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Executive Function in Early Childhood: Qualitative and Quantitative Patterns of Development Among Students within a Montessori Classroom

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EXECUTIVE FUNCTION IN EARLY CHILDHOOD: QUALITATIVE AND QUANTITATIVE PATTERNS OF DEVELOPMENT AMONG STUDENTS WITHIN A MONTESSORI CLASSROOM

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ABSTRACT

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This mixed methodology study observed five executive function components (working memory, attention, planning, cognitive flexibility, and inhibitory control) in a Montessori preschool environment for three to five year olds. The purpose of the study was to understand patterns of development for three, four and five year olds in a natural environment. There were five findings found after analysis: 1) a cluster of components of working memory/planning/attention, 2) patterns of frequency of components, 3) the role of interest in EF components, 4) patterns within each of the five components and 5) patterns of data triangulation between the parent, teacher and researcher. The current literature has varying views on how components interrelate as well as patterns in age and gender. After analyzing the data from the current study, four of the five findings were across age groups with the exception of some patterns in the isolated components such as planning, working memory, attention and cognitive flexibility.

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CHAPTER ONE

INTRODUCTION

With the increasing knowledge of the young child's rapid cognitive development, the early childhood stage has become an important focus for supporting learning and development (Blair et al., 2005; Sprenger, 2008). An infant's brain begins with a surplus of neurons and then prunes them as the excess is not needed over the first three years of life (Eliot, 1999). After the brain creates this surplus, the child loses approximately 20 billion synapses per day between early childhood and adolescence in order to prioritize connections that are relevant to daily experiences. (Eliot, 1999). After this tremendous dendritic growth from birth to three, the child enters a new stage of brain development involving social, emotional, cognitive, motor, sensorial and language development (Eliot, 1999; Blair et al., 2005).

The prefrontal cortex (PFC), found in the frontal lobe of the brain, plays an important part in this stage of the child's cognitive development. The PFC is the slowest part of the brain to mature and myelination of these nerves can continue into the mid-twenties (Eliot, 1999). The prefrontal cortex also supports executive function in the brain. Executive function is an umbrella term for actions and abilities of the prefrontal cortex which involve higher level functions (Barkley, 2012; Kloo, Perner, & Giritzer, 2010; and Yeager & Yeager, 2013). These functions assist in skills such as paying

attention, holding information in one's memory, blocking out other distracting stimuli, as well as many other functions.

Researchers are still defining exactly which skills are involved in executive function (Barkley, 2012). Although there are similar terms used when referring to executive function in research, there is not a specific accepted definition (Barkley, 2012; Martin & Failows, 2012). However, most researchers acknowledge that there are three core Executive Function components: working memory, inhibition, and cognitive flexibility (Diamond, 2013; Garon et al., 2008).

Recently, interest in brain function in the early childhood years has increased due to an important shift in development around age three (Weibe et al., 2011). The preschool age is an important stage to research as many of the skills in executive function begin to integrate (Garon et al, 2008). Much of the current literature for this age group focuses on these three areas: understanding the model of executive function development (unitary vs integrated), how the components relate and how the components relate to other developmental features such as theory of mind, socialization, and language development (Barkley, 2012; Garon et al., 2008).

However, there has been difficulty in learning more about executive function in the early childhood age due to the scarcity of measurements and the reliance of laboratory methods. For example, many of the measures used to evaluate executive function are for elementary and adolescent children and are difficult to apply in the assessment of executive function at the preschool age due to validity issues (Blair et al., 2005; Weibe et

al., 2011). These assessments tend to be too mature for the preschool age child and the instrument does not measure the skill in this younger age group.

Another aspect of current research is that many of the studies measure executive function by asking the participant to complete tasks in a controlled, laboratory setting. Isquith et al. (2004) added to this body of research by using a measurement called BRIEF, which is a rating scale to measure executive function in everyday activities for older children. The BRIEF rating scale addresses the problem of reliance on measuring EF in a clinical setting due to time constraints and thus extends the current research into a child's natural setting.

Isquith et al. (2004) not only used this measure to evaluate children in a natural setting but also modified the tool for preschoolers (BRIEF-P). They conducted a study to see if their adaptation was a valid tool and if it would be able to discriminate between children with developmental differences.

Along with understanding developmental differences, research on EF has also increased due to the correlation between executive function skills and academic tasks (Willoughby, Kupersmidt & Voegler-Lee, 2012). Diamond (2013) explains that along with this correlation, there have been many studies that show that executive function can be improved within certain types of educational environments and programs. She mentions both the Tools of Mind program and Montessori education as examples of experiences shown to increase executive function in young children. Lillard's research (2012) used different EF tasks to measure children's skills level in varying educational

settings: traditional, Montessori-like and full-Montessori programs. She found that the children in the Montessori classrooms had the highest levels of executive function.

As more information is being discovered by researchers about executive function, there is an increasing interest in the development of early childhood children as well as how to support their EF development through their environment and particular types of strategies.

Problem Statement

Executive Function development of preschool children mainly relies on results from laboratory studies and qualitative perspective in a natural setting is lacking. Two major characteristics of executive function are currently reflected in the research literature: 1) new information on Executive Function, especially for the preschool years, continues to be generated, 2) relevant methodologies and task measurements are still being developed for executive function for the early childhood age group. In a similar fashion, each year more information is being generated regarding executive function across age groups, the model of analyzing EF development, as well as the implications of supporting EF development in young children.

Many current researchers acknowledge the difficulty to understand and assess executive function at the early childhood age (three to five) due to the scarcity of measures (Blair et al., 2005; Weibe et al., 2011). Typically, there are known tasks that attempt to measure different components of executive function. However, many of these tasks are for elementary and adolescent children or adults and are developmentally inappropriate for measuring early childhood children (Isquith et al., 2004).

The creation of the assessment, the BRIEF-P allowed researchers to begin observing in a natural setting as well as evaluate children in a three to five age span (Isquith et al., 2004). This assessment consists of questions to measure five executive domains: Inhibition, Shift, Emotional Control, Working memory and Play/Organize. This tool is an important addition to literature because it provides an appropriate measure for the preschool age group as well as a way to observe in a learning setting. However, this tool is used as a diagnostic for children that are not in the typical range of development.

Lastly, there is a need for a qualitative perspective in understanding executive function. BRIEF-P provided a starting point for evaluating the preschool age. However, it is a diagnostic, quantitative tool that only provides limited information for children's classroom and at-home behavior. It is necessary for the literature to provide information on EF in children within a natural setting. The closest research to this is Lillard's (2012) comparison of different school settings which utilizes quantitative task measurements. The qualitative aspect of executive function in a structured classroom setting gives new insights into children's behavior and learning as well as insight to natural behavior instead of responses to tasks.

Theoretical Framework

Constructivism

Executive function and child development is best understood through the lens of constructivism. In a Constructivist view, a child learns and develops through his own experiences (Noddings, 2007). Constructivists believe that as children experience their

world, knowledge is created and this knowledge is not received in a passive manner (Noddings, 2007).

Incongruity is a term used by constructionists to describe when a child finds equilibrium between old knowledge and assimilating it with new knowledge (Schunk, 2012). Incongruity is a process where students work through the disequilibrium of old and new knowledge. The child works hard to construct himself and to assimilate and understand the new knowledge. This is important when children are developing skills such as inhibition, working memory, and cognitive flexibility to be able to grow from past experiences and assimilate new knowledge.

Vygotsky also described the *zone of proximal development,* similar to incongruity, which looks at the hardest task a child can do alone ranging to the task he could do with a little assistance (Mooney, 2000). The assistance "scaffolds" the child to allow him to stretch to the next skill. Jean Piaget described the preschool stage of development as *preoperational* for the age from 18 months through 6 years in which the child is learning through limited experience and perceptions (Mooney, 2000).

Montessori Education

The perspective of the research-based Montessori System of Education is also important to consider because of the research that shows how it supports the development of executive function (Lillard, 2012). Maria Montessori, an Italian physician and educator, developed her research-based system of education by observing children scientifically in an especially prepared environment. Montessori's research lead her to discover new insights into how children actually develop and how a learning environment

filled with classified, structured, developmentally appropriate teaching/learning materials can help children achieve their highest potential (Mooney, 2000). Montessori's research demonstrated that children learn best through purposeful activities that require movement. She discovered that children will work without compulsion and that their work leads to the emergence and development of concentration which becomes a transforming event in their lives. By working independently from the adult, children developed responsibility for themselves and their environment. Montessori also discovered that children from birth though six years of age need to repeat activities spontaneously. When they are permitted to do so, they repeat the activities and these experiences and work to develop an absolute mastery over them. That is the reason that the Montessori classroom provides a three hour time frame for repetition and free time for the children to work. This pursuit of purposeful activity and repetition greatly enhances the child's cognitive development by allowing children to construct themselves through creative interactions with elements in their environment that have been scientifically designed to respond to their developmental needs at each stage of their lives.

Through her scientific observation of children, Montessori discovered the powerful influence of the environment and developed a new and more effective role for the teacher who now is the *dynamic link* between the prepared environment and the child. She understood that it was the teacher's responsibility to help develop the *whole child,* by preparing the child, not just for school, but for *life*. She found that children not only need physical movement, but also need activities which specifically support their sensory and vestibular development as a foundation for subsequent cognitive development and

understanding. Montessori observed the difficulty of persuading adults to live in peace so she also introduced a program of peace education designed to help bring about a world of peace through the education of one child at a time (Montessori, 1912).

In *Montessori's Own Handbook* (1914), Montessori discussed the techniques used for educating children based on her observations of young children. One of the unique aspects of Montessori's perspective on education is her focus on children becoming confident and independent. She created many lessons that teach the child how to care for himself such as dressing and undressing, pouring liquids and spooning, serving and drinking juice and tea. The Montessori teacher takes the time to model very specific lessons on how to act in the classroom such as speaking with a soft voice so as not to disturb classmates that are concentrating on their work. Montessori adds in her handbook to teach "how to sit, to rise from one's seat, to take up and lay down objects, and to offer them gracefully to others" (p. 323). Children also practice "washing their faces, polishing their shoes, washing the furniture, polishing the metal indicators of the pedometer, brushing the carpets" (p. 335).

Although it may seem trivial to spend time on these types of lessons with all the pressures of academics, these lessons give children a foundation for experiencing success and developing their ability to concentrate which leads to their becoming competent, confident and independent from the adult. Their success with these lessons serves as a foundation for the children to be more successful with *academic* lessons because they have become competent and independent individuals that respect themselves, respect each other, and respect the lessons that they pursue individually and with each other.

In a Montessori classroom, the teacher, the children, and the classroom environment all work together to support the child's physical, emotional, social and cognitive development (Montessori, 1912). The Montessori curriculum is classified and structured in such a way as to provide the child with a foundation to be successful in life. The carefully prepared environment provides opportunities for the child to have concrete examples while developing motor skills and refined control of movement, establishing sensorial foundations for intellectual life, developing language and literacy skills in one or more languages, experiencing the early preparation of the mathematical mind, and developing skills in music, art, science and social studies.

