8-2017

Exploring the Relationship between Physical Activity and Executive Function in Early Childhood Populations: An Investigation of Maternal Encouragement of Activity

Lauren P. Driggers-Jones
East Tennessee State University

Exploring the Relationship between Physical Activity and Executive Function in Early Childhood Populations: An Investigation of Maternal Encouragement of Activity

---

A thesis

presented to

the faculty of the Department of Psychology

East Tennessee State University

In partial fulfillment

of the requirements for the degree

Master of Arts in Psychology

---

by

Lauren P. Driggers-Jones

August 2017

Wallace E. Dixon, Jr., Ph.D., Chair

Eric Sellers, Ph.D.

Jason Steadman, Psy.D.

Keywords: Executive function, physical activity, maternal encouragement of activity

ABSTRACT

Exploring the Relationship between Physical Activity and Executive Function in Early Childhood Populations: An Investigation of Maternal Encouragement of Activity

by

Lauren P. Driggers-Jones

Researchers have found positive associations between physical activity and executive function in adolescence and adulthood. However, research in early childhood has revealed only negative relationships. In the present study, I explored whether maternal encouragement of physical activity might moderate this relationship in very young children. Using video recordings from an archival dataset, eight maternal encouragement measures were derived from mother-child free play sessions. Although it was expected that maternal encouragement of child activity would broadly play a moderating role in the relationship between children's physical activity and their executive function, only maternal questions seemed to moderate this relationship. One explanation for these overarching null findings is that maternal encouragement of physical activity may not have a moderating effect until later, such as when children are well on their way into language. Future efforts to explore the impacts of physical activity on executive function may benefit from experimental approaches.

ACKNOWLEDGMENTS

To begin, I would like to thank my advisor Dr. Wallace Dixon Jr. for his time and guidance in the construction, implementation, and writing of this project. His help has been invaluable to not only this project, but to my overall success in this program, and professional development.

Also, I would like to thank my committee members, Dr. Eric Sellers and Dr. Jason Steadman for their time and insight; and all of the members of The Program for the Study of Infancy for the countless hours they spent coding behavioral measures, and entering data for me. This project would not have been possible without their help.

Lastly, I would like to thank my husband extraordinaire, Dr. Maximilian Jones for his endless support in all aspects of my life, for believing that I can achieve anything that I put my mind to, and for always pushing me to improve. The love and light he brings to my life makes me a better person, just for having met him.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Recent research has suggested a new avenue to improve cognitive functioning, namely physical activity (Alexander, Allen, & Bindoff, 2013; Chaddock-heyman, Hillman, Cohen, & Kramer, 2014; Chaddock et al., 2012; Etnier & Chang, 2009; Kamijo & Takeda, 2010). Indeed, physical activity has proven to be a catalyst for myriad positive outcomes in human development (Centers for Disease Control, 2014). The most documented effects are those involving improvements in physical health; these include improvements in cardiovascular functioning, diabetic and stroke risk reduction, improved muscle and bone strength, as well as an increased life span (Centers for Disease Control, 2014). However, psychological research has begun investigating the effects of physical activity on mental functioning and well-being as well. This area of research has led to interesting findings such as its ability to alleviate symptoms of depression, improve self-concept and social skills, reduce anxiety symptoms as well as stress responses; and there is also some evidence that physical activity may prove to be beneficial in alcohol and substance abuse treatments (Taylor, Sallis, & Needle 1985).

More recently, physical activity, both acute and chronic, has also been shown to improve executive function (Best, 2010). Executive function refers to higher order cognitive processes including attention, memory, and goal-directed behaviors that develop through childhood and into adolescence (Carlson, 2005). In fact, Lezak (1983) conceptualized executive function as being essential for effective, appropriate, and socially acceptable adult behavior. Research on the effects of physical activity on executive function has predominantly focused on two age groups: on adolescent populations as an intervention to promote academic success (Kamijo & Takeda, 2010), and on geriatric populations as prevention therapy for Alzheimer's and dementia

(Carlson et al., 2008). However, little research investigating the effects of physical activity on executive functioning in early childhood exists.

Surprisingly, the limited research on this latter topic has actually shown a negative relationship between executive function and physical activity level (Rothbart, 2001), suggesting that high activity levels in children are actually predictive of lower scores on executive function measures. Taken at face value, these findings may seem to contradict results found in adolescent and adult populations; however, the relationship between executive function and physical activity may not be linked directly, but may be influenced by outside factors.

The purpose of the present investigation was to explore these diverging results by investigating a possible moderator of the relationship between physical activity and executive function in early childhood; namely maternal encouragement of activity. It stands to reason that maternal encouragement of physical activity should not only increase children's physical activity level, but should improve the type and intensity of activity most relevant for improving executive functioning in children. Maternal encouragement may serve to keep children on task while playing, encourage their interest in activity, enhance their intrinsic motivation for activity, and inspire cognitively engaging physical activity and play. By investigating maternal encouragement of physical activity, I hope to offer a better understanding of the relationships found between physical activity and executive function in early childhood populations, as well as add to the limited literature concerning these topics.

In the following sections I will first introduce the construct of executive function, and describe its components with special attention paid to behavioral inhibition, attention, and working memory. I will review briefly how executive function contributes to cognitive growth, its stability across the lifespan, and discuss measurement issues in early childhood populations. I will then report on the literature that has investigated the relationships between physical activity and executive function in adolescent and geriatric populations, and discuss theorized explanations for these relationships. Next, I will consider the contrasting relationships found in early childhood populations, as well as theorized accounts of these results. Following, I will introduce maternal encouragement of physical activity as a possible moderator of the relationship between physical activity and executive function in early childhood populations, provide evidence for this hypothesized moderation, and describe specific mechanisms by which I theorize maternal encouragement may impact the types and intensities of children's physical activity. Finally, I will conclude with specific hypotheses about the nature of the relationships among these three variables: physical activity, executive function, and maternal encouragement of activity.

Executive Function

One of the first definitions of executive function was contributed by Baddeley and Hitch (1974), who described a "central executive" as comprising four components: goal formation, planning, goal directed behaviors, and effective performance. Since then, executive function has become a popular area of research in developmental psychology (Gartstein, Bridgett, Panksepp, & Power, 2013; Groppe & Elsner, 2015), neuropsychology (Juardo & Rosselli, 2007), and social psychology (Baumeister & Vohs, 2003), among others. With this increase in interest, the definition of executive function has become much broader, and the definition often varies between researchers. For the purposes of the present investigation, I will use *executive function* as an umbrella term comprising higher order cognitive processes that support the monitoring and control of thoughts and actions (Carlson, 2005).

Within the category of "higher order cognitive processes," executive function researchers have postulated a multitude of specific, observable skills. The complete list of executive function components is beyond the scope of this review; however, typical component abilities include attentional control, working memory, behavioral inhibition, self-regulation, emotional regulation, planning, and goal directed behaviors (Suchy, 2009). Although all components of executive function play unique roles in cognitive growth, for the purposes of brevity I will focus on three core components: behavioral inhibition, working memory, and attentional control.

Behavioral inhibition refers to a person's ability to consciously curtail a dominant behavioral response or desire when such behaviors or desires are not appropriate or when they may impede goal attainment (Wolfe & Bell, 2004). Take, for example, a child who is eager to learn in a classroom. Now imagine everything else that is usually found in a classroom, colorful posters, books, toys, and other children. For a young child, if given the choice between listening to the teacher or playing with toys, many children would prefer the toys; however, playing with toys interferes with the ultimate goal of learning new material. Therefore, for the optimum learning experience the child must inhibit his or her natural desire to play with the toys in order to learn from the teacher.

Working memory describes a cognitive system that is able to store, retrieve, and maintain information necessary for higher order cognitive tasks (Baddeley, 1992). Again, reflecting on the child in the classroom and his ultimate goal of academic success, we must think about everything the child must commit to memory to achieve this goal. The child must first remember the rules of the classroom as well as consequences for breaking the rules, as breaking a rule may result in removal from the classroom area and the obstruction of goal attainment. The child must also recall into working memory the content of previous lectures given by the teacher in order to properly complete assignments and homework. Incomplete or incorrect assignment submissions may reflect poor academic success and ultimately goal failure.

