptoms. Our third and final goal was to test Diamond's proposed theoretical model (Diamond, 2012) by looking at whether children's participation in everyday activities was related directly to executive function or indirectly related to depressive symptoms through increased feelings of social belonging and support and executive function by using path analysis.

Overall, the primary findings of the study supported Diamond's model by showing that children who participated in more activities, reported a greater sense of social belonging and support from peers, demonstrated better executive function skills, and reported fewer depressive symptoms. The results are consistent with prior research that has suggested positive relationships between program participation and aspects of positive development such as social belonging and support (Eime et al., 2013), executive function (Diamond & Lee, 2001), and mental health (Barber, Stone, & Eccles, 2005). Importantly, our findings add to the existing literature by showing that common, everyday childhood activities, not just those specifically designed to enhance development, are beneficially related to positive aspects of development.

An unplanned finding of this study was that children coming from families who reported greater annual incomes reportedly participated in a greater number and wider breadth of activities. This finding is not surprising because research has previously established that children who have higher socioeconomic status participate in more organized activities (e.g., Bartko & Eccles, 2003). This finding and prior supporting literature is troubling because it indicates a possible disadvantage for children of families with lower incomes. This result indicates that if a child comes from a home with fewer monetary resources, they may have fewer opportunities to engage in activities that have known social, cognitive, and physical benefits. Unfortunately, prior literature that has found that children of poor SES indeed have reduced social, cognitive, and academic achievement throughout life (e.g., Bradley & Corwyn, 2002; Brooks-Gunn & Duncan, 1997; Farah et al., 2006; Hackman & Farah, 2009). Activities like recreational team sports and music in the classroom are easier and less expensive to implement and encourage than formal programs designed to enhance EF and outcomes. Thus, if activities, like those examined in this study, have beneficial relationships with cognitive and social development, as our results would suggest, they are worthy of more empirical exploration and support because they could potentially be more accessible to a broader, more diverse population of youth.

Another primary finding was that although children's participation in a greater number of activities predicted fewer depressive symptoms (accounting for 3% of the variance), it was feelings of social belonging and support that accounted for the most variance in depressive symptoms (33%). Children who reported higher levels of social support reported fewer depressive symptoms than children who reported lower levels of

social support. Since we cannot make any causal inferences regarding the direction of this relationship, it is worth mentioning that some literature, in the clinical realm, has demonstrated that depressed individuals have a greater sensitivity to social interactions and make more negative attributions about social events than nondepressed individuals. Thus, it could be that depressed individuals perceive themselves as having poorer social belonging and support regardless of the reality of their social networks (e.g., Steger & Kashdan, 2009). Other research has supported the directionality hypothesized by Diamond's model by showing that individuals who lack a positive social network and social support are at greater risk for developing depression (Hagerty & Williams, 1999; Hagerty, Williams, Coyne, & Early, 1996). Similarly, Hagerty and Patusky (1995) stated that a lack of or poor sense of social belonging was a precursor for developing depression.

Interestingly, the only executive function assessments that accounted for unique variance in depressive symptoms were those that measured working memory. One possible explanation for this finding could be that working memory, over and above other EF skills, is the most important and predictive cognitive ability. Prior research would support this explanation as some authors have argued that it is not executive function broadly, but working memory capacity (or executive attention), that is the most predictive ability of general cognitive functioning and positive outcomes such as general fluid intelligence (Baddeley, 1981; Baddeley, 2003; Engle, 2002; Engle & Kane, 2004). However, we think a more plausible reason for why we found only working memory measures to be related to our outcome is a result of the specific outcome we were investigating. Indeed, several recent articles have demonstrated working memory to be an

especially relevant cognitive process associated with symptoms of depression such as rumination and anxiety (De Lissnyder, Koster, & De Raedt, 2012; Levens & Gotlib, 2010; Stout & Rokke, 2010). As mentioned above, from this study, we cannot determine directionality; therefore, we acknowledge that the relationship between working memory and depressive symptoms could be related to findings that suggest that poorer working memory skills are a direct result of depression (Christopher & MacDonald, 2005). None of the children in this study reported levels of depressive symptoms that reached the range of clinical depression. Therefore, it seems more likely that having poor working memory skills contributed to feelings of depression.