The purpose of the Montessori school is to provide both social growth and education (Montessori, 1912). Education for three to six year olds involves helping children to refine their senses. Montessori emphasizes that "the education of the senses must be of the greatest pedagogical interest" (p. 215). Educating children in the Montessori environment involves providing materials that have a control of error and isolating the difficulty that is being presented so that the child can be successful.

Montessori was a revolutionary educator for the 20th century and continues to impact education today. There is a synergy between the teachers, children, and the environment that enables children to grow into independent, whole beings. This environment honors the child's natural abilities and developmental levels and focuses on the needs of the child. The effective implementation of Montessori's insights in classrooms allows the child to learn how to work independently, take pride in his or her work, develop concentration, and to repeat activities to develop certain skills.

Purpose Statement

The purpose of this mixed methods research study is to identify patterns of development of executive function of children three to five years of age in a Montessori classroom. This study focuses on the core executive function: working memory, cognitive flexibility, inhibition as well as attention and planning. The sources of data were collected from the researcher's observations and a teacher and a parent questionnaire. The quantitative component was from the analysis of frequency and patterns in components seen among participants over the 12 week session.

This research study intends to take a deeper look at children's development in order to identify and understand patterns in executive function within a Montessori classroom environment through a mixed methodological perspective.

Rationale and Significance of Study

This study aims to make a contribution to current literature as it focuses on the development of executive function of young children within a natural setting. Many current studies focus on the preschool age executive function and only provide information in a laboratory setting (Barkley, 2012; Yeager & Yeager, 2013).

Many of the current studies use assessments that measure one or two specific components of EF instead of how the components relate to one another (Yeager & Yeager, 2013). This isolation makes it difficult to understand the development and integration of executive function components within a natural setting, such as Montessori classroom environment.

This study complements the quantitative research currently available through the use of a mixed methodology within a Montessori classroom environment. This information provides valuable insights into development, use and interrelationships of executive function of children within a particular early childhood classroom setting. This research offers a contribution to the field of education in the form of specific examples regarding how children can be supported in this type of classroom.

Research Questions

The following research question and subset questions directed this study in order to bridge the current research with a more in-depth understanding of development and interrelationships of Executive Function abilities and the activities in three to five year old children within a preschool setting.

1. What are the patterns of development involving the elements of Executive Function—specifically, *inhibition, working memory, cognitive flexibility, planning* and *attention*—exhibited by the behaviors of three, four, and five year-old children in a Montessori classroom context?

How do these EF patterns vary across each age group?

   a. How do these EF patterns vary within each age group?
   b. What are the similarities in executive function patterns as seen in the classroom by the observer and as reported by the teacher and the parent in the questionnaires?

c. What are the differences in executive function patterns as seen in the classroom by the observer and as reported by the teacher and the parent in the questionnaires?

Definition of Key Terms

Executive Function: An "umbrella term" for a set of actions and abilities of the prefrontal cortex that are characterized as higher level functions (Barkley, 2012; Kloo, Perner, & Giritzer, 2010; and Yeager & Yeager, 2013). However, most researchers acknowledge that there are three core Executive Function components: working memory, inhibition, and cognitive flexibility (Diamond, 2013; Garon et al., 2008; Yeager & Yeager, 2013).

Working Memory: a component of executive function that enables the child to have information in mind and connect it with new information (Hoskyn, 2010).

Insufficient Working Memory: this is used in the methodology and result section to refer to a participant that is having difficulty making the connection with old and new information.

Inhibition or Inhibitory control: ability to suppress an emotion or action in order to do something else (Giesbrecht et al., 2010)

Insufficient Inhibitory control: a term used when a participant is having difficulty suppressing an action.

Cognitive Flexibility: Ability to manipulate information, weigh different perspectives (one's own and those of others), and compare past consequences and possible future outcomes (Yeager and Yeager, 2013).

Insufficient Cognitive Flexibility: a term used when a participant is having difficulty manipulating information and making an appropriate decision.

Attention: Involves using the orienting, alertness, and selection-executive function in the brain. It allows adaptation to the environment by being able to process and prioritize information (Berger, Kofmab, Livneh, and Henik, 2007).

Orienting is the ability to visually locate and focus on a source.

Alertness involves being sensitive and aware of a situation and also sustaining focus for a period of time.

Selective attention is when the brain chooses which stimuli to focus on.

Insufficient Attention: a term used when the participant is having difficulty processing and prioritizing information.

Planning: Goal orientation or ability to make a plan to achieve a goal, keep this information in the mind and execute the plan in a timely manner. Planning also includes self-motivation and awareness of progress in completing the plan. (Yeager and Yeager, 2013).

Insufficient Planning: a term used when the participant is having difficulty planning to achieve a goal and executing plan.

Summary

Executive function research, specifically for the three to five year old age group, has become an important part of current neuroscience research (Weibe et al, 2008). As more research is done on executive function, it will increase the information relevant to

child development and education as well as impact learning in early childhood (Diamond, 2012). Assessing executive function for the preschool age and knowing how to evaluate everyday behavior is also an important missing component in the literature (Isquith et al., 2012). A mixed methodological perspective adds to the body of quantitative research that is available in order to understand and support young children in their everyday environments.

CHAPTER TWO

REVIEW OF LITERATURE

This review of literature presents current research related to executive function, the importance of understanding the early childhood age and the importance of bridging research to everyday settings. The following topics are addressed:

1. Defining Executive Function
2. Importance of the Three to Five Age Period
3. Understanding Executive Function Components
4. Current Research: problems, methodologies and findings
5. Improving Executive Function

Throughout early childhood, children are learning both how to problem solve and relate to others (Hammond, Bibok, & Carpendale, 2010). As children develop cognitive thinking skills, they are using executive function in the brain through use of the prefrontal cortex. The cortex controls problem solving skills, working memory, inhibitory control and attentional flexibility; all of which develop throughout childhood and adolescence (Lewis, Carpendale, Towse, & Maridaki-Kassotaki, 2010).

Defining Executive Function

Executive function is an "umbrella term" for a set of actions and abilities of the prefrontal cortex that are characterized as higher level functions (Barkley, 2012, Kloo, Perner, & Giritzer, 2010; and Yeager & Yeager, 2013). EF development begins at

infancy and develops through adolescence (Cartwright, 2012). Although there are similar terms used when speaking of executive function in research, there is not a specific accepted definition (Barkley, 2012; Martin & Failows, 2012).

For example, one definition of executive function is "planning, working memory, interference control, regulation of attention, inhibition of inappropriate actions, and set-shifting" (Kloo et al., 2010, p. 194). However, the problem with defining EF by specific skills is that there is disagreement on the skills EF provides (Barkley, 2012). There have been lists made for EF including up to 33 functions (Elsinore, 1996 as cited in Barkley, 2012; Yeager & Yeager, 2013). However, most researchers acknowledge that there are three core Executive Function components: working memory, inhibition, and cognitive flexibility (Diamond, 2013; Garon et al., 2008; Yeager & Yeager, 2013). These three core components are often used as a base for studying and comparing the components to other functions such as planning or to other developmental abilities such as theory of mind, language, or socialization.

The Importance of the 3-5 Age Period

Executive function develops from childhood through adolescence (Barkley, 2012). However, there is an important significance and focus on the early childhood years as there is rapid development in executive function (Yeager & Yeager, 2013). Around the age of three, there is a shift that occurs in children's abilities as they experience rapid growth in their prefrontal cortex and begin to integrate EF components (Garon, 2008, Weibe, 2011). The literature presented in this review focuses on this age

span in order to understand more about patterns in the research and how to best support this rapid development of EF.

Understanding Executive Function Components

The following parts of the literature review breaks down specific components of executive function: working memory, inhibition, and cognitive flexibility. Information is also presented for a few other components that have been related to the core, specifically planning and attention.

Working Memory

Hoskyn (2010) discusses working memory as an executive function that allows the child to have information in mind and connect it with new information. It is important for a child's language development and social understanding (Hoskyn, 2010; Rose, Feldman, and Jankowski, 2009). Hoskyn explains that working memory allows the child to be successful in social interactions because the child can assess and make decisions in an unpredictable environment.

Working memory, also referred to as *Updating,* is the ability to understand incoming information and knowing what to do with it. The child has to prioritize the information and know what to replace for working memory to be effective.

Inhibition

Inhibition is being able to suppress an emotion in order to do another action of a higher priority (Giesbrecht et al., 2010). Giesbrecht et al. (2010) encourage scaffolding and drawing attention to something else in order to help the development of inhibition.

Carlson, Moses, and Claxton (2004) state that inhibition is an important skill for the preschool age.

Cognitive Flexibility

Yeager and Yeager (2013) refer to cognitive flexibility as the ability to manipulate information, weigh different perspectives (one's own and those of others), and compare past consequences and possible future outcomes. Yeager and Yeager also discuss how current studies support children being able to remain goal oriented by using cognitive flexibility. They can practice strategies to let go of initial desire or focus.

Planning

Planning can be defined as goal orientation. Yeager and Yeager (2013) define planning as goal orientation or ability to make a plan to achieve a goal, to keep this information in the mind and to execute the plan in a timely manner. Planning also includes self-motivation and awareness of progress in completing the plan.

Planning improves in the preschool years as the child encounters new experiences (Carlson, Moses, & Claxton, 2004). Executive function involves planning which is developed in social and emotional situations (Perez & Gauvain, 2010).

Attention

Attention helps children adapt to their environment by being able to process and prioritize information (Berger, Kofmab, Livneh, & Henik, 2007). Attention involves using the orienting, alertness, and selection-executive function in the brain. Orienting is the ability to visually locate and focus on a source. Alertness involves being sensitive

and aware of a situation and also sustaining focus for a period of time. Selective attention and executive function is when the brain chooses which stimuli to focus on.

The regulation of attention greatly increases in skill between three and five years of age (Garon et al., 2008). Attention is important for many tasks such as self-regulation because the child has to shift his attention away from a desired object in order to regulate himself (Giesbrecht et al., 2010). Blankson et al. (2012) found that a child who is able to control his or her attention may be able to understand others emotions because they are able to focus and be aware of them. Because attention is so important for development, Garon et al. (2008) explain that if a child does not have the appropriate development, it can greatly impact the development of the other executive function.

Current Research: Problems, Methodology, and Findings

There are a few themes in the current executive function research. Many researchers, when trying to understand the components of EF want to understand which model reflects the relationships of the components. Many of the current research studies aim to understand how specific components are related to each other or to an external ability such as social emotional competence or academics.

Creating an EF Model for Early Childhood Development

Creating a model of the development of executive function has been an important part of the field since the 1990's (Garon et al., 2008). There are different perspectives of how EF is developed in infancy and preschool. Garon et al. (2008) compare the unitary model and the component model in their framework. To understand EF and the

components, we need to understand the development and relationships of the components.