Lastly, attentional control refers to a person's ability to direct and maintain attention to goal-relevant stimuli (Putnam, Gerstein, & Rothbart, 2006). In fact, attentional control has been described as a necessary foundation on which all other elements of executive function develop (Cuevas et al., 2012). Indeed, looking back to the previous two examples of the child in the classroom one can see how attentional control comes into play. Within the first example describing behavioral inhibition, the child had to inhibit acting on his or her desire to play with toys, and the child in the second example needed to rely on working memory to maintain the rules of classroom decorum. Both responses were necessary in order to effectively attain the ultimate goal of learning. However, it could be theorized that neither response would be possible without attentional control. Attentional control would be necessary to switch attentional resources away from the toys and onto the teacher or activity; in addition, attentional control would be imperative for working memory, because without attending to classroom rules, there would be no rules available in working memory to restrict predominant behaviors.

Jurado and Rosselli (2007) characterized executive function as being essential for success in everyday life, including work and school. It enables us to plan, initiate, and complete objectives, adapt to changing environments, and inhibit inappropriate behaviors or responses. Indeed, executive function measured at age four has predicted school preparedness in terms of post-kindergarten social, reading, and mathematical skills (Kraybill & Bell, 2013; Welsh, Nix, Blair, Bierman, & Nelson, 2010). In addition, executive function has been associated with language development and language use (Ye & Zhou, 2009), and healthy eating styles in children aged 6-11 years (Groppe & Elsner, 2014).

Executive Function and Physical Activity

Recently, researchers have begun investigating the effects of physical activity on executive function in adolescence and adulthood. One of the first definitions of executive function in the physical activity literature was provided by Kramer et al. (1994), who defined it as consisting of planning and task coordination, the initiation and termination of behaviors, and word processing. Since that time, executive function definitions in the adolescent and adult physical activity literature have been modified slightly, and are now typically described as consisting of working memory, planning, scheduling, and inhibition (Etnier & Chang, 2009); which largely parallels definitions employed in the childhood literature. Experimental investigations into the activity level-executive function relationship in adulthood have thus far produced positive associations, with moderate to vigorous physical activity improving executive function abilities (Kamijo & Takeda, 2010). Such investigations have found improvements in multiple components of executive function, using both acute and chronic physical activity regimens (Best, 2010).

Some of the most notable improvements found in executive function after physical activity have involved improvements in behavioral inhibition, working memory, and attention (Best, 2010). For example, Kamijo and Takeda (2010) found that adolescents who regularly participated in physical activities performed significantly better on a task switching paradigm task than did a sedentary group. Improvements in the task switching paradigm are indicative of executive function improvements because the task involves working memory to remember the rules of the task, behavioral inhibition to halt the pre-switch dominant response, and attending to when the rules of engagement have changed. Moreover, the researchers also reviewed participant's P3 event-related brain potentials (ERPs) and found that the sedentary group showed significantly smaller P3 ERP amplitudes during the task switching paradigm compared to an unchanging task, while no differences in amplitudes were found in the active group (Kamijo & Takeda, 2010). Because P3 ERP amplitudes are associated with working memory (Linden, 2005), these findings suggest that the sedentary group had fewer executive function resources to allocate to working memory demands during the task switching paradigm; while the active group was better able to appropriate attentional resources, demonstrating a more efficient executive function system.

In a study investigating the effects of acute physical activity regimens on executive function in a group of overweight preadolescents, Davis et al. (2007) found that longer exposure to a running program (e.g., 0 minutes, 20 minutes, 40 minutes) resulted in higher scores on the Cognitive Assessment System (Naglieri & Das, 1997). Interestingly enough, the aerobic training resulted in improvements only on tasks that involved executive function, such as attention and working memory tasks; and not other cognitive measures, such as spatial reasoning and sentence comprehension. Thus, physical activity may not be profitable to all mental processes, and may solely act on executive function abilities.

The existing literature also suggests that not all types of physical activity are equally beneficial. Recent research has alluded to the possibility that cognitively engaging physical activity may engender additional profit (Best, 2010). Evidence of this effect was reported by Budde et al. (2008) wherein adolescents participated in either a ten-minute non-coordinative exercise or a ten-minute exercise requiring skilled coordination. Participants who were in the skilled coordination group performed significantly better on executive function measures for attention and behavioral inhibition. Further corroboration for this effect can be seen in a study by Pesce et al. (2009) wherein preadolescent participants engaged in both a one-hour individual exercise session as well as a one-hour group exercise session. Participants were tested after each session on both an immediate word recall measure as well as a delayed word recall measure. Results showed that immediate word recall improved only after group exercise, suggesting that group exercise may be more cognitively engaging than individual physical activity.

The enhanced results of cognitively engaging activities has face validity. Consider, for example, a young girl playing softball with her little league team compared to the same girl running circles in her back yard using the same amount of physical energy. Assume both activities are equally strenuous on the musculoskeletal system. Imagine, however, that during the softball game the young girl, while physically engaged, is also using mental resources to maintain attention along multiple dimensions, including focusing on the specifics of the game situation, what her teammates think of her, and whether or not the first-base runner is going to try to steal second. Additionally, she is having to use working memory to recall her coach's instructions for particular situations, and having to inhibit looking at her parents in the stands to maximize performance. In this sense, cognitively engaging play emerges as a true full body work-out, which includes the exercise of components of executive function as well.

Despite the growing body of evidence supporting the possibility that physical activity promotes executive function, researchers are still unsure of the specific mechanisms by which this relationship may function. However, some have been postulated. The most heavily researched involves the physiological changes physical activity imposes on the body (Best, 2010; Chaddock-heyman et al., 2014). In particular, evidence suggests that physical activity engenders changes in the prefrontal brain regions involved in executive function, through the up-regulation of several growth factors which promote the growth and development of new neurons, synaptic transmission, and synaptic plasticity (Best, 2010). Yet this model alone does not account for the enhanced effects of cognitive engagement during physical activity.

Because executive functions are only involved in conscious cognitive efforts, and not in automated or unconscious cognitions, researchers have also hypothesized that executive function skills may be strengthened through repeated use (Best, 2010). Cognitively engaging physical activities may serve to streamline some elements of executive function by making processes such as attention-shifting and inhibition easier to employ, in turn, requiring less attentional demand during daily life activities (Suchy, 2009). This possibility, in collaboration with the idea that cognitively engaging physical activity activates brain regions involved in executive function, may serve to promote synaptic and neural growth in those specific areas (Suchy, 2009).

Of particular interest in the present investigation is the link between physical activity and executive function in early childhood. Literature in this area is scarce, and the little that exists surprisingly does not report the same relationships as those found in adolescent and adult populations. For example, in a factor analysis of temperament measures using the Early Childhood Behavior Questionnaire, Rothbart (2001) reported that activity level was negatively correlated with measures of "effortful control" (a common indicant of executive function), implying that children who are more active tend to have lower executive function scores. The source of the apparent divergence in findings is unknown, but a few possible explanations come to mind.

As was discussed earlier, early childhood represents a peak time for the development of executive functioning. To study executive functions in early childhood, measures used in adolescents or adult populations may need to be simplified to reflect the performance abilities of the age group, and task instructions need to be easily explained and understood by younger children. In addition, as executive function comprises a myriad of components, studies that evaluate executive function ability do not always focus on the same components or use the same measures for similar components, which can make comparisons between studies difficult. Also, Rothbart's (2001) factor analysis used only maternally-reported measures of activity level which may not distinguish between cognitively engaging physical activity and simple motor activity levels. Lastly, there could be a third variable acting on this relationship, which, if identified, may expose a positive correlation like those found in older populations. The current study will investigate this latter possibility by examining the effects of maternal encouragement of activity on the relationship between physical activity and executive function.

Maternal Encouragement of Activity

Bandura's (1986) social cognitive theory provides support for the assumption that social variables such as maternal encouragement may play an important role in maternal influences concerning physical activity. Maternal encouragement of physical activity can be defined as the training of beliefs and skills that model healthful attitudes and behaviors associated with engaging in physical activity (Edwardson & Gorely, 2010). Maternal encouragement of physical activity has been shown to be positively related to overall physical activity level in children aged 6-11 years (Edwardson & Gorely, 2010; Guftafson & Rhodes, 2006), leisure time physical activity in children aged 6-11 years (Edwardson & Gorely, 2010), and intrinsic motivation for physical activity in children aged 9-12 years (Woogler & Power, 2000). These associations could be achieved through a multitude of avenues including modeling and social provision of support. In a systematic review of maternal correlates of physical activity, Gustafson and Rhodes (2006) identified the most important forms of maternal support for physical activity as encouragement, involvement, and facilitation.