Finally, the third aim of this exploratory study was to preliminarily test Diamond's recently hypothesized model (Diamond, 2012). Our final mediation model that accounted for the most variance in depressive symptoms (40%) partially supported Diamond's theory. Diamond proposed that there are direct and indirect routes as to how programs relate with executive function to influence beneficial outcomes such as academic achievement and reduced EF related disorders (ADHD, substance use, conduct disorder, etc.). Our results partially supported her model by showing that children's participation in a great number of activities was in fact related to aspects of positive child development in more ways than one. Our final statistical model varied slightly from Diamond's proposed model as we found children's participation in a greater number of activities was directly related to fewer depressive symptoms but not directly to executive function (working memory). The model did fully support a significant indirect relationship between activities and depressive symptoms through both mediators of

increased feelings of social support and executive function as represented by working memory.

The results of this study add to existing literature in an important way because it is one of the first, to our knowledge, to preliminarily test Diamond's recently published theoretical model. Little to no research has actually looked at all of these types of variables at the same time. Our findings suggest that program participation relates to developmental outcomes directly and indirectly through social belonging and support, and executive function. Our findings expand current scientific knowledge by helping to elucidate the mechanisms by which childhood activity participation impacts developmental outcomes such as depressive symptoms. As with all cross-sectional research, a possible alternative explanation could be that children with fewer depressive symptoms and more advanced social and EF skills are more likely to participate in activities. However, our goal was to test these variables in the order that they have been previously hypothesized by developmental literature and as proposed by Diamond (2012). Specific directionality of this relationship would be best explored with longitudinal research in the future.

We acknowledge that we cannot make any casual claims about the temporal precedence of these variables due to the cross-sectional nature of our data. However, there is much to be gained by way of understanding how these variables dynamically interact and influence each other throughout development. Future research would greatly benefit by tracking these concepts over time throughout development to allow for additional statistical analyses that can better determine causality and temporal order. Another limitation is the fact that we did not have measurements of the duration of

children's activity participation, age of initial participation, or frequency of participation. In future studies, we plan to obtain such information to be better able to decipher specifically which types of activities, activity duration, and frequencies best influence development. One serious limitation was the series of analytic approaches used. By only including the variables that accounted for more than 1% of the variance in the second and third steps of the model building approach, we restricted the generalizability of our findings. It could be that in another sample, the variables explaining more than 1% of the variance could be quite different. Consequently, these results may be specific to our sample only.

Our study was novel in examining the activities that kids engage in as opposed to formal, empirically designed, expensive programs, yet it still remains unclear which activities, specifically, have the greatest impact on specific elements of EF (working memory, cognitive inhibition, mental flexibility) and developmental outcomes. Research has pointed to participation in music (e.g., Moreno, Bialystok, Barac, Schellenberg, Cepeda, & Chau, 2011) and activities that involve physical activity (e.g., Pirrie & Lodewyk, 2012) as being predictive of EF enhancement. In order to determine which activities might have the best "bang for their buck," future research should focus on how various activities influence the specific development of these processes and therefore which activities might be most beneficial and worth marketing to parents and educators.

We found that social support and aspects of EF were significantly related to depressive symptoms. Therefore, we suggest that activities with an emphasis on promoting social support, belongingness, and cognitive skills, such as cognitively engaging physical activities that also involve team work, would likely have the greatest

impact on psychological outcomes such as improved well-being through a reduction in depressive symptoms in children. Additionally, we found that children from families with lower incomes participated in significantly fewer activities. Based on the findings that number of activities had a positive association with increased social support, aspects of cognitive functioning, and ultimately, depressive symptoms, it is of utter importance that activities such as those studied here be made more accessible to all children. One plausible way to do this would be to utilize school systems. Schools could be an ideal place to begin implementing or introducing more activities that involve social and cognitive benefits in order to give all children greater opportunities to benefit from the types of activities that promote positive development.

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