Unitary model. Weibe et al. (2011) focused their research on gaining clarity on the use of executive function in children three years of age because research supports that this could be a pivotal point in EF development. By focusing research of EF at this age, they can assess if a unitary or fractionated model of EF is appropriate at 3 years old. A unitary model is where executive function is broken into many different individual components without dependence on each other for growth. A fractioned model is where the components are related to each other. This model can imply that one component has to develop first before another component can develop.

Weibe et al. (2011) specifically considered the relationship of two functions—working memory and inhibitory control. The sample included 228 three year olds (115 girls, 113 boys) all within three weeks of their third birthday. The sample was collected by advertising the study through flyers and word of mouth. Parents participated in a telephone screening in order to weed out families who have a primary language other than English or those who were going to move to another location. The ethnicity was primary Caucasian (173 Caucasian, 13 African America, 17 Hispanic and 25 multiracial). Parents consented to participate while the researchers were at a home visit. The child and a parent came to the laboratory to participate in the tasks done on several computer softwares: *E-Prime* and *Superlab*. Three tasks, *Nine Boxes, Nebraska Barnyard*, and *Delayed Alternation* were used for measuring working memory. Four tasks, *Big-Little Stroop, Go/No-Go, Shape School,* and *Snack Delay* measure inhibition.

To evaluate the EF structure, the researchers analyzed all tasks as one to evaluate the unitary model then they analyzed inhibitory versus memory, and lastly they analyzed the tasks based on other factors such as being computerized or not. The model that best fit the data was the unitary model where executive function is best explained as a single factor model for three year olds. They found in their data analysis that the low-risk children performed better on five tasks: *Nebraska Barnyard, Big Stroop/Little Stroop, Go/No-Go, Shape School* and *Snack Delay*.

Weibe et al. (2011) concluded that the unitary model of EF is the best fit for understanding EF in children of three years of age. However, other research suggests that working memory emerges first. Weibe et al. suggest looking further at executive function development post preschool years to better understand differences between different executive function in preschool.

Integrative model. Garon et al., (2008) in contrast to Weibe et al. (2011) found an integrated model works better in understanding EF components as seen in Miyake's et al. (2000) research. The integrative model is based on the dissociable components of working memory and inhibition as seen in Diamond's (2002) research. The confirmatory factor analysis (CFA) was introduced as a way to compare models and test their validity. Garon et al. (2008) presented a literature review on the importance of three to five year age for cognitive development of EF. Garon et al. also poses that the attention system may be the base for EF development.

Two-factor model. Miller et al. (2012) took a latent approach to expandon Weibe's work. They wanted to replicate the unitary model as well as compare the

outcome when the indicators for working memory and inhibition were changed. Their participants were fifty-five 3 year olds, sixty-four 4 year olds and ten 5 year olds. The children participated in two 45 minute sessions conducted about two weeks apart. They used the *Backward Pan tasks* where a puppet would say nonsequential numbers and the children were asked to say the reverse order. *The Boxes Task* measured working memory by playing a computerized jack in the box game. The first choice was always empty; the second choice always had the Jack. The child was asked to find Jack again but they were informed that the Jack would hide in a different box. The preschool continuous performance test is a computerized test asking children to feed only the sheep because all other animals have been fed. The *Boy-Girl Stroop Test* asked the child to say "boy" when a girl cartoon appeared and girl when a boy cartoon appeared. *Tower of Hanoi* is a computer task where children are asked to put monkeys in order from small to big on the tree with the bananas. *Go/No Go* is also a computerized task asking children to press the space bar when they saw a dog, then the rule changed to pressing it for a koala. *The Border version* of *the Dimensional Change Card Sort* measured the child's ability to sort specific cards and *the Peabody picture vocabulary Test-Third Edition* measured receptive vocabulary. Miller et al. (2012) found that their study matched the unitary model of Weibe's however, after using the CFA approach to test task impurities the two factor model seemed more consistent. There is a correlation between working memory and inhibition and that Miller states is "separated by related components of EF" (p. 417).

The research is still developing to truly understand if the unitary versus two factor model at the preschool age group is more appropriate. There are many studies that support both models. As more studies are conducted and more assessments are

developed, researchers will continue to develop appropriate models to understand EF development in early childhood.

Methodologies Used to Study EF

When conducting studies on executive function, many researchers use the same series of battery tests to examine different functions. These are familiar tests in the research community and often researchers do not even list the specifics of the task because they anticipate the audience to understand the terminology. For example, the *Tower of Hanoi, Bear/Dragon, Truck Loading, Whisper, Gift Delay, Kitten Delivery, Go/No-Go, Nine Boxes, Nebraska Barnyard, Delayed Alternation, Shape School, Snack Delay, Day/Night Task, Balance Beam Task, Pencil Tap* or *Peg Tapping Task* are common tasks used to assess executive function (Carlson et al., 2004; Weibe et al., 2011).

Many studies use the *Bear/Dragon, Whisper, Gift Delay, Big- Little Stroop, Go/No-Go, Shape School, Snack Delay, Day/Night Task, Balance Beam Task, Pencil Tap or Peg Tapping Task* for inhibitory control for studying inhibition (Weibe et al., 2011). The *Bear/Dragon task* is an inhibitory control measure similar to *Simon Says*. The children have to listen and inhibit the response to move when "Simon doesn't say" for example. *Whisper* is where children are asked to whisper their names and cartoon characters' names and inhibit the tendency to raise their voices as they talk. *Gift Delay* is a delay of gratification where children have to sit in a chair and try not to look at the experimenter while she wraps a gift for them. *Big/Little Stroop* is a task where children are asked to name a small picture embedded in a larger picture. They have to remember

the rule to name the small picture and not say the name of the larger picture. Often times, the two pictures are related as well. *Go/No-Go* is a task where children look at pictures of colored fish and have to "catch" the fish by pressing a button on a computer. In the No-Go trial, a shark appeared and the children are instructed to let it go by not pressing a button. This requires the children to remember the rule and not click the button when they see a shark. *The Shape School Task* asks children to name the color of cartoons that had a happy face and remain silent when the cartoon has a sad face. *The Snack Delay Tasks* gave children M&Ms and the researcher asked the children to put their hands on the placemat that was decorated with two handprints. Children were given up to three points for standing still, keeping their hands on the mat, and remaining silent. *The Day/Night Task* asked children to say the opposite of what a picture depicted. This required the child to inhibit the response to say the name of the picture and remember to say the opposite. *The Balance Beam Task* measures motor inhibition. This task asked children to walk a line on the floor three times, each time progressively slower. *The Pencil Tapping Task* or *Peg Tapping* was a task where the instructor would tap his pencil one or two times and the child was asked to tap his pencil two or one time, respectively. This required the student to not just mimic the instructor. The child had to inhibit the response to mimic and remember to respond with a different number of taps.

Researchers have used the *Tower of Hanoi*, *Truck Loading* and *Kitten Delivery* to understand the planning ability of children (Carlson et al., 2004). The *Tower of Hanoi* is a toy with almost concentric rings that stack upon each other. Children have to plan how to stack the rings in the correct order. *Truck Loading* is also a planning task where children have to pretend that they are mail carriers and use a truck to deliver invitations to

colored houses. *Kitten Delivery* is a planning exercise where children have to decide the quickest way to gather kittens in buckets around the room.

For working memory, *Nine Boxes, Nebraska Barnyard* and *Delayed Alternation tasks* can be used (Chevalier et al., 2012; Weibe et al., 2011). *Nine Boxes Task* is an activity where children have to search for figurines that have been hidden in boxes that are various shapes and colors. Children can open one box per trial and could try 20 times until they found all the figurines. *Nebraska Barnyard task* asks children to remember the sequence of animal names and press buttons on the computer to put them in the correct order. *The Delayed Alternation Task* asked children to get a small reward from a well. The wells were covered with identical covers so the child had to remember the location of the reward. Once a child chose the well with the reward, the next time the reward would be in the opposite well. It required the children to remember the previous location so they could get the most rewards.

Sustained attention can be measured by a PDTP-R instrument and *the Shape Task* (Weibe et al., 2011). Children use a self inking stamper to mark the shapes on the page that are the same as an outlined example. *The Main Cat Task* is the same as the shape task but it is a cat figure instead of a cat. The researchers asked children to mark the target cat on different pages as fast as they could.

Executive Function Components and Relationships

There are many studies that focus on different components of executive function such as working memory, planning, inhibition, attention and flexibility. Much literature looks at these interactions of executive function as well as how it relates to another

developmental component such as theory of mind (understanding social awareness) or social emotional development for example.

Reck and Hund (2011) discuss in their research that inhibition and attention can be linked for the young child. However, there are not many studies on the existence of predictive relationships. Reck and Hund specifically wanted to understand how sustained attention and age predicted inhibitory control in early childhood. The PDTP-R instrument was used to measure attention. *The Shape Task* was used for a training lesson. They used observational tasks such as *Bear/Dragon, Whisper, Day/Night*, and *Gift Delay* to understand inhibitory control. They also used a parent-rated scale, BASC-2 and the CBQ short form, to assess temperament and behavior. The participants consisted of 103 (46 boys and 57 girls) between 3 and 6 years of age and one parent for each child. Most children were Caucasian from low-risk families.

Reck and Hund (2011) performed a cross-product regression and found that omission errors and age were predictive of inhibitory control. This suggests that younger children who had less errors have more inhibitory control. But this was not found in older children. They used a two-factor model because they found that attention and inhibitory control were separate components. One limitation of this study was that it did not measure verbal ability or intelligence to control for variables.

Rhoades et al. (2009) explain that social emotional competence is being developed during preschool and that many factors have already been researched as predictors: age, academics, etc. However, they wanted to specifically focus on the executive function of inhibition. They wanted to investigate how children's impulse

control in situations is important for social emotional competence. Rhoades et al. (2009) studied the relationship of inhibition on social emotional competence. Their research purpose was based on wanting to understand the role of inhibitory control in predicting children's social emotional competence. The study's participants were preschool children that had participated in a clinical trial of PATHS program. PATHS is a program to develop social emotional competence. Assessments were conducted in the fall of both the intervention and control group that included 146 children 4-5 years old. They used the *Peabody Picture Vocabulary Test- revised* to measure receptive vocabulary. *The Kusche Emotional Inventory* was used to understand children's recognition of emotions. *The Leiter-Revised Attention Sustained Subtest* looked at children's ability to sustain attention to detail. For inhibitory control, students participated in *Stroop-like Task* called *Day/Night* and *Luria's Tapping Task called Peg Tapping*. The preschool and kindergarten behavior scales were used to look at social skills and problem behaviors from the teacher's perspective. Rhoades et al. (2009) found in their study on inhibition and social emotional competence that their participants were one standard deviation below the norm in receptive vocabulary, and were in the normal ranges relative to sustained attention and performed higher on *Day/Night* than on *Peg Tapping*. They found that receptive vocabulary was strongly related to emotional knowledge and moderately to sustained attention. Inhibitory control had a positive correlation with emotional knowledge and sustained attention. Emotional knowledge was moderately correlated with sustained attention. These correlations suggest that greater receptive vocabulary and inhibitory control are associated with more social competence and the fewer internalizing problems the child would have. Greater receptive vocabulary also is

related to having fewer externalizing behaviors. In their discussion, they stated that inhibitory control is a predictor of social skills and internalizing problems. Their limitations in this study were that the tasks conducted were not solely measuring on EF. They suggested that an early intervention program be available to children with low inhibitory control. They also mentioned that the teachers' scale was the only source used to learn about the child's social emotional competence. They recommend using multiple sources in future research. They also stated that the research pointed to planning and working memory as being related to children's behavior.