Encouragement of physical activity can be a strong catalyst to embolden a physically active lifestyle in young children (Edwardson & Gorely, 2010). Encouragement, however, should not be confused with directiveness, which would be defined as a direct command to do something. Indeed, evidence has shown that maternal directives may decrease initiative (Lloyd & Masur, 2014) and intrinsic motivation (Woogler & Power, 2000). Thus, commands may not be the most productive way to encourage a behavior. Mothers may have a greater impact by using tactics such as praise for hard work, or re-directives to re-engage children who fall off task while playing.

Maternal involvement in physical activity can include both verbal and physical interaction during physical activities. A mother may, for example, simply ask questions about a certain activity such as, "What are the rules of your game?" or "Where does the ball need to go?" Questions may help to encourage more cognitively engaging physical activity by having the child reflect on specific aspects of the activity. A mother may also physically engage in the activity with the child by kicking a ball back and forth, or competing with the child in a game of soccer. These interactions may help to model an optimal form of the activity and introduce a standard or goal of physical fitness for the child, while also providing social support for play that the child may not receive exercising alone.

Lastly, facilitation of activity level, as defined in Gustafson's (2006) review, consists of actions taken by parents to remove obstacles to physical activity. In older populations, facilitation may involve driving a child to an organized basketball game, or paying for karate lessons. For the purposes of the present investigation, facilitation will consist of scaffolding behaviors performed by the mother. Facilitation may involve offering instructions on how to play a certain game, labeling certain toys and describing their characteristics, as well as explaining how certain toys or tools function in a particular activity. These kinds of supportive behaviors should encourage not only a predilection for activity, but may also serve as a foundation for promoting interest in learning and exploring new avenues for physical activity. In sum, these maternal tactics for encouraging physical activity should help to moderate the relationship of physical activity and executive function by separating out those children who are encouraged to participate in cognitively engaging physical activity, from those that who only engage in simple motor movements.

Current Study

The specific aim of the current investigation was to explore the potentially moderating effect of maternal encouragement of physical activity on the relationship between actual physical activity and executive function in early childhood. A significant moderating effect of this kind may help explain the otherwise contradictory relationships between executive function and physical activity observed in young children vis-à-vis those observed in older populations. Based on the literature reviewed above, I propose the following overarching hypothesis, which subsumes two subordinate corollary hypotheses:

- H1: Because cognitively engaging physical activity seems to produce the greatest effect on executive function, a positive relationship between physical activity and executive function abilities will emerge among children with high maternal encouragement of activity.
- H1a: Because mother-reported, observational, and sociocognitive measures of physical activity are presumed to be different indices of the same measure, I anticipate that they will be correlated, and therefore, can be combined into one composite measure of physical activity.

- H1b: Because self-reported authoritative parenting style is characterized by high support and control, it should be positively correlated with observed maternal encouragement of physical activity, and the two can be combined into a single composite measure. In addition, the various component measures of observed maternal encouragement should also be intercorrelated.

CHAPTER 2

METHODS

Participants

Data used in the present investigation were derived from an archival data set from the Program for the Study of Infancy at East Tennessee State University. Fifty-six 18-month-olds participated in the initial one-time laboratory visit, which lasted approximately 65 minutes. Fifty-six of the original children (26 boys) contributed at least some data that could be used in the present investigation. Children's ages ranged from 17.55 months to 18.87 months (M = 18.3 months, SD = 0.43 months); however, additional demographic information such as race, income, and family education were not available. Participants were selected through birth announcements in the local newspaper, and then contacted by mail or phone wherein the details of the study and requirements for participation were described. Parents who agreed to participate were sent a packet containing two surveys (described below) which were completed and returned to the laboratory at the time of their visit. Upon arrival at the laboratory, experimenters verbally briefed parents to provide for informed consent, and answered any questions parents had regarding the laboratory visit. Child participants were compensated with a toy valued at approximately $10 at the end of their laboratory visit.

Materials and Tasks

As part of the broader study, infants participated in multiple behavioral tasks for the duration of their visit, which concluded with a five-minute mother-child free play period followed by a ten-minute child-only free play period. Observational measures relevant to the present investigation were derived through video recordings of both the mother-child, and child-only free play periods. Measurements of the mother-child free play period were coded using a modified version of the Dyadic Parent Child Interaction Coding System (DPICS; Eyberg, Nelson, Duke, & Boggs, 2005), while child-only free play was coded using both a modified version of Tamis-LeMonda and Bornstein's play competence scale (1990) and a modified version of the Observational System for Recording Physical Activity in Children - Preschool version (OSRAC-P; Brown et al., 2006).

Surveys relevant to the present investigation included the Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006) and the Parental Authority Questionnaire (PAQ; Buri, 1991), which assessed mother-reported effortful control and activity level, and parenting styles, respectively.

Observational Measures

Maternal Encouragement of Physical Activity. The DPICS is a coding system for measuring the quality of interpersonal relations between a parent and child, and incorporates a coding rubric for characterizing parent and child play initiations and responses. However, for the purposes of the present investigation, the DPICS was used solely for measuring maternal communication or involvement that pertained to physical activity. In an effort to address the three most influential factors to physical activity found by Gustafson and Rhodes (2006), observed maternal behaviors were grouped into three measures reflecting encouragement, involvement, and facilitation.

Encouragement. Maternal-encouragement was coded using the DPICS guidelines for scoring commands and praise, alongside an additional coding scheme for scoring redirections. These measures were chosen as representative of encouragement, because each either encourages movement or action, or reinforces play behaviors. To this end, a command was defined as a statement which directed the behavior of the child. Commands could be direct or indirect in nature. Direct commands included declarative statements that contained an order or direction for a behavior to be performed, as well as an indication that the child should perform this behavior. Indirect commands included suggestions for a behavior to be performed, which could be implied or in question form. Redirections were also coded for the purposes of the present investigation, and were defined as including statements or suggestions that redirected children's attention back to a task or action.

As defined by the DPICS, praise included expressions of support toward a child's behavior, attributes, or a product of the child; and could be either labeled or unlabeled. Labeled praise targeted a specific behavior, or product of a child; while unlabeled praise targeted an unspecified behavior, or product of a child.

Commands and praise were coded on a four and three-point scale, respectively. Because direct commands presumably *decreased* initiative and internal motivation, they were negatively scored; otherwise, all other commands and praise components were scored based on the amount of elaboration used by the mother. Therefore, the command scale consisted of direct commands (-1), no command (0), indirect commands (1), and redirections (2). The praise scale consisted of no praise (0), unlabeled praise (1), and labeled praise (2), with scores based on the amount of elaboration required, with more points awarded to higher amounts of elaboration.

Involvement. Verbal involvement was coded using the DPICS guidelines for Questions, as asking questions regarding physical activities shows cognitive involvement and inspires cognitive engagement within the activity. Questions, as defined by the DPICS, included maternal inquiries demarcated by a rising inflection, or by having the grammatical structure of a question. Questions were also broken into two subgroups: descriptive/reflective questions and information questions. Descriptive/reflective questions included those which could be answered with a brief "yes/no" response; while information questions requested specific information from the child beyond a brief "yes/no" answer. The questions scoring scale consisted of no questions (0), descriptive/reflective questions (1), and information questions (2).

Level of physical involvement was included in the involvement measure, as a mother's involvement may serve to model appropriate play behaviors, or increase a child's engagement in the play activity. Physical Involvement, as defined for the present study, included any physical involvement in play activities that were cooperative with the type of play the child was already involved in. Thus, physical involvement did not include maternal engagements meant to change or guide children's activities. Level of physical involvement was coded using coder judgments of recorded interactions between mother and child, and were scored as either high, medium, low, or no physical involvement. Physical involvement was scored as follows: no involvement (0), low involvement (1), medium/average involvement (2), and high involvement (3).

Facilitation. Facilitation was measured using the DPICS guidelines for talk/descriptions and touching, in addition to coder judgments of scaffolding behaviors. Talk/descriptions included neutral talk, behavioral descriptions, and play talk; and were chosen as a facilitative measure, because by describing specifics of toys or activities, mothers help their children develop an understanding of the toys around them as well as how to utilize them in play behaviors. Neutral talk, as defined by the DPICS, included statements that introduced information, but did not reference a child's behavior. Behavioral descriptions referred to non-evaluative statements which included a verb describing a child's previous or continuing behavior. Lastly, play talk included verbalizations that were not direct communications from the mother to the child, but that comprises pretend verbalizations from characters or toys to the child. The talk/description scoring scale was comprised of no talking (0), neutral talk (1), behavioral descriptions (2), and play talk (3).