Carlson et al. (2004) presented their research on executive function, specifically inhibition and planning, being related to the development of theory of mind but there is no strong research explaining which components are related to theory of mind. They wanted to understand the executive function components, inhibitory control and planning, and how they contribute to theory of mind. In this study, they studied the relationship of inhibition and planning to theory of mind. They worked with 49 preschoolers in Seattle Washington. Twenty four were 3 year olds (10 boys and 14 girls) and 25 were 4 year olds (12 boys, 13 girls). Children participated in 45 minute sessions that included the *Peabody Picture Test, Appearance-Reality, Tower of Hanoi, Bear/Dragon, Contents False Belief, Truck Loading, Whisper, Location False Belief, Gift Delay* and *Kitten Delivery*. Carlson et al. (2004) found that the vocabulary assessment was correlated with age. The theory of mind assessment showed that appearance-reality and false belief were related and four year olds performed better than three year old. For the executive function assessments, they looked at inhibitory control and planning. For both categories, they analyzed the groups of the same task and then ended up having to

analyze them separately. For inhibitory control, they analyzed the three tasks as a group and found that the four year olds performed better than three year olds but it was only significant on *the Whisper Test*. When they analyzed them separately, they found that *Bear Dragon* and *Gift Delay* were correlated and whisper was not related. *Bear/Dragon* was significantly correlated with age. Between these two analyses, *Bear/Dragon* and *Whisper* are significantly related to child's theory of mind. These are referred to as *conflict tasks* where child have to suppress a more dominant response.

Carlson et al. (2004) found that for planning measures the *Truck Loading* and *Tower of Hanoi* were related but *the Kitten Delivery* was not related. *Truck Loading* was significantly correlated with age and the PPVT. *Tower of Hanoi* was related to PPVT. *Kitten Delivery* was not related to either. They also conducted multiple regressions to determine specific contributions of inhibition and planning. After analyzing planning, they found that an individual's inhibitory control, not planning, is related to theory of mind. They also add in their discussion that they focused on action planning and it is possible that different planning measures may see a correlation with theory of mind. This research showed a relationship between conflict inhibition and theory of mind.

Blaye and Chevalier (2011) looked at goal representation in flexibility and inhibition. Goal representation is important to many components of executive function because a person needs to set a goal to know what needs to be achieved. Blaye and Chevalier found that the current literature does not look at children setting goals for themselves but rather goals being made for them.

Chevalier et al. (2012) continued this by conducting research to understand the relationship of inhibition and working memory on flexibility. They specifically focused on switch cost literature that highlight two parts of flexibility: goal representation and switch implementation. There is research that points to flexibility being a byproduct of working memory and inhibition. They wanted to delineate the three and figure out if flexibility is separate as well as how this relationship of working memory, inhibition, and flexibility change over the course of the preschool experience.

Chevalier et al. (2012) used *the Shape School* as their methodology instrument. The participants were 250 preschoolers in which 130 were boys, and 120 were girls mainly Caucasian with a small percentage of Hispanic, African American, and Multiple Race categories. The researchers placed ads promoting awareness in doctor's offices, preschools, birth announcements and relied on word of mouth. The researched conducted phone interviews in order to make sure all participants did not have any language or developmental delays. This was a longitudinal study that conducted battery tests every nine months starting at three years of age all the way through five years 3 months. The researchers worked with the children for 120 minutes to conduct these tests: *Shape School*, *Go/No Go, Nebraska Barnyard*. The parents were compensated and the children were compensated with stickers and small toys.

In *the Shape School Task,* the researchers wanted to study flexibility by having the child name the object by shape or color. The object was a cartoon character whose body was a specific shape and color. The child was asked to say the names as fast as possible but the researcher did not move on to another figure until the child responded.

The switch condition involved having the children name the cartoon characters with a hat by shape and the ones without a hat by color.

For *Go/No Go*, the research wanted to understand inhibition. The participants were asked to look at fish and sharks. They had to catch the fish but leave the shark. *The Nebraska Barnyard Task* measures working memory and required the participants to place pictures of animals in the correct order in a grid. The grid was color coded to match the animal's color. Then the child had to press the grid square that was associated with the animal when the researcher said the animal's name. They analyzed the data using a multilevel modeling. The limitation in the study was that since they used shape and color as factors, it was very difficult to understand how this affected inhibition, working memory, or flexibility.

Chevalier et al. (2012) found that the components of flexibility (goal representation and switch implementation) are not by products of flexibility. The goal representation seems to be the primary factor in this relationship and switch implementation is separate from these executive function components. They also found that children use inhibition and working memory at different ages. They posit that goal representation could be a foundation for EF development.

Executive Function and Academics

Burrage et al. (2008) wanted to understand two executive function components that would support school-based performance: working memory and inhibition. They found in current literature that prekindergarten and kindergarten skills help children with many school readiness skills such as literacy or social skills. They wanted to understand

the role of executive function and how the school experience possibly increases executive function. Burrage et al. (2008) conducted a study to understand working memory and response inhibition and how this relates to school performance. The participants consisted of 45 children: 18 older prekindergarteners and 27 younger kindergarteners. A high percentage was Caucasian with less than 10% were African American, Hispanic, biracial, or Asian American.

Burrage et al. collected data over two school years. They received consent through letters received by the student's teacher. They conducted a series of EF tasks once in the fall and then again in the spring with 20-30 minute sessions. *The Auditory Working Memory Test* and the *Head Shoulders Knees and Toes* were used for working memory and inhibition task respectively. They also administered the letter-word identification from WJIII Test of Achievement as a control.

Burrage et al. (2008) found that both *the Auditory Working Memory Task* and *the HTKS task* were correlated with the letter word identification task. *The Working Memory and Letter Word Task* both increased from fall to spring in both groups. Even though they were the same age, they found that kindergarteners had higher scores in *Working Memory and Letter Word* which they attributed to the experience of an additional school year (prekindergarten). One cautious result was that the students that attended prekindergarten had higher inhibitory control. A limitation was that they had a small number of tasks to compare and the participants were not randomly assigned. They recommend in the future using more tasks because the tasks can be interrelated. They also did not have a great socioeconomic diversity.

Brock et al. (2009) divided the executive function components into two groups called *hot* and *cold* executive functions and studied how this relates to achievement. They define hot EF as emotion and cold EF as cognitive problem-solving.

Brock et al. wanted to understand hot and cool EF as it related to kindergartners' academic achievement and learning-related behaviors and engagement. Brock et al. conducted a study with 36 kindergarten classrooms with 173 children with primarily Caucasian and some African Americans, other ethnicities.

They administered a Family demographic questionnaire and EF and achievement tasks to understand cool and hot EF. The researchers also observed children's engagement in learning. The Woodcock Johnson III Test of Cognitive Abilities and brief intellectual assessments were used for understanding cognitive abilities. Cool EF was measured by *the Balance Beam Task* and *the Pencil Tap*. The Hot EF were measured by *Toy Sort Task* and *Gift Wrap Task*. *The Toy Sort Task* asked children to sort very attractive toys without being able to play with them. They looked at learning related behaviors by using a Social Competence and Adjustment Scale. This measured self-directed learning style and hyperactive-distractibility. During observation of children, they observed Self-reliance, Attention, Disruptive behaviors, Compliance, and Engagement.

Brock et al. (2009) found that there was a moderate positive correlation between hot and cold EF. Hot EF were positively correlated with academic and behavioral outcomes except full reading. Cool EF were correlated with less family risk, cognitive ability, and academic and behavioral outcomes. Cool EF, cognitive ability, and fall math

scores were significant predictors for spring scores. *Pencil task* and *Balance Beam* were predictors of math scores. Hot EF did not predict achievement. Regarding cool EF cognitive ability, preschool age and the girl gender were rated by teachers to have higher learning related behaviors and increased classroom engagement. Hot EF was found to be a predictor of learning related behaviors. In their discussion, they mention that cool EF predicts math achievement learning-related behaviors. Hot EF did not predict academic achievement or behavior. Limitations of this study included that the tasks required some use of fine and gross motor skills which could have impacted the scores.

Relating EF to Everyday Environments

Much of the research available focuses on quantitative research in a lab setting with specific tasks that children perform. To understand the child's behavior in an environment such as school, it is important to find alternatives to lab settings. Isquith et al. (2004) explain that a new rating scale called BRIEF can be used to measure executive function in everyday activities. Because relying on a clinical setting requires children to be available and desire to participate in a foreign setting, using an assessment or scale in a child's natural setting would complement the current research. Isquith et al. (2004) wanted to see if their modified BRIEF for preschoolers (BRIEF-P) was a valid tool and if it would be able to discriminate between children with developmental differences. This is an important addition to the literature because of the difficulty to understand and assess executive function at the preschool age due to the scarcity of measures available (Blair et al., 2005; Weibe et al., 2011).

Isquith et al. (2004) sought to understand executive function in a natural setting by addressing three questions: 1. Can dimensions of EF be defined and are there differences related to age and gender? 2. What is the structure of EF that explains the relation of these components? 3. Can these components differentiate between typical and dysfunctional behaviors?

They took two samples of participants, age two to five years of age. One sample was used to make the scale development and the second was for replication. For the sample, 1,372 parents completed ratings of their children. The families were found through preschool programs and health care clinics. Teachers also provided information on 201 of the children. The data showing children with any type of special needs were not included. This was repeated with 88 parents from the same demographics and 101 teachers. The researchers edited the BRIEF scale to reflect preschool terminology. The researchers were able to create a 63 item scale with five executive domains— Inhibition, Shift, Emotional Control, Working Memory and Play/Organize.

Their second study looked at children that had been clinically diagnosed and found that the scale could pick up differences. The participants were 50 children from two to five year olds with ADHD, ASD, or a language disorder. Fifty parents completed the brief scale and twenty teachers participated. The researchers matched a sample group of children without disorders to compare. This study had limitations because the sample was small.

Isquith et al. (2004) found a small age and sex difference between the samples in their modified BRIEF scale. Boys had a slightly lower inhibitory control and in a school

setting, they had difficulty with working memory, planning and organization. Three year old children had a harder time with regulation than 2, 4, and 5 year olds. After analyzing the scales, they found three common factors: inhibitory self-control, flexibility, and emergent metacognition. In the parent sample, the scale had a significant difference between groups. In the teacher response, there was a significant difference between groups in all categories except inhibition. They confirmed through this study that inhibition and working memory are examples of fundamental EF and differentiate earlier where planning and problem solving are more complex. They also confirmed that their modified BRIEF scale is "a tool that is complementary to developmentally appropriate cognitive performance tests that measure the specific executive function processes." (p. 419).

Improving EF

Executive functioning is important in the young child's development especially in the preschool years and there is research that shows that executive function can be improved (Diamond, 2012). Diamond (2012) stressed that with this research children need to be given support and tools to help them emotionally, socially, and physically in order to be successful academically. She stated that the best activities are CogMed, a computer-based program, interactive games, task-switching computer based programs, taekwondo, PATHS program and Chicago School Readiness Project. She also mentioned mindfulness, yoga, aerobics, "Tools of the Mind" and Montessori programs as showing results. Executive function skills improve with repetition and challenging or scaffolding their current skills. Improving executive function will lead to more flexibility and

discipline. Scaffolding behaviors and emotions helps the child with the development of executive function (Carlson, 2003).

Montessori Education and Executive Function

Both Diamond (2012) and Lilliard (2012) mention Montessori education as providing support to executive function development. Montessori is a type of education for birth through adolescence and is able to provide structure for children three to five that are experiencing the spurt in executive function development. The following section will address specific examples in the curriculum and how it is similar to the tasks used in research as well as how it supports the development of executive function.

Attention. The regulation of attention greatly increases in skill between three and five years of age (Garon et al., 2008). It is important for self-regulation because the child has to shift his attention, away from a desired object for example, in order to regulate himself (Giesbrecht et al., 2010). Attention helps children adapt to their environment by being able to process and prioritize information (Berger, Kofmab, Livneh, and Henik, 2007). Sustained attention can be measured by a PDTP-R instrument and *the Shape Task*. For *the Shape Task*, children use a self inking stamper to mark the shapes on the page that are the same as an outlined example.

Although Montessori teachers do not encourage children to work as fast as they can, they do have many lessons where children have to discriminate and concentrate on their work. Montessori believed that concentration is the way children transform themselves (Montessori, 1912). In the Montessori classroom, children will work on a lesson that has sequential steps such as polishing a table. The child has to focus on the

material and not be distracted by other activity in the room. Then the child has to stay alert and maintain attention on the task of polishing a table. Similarly, children have to show selection of which material they are focusing upon— for example which part of the table needs to be polished or what material they are using.

Working memory. Hoskyn (2010) discusses working memory as an executive function that allows the child to have information in mind and connect it with new information. For working memory, there are also common tasks used to measure this component of executive function which include: *Nine Boxes, Nebraska Barnyard* and *Delayed Alternation Tasks* among others. *Nine Boxes Task* is an activity where children have to search for figurines that have been hidden in boxes that are various shapes and colors. Children can open one box per trial and can try up to 20 times until they found all the figurines. *Nebraska Barnyard Task* asks children to remember the sequence of animal names and press buttons on the computer to put them in the correct order.

In a Montessori classroom, there are many language lessons that require students to remember names and sequence of pictures while matching pictures and words. There are also practical life tasks that require memory of the items needed for a lesson and the sequence they need to be placed on the table.

The Delayed Alternation task asks children to find a small reward from a well. The wells are covered with similar covers so the child has to remember the location of the reward. Once a child chose the well with the reward, the next time the reward will be in the opposite well. It requires children to remember the previous location so they can accumulate the most rewards. This is similar to the idea that children have to remember

where materials go in the room. There are many shelves and materials and when a child chooses a material, he or she must remember where it needs be placed.

Inhibition. Response inhibition is the ability to suppress an emotion in order to do something else (Giesbrecht et al., 2010). The various tasks for measuring inhibition are *Bear/Dragon, Whisper, Gift Delay, Big- Little Stroop, Go/No-Go, Shape School, Snack Delay, Day/Night Task, Balance Beam Task, Pencil Tap* and *Peg Tapping Task.* There are many tasks that require the student to remember a rule in order to follow the directions. *The Bear/Dragon task* is an inhibitory control measure similar to "Simon Says." The children have to listen and inhibit the response to move when "Simon doesn't say" for example. *Go/No-Go* is a task where children look at pictures of colored fish and have to "catch" the fish by pressing a button on a computer. In the No-Go trial, a shark appears and the children are instructed to let it go by not pressing a button. This requires the children to remember the rule and not click the button when they see a shark. *The Shape School Task* asks children to name the color of cartoons that had a happy face and remain silent when the cartoon has a sad face. *The Day/Night Task* asked children to say the opposite of what a picture said. This required the child to inhibit the response to say the name of the picture and remember to say the opposite. *The Pencil Tapping Task* or *Peg Tapping* is a task where the instructor would tap his pencil one or two times and the child was asked to tap his pencil two or one time respectively. This required the student to not just mimic the instructor. The child had to inhibit the response to mimic and remember to respond with a different number of taps. In the Montessori classroom, there are many lessons in which a child has to remember a rule. For example, some lessons are too large for a table and should be placed on a rug. Children also have to

remember when it is appropriate to speak to a teacher. If a teacher is already working with a child, the child must inhibit the desire to interrupt her.

Whisper is where children are asked to whisper their names and cartoon characters' names. They have to inhibit the tendency to raise their voice as they talk. In a Montessori classroom, the teacher models as well as gives the child a lesson on the "soft voice". It is an expectation that the child will have to remember to keep his or her voice quiet in order to refrain from disturbing other peers.

Gift Delay is a delay of gratification where children have to sit in a chair and try not to look at the experimenter while she wraps a gift for them. This is analogous to children having to wait their turn until after teachers present the lesson. Sometimes lessons are also not available to the child because another child is using it. The Montessori child must inhibit his emotion and response to understand that he needs to wait until the material is available.

The Snack Delay Tasks gives children M&Ms and the researcher asks the children to put their hands on the placemat decorated with two handprints. Children are given up to three points for standing still, keeping their hands on the mat, and remaining silent. In the Montessori classroom, children are invited to prepare food for a classroom snack. They need to inhibit the desire to eat the snack while preparing it.

The Balance Beam Task measures motor inhibition. This task requires children to walk a line on the floor three times, each time progressively slower. This is very similar to the lesson on walking on the line where the child learns how to walk carefully around

an ellipse. The child learns from the teacher how to walk carefully through the classroom, around tables and rugs.

Planning. Planning, like many executive function components, improves in the preschool years as the child encounters new experiences (Carlson, Moses, & Claxton, 2004). Planning allows children to think through a task and be intentional about their decisions with a goal in mind.

Researchers have used the *Tower of Hanoi, Truck Loading* and *Kitten Delivery* to understand the planning ability of children. *The Tower of Hanoi* is a toy with almost concentric rings that stack on each other. Children have to plan how to stack the rings in the correct order. There are many lessons like this in the Montessori classroom. The lessons that use size discrimination are the tall tower, broad stair, long stair, graduated cylinder blocks, colored graduated cylinders, etc. There are also many other sensory tasks that involve order such as grading sandpaper tablets, baric tablets, etc.

Truck Loading is also a planning task where children have to pretend that they are mail carriers and use a truck to deliver invitations to colored houses. *Kitten Delivery* is a planning exercise where children have to decide the quickest way to gather kittens in buckets around the room. Both of these tasks ask the child to think through their movements around a room. In many activities in the classroom, children have to remember many steps as well as go back and forth to the shelf. For example, in a food preparation lessons, children have to prepare the table with tools, prepare the floor with the pail, retrieve the water, wash and cut the piece of fruit or vegetable.

Summary

The literature reviewed supports executive function as a crucial part of child development, especially in the early childhood years. The research points to themes that the executive function components in the brain are a complex and intricate system that we are continuing to learn about.

Although much of the research regarding executive function involves assessments, disorders, or implementing a program to see improvements, there is a need for more research in the observation of executive function in a natural setting, particularly the preschool setting. As more is learned about children's development, especially in executive function, this development can be supported and effective ways to guide the child to ensure a strong foundation for effective learning can be implemented.

CHAPTER THREE

METHODOLOGY

This research study focused on executive function development of three, four and five year olds within a Montessori classroom environment. The purpose was to observe the child's behavior in an academic setting by identifying the frequency of executive function components and recording patterns of behavior in the classroom. Since previous research has shown that the Montessori classroom environment supports executive function development, this research aimed to understand the child's executive function in a classroom setting and add to research by providing a mixed methodological perspective.

Research Questions

2. What are the patterns of development involving the elements of Executive Function—specifically, *inhibition, working memory, cognitive flexibility, planning* and *attention*—exhibited by the behaviors of three, four, and five year-old children in a Montessori classroom context?
    a. How do these EF patterns vary across each age group?
    b. How do these EF patterns vary within each age group?
    c. What are the similarities in executive function patterns as seen in the classroom by the observer and as reported by the teacher and the parent in the questionnaires?

d. What are the differences in executive function patterns as seen in the classroom by the observer and as reported by the teacher and the parent in the questionnaires?

Research Design

A mixed-methods ethnographic design was used for this study specifically collecting data from a teacher and a parent questionnaire as well as observations in a classroom setting for their analysis and interpretation (Creswell, 2009). Mixed method research uses both qualitative and quantitative methods in order to gain understanding from both perspectives (Creswell, 2009). *Concurrent mixed methods* allow the researcher to use both qualitative and quantitative sources to integrate the information. This specific study employed the concurrent mixed methods in order to analyze the overall results.

Ethnography is an approach to understand individuals in everyday activities by observation in a natural setting (Creswell, 2009). It is founded in anthropology as a way to observe the field (Merriam, 2009). Ethnography uses description and details of observation. Wragg (2002) reminds us that observation can often be labeled, coded, or marked without considering the "significance, meaning, [or] impact" of the events. This is why the ethnographic observation is important as it provides an anthropological approach to the classroom. Maria Montessori, who studied anthropology after medical school, made a great contribution of anthropology to the field of education (Spindler, 2000). Spindler and Hammond (2000) explain that anthropology has contributed to the field of education by studying the culture and developing the methodology of ethnography. However, all qualitative research is certainly not ethnography. The

Spindlers' spent time defining different types of ethnography such as socioethnography and psychoethnography in order to gain a clearer understanding of the word.

Spindler explains that for a study to involve ethnography, it needs to include observation (which he specifically mentions as a participant observer), spending long periods of time at the site (more than a year), and collecting a plethora of data (notes, audio, video tape, photography, drawings. Spindler and Hammond (2000) recognize that the education field is not completely ideal for these situations. For example, a teacher is a participant observer but is also balancing other tasks which may hinder the amount of detailed notes and observations she is able to do. They describe much education research as "reflective and active" where ethnography is "explanatory" (p. 47). Although this study does not reach the longevity of Spindler's requirements, it does provide detailed notes and observations as well as the goal and focus of explanation. Spindler and Hammond concur that the two fields, albeit different, do contribute to each other in an important way.

The quantitative aspect of the study analyzed the frequency and patterns of executive function component behaviors individually, weekly, and across the twelve weeks. The quantities of these behaviors were compared across and within ages for a clearer understanding of each participant, age, and gender.