Touching, as described by the DPICS, included intentional physical contact from the mother to the child; and included two categories, positive and negative. Touches were included in the facilitative measure as through touching, a mother may guide a child towards appropriate uses of toys or play behaviors. Positive touches were defined as those eliciting positive responses from the child (e.g., smiling, laughing, or a continuance of play); while negative touches elicited a negative reaction from a child (e.g., crying, a discontinuance of play, or a retreat from the parent). Touching was scored as negative touch (-1), no touch (0), and positive touch (1).

Finally, scaffolding behaviors were measured using coder judgments, and were defined as any physical contact from the mother toward the child that facilitated new or ongoing activities. Scaffolding was included as a facilitative measure because through scaffolding behaviors, a mother may make not only play behaviors easier, but also sociocognitive engagement easier as well. An example of a scaffolding behavior would be a mother moving a toy to where the correct side was facing a child, or bringing a complementary toy closer to a child such as adding a tea cup to an ongoing bout of play involving eating. Scaffolding was scored as either no scaffolding behaviors (0) or scaffolding behaviors (1).

Each observational measure described above was coded during each of 30 ten-second epochs. If multiple scores were achieved on one measurement during an epoch, the highest score achieved was recorded. Total scores for each observational measure were derived by summing the individual measurement scores across all epochs. Examples of several common maternal utterances for each maternal encouragement dimension can be found in Table 1.

Table 1

Common Maternal Utterances for Maternal Encouragement Dimensions

Maternal Praise	Unlabeled Praise	"Good Job!" "Very Good!" "Perfect!" "Yay!"
	Labeled Praise	"Good Job putting the circle in the bucket!" "You're doing a great job stirring!" "You're a good cook!" "Good Job putting the baby to sleep!"
Maternal Commands	Direct Command	"Look" "Come here" "Sit Down" "Bring me the star"
	Indirect Command	"Do you want to read the book with me?" "Do you want to cook?" "Can you bring me the square?" "Can you go sit and play?"
Maternal Talking	Neutral Talk	"The pot is beside you" "This bear is soft" "This is a puzzle" "The baby is sleeping"
	Behavioral Descriptions	"You put the circle in the hole!" "You did it!" "You wrecked the cars!"
	Play Talk	"Hello, yes, (the child) is here" (talking on play phone) "Ring Ring…" (play phone ringing) Smacking lips after taking a bite of play food "Quack Quack!" (making sound of duck in child's book
Maternal Questions	Descriptive/Reflective Question	"Is that a star?" "Are you feeding big bird?" "Are you cooking?" "Are you reading the book?"
	Information Question	"What are you cooking?" "Where does the star go?" "What is that?" "Where are big bird's eyes at?"

Child Activity Level. As an observational assessment of children's physical activity intensity, child-only free play was scored using a modified version of the OSRAC-P. The OSRAC-P is a time sampling observational coding system which relies on coder judgments, and which has shown inter-rater reliability of $\kappa = 0.80$. Guidelines for the OSRAC-P recommend that behaviors be sampled in 30 second epochs; however, for the purpose of even epochs across measurements, ten second coding intervals across five minutes were used in the present investigation. The child-only free play period was coded for activity intensity, as well as sociocognitive engagement.

Intensity. Based on OSRAC-P guidelines, five levels of activity intensity were scored: stationary or motionless, stationary with limb or trunk movements, slow easy movements, moderate movements, and fast movements. *Stationary or motionless activity level* was characterized by no movement of limbs or major joints, and included standing, sleeping, or sitting passively. *Stationary with limb or trunk movements* referred to low intensity movements of limbs or trunk without locomotion, and could include standing up, holding an object, or hanging off of a surface. *Slow easy movements* referred to locomotion at a slow and easy pace, and could include walking with both feet or crawling. *Moderate movements* referred to locomotion while moving arms or holding an object, and could include two repetitions of skipping or jumping, or hanging from a surface while swinging legs. Lastly, *fast movements* referred to locomotion at a fast pace, and could include running, or three or more repetitions of skipping or jumping, or flipping or rolling on the floor. Scores on the activity intensity scale ranged from zero to four and were comprised of stationary or motionless (0), stationary with trunk or leg movement (1), slow easy movements (2), moderate movements (3), and fast movements (4).

Sociocognitive Engagement. The presence or absence of sociocognitive engagement of activity was measured using a modified version of Tamis-LeMonda and Bornstein's (1990) play competence scale. Although children's performance on the scale essentially represents a dichotomy, in the interest of comprehensiveness I describe each of the nine play levels indexed by the scale: simple manipulation, functional manipulation, relational inappropriate, relational functional, pretend self, pretend other, substitution, sequenced pretend, and sequenced pretend with substitution, will be described.

Simple Manipulation described any visually guided exploratory manipulations during play, such as a child picking up a toy block to examine its properties. *Functional Manipulation* described visually guided manipulations which were "appropriate" for the objects being explored, such as a child exploring a toy car by pushing it across the floor. *Relational Inappropriate play* referred to play wherein a child brought together and integrated two or more objects in a novel way, such as placing a stuffed animal in a cooking pot. *Relational functional* play, on the other hand, referred to play wherein a child brought together two or more toys in a way they were intended; for example, placing a spoon in a cooking pot. *Pretend Self* described any pretend play directed toward the self, such as bringing a cup to the mouth and pretending to drink or sip; while *Pretend Other* described any pretend behavior directed away from the self, such as tucking a baby doll in covers and laying them down to sleep. *Substitution* referred to play acts wherein a child used one object to symbolize an object of a different type; such as stacking blocks in a cooking pot and then stirring them as if they were food. *Sequenced Pretend* described play scenarios wherein the child repeated a single pretense act with minor variations. For example, a child may have sipped from a toy cup, and then had a baby doll sip from it as well. Lastly, *Sequenced Pretend with Substitution* referred to play scenarios wherein a child engaged in sequenced pretend play while also using substitution. An example would be placing toy blocks in a saucepan, stirring them with a spoon, and then using the spoon to "taste" the food.

As discussed above, I was only interested in identifying when infants engaged in sociocognitive activity. Accordingly, I defined instances of sociocognitive activity as comprising instances of relational functional play or higher. Simple manipulation, functional manipulation, and relational inappropriate play were considered to reflect no sociocognitive engagement. Thus, scores on the final sociocognitive engagement scale ranged from zero to one and reflected either the absence of sociocognitive engagement (0) or the presence of sociocognitive engagement (1), during each 10-second epoch. Final scores were derived by summing the total number of sociocognitive engagements across.

<u>Reliability.</u> Inter-rater reliability for three of the nine observational measure was ensured by using teams of two human judges to score behavioral measures. In each case, team members scored ten percent (N = 6) of video recordings until interrater reliability of 80% or higher was achieved for each measure. After reliability was achieved, each team member coded about half of the remaining videos. Upon coding completion, an additional six videos were randomly chosen and assessed for post-scoring interrater reliability, to ensure coders remained reliable throughout the coding process. The three measures that were coded using independent judges included commands, praise, and sociocognitive aspects of play. Interrater reliability for these measures, defined as number of agreements divided by number of agreements plus disagreements, can be found in Table 2.

For the remaining six observational measures, interrater reliability was unable to be achieved. These measures included questions, talking, touching, scaffolding, maternal physical involvement, and child activity intensity. For the most part, failure to achieve inter-rater reliability on these measures was due to poor audio and video quality, including insufficient audio volume and suboptimal camera angles. But individual judges also often made discordant assumptions of intentionality without supporting evidence in the form of explicit behaviors or utterances. In these instances, judges were instructed to code collaboratively and to code only instances wherein the mother explicitly performed an action or was specific in her utterances in a manner that was loud enough to distinguish, or could be confirmed by context within the video. Any intercoder disagreements were resolved through discussion.

Table 2

Reliability of Coded Measures

Coded Measures	Pre Reliability Score	Post Reliability Score
Praise	0.94	0.95
Commands	0.80	0.80
Sociocognitive Engagement	0.84	0.95

Maternal Report Measures

ECBQ: Child Executive Function and Child Activity Level. In the Early Childhood Behavior Questionnaire (Putnam et al., 2006), parents were asked to reflect on their children's behavior over the previous two weeks and to rate their children on a scale from one (never) to seven (always) on 201 items characterizing their children's daily activities. The ECBQ is comprised of 18 subscales, reflecting three overarching superdimensions: surgency, negative affectivity, and effortful control. The two ECBQ dimensions of relevance for the present investigation included the activity level subdimension, and the effortful control superdimension. Putnam et al. reported Cronbach's alphas for activity level in the .66 to .71 range. Cronbach's alpha for activity level in the present study was 0.74.