From the qualitative aspect, the observations from the researcher were coded in Atlas ti and analyzed for themes and patterns. The observations, field notes and reflections were triangulated with data in children's behavior from the teacher and parent questionnaires in order to understand the executive function development of children three to five years (as cited in Bogdan & Biklen, 2011). Both the results from the

qualitative and quantitative sections were compared in order to have a deeper understanding of each age group's and each child's pattern of executive function development.

Positionality as Researcher

I am currently a student and a teacher in the field of education; however, I have a bachelor's degree in neuroscience and filter the way I see children through a developmental lens. Studying the development from birth to five is important to me because of the vast brain development during this time. I am now completing my doctorate degree in early childhood education. I strongly believe in life-long learning and giving children a strong foundation. In my research, my aim was to better understand child development and brain processes in early childhood.

I have taught at the school I observed in for the past seven years, since 2006. I have taught at both of its campuses and since May 2013, I serve as the curriculum director.

For my graduate studies, I reflected on my time teaching children. I observed that the children sometimes are successful in following through and focusing, and other times get lost or lose their intent of what they were doing. The children have tendencies to become distracted from working by socializing or loss of thought or focus. I wanted to learn more about the executive function relative to this age range in order to contribute to the current body of literature and support their learning in a more efficient way.

In designing the study, I hoped to gain a better understanding of how the children develop and use executive function in the classroom environment and understand the

patterns in their development for the three to five age span. To avoid subjectivity, I observed children and recorded factual information.

Data Triangulation in the Mixed Method Research Design

Participants and Setting

The participants were students, teachers, and parents from a primary classroom (age 2-5) at a private Montessori preschool in Georgia. The school had approximately 210 children in seven classrooms for the 2013-2014 school year. The seven classrooms consisted of three *Primary classrooms* for two to five year olds, two *Preprimary classrooms* for eighteen months to three year olds, one *Level Two* classroom for 12 to 24 months and one *Level One* classroom for three to 12 months. The school also has a second campus with approximately 310 students.

Since the primary classrooms use a multiage approach with two to five year olds, this provided an appropriate environment to observe components of executive function for this age group. The selected primary classroom had 27 students with two teachers and an assistant teacher. The children began class together in August 2013 although some of them had been students of the teachers the previous year. The school used a Montessori curriculum in a full day program.

At the primary level, the children chose lessons and worked on them independently. They were often sitting near other children at tables or on the floor while working on individual lessons. Older children offered to show new lessons and materials to younger children when the older children show competency in the lesson. The classroom had materials for lessons on Language, Sensorial, Math, Science, Social Studies and Practical Life.

There were 9 participants in the student sample: four 3 year olds (2 males and 2 females), four 4 year olds (2 males and 2 females), and one 5 year old male. The original goal was for 12 participants to consent so there would be two males and two females for each age group: three, four, and five years old. The sample was a purposive sample as the intent was to study executive function in a Montessori school. As the parents submitted their consent forms and questionnaires, the researcher chose participants based on their submission time. For example, the first two three year old females' consent forms and questionnaires to be received were placed as participants. If a third three year old female turned in her paperwork, she was not included in the study.

The parent participants received a letter explaining the intent of the study and the researcher requested that a consent form and a questionnaire be completed and returned. The parental consent was two-fold— to give permission for the child to be observed in the classroom as well as to give consent to completing the questionnaire. .

The two teachers and assistant also completed a consent form; however, there were two different versions of the form. One teacher and assistant completed a form giving consent for the research to be conducted in their classroom and possibly be observed if interacting with a student participant. The second teacher signed the same consent form but also gave consent to fill out the questionnaire for the nine participants as well as the rest of the class. It was important that the teachers not be aware of the specific participants in order to limit a bias or confounding information.

Instruments and Sources of Data

Quantitative Research Instrument

Observations. Wragg (2002) reflects on Bales' as well as Flanders' work observing groups of people. He reports that observations can also provide insight into the frequency of an event. The observer marks this type of categorical event occurred within this amount of time and also quantifies the time an event took. Flanders used a category system (FIAC) to mark the frequency of an event each minute (Wragg, 2002).

While observing, the researcher recorded the frequency of a typically occurring behavior (the five components and subcomponents) as defined by the executive function components at five minute intervals. For example, inhibition can be observed when the child controls his body, voice, and limits interrupting. Anytime these behaviors were seen in a five minute period, this was indicated in the inhibitory control chart.

Qualitative Research Instrument.

Observations. Wragg (2002) also noted that observations can take a qualitative lens that "[tells] the whole story" not just the frequency of an event (p. 10). Gestures, movement, body language can all be an important part of the classroom (Wragg, 2002). The researcher observed children in the classroom for the following categories related to executive function: Inhibitory control, working memory, attention, planning, and cognitive flexibility. As each child was observed, the specific dialogue, expressions, interactions, behavior, and lessons were recorded along with the frequencies mentioned previously (Merriam, 2009; Wragg, 2002). Some relevant pictures of the children were also taken as they related to the five categories. Within the observation session, which

typically was an hour to an hour and half, the researcher attempted to observe each participant for five to ten minutes. While observing the participant, the researcher observed for the five components of executive function and then recorded the details of each behavior.

The time was not held constant for each participant. When the researcher observed a participant, the aim was to watch an entire event or process. In some cases, this meant that a participant was observed for 10-30 minutes and not all participants were always observed every morning.

Reflections. As observations were documented, the researcher spent time writing down reflections on patterns and thoughts about the daily and weekly observations in a reflective journal throughout the study (as cited in Bogdan & Biklen, 2011). This is an important aspect of the qualitative study as insights and emerging patterns were tracked throughout the study.

Questionnaire. The teacher and parental questionnaire was a compilation of twelve multi-part questions in order to gain their perspectives on the child's behavior as they related to executive function components in the classroom and at home, respectively. The questions centered around understanding the child's personality, interests, style and ability to communicate, response to direction or redirection, memory, planning with interesting activities, concentration and attention. These questions were used to frame responses to the five components of executive function: working memory, planning, attention, inhibitory control, and cognitive flexibility.

Trustworthiness

To show the trustworthiness of the data, both the internal validity and external validity were examined (Merriam, 2009). The internal validity can be seen through triangulation and member checking. The data were triangulated to determine how the perspectives of the teacher, parents and researcher as well as the observations of the students showed patterns of child development (Creswell, 2009). The researcher's positionality was also important in understanding the validity of the study (Merriam, 2009). The researcher reflected upon the bias that may have played a part in the process of the study by reviewing the observations and personal journal.

Data Collection Procedures

Quantitative Data Collection Procedure

Throughout each morning, the researcher used a tracking form for each participant. This form had the five components and a few behaviors that could be observed. When the behavior was observed during five minute intervals, the researcher would mark on the form for that participant. At the end of each morning observation, the researcher would ensure that each participant's frequencies were recorded for the session in the five minutes intervals. This data were organized in an Excel spreadsheet for the frequencies observed daily for each participant's five components.

Qualitative Data Collection Procedure

Observations. After gaining consent from the teachers and the parents, the researcher began observing children in the following categories for executive function: inhibition, cognitive flexibility, working memory, planning and attention. Over a twelve

week period, the participants were observed for an hour to an hour and a half each day (Merriam, 2009). The researcher spent on average four to five hours per week during the morning hours of the school day observing the twelve children. There were some weeks due to the school's spring break and a conference that the hours were less than the average. The details of the participants' behavior as well as any dialogue, actions, facial expressions were recorded as well as any pertinent pictures were taken of the participants in the classroom on the tracking form mentioned previously.

Reflections. Any personal observations and thoughts in a reflective journal were documented after the observation session. Throughout each day, any observations from the environment were noted concerning the children's behavior and recorded reflections for later use (as cited in Bogdan & Biklen, 2011).

Questionnaires. The parents and one teacher completed a questionnaire on each participant. The teacher was asked to complete a questionnaire for each of the classroom students including the nine participants. The data from the parent and the questionnaire were placed into charts for each individual as well as by question for all participants for comparison.

Overall Collection

Throughout the twelve weeks of data collection, the questionnaires, observations, pictures, and reflections were gathered and organized to gain a better understanding of patterns in the classroom and process. The questionnaires were organized into nine individual charts as well as twelve charts by question. The qualitative observations were typed into word documents by individual each week to aid in analysis. The quantitative

frequencies were organized in Excel spreadsheets by individual, daily, weekly, and total summaries.

Data Analysis

Qualitative Analysis

All of the information from the observations on the children's behavior, pictures and journal notes were organized for ease of use and safety protection. Then, the data were uploaded in *Atlas ti* and reviewed to gain a general sense about patterns of executive function. This data included the weekly observations, reflections, parent questionnaire responses by question, and teacher questionnaire responses by question. The information was coded by component or other patterns in order to analyze themes. After organizing and coding the data in Atlas ti, the information was moved to a word document and organized by executive function component, patterns in ability, and development over the three months. Further analysis was done for each student as a case study analysis. The case studies were then merged to gain an understanding of answers for the research questions across and within age groups and genders.

Quantitative Analysis

The researcher entered the frequencies of each component for each student into an Excel spreadsheet daily, weekly, and across the twelve weeks for each child in inhibition, cognitive flexibility, working memory, attention and planning. These categories were analyzed with descriptive statistics for patterns with the classroom observations for the individual as well as age group.

The daily, weekly, and three-month frequencies were compared by age, gender, and within each individual. The summary frequencies across twelve weeks were also

compared between each component and insufficient component to understand ratios of behaviors.

Mixed Method Analysis

After each age group and gender was analyzed from the qualitative and quantitative data, the information was compared for any patterns. The summaries of the frequencies and the themes and patterns from the qualitative method were analyzed and compared. Each qualitative theme discovered was also compared to the patterns found in the quantitative data.

Triangulation of the Data

The triangulation of the questionnaires from the teacher and the parents as well as the patterns found in the researcher's observations was necessary to answer the final two research sub-questions. The teacher and parent questionnaires were analyzed for themes for each component: working memory, inhibition, planning, attention, and cognitive flexibility. These were compared to the researcher's findings and the similarities and differences were determined.

Protection of Human Subjects

The researcher gained consent from all of the participants prior to beginning the study. Each participant's parent and teachers signed a consent form. There are no known risks for participants in the study. Their identities were kept confidential. The researcher submitted a document stating the purpose of the study to the Institutional Review Board in the beginning of February 2014 and began the study in late February 2014. Participation was voluntary and the individuals participated voluntarily.

Summary

The mixed method approach provided valuable information on behaviors of executive function for children three, four, and five year olds. The quantitative analysis provided general information about the five categories and the qualitative analysis provided specific everyday examples. The two approaches were compared for similarities and differences. They both shed light on executive function in a statistical approach and observational approach. This methodology provides a solid foundation for executive function for three, four, and five year old children.

CHAPTER 4

FINDINGS

This study intended to observe and examine executive function development in three to five year olds in a Montessori classroom setting. The methodology of the study sought to address the main research question: what are the patterns of development involving the elements of Executive Function—specifically, *inhibition, working memory, cognitive flexibility, planning* and *attention*—exhibited by the behaviors of three, four, and five year-old children in a Montessori classroom context. The sub-questions addressed understanding how executive function patterns vary across and within each age group as well as the differences and similarities in executive function patterns, as documented in the researcher's observations, the teacher questionnaire, and the parent questionnaire.

The study was conducted in a private Montessori preschool in Atlanta, Georgia with a total of nine participants, spanning three to five years of age. The following chart describes the demographic information of the participants. The participants' identities are protected as the listed names are pseudonyms.

	Age	Gender
Stacy	3y 5m	F
Elizabeth	3y 9m	F
George	3y 9m	M
Charles	3y 10m	M
Benjamin	4y 0m	M
Kyle	4y 4m	M
Julia	4y 6m	F
Sara	4y 10m	F
David	5y 0m	M

The sources of data include both quantitative and qualitative aspects. The frequencies of the five components (working memory, inhibition, cognitive flexibility, attention, and planning) were included in the quantitative analysis. The researcher's observations of the participants, teacher questionnaire, and parent questionnaire were included in the qualitative analysis.

After completion of the twelve weeks of data collection, the qualitative data were coded and analyzed for themes and patterns and the quantitative data were analyzed through comparative statistics in order to understand the development of executive function of children three to five years of age in a Montessori classroom. These findings were organized so as to answer the main research question and sub-questions as listed above.

The researcher began the analysis phase by loading all of the documents including observations, teacher and parent questionnaires, memos, field notes, and frequency charts

into a qualitative data analysis software called *Atlas ti*. This software allowed the data to be organized by code, families, and quotations from multiple documents in order to discover phenomena, patterns and themes in the data. The quantitative data were organized in *Excel*, a spreadsheet software, by the five components' frequencies for each individual. The frequencies were further analyzed by calculating ratios of each component frequency to the insufficient component frequency for each participant. The calculated ratios provided a different perspective in order to analyze the frequencies and consider the patterns by gender and age.

Qualitative Data

The researcher coded the data for the following components of Executive Function: *working memory, planning, attention, inhibitory control,* and *cognitive flexibility*. After coding the 24 documents, an 1800 page listing of the coded examples was transferred into a word document for further analysis. For each individual participant, the researcher wrote a case study summary and analysis for the five components. Each case study was on average 20 pages in length with a wealth of data on each participant. These data were merged and organized by component and age. At this point, the researcher was able to discover patterns in each executive function component as well as understand differences or similarities between genders. The first draft of the findings chapter was written after analyzing each component for themes and patterns across and within age and by gender. This draft went through a series of revisions as more patterns and themes emerged.

Quantitative Data

The researcher made several charts to organize the quantitative data which consisted of the frequencies of the five components for each participant weekly and overall. These data were analyzed by comparison of quantities and ratios to reveal relationships between the components. The researcher also calculated the percentage of participants that exhibited examples for each of the quantitative findings. For example, one of the patterns of the executive function component of attention was taking mental breaks and 100% of participants were observed doing this while working. If the number of participants was more than fifty percent of the group across the whole, age, or gender, it was kept as a pattern of the component. If it was less than fifty percent, it was left out of the analysis.

Data Analysis Findings

The main patterns identified were based on the following components of executive function: working memory, planning, attention, inhibitory control, and cognitive flexibility. The overall finding in the data was that there was no pattern based on age or gender. The sub findings are explained below by cluster, patterns, and relationships between these components. The five sub findings of the patterns of executive function components in the Montessori classroom were 1) the cluster of working memory/planning/attention, 2) patterns of frequency of components, 3) the role of interest in EF components, 4) patterns within each of the five components, and 5) patterns of data triangulation between the parent, teacher and researcher. The matrix listed below provides an illustration of the overall findings.

Master Matrix

		# Participants	% Participants	
1.0	**Working Memory, Planning, and Attention**			
1.1	**Working on a lesson**	**9**	**100%**	
1.2	**Ability to complete a lesson**	**9**	**100%**	
2.0	**Quantitative Analysis and Development**	**9**	**100%**	
3.0	**Interest**	**9**	**100%**	
4.0	**Isolated Components**			
4.1	**Patterns of insufficient working Memory**			
4.1.1	***Incomplete tasks***	***4***	***100% of three year olds, 44% overall***	
4.1.2	***Developing skill for activity***	***5***	***55%***	
4.2	**Patterns of attention**			
4.2.1	***General ability***	***9***	***100%***	
4.2.2	***Interest & repetition.***	***7***	***77%***	

4.3	**Patterns of insufficient attention**			
4.3.1	***Transitioning***	***3***	***66% of males, 33%***	
4.3.2	***Mental breaks***	***9***	***100%***	
4.3.2.1	*Exploration*	*7*	*77%*	
4.3.2.2	*Observing*	*7*	*77%*	
4.3.2.3	*Fatigue*	*7*	*77%*	
4.3.2.4	*Looking out window or across room*	*7*	*77%*	
4.3.2.5	S*ocializing*	4	44%	
4.4	**Patterns of inhibitory control**			
4.4.1	***Movement***			
4.4.1.1	*Body*	*9*	*100%*	
4.4.1.2	*Materials*	*9*	*100%*	
4.4.2	***Voice***	***8***	***88%***	
4.4.3	***Interrupting***	***8***	***88%***	
4.5	**Pattern of insufficient inhibitory Control**			
4.5.1	***clumsy movements***	***6***	***66%***	
4.6	**Patterns of cognitive flexibility**			
4.6.1	***Problem solving***			
4.6.1.1	*Individually*	*9*	*100%*	
4.6.1.2	*Teacher's help*	*7*	*77%*	
4.6.1.3	*Peer's help*	*4*	*75% of three*	

			year olds, 44% overall	
4.6.2	**Redirection**	**9**	**100%**	
4.7	**Patterns of Planning**			
4.7.1	***Watching peers***	***5***	***80% of males, 55% overall***	
4.7.2	***Transition***	***4***	***60% of males, 44% overall***	
4.7.3	***Verbalizing planning***			
4.7.3.1	*Communication with teacher*	*5*	*55%*	
4.7.3.2	*Problem solving*	*5*	*55%*	
4.7.3.3	*Making decisions*	*6*	*66%*	
4.8	**Examples of insufficient planning**	**7**	**77%**	
5.0	**Patterns in Triangulation of Data**	**Parents**	**Teachers**	**Observations**
5.1	**Working memory**	**=**	**=**	**=**
5.2	**Planning**	**=**	**=**	**=**
5.3	**Attention**	**≠**	**=**	**=**
5.4	**Inhibitory control**			
5.4.1	***Voice***	**≠**	**=**	**=**
5.4.2	***Interrupting***	**≠**	**=**	**=**
5.5	**Cognitive flexibility**	**≠**	**=**	**=**

The first four sub findings detailed below are structured to answer the main research question and first set of sub-questions: 1) what are the patterns of development involving the elements of Executive Function—specifically, *inhibition, working memory, cognitive flexibility, planning* and *attention*—exhibited by the behaviors of three, four, and five year-old children in a Montessori classroom context and 2) how do executive function patterns vary across and within each age group. The fifth sub finding answers the second set of sub questions: what are the similarities in executive function patterns as seen in the classroom by the observer and as reported by the teacher and the parent in the questionnaires and what are the differences in executive function patterns as seen in the classroom by the observer and as reported by the teacher and the parent in the questionnaires.

Working Memory, Planning, and Attention

The first finding was the emergence of a cluster of three of the five executive function components: *working memory, planning and attention*. There were two patterns within this cluster across age groups— working on lessons as well as the ability to complete the lesson. The three components of working memory, planning, and attention were observed simultaneously when the participant was engaged in working on a lesson. If the participant was observed as confidently being able to complete the lesson, these three components of executive function were also observed simultaneously. The opposite was also observed— if the participant was not engaged or was not competent with working on the lesson, there were aspects of insufficient attention, insufficient working memory, and insufficient planning that were observed.

Working on lessons. The cluster pattern was repetitively observed while children were engaged in a lesson. An example of this pattern is when participants demonstrated working memory and planning of where to find materials and how to put them away. For example, when working on a self-guided project, all participants were able to gather materials such as pencils, scissors, and glue that were necessary to complete the project.

When working in each subject area, the participants were observed using working memory, planning and attention skills to be able to successfully complete lessons. For example, in math, the participants remembered and planned how to count quantities, complete operations and write numbers in order to complete lessons. This required working memory of numerals and quantities, planning to complete the equation and attention to follow the equation. In language, there were many lessons using sounds, letters, writing, and reading. The participant had to remember the sound and letter association, plan the steps to write or read the word as well as sustain attention to complete the task.

The youngest participant, Stacy (3:6F), showed the least frequency of this cluster. She repeatedly chose the same work— the binomial cube and did not work with lessons that required completing multiple steps for working memory such as food preparation lessons. The Binomial Cube is a sensorial lesson with four prisms that when put together create a larger cube based on the binomial cube equation $(a + b)^3$. However, her frequency of *working memory, planning, and attention* increased over the twelve weeks when she returned to work with the tall tower and the broad stair. The tall tower and broad stair are two series of cubes or prisms respectively for understanding size

discrimination. In contrast, a slightly older three year old, Elizabeth (3:9F), was able to complete multiple steps of lessons such as working with addition by reading the equation, collecting the beads, calculating the sum and recording the equation.

A four year old, Julia (4:6F), was still mastering and building this cluster of components with more advanced math lessons such as the multiplication board. The multiplication board is a special indented board which holds beads in order to illustrate multiplication equations. If a child chose the equation "5 x 4 =", he would create four columns of five beads to create a rectangle representing the product of 20. However, when Julia was working with lessons such as banana slicing and writing short vowel words with the moveable alphabet, she was observed having strong attention, working memory, and planning. The moveable alphabet is a material that includes alphabet letters organized in a compartmented box which allows the child to write words by placing the letters together.

The participants with the strongest examples of working memory, planning and attention were the two oldest participants who were four and five years of age (Sara 4:10F, David 5:0M). They maintained high frequencies of this cluster of components over a period of time when working in practical life, sensorial, language, and math.

Ability to complete the lesson. A second pattern of this cluster was that these components were observed when the participant was competent with the lesson. If the participants seemed to not be fully competent with the lesson, they had trouble maintaining their attention and completing the lesson. All ages were able to focus and complete many lessons in practical life such as food preparation and washing lessons. One three year old, George (3:9M), was able to focus and complete washing a table up to

four times in repetition. A four year old, Julia (4:6F), was observed completing banana slicing two times in a row. A five year old, David, was observed working on cloth washing with many repetitions as well.

When the participant was not competent with the lesson and appeared to be learning a new concept, the participants showed patterns of losing focus, looking around the room, and watching their peers. For the three year old participants, it was more common for the participant to lose focus when working with initial sounds or sounding out words. Tasks such as reading, addition, multiplication or subtraction were common examples with the four and five year old participants.