The effortful control superdimension is calculated by averaging six subdimensions: attentional focusing, attentional shifting, low-intensity pleasure, inhibitory control, cuddliness, and perceptual sensitivity. Putnam et al. (2006) reported alpha levels ranging from 0.81 to 0.86 for these six subdimensions. Alpha levels for these dimensions in the present study were also acceptable (ranges from .75 to .90), with the exception of attention shifting ($\alpha = 0.24$).

Accordingly, the subdimension of attention shifting was not included in the composite measure of effortful control.

Because the ECBQ provides a parent-reported index of activity level in addition to my observational intensity and sociocognitive indices, it was possible to create a composite measure of activity level that included both state (intensity and sociocognitive) and trait (parent-reported) levels of measurement.

PAQ: Maternal Encouragement. The Parental Authority Questionnaire (Buri, 1991) is a self-report survey used to measure Baumrind's (1971) authoritarian, authoritative, and permissive parenting styles. The PAQ consists of thirty questions, ten per style, reflecting an individual parent's self-appraisal of his or her employment of support and authority in the parent-child dyad. Because by definition different parenting styles reflect differing levels of parental encouragement, parenting styles were conceptualized in the present investigation as reflecting differences in the provision of maternal encouragement of activity level. Thus, mothers' scores on the authoritative parenting dimension served as a proxy measure of self-reported maternal encouragement. Permissive and authoritarian parenting styles, for the purposes of the present investigation, were conceptualized as non-encouraging due to the low amounts of control associated with permissive styles and the low encouragement of independent action associated with authoritarian styles; therefore, these measures were not included in my analyses. The PAQ has shown test-retest reliabilities ranging from 0.77 to 0.92, as well as internal consistency, with Cronbach's alphas ranging from 0.74 to 0.87 (Buri, 1991). In the present study, Cronbach's alpha for authoritative parenting was 0.66.

CHAPTER 3

RESULTS

Descriptive Statistics

Fifty-six parents from the original sample completed surveys used in the present investigation (i.e., the ECBQ and the PAQ). Mean scores were calculated for activity level (M = 6.50, SD = 0.73), effortful control (M = 4.17, SD = 0.49), and authoritative parenting (M = 4.13 SD = 0.38) parenting styles.

However, some missing data resulted when scoring the observational measures. As referenced above, there were many instances wherein children or mothers were not in view of the camera, when behaviors or speech could not be determined due to microphone volume or camera angles, when experimenters ended play sessions prematurely, or when video recordings were missing altogether. A complete list of descriptives and related sample sizes for observed measures can be found in Table 3.

Table 3

Descriptive Statistics: Observed Measures

	N	Minimum	Maximum	Mean	Std. Deviation
Commands	33	-15.00	6.00	-0.64	5.52
Praise	45	.00	10.00	2.42	2.73
Talking	36	8.00	45.00	20.94	9.07
Touching	30	.00	30.00	4.53	7.36
Scaffolding	41	1.00	21.00	10.78	4.88
Questions	36	6.00	53.00	21.64	11.81
Maternal Physical Involvement	39	8.00	46.00	28.23	10.08
Sociocognitive Aspects of Play	27	.00	27.00	9.22	7.39
Child Activity Level	25	30.00	77.00	44.24	14.51

Data Management

The overarching hypothesis for the present investigation was that the relationship between child activity level and executive function would be moderated by maternal encouragement of physical activity. Specifically, I expected to observe a positive relationship between physical activity and executive function abilities among children with high maternal encouragement of physical activity. However, this hypothesis was founded on two assumptions: that observed activity (intensity and sociocognitive indices) and mother-reported activity level would be correlated, and therefore could be combined into a composite measure of activity level (Hypothesis H1a); and that authoritative parenting would be correlated with observed measures of maternal encouragement, the latter of which would also be intercorrelated, and so could be combined to form a composite measure of maternal encouragement (Hypothesis H1b). Absent the ability to form composite measures, moderation analyses would have to be conducted separately for each component measure.

Thus, in order to test my overarching hypothesis as proposed, it was first necessary to validate the subordinate hypotheses (i.e., the assumptions). To test H1a, I conducted a Pearson product-moment correlational analysis between intensity of child play, sociocognitive play, and mother-reported activity level. Results indicated that there were no significant correlation among these measures, which suggests that the three may not be indices of the same measure. Because these measures were not significantly correlated, they were not combined, and subsequent analyses tested separately the relations of each physical activity measure with executive function.

Next, to partially address H1b, that observed maternal encouragement measures would be associated with one another, we first evaluated whether components of each index of maternal encouragement were interrelated. To evaluate encouragement, a bivariate correlational analysis between commands and praise was conducted. This correlation yielded non-significant results. Therefore, subsequent moderation analyses tested the relationship between physical activity and executive function separately for commands and praise. Next, to test involvement, a bivariate correlation between questions and maternal physical involvement, was computed. These correlations were also non-significant; therefore, subsequent moderation analyses were computed separately for each of these two measures. Lastly, to evaluate facilitation, a bivariate correlation was conducted between talking, touching, and scaffolding. Relationships between these measures were non-significant as well, and further analyses tested the relationship between physical activity and executive function separately for each of these measures.

Despite these null findings, I did find there were significant correlations between scaffolding, questions, and physical involvement (Table 4). Thus, these measures were combined to form a post-hoc composite score of maternal encouragement. Subsequent moderation analyses testing the relationship between physical activity and executive function, then, were conducted separately for each maternal encouragement variable as well as the post-hoc composite maternal encouragement variable.

Finally, and perhaps not surprisingly, none of the maternal encouragement measures were correlated with authoritative parenting style. Therefore, the self-reported measure of authoritative parenting style was used as an individual possible moderator to the relationship between physical activity and executive function.

Table 4

Correlations Among Maternal Encouragement Variables

	1	2	3	4	5	6	7
1 Commands	__						
2 Praise	.00	__					
3 Talking	.17	-.17	__				
4 Touching	.19	-.19	.10	__			
5 Scaffolding	.10	.30	.19	.14	__		
6 Questions	.11	.31	-.07	-.06	.38*	__	
7 Physical Involvement	-.20	.34*	.05	-.21	.68**	.16	__
8 Authoritative	-.08	.10	-.02	-.11	.22	.22	.31

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

Zero-Order Correlations between Activity Level and Executive Functioning

The next step was to explore whether data from the present investigation replicated previous findings, namely those reported by Rothbart (2001), in which activity level was found to negatively correlate with executive function. As shown in Table 5, Pearson correlations indeed revealed a significant, negative relationship between mother-reported activity level and executive function ($r = -.42$, $p < .01$). However, neither of the observed measures of child activity were correlated with executive function.

Table 5

Correlations Between Activity Level and Executive Function

	1	2	3	4
1 Mother-Reported Activity	__			
2 Sociocognitive Activity	.21	__		
3 Observed Activity	-.01	-.14	__	
4 Executive Function	-.42**	-.12	.28	__

Note: **$p < .01$

Moderation Analyses

Because measures of maternal encouragement of activity were not correlated with one another, and therefore could not be combined into composite scores, evaluation of my overarching hypothesis took place first through a series of regression analyses, conducted separately for each measure of maternal encouragement (N = 9) and each measure of activity level (3), for a total of 27 regression analyses. Because these moderation analyses were exploratory in nature, I did not control for the family-wise error rate so as not to avoid Type II errors (i.e., rejecting the null when the null is true).

Regressions were conducted with executive function simultaneously regressed on 1) the measure of child activity level, 2) the maternal encouragement measure, and 3) the activity x maternal encouragement interaction term (representing the moderation term). Results can be found in Table 6. Mother-reported activity level was significantly predictive of executive function when included in the regression equation with scaffolding, physical involvement, authoritative parenting styles, as well as the ad hoc composite maternal encouragement variable. However, no moderation terms reached statistical significance.

When evaluating regressions involving intensity of activity level, results revealed no significant main effects or moderation terms. However, regressions involving sociocognitive activity revealed a significant main effect of commands, as well as a significant moderation effect for maternal questions. This one significant moderation effect suggested that the more mothers used questions to encourage children's activity, the stronger the link between a child's executive function and physical activity was (see Figure 1). Unfortunately, given the large number of regression analyses that were conducted, this "significant" finding could represent a Type I error.

Table 6

Regressions of Executive Function onto Activity Level Controlling for Maternal Encouragement Variables

	Mother-Reported activity Level				Sociocognitive Activity Level			
Variable	B	SE	b	*df*	B	SE	b	*df*
Commands								
Activity	-.12	.10	-.23	30	.02	.01	.33	17
Maternal Encouragement	-.01	.01	-.17		-.03	.01	-.52*	
Moderation Term	.04	.02	2.80		.00	.00	.14	
Scaffolding								
Activity	-.19	.09	-.34*	38	-.01	.01	-.19	23
Maternal Encouragement	-.01	.01	-.11		.01	.02	.14	
Moderation Term	-.02	.02	-1.16		-.00	.00	-.24	
Questions								
Activity	-.16	.09	-.28	33	-.01	.01	-.22	19
Maternal Encouragement	.01	.01	.20		.01	.01	.36	
Moderation Term	.00	.01	.17		.00	.00	1.00*	
Physical Involvement								
Activity	-.21	.09	-.36*	36	.01	.01	-.14	22
Maternal Encouragement	.00	.01	.04		.00	.01	-.00	
Moderation Term	-.01	.00	-1.81		-.00	.00	-1.02	
Authoritative								
Activity	-.29	.08	-.43*	55	-.01	.01	-1.30	26
Maternal Encouragement	-.06	.16	-.05		-.20	.21	-.20	
Moderation Term	-.11	.23	-.77		.05	.05	3.87	
Composite Maternal Encouragement								
Activity	-.19	.09	-.34*	28	-.00	.01	-.06	18
Maternal Encouragement	.00	.01	.01		.00	.01	.12	
Moderation Term	-.02	.01	-1.54		.00	.00	.17	

Note: *$p < 0.05$

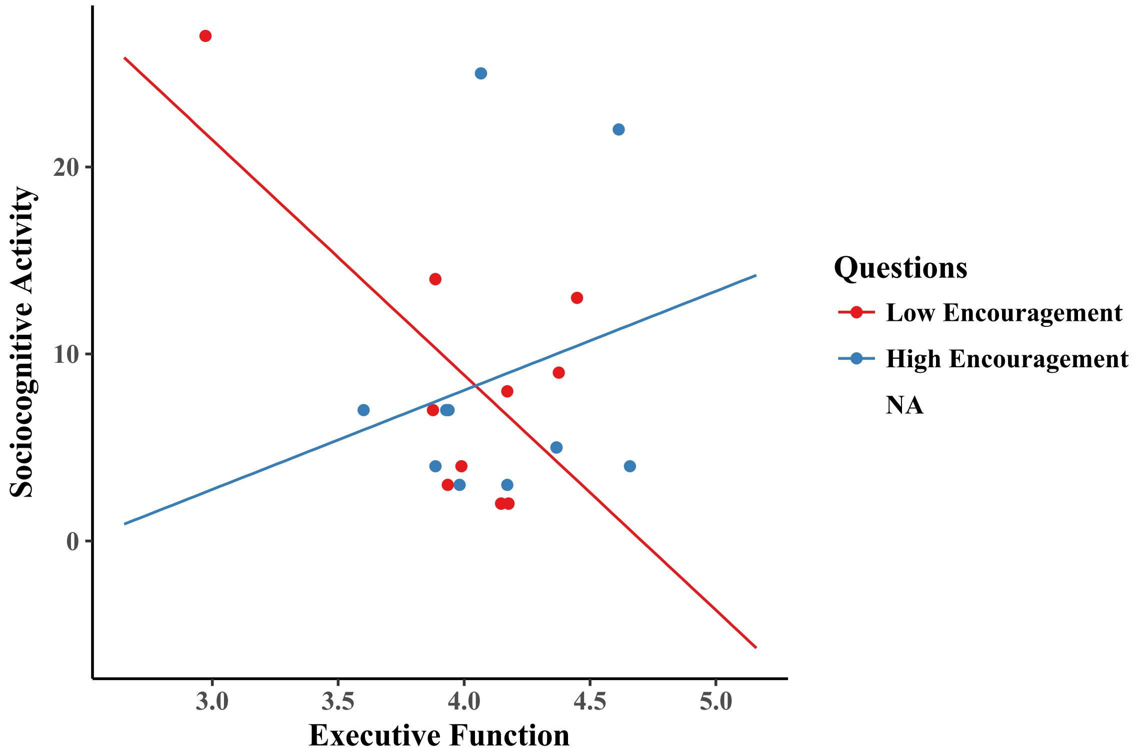

Figure 1: Scatter plot depicting the moderating effects of maternal questions on the relationship between sociocognitive activity level and executive function.

CHAPTER 4

DISCUSSION

The overarching goal of this study was to account for the apparently divergent findings which link activity level to executive function abilities differentially in children and adults. In this study I focused particularly on the potentially moderating role played by maternal encouragement of physical activity in very early childhood. I argued that this moderating effect might be able to explain the otherwise discrepant findings observed between the child and adult literatures (Rothbart, 2001). However, in the present sample, only one maternal encouragement measure, questions, played a moderating role linking children's activity level to their executive function. But even this finding was suspect given the likelihood of family-wise error.

It was surprising that the subordinate hypotheses failed to be confirmed. The failure to confirm H1a may reflect that the three activity measures addressed differing aspects of activity in infancy. For example, mother-reported activity level focused on activities such as tapping, blinking, fiddling, twitching, scratching and rocking motions while playing. In contrast, activity intensity was based on overall gross motor movements and their intensities (i.e., the amount of energy required for each motion), and sociocognitive activity measured a child's sociocognitive engagement during play. Therefore, a child who was high in maternal reported activity (e.g., rocking) may have been observed as low in activity intensity, because rocking on my observed scale was considered a low intensity activity. Indeed, the correlation between observed activity intensity and mother-reported activity levels, although non-significant, trended toward negative.

Further, differences between mother-reported and observed measures of activity level could be a product of differences in trait versus state activity levels. A child's trait, or typically occurring activity level, may differ depending on the context in which the child is participating.

Some children who are regularly high in activity level in the home context, for example, may decrease their activity level when in an unfamiliar, laboratory setting. Future researchers interested in the investigation of activity level in early childhood may benefit from a controlled experimental paradigm testing the effects of the laboratory setting on trait activity level; because it may be that the unfamiliar laboratory setting affects state activity level differentially for high versus low trait activity children.

With respect to my measure of sociocognitive activity, it could be that sociocognitively engaging play is not necessarily reflective of child activity. For children to display sociocognitive aspects of play, they must manipulate toys or objects in specific and oftentimes sequenced ways. For example, sequenced pretend play requires a child to repeat a pretend act with minor variations (e.g., drink from an empty cup, and then have a doll drink from the same cup). In our sample, sequenced pretend play was most often completed while the child was stationary; which makes sense since it would be difficult to complete this type of play while running or skipping around the room. Indeed, there was a nonsignificant, albeit negative trending correlation between sociocognitive play and activity intensity. Additionally, because mother-reported activity level focused on activities such as tapping, rocking, and blinking, it could be that this measure did not differentiate between gross motor movements and sociocognitive activity. Thus, the observed sociocognitive activity level and mother-reported activity level may not be measures of the same construct.

I also hypothesized (H1b) that an authoritative parenting style would be correlated with, and could therefore be combined with, observed measures of maternal encouragement that were themselves intercorrelated. In the current sample, however, intercorrelations between my maternal encouragement measures were not as expected. Although correlations were found between scaffolding, questions, and physical involvement, and these were combined to form a post hoc composite score of maternal encouragement, none of the observed measures of maternal encouragement or the composite maternal encouragement score was correlated with authoritative parenting. These null findings may be due, again, to discrepancies between trait and state measures. Self-reported authoritative parenting may reflect general dispositions that differ based on context; meaning, a mother's likelihood of giving commands, for example, may not be empirically associated with giving praise in a laboratory context.

The null findings among the remaining observed maternal encouragement measures may have been due to unanticipated moderating variables. For example, mothers' interpersonal objectives in the free play setting may have influenced their likelihood of using one or another strategy when encouraging children's physical activity. If a mother's focus or intent was to promote an ongoing activity, she may have chosen praise over commands. Conversely, if her intent was to promote novel activity, she may have chosen commands over praise.

In terms of maternal involvement and maternal facilitation (i.e., questions & physical activity and talking & scaffolding, respectively), if a mother's focus or intent was to promote sociocognitive activity, she may have preferred questioning or talking strategies. However, if her focus or intent was to promote movement, she may have chosen to become physically active herself in order to model those behaviors, or have used scaffolding strategies in an effort to make movements easier for the child.

When considering why maternal touching was not associated with scaffolding or talking, it appears that mothers used touching strategies in unanticipated ways. For instance, I anticipated that maternal touching would be employed as a scaffolding technique, which may have included moving a child's hand to correctly grasp a spoon, or guiding a child's hand to the appropriate opening on a shape sorting box. However, mothers most often used touches as a provision of social or emotional support; which included hugging, wrapping their arms around their children as they read a book, or helping them blow their nose. Touching as an emotional support strategy may be used very differently than touching as a physical support strategy.

Lastly, a major assumption of the present investigation was that laboratory observational measures would accurately characterize typical mother and child behaviors. However, the lack of coherence among the mother-reported and laboratory-observed measures may be an indication of a lack of continuity across assessment formats. That is to say, the observed measures of maternal encouragement, sociocognitive play, and intensity of child activity level may not have been reflective of how the mother or child generally behave. The laboratory setting may have induced some reactivity in both the mother and child, which may have impacted the nature of interaction or activity they displayed during free play sessions. It may be useful in future research to examine these components in a naturalistic or home setting in order to gain a more ecologically valid glimpse of typical mother-child behaviors.

The failure to confirm my subhypotheses notwithstanding, it was still possible to conduct moderation analyses at the level of the individual variable. Even so, only the moderating effect involving maternal questioning achieved statistical significance. This one effect indicated that children whose mothers used more questions during mother-child free play, were more likely to exhibit a positive relationship between executive function and activity level. This finding was in line with my expectations, as it was theorized that the use of questions during activity would incite a greater degree of sociocognitive engagement during activities when playing alone; and further, that this sociocognitive engagement during play would increase overall executive function abilities. Despite this one effect, which could have arisen by chance, the overall null findings involving moderation effects can be taken to imply that maternal encouragement simply doesn't play the facilitative role that I anticipated, at least not in this age range.

Study Limitations

There were, however, a number of limitations to the current study. First, it is possible that the effect sizes were smaller than expected, and therefore may have been harder to detect with the sample size used in the current study. Compared with those reported in the adolescent and adulthood literature, smaller effect sizes involving executive functioning in very young children would not be surprising given the rapid development, and therefore instability, of executive function in the second year of life (Gartstein et al., 2013). Additionally, because I used video recordings for my observed measures, deficiencies in these recordings (poor angles, low volume, experimenter interruptions, and premature endings) further reduced the anticipated sample size for my observed measures. Future attempts at exploring these relationships may benefit from the availability of higher quality video recordings and better training in experimenter videography.

In addition, the narrow selection of 18-month-olds may have also been a limiting factor. Although it was a goal to explore activity level-executive function links during the second year of life, it may be that 18 months of age is too early to elucidate those links. Recent data from our own lab has indicated that there seems to be a transition during the vocabulary burst phase (16-24 months) indicating that among "pre-burst" children, effortful control and activity level are negatively correlated, while among children in the "burst" phase, effortful control and activity level are positively correlated (Price, Driggers-Jones, & Dixon, 2017). These results suggest that activity level-executive function links may not be evident until children are well into, or beyond, the period of first-word acquisition.

This possibility is consistent with a dynamic systems perspective. Specifically, a dynamic systems perspective would suggest that systems shift and reorganize over time to meet the current needs of the organism (Thelen & Smith, 1994). Thus, it may be that before the period of the vocabulary burst, the developing physical activity system of the organism maintains developmental priority, which may in turn hinder language learning and cognition by restricting children's attentional access to linguistically relevant stimuli (cf. Libertus, & Violi, 2016). During the burst phase, in contrast, the physical activity system of the organism may bolster language learning and cognition. During this phase the organism may actively seek out linguistically-relevant stimuli, and direct attention toward multiple stimuli that may promote linguistic and cognitive development. Thus, for 18-month-olds at least, a dynamic systems exploration may prove more fruitful. Research of this type may help investigators understand how relationships between activity level and executive function change as a function of linguistic status. It may be only after children have become linguistically proficient that activity level-executive function associations begin to resemble those observed in adolescence and adulthood (Edwardson & Gorley, 2010).

In conclusion, while I did observe one moderating effect of maternal encouragement, this was only true for maternal questions. And even so, these regression results do not imply that maternal encouragement of physical activity is necessarily the cause of positive links between activity level and executive function. Future research in this area may benefit from controlled experimentation, which has the potential to identify specific causal links between activity level, executive function, and the possible moderators thereof. Maternal encouragement of child activity level may yet be found to moderate links between children's activity level and their executive function. Physical activity may not only improve the physical health of young children, but may also help to improve cognitive abilities and growth.

REFERENCES

Alexander, L., Allen, S., & Bindoff, N. L. (2013). Associations Among Physical Activity, ADHD Symptoms, and Executive Function in Children with ADHD. *Journal of Chemical Information and Modeling*, *53*(September 2013), 1–36. http://doi.org/10.1017/CBO9781107415324.004

Baddeley, A. (1992) Working Memory. *Science, 255*(5044), 556-559. DOI: 10.1126/science.1736359

Baddeley, A. D., & Hitch, G. (1974). Working memory. In G.H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 8, pp. 47–89). New York: Academic Press.

Bandura, A. (1989). Social cognitive theory. In R. Vasta (Ed.), Annals of child development. Vol. 6. Six theories of child development (pp. 1-60). Greenwich, CT: JAI Press.

Baumeister, R. F., & Vohs, K. D. (2003). Self-regulation and the executive function of the self. In M. R. Leary & J. P. Tangney (Eds.), Handbook of self and identity (pp. 197–217). New York: Guilford Press

Baumrind, D. (1971). Current Patterns of Parental Authority. *Developmental Psychology, 4* (1), 1-103.

Best, J. (2010). Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Developmental Review , 30* (4), 331-351.

Brown, W. H., Pfeiffer, K. a, Mclver, K. L., Dowda, M., Almeida, M. J. C. a, & Pate, R. R. (2006). Assessing preschool children’s physical activity: the Observational System for Recording Physical Activity in children-preschool version. *Research Quarterly for Exercise and Sport*, *77*(2), 167–76. http://doi.org/10.1080/02701367.2006.10599351

Budde, H., Voelcker-Rehage, C., Pietrabyk-Kendziorra, S., Ribeiro, P., & Tidow, G. (2008). Acute coordinative exercise improves attentional performance in adolescents. Neuroscience Letters, 441, 219–223.

Buri, J. R. (1991). Parental Authority Questionnaire. *Journal of Personality and Assessment*, *57*, 110–119. http://doi.org/10.1016/S0003-3472(82)80142-5

Carlson, S. (2005). Developmentally Sensitive Measures of Executive Function in Preschool Children. *Developmental Neuropsychology*, *28*(2), 595–616. http://doi.org/10.1017/S1355617712001555

Carlson, M. C., Saczynski, J. S., Rebok, G. W., Seeman, T., Glass, T. a, McGill, S., Tielsch, J., Frick, K. D., Hill, J., Fried, L. P. (2008). Exploring the effects of an "everyday" activity program on executive function and memory in older adults: Experience Corps. *The Gerontologist*, *48*(6), 793–801. http://doi.org/10.1093/geront/48.6.793

Centers for Disease Control. (2014, 6 4). *The benefits of Physical Activity*. Retrieved from Centers For Disease Control: http://www.cdc.gov/physicalactivity/basics/pa-health/

Chaddock-heyman, L., Hillman, C. H., Cohen, N. J., & Kramer, A. F. (2014). the Importance of Physical Activity and Aerobic Fitness for Cognitive Control and Memory in Children. *Monographs of the Society for Research in Child Development*, *79*(4), 25–50. http://doi.org/10.1111/mono.12129

Chaddock, L., Hillman, C. H., Pontifex, M. B., Johnson, C. R., Raine, L. B., & Kramer, A. F. (2012). Childhood aerobic fitness predicts cognitive performance one year later. *Journal of Sports Sciences*, *30*(5), 421–430. http://doi.org/10.1080/02640414.2011.647706

Cuevas, K., Swingler, M. M., Bell, M. A., Marcovitch, S., & Calkins, S. D. (2012). Measures of frontal functioning and the emergence of inhibitory control processes at 10 months of age. Developmental Cognitive Neuroscience, 2(2), 235-243.

Davis, C. L., Tomporowski, P. D., Boyle, C. A., Waller, J. L., Miller, P. H., Naglieri, J. A., & Gregoski, M. (2007). Effects of aerobic exercise on overweight children's cognitive functioning: A randomized controlled trial. Research Quarterly for Exercise and Sport, 78(5).

Edwardson, C. L., & Gorely, T. (2010). Parental influences on different types and intensities of physical activity in youth: A systematic review. *Psychology of Sport and Exercise*, *11*(6), 522–535. http://doi.org/10.1016/j.psychsport.2010.05.001

Eyberg, S. M., Nelson, M. M., Duke, M., & Boggs, S. R. (2005). Manual for the dyadic parent–child interaction coding system, 1–243. Retrieved from www.PCIT.org

Etnier, J. L., & Chang, Y.-K. (2009). The effect of physical activity on executive function: a brief commentary on definitions, measurement issues, and the current state of the literature. *Journal of Sport & Exercise Psychology*, *31*(4), 469–483.

Gartstein, M. a., Bridgett, D. J., Young, B. N., Panksepp, J., & Power, T. (2013). Origins of Effortful Control: Infant and Parent Contributions. *Infancy*, *18*(2), 149–183. http://doi.org/10.1111/j.1532-7078.2012.00119.x

Groppe, K., & Elsner, B. (2015). The influence of hot and cool executive function on the development of eating styles related to overweight in children. *Appetite*, *87*, 127–136. http://doi.org/10.1016/j.appet.2014.12.203

Groppe, K., & Elsner, B. (2014). Executive function and food approach behavior in middle childhood. *Frontiers in Psychology*, *5*, 447. http://doi.org/10.3389/fpsyg.2014.00447

Gustafson, S. L., & Rhodes, R. E. (2006). Parental Correlates of Physical Activity in Children and Early Adolescents. *Sports Medicine*, *36*(1), 79–97. http://doi.org/10.2165/00007256-200636010-00006

Jurado, M. B., & Rosselli, M. (2007). The Elusive Nature of Executive Functions: A Review of our Current Understanding. *Neuropsychology Review*, *17*(3), 213–233. http://doi.org/10.1007/s11065-007-9040-z

Kamijo, K., & Takeda, Y. (2010). Regular physical activity improves executive function during task switching in young adults. *International Journal of Psychophysiology*, *75*(3), 304–311. http://doi.org/10.1016/j.ijpsycho.2010.01.002

Kraybill, J. H. and Bell, M. A. (2013), Infancy predictors of preschool and post-kindergarten executive function. Dev. Psychobiol., 55: 530–538. doi: 10.1002/dev.21057

Libertus, K., & Violi, D. A. (2016). Sit to talk: Relation between motor skills and language development in infancy, *7*(847), 1–17. http://doi.org/10.3389/fpsyg.2016.00475

Linden, D. E. J. (2005). The p300: where in the brain is it produced and what does it tell us? *The Neuroscientist : A Review Journal Bringing Neurobiology, Neurology and Psychiatry*, *11*(6), 563–576. http://doi.org/10.1177/1073858405280524

Lezak, M. D. (1983). Neuropsychological assessment (2nd ed.). New York: Oxford University Press.

Lloyd, C. A., & Masur, E. F. (2014). Infant behaviors influence mothers' provision of responsive and directive behaviors. *Infant Behavior and Development*, *37*(3), 276–285. http://doi.org/10.1016/j.infbeh.2014.04.004

Naglieri, J. A., Das, J. P. (1997). Cognitive Assessment System. Riverside Publishing Company. Itasca, IL.

Pesce, C., Crova, C., Cereatti, L., Casella, R., & Bellucci, M. (2009). Physical activity and mental performance in preadolescents: Effects of acute exercise on free-recall memory. Mental Health and Physical Activity, 2, 16–22.

Price, J. S., Driggers-Jones, L. P., & Dixon, W.E. Temperament-vocabulary links during the transition to first word production: Contrary to expectations. Poster presented at: Biennial Conference of the Society for Research in Child Development; 2017 April 6-8; Austin, TX.

Putnam, S. P., Gartstein, M. a., & Rothbart, M. K. (2006). Measurement of fine-grained aspects of toddler temperament: The Early Childhood Behavior Questionnaire. *Infant Behavior and Development*, *29*(3), 386–401. http://doi.org/10.1016/j.infbeh.2006.01.004

Rothbart, M. K. (2001). Investigations of temperament at three to seven years: the Children's Behavior Questionnaire. *Child Development* , *72* (5), 1394-1408.

Shiner, R. L., Buss, K. a., Mcclowry, S. G., Putnam, S. P., Saudino, K. J., & Zentner, M. (2012). What Is Temperament Now? Assessing Progress Temperament Research on the Twenty-Fifth Anniversary of Goldsmith et. al. (1987). *Child Development Perspectives*, *6*(4), 436–444. http://doi.org/10.1111/j.1750-8606.2012.00254.x

Suchy, Y. (2009). Executive Functioning: Overview, Assessment, and Research Issues for Non-Neuropsychologists. Annals of Behavioral Medicine. http://doi.org/10.1007/s12160-009-9097-4

Tamis-LeMonda, C. S., & Bornstein, M. H. (1990). Language, play, and attention at one year. *Infant Behavior and Development*, *13*(1), 85–98. http://doi.org/10.1016/0163-6383(90)90007-U

Taylor, C. B. (1985). The relation of physical activity and exercise to mental health. *Public Health Reports* , *100* (2), 195-202.

Taylor, C. B., Sallis, J. F., & Needle, R. (1985). The relation of physical activity and exercise to mental health. *Public Health Reports (Washington, D.C. : 1974)*, *100*(2), 195–202. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1424736&tool=pmcentrez&rendertype=abstract

Thelen, E., & Smith, L. (1994) A Dynamic Systems Approach to the Development of Cognition and Action. MIT Press. Cambridge, Massachusetts

Welsh, J. A., Nix, R. L., Blair, C., Bierman, K. L., & Nelson, K. E. (2010). The Development of Cognitive Skills and Gains in Academic School Readiness for Children from Low-Income Families. *Journal of Educational Psychology*, *102*(1), 43–53. http://doi.org/10.1037/a0016738

Wolfe, C. D., & Bell, M. A. (2004). Working memory and inhibitory control in early childhood: Contributions from physiology, temperament, and language. *Developmental Psychobiology*, *44*(1), 68–83. http://doi.org/10.1002/dev.10152

Woogler, C., & Power, T. G. (2000). Parenting and Children's Intrinsic Motivation in Age Group Swimming. *Jouranl of Developmental Psychology*, *21*(6), 595–607.

Ye, Z., Zhou, X. (2009). Executive Control in Language Processing. *Neuroscience & Biobehavioral Review*, *33*(8),1168-1177

VITA

LAUREN P. DRIGGERS-JONES

Education:	Public Schools, Winston-Salem, North Carolina B.S. Psychology, Appalachian State University, Boone, NC, 2015 M.A. Psychology, East Tennessee State University, Johnson City, TN, expected 2017
Professional Experience:	Undergraduate Research Assistant, Appalachian State University, 2014-2015 Graduate Assistant, East Tennessee State University, College of Arts and Sciences 2015-present Instructor, Design and Analysis II Lab, East Tennessee State University, Fall 2016 Instructor, Design and Analysis II Lab, East Tennessee State University, Spring 2017
Select Presentations:	Price, J. S., Driggers-Jones, L. P., & Dixon, W.E. (April, 2017). Temperament-vocabulary links during the transition to first word production: Contrary to expectations. Poster presented at: Biennial Conference of the Society for Research in Child Development; 2017 April 6-8; Austin, TX. Dixon, W. E., Gouge, N. B., Price, J. S., Driggers-Jones, L. P. (April, 2017). Household income moderates the relationship between temperament and language development. Poster presented at: Biennial Conference of the Society for Research in Child Development; 2017 April 6-8; Austin, TX.
Honors and Awards:	Treasurer: Graduate Student Association of Psychology (GSAP). East Tennessee State University, August 2016 President: Graduate Student Association of Psychology (GSAP). East Tennessee State University, May 2017