One three year old, George (3:9M), was having difficulty with the initial sound/letter association of words. He was working on sorting pictures by their initial sound. The teacher sat with him and asked him what several pictures were. He was able to tell the teacher that the picture was an alligator and told her what it started with. However, when he returned to the table to work by himself, he picked up the picture of "milk" and said the sound, and had to ask a peer which letter milk goes with.

When a four year old boy, Kyle (4:4M), was working on multiplication, he was trying to complete the multiplication board for the table of three. He was observed playing with his pencil until the teacher sat with him. A five year old child, David (5:0M), sometimes got confused while working with the two colored alphabets when writing long vowels. The two colored alphabets are two boxes of cards each depicting a letter of the alphabet. One box has red letters and the other box has blue allowing the child to form the word as done with the moveable alphabet but highlighting the long vowel. For example, the word "cape" would have a blue "c" and "p" and a red "a" and

"e". He tried to write the word and then go tell the teacher the letters he used to see if it was correct.

Quantitative Analysis & Development

The main findings in the analysis of the quantitative data were that the overall frequencies did not have a pattern based upon a comparison of age or gender, except for the ratio of the cluster to insufficient attention. The cluster of *working memory, attention and planning* to insufficient attention ratio for each individual was the only comparison that was related to age. The older participants had lower ratios with higher frequencies of the cluster and lower frequencies of insufficient attention. This illustrated that the older participants spent more time in productive behavior and less time on task behaviors than their younger peers. The younger participants had higher ratios of the cluster to insufficient attention with a smaller gap between their frequencies of the cluster and insufficient attention (See Table 3). This illustrates that the younger participants spent less time than their older peers on productive behaviors and more time on off task behaviors.

The cluster of *attention, planning and working memory* emerged in the highest frequencies as compared to the five isolated components of Executive Function (attention, working memory, planning, cognitive flexibility, and inhibitory control). The lowest frequencies across ages were insufficient working memory and insufficient planning. Attention, insufficient attention, inhibitory control, insufficient inhibitory control, cognitive flexibility, insufficient cognitive flexibility had similar counts across all ages. Most participants had more examples of each component than the insufficient component examples. However, three participant's frequencies (Charles 3.10M,

Benjamin 4.0M, and Julia 4:6F) for inhibitory control had more examples of insufficient inhibition than examples of demonstrating inhibition.

Interest

The third major finding in the data was the role interest in the activity played in all five of the components of executive function. In a Montessori classroom, children make their own decisions regarding which lesson they would like to work on. When a participant chose a lesson and showed interest in working on the lesson, examples of working memory, planning and attention were observed. The participant was focused on the activity and concentrated for a period of time in order to complete the lesson.

The pattern of interest was also observed with the behaviors of inhibitory control. The participants concentrated on controlling their movements and voice in order to complete the activity. The cognitive flexibility component was more complicated to observe than the other components. For example, most participants responded positively to redirection. Redirection occurred when the participant was invited to join a lesson with the teacher, was showing inappropriate behavior or was asked to transition for a classroom routine such as lunch. However, one participant, Benjamin (4:0M), who wanted to do a lesson that another child was already working on became very upset and showed insufficient cognitive flexibility when he had interest in the unavailable activity.

Isolated Components

A fourth finding in the data was that each of the five components (working memory, attention, planning, inhibitory control, and cognitive flexibility) exhibited certain patterns that arose within each component, across age groups or within age groups or genders. The components are presented below with descriptions of the patterns that

emerged. The percentage of participants that exhibited these behaviors was also recorded. Only patterns that had 50 percent or more of the participants represented in the data were considered significant and were included in the findings.

Patterns of insufficient working memory. There were two patterns that emerged when analyzing the examples of insufficient working memory: (a) the participant did not fully complete a task or (b) the participant was still developing the skill he or she was working on but still needed assistance from the teacher.

Incomplete tasks. This pattern was observed in 100 percent of the three year old participants and 44% of the total participants. Many three year old participants were observed not completing the lessons or not cleaning up their work completely when they put it away on the shelf. The teacher also mentioned this phenomenon in the questionnaire, specifically for the two three year old females, Stacy and Elizabeth (3:5F, 3:9F) and one three year old male, George (3:9M). George (3:9) showed patterns of not cleaning up with language projects but was conscientious with it in practical life.

Developing skill for activity. In the observations, working memory was inconsistent when participants were developing a skill for an activity as seen in 55% of the participants across all age groups. These participants spoke out loud about the task they were working on as well as talked to their peers and teacher. The three year olds were observed working on a lesson in an area where the teacher initiated a task such as working on initial sounds. The four year olds and a five year old needed assistance from the teacher in more advanced math or language work such as multiplication, skip counting, and reading that they had initiated themselves. They often stopped working and went to the teacher for help. A four year old participant, Julia (4:6F), when working

on math lessons such as multiplication or skip counting sometimes stopped in the middle and said out loud, “how do you do it?”. A four year old, Sara (4:10F), and a five year old male, David (5:0M), both worked on challenging lessons and sometimes needed the teacher’s assistance in language or math lessons.

Patterns of attention. There were three patterns of attention that were observed: level or ability of skill for specific task, interest, and repetition. Each participant had a range of ability and interest. Many participants were observed repeating the same activities in the areas that they also showed the most sustained attention and interest in. The participants were observed concentrating and having attention on the activity that they were competent completing.

General ability. The ability to sustain attention varied among participants. The youngest participant, Stacy (3:5F), had the least attention span for completing lessons in the beginning but showed the most improvement over the twelve weeks as her competence in working with her lessons improved.

Two males, Charles and Benjamin (3:10 and 4:0) were similar in their attention spans. They both were focused when they were not distracted by their peers and when working on something that interested them. Four other participants, George, Elizabeth, Sara and David (3:9F, 3:9M, 4:10F, 5:0M) were observed with consistent focus for long periods of time and could transition well between activities.

Four participants, George, Elizabeth, Kyle and Julia (3.9F, 3.9M, and 4:4M, 4:6F) showed consistent focus when creating something while cutting, coloring, paper punching or gluing. Two participants, George and Sara (3:9M and 4:10F) also showed

patterns of consistent attention when working in practical life with the longer lessons such as banana slicing or table washing. Two participants, Stacy and Kyle (3:6F and 4:4M) were observed being focused when the teacher initiated an activity.

The two oldest participants, Sara and David (4.10F and 5:0M), had a consistent attention span in all areas of the room as well as for the entire observation segment most mornings. Almost every morning, they stayed in a focused state and did not show any examples of being distracted or losing focus. The female participant (4:10F) worked on many lessons over a span of time such as initial sounds, writing, reading, and polishing a mirror. The male participant (5:0M) worked on one lesson for a long period of time (sometimes over an hour) such as sewing or various operations in mathematics.

Interest & repetition. The two patterns of interest and repetition were consistent and are presented together. The level of interest a child showed in an activity, the level of concentration and the use of repetition of the activity were often observed together.

The youngest participant, Stacy (3.5F), showed interest, attention, and repetition when she was working on a project the teacher gave her. Some participants had concentration, interest and repetition when working on projects in language (Elizabeth 3:9F, Kyle 4:4M, Julia 4:6F). Others showed concentration, interest, and repetition when working in practical life (George 3:9M, Charles 3:10M, Benjamin 4:0F, Julia 4:6F). The two oldest participants, Sara and David (4:10F, 5:0M), spent the majority of their time in math and language. The oldest participant, David (5:0M), repeated many lessons and typically worked for over an hour on each activity. There were two participants, Charles

and Benjamin (3:10M and 4:0M) that did not typically repeat lessons. They worked until it was complete but not necessarily did the work over again.

Patterns of insufficient attention. There were many examples of participants with insufficient attention across the three and four year old age groups with *on task/off task* behaviors. On task/off task behaviors were observed when the participant was alternating between being focused on the task at hand and being distracted or taking a break. The two patterns of insufficient attention that emerged were transitioning in the room and taking mental breaks.

Transitioning. Sometimes participants were observed transitioning between activities and appeared to be "off task" and not engaged in looking for another activity. For example, 60% of male participants (Charles 3:10M, Benjamin 4:0M, Kyle 4:4M) walked around the room and at times would pull on their clothes. It is hard for the researcher to say if this was an unproductive or productive use of their time.

Mental breaks. At times, in the middle of working on a lesson, many participants were observed with "off task" behaviors such as taking a break, pausing or stopping doing their work for a period of time. Similar to transitioning, the main finding with the on task/off task behaviors was that it was difficult to observe the result or implication of the off task behavior and if it was a productive use of the participant's time to find work. It is possible that the off task behaviors were ways of processing information or preparing themselves for the next steps.

These breaks varied for different participants and different scenarios. Sometimes the participant explored the material instead of completing the lesson, other times he or

she observed peers, spent time looking around the room or out the window, showed fatigue, or socialized with a peer.

Exploration. Seventy-seven percent of the participants (except Stacy 3:5F and Sara 4:10F) showed examples of exploration with their materials at some point over the twelve weeks. These participants showed concentration in the lesson but there was a certain "trigger" activity that typically led them to take a break and explore the materials. For example, for some participants (Charles 3:10F, Benjamin 4:0M, Julia 4:6F), working on an operation in mathematics led them to start coloring on a paper or playing with the materials. For one male participant, George (3:9), working on paper punching was an activity where he did not complete the activity and played with the awl. Paper punching is an activity where the child uses an awl to perforate the paper to create a shape. For another male participant, Charles (3:10), when working on the exponential cube, he explored the materials but not necessarily used the cube and prisms in the correct way. The exponential cube is similar to the binomial cube mentioned previously but it represents the power of two where each prism is double the size of the previous. Although this was atypical, a five year old male participant, David, only had one day where he was observed exploring materials with matching objects in language by making the animals interact.

Observing. Seventy-seven percent of the participants also spent time observing their peers in the room (Stacy 3:5F, George 3:9M, Elizabeth 3:9 F, Charles 3:10 M, Benjamin 4:0M, Kyle 4:4 M, Julia 4:6F). One three year old, George (3:9M) and one four year old, Kyle (4:4M) watched their respective peer's activities and if it was something they knew how to do, they often chose this after the peers had completed their respective

tasks. Other three and four year olds, Charles and Benjamin (3:10M and 4:0M) watched their peers intermittently while working on their own work. The two oldest, Sara and David (4:10F and 5:0M), were not observed taking breaks to watch their peers.

Fatigue. Seventy-seven percent of participants were also observed showing signs of fatigue while working or taking a break. They were observed rubbing their eyes, yawning, and stretching. Two participants, Stacy and Kyle (3:5F, 4:4M) were often observed yawning and stretching while working or while taking breaks. Although this was atypical, the two oldest participants, Sara and David (4:10F, 5:0M) were infrequently observed seeming tired while working by yawning or rubbing their eyes.

Looking out the window or across the room. Seventy-seven percent of participants took breaks by looking out the window or across the room. There were only a few examples where two participants, Stacy and Benjamin (3:5F, 4:0M) looked out the window. For example, the youngest participant, Stacy (3:5F) looked out the window and rolled her head around or looked across the room often appearing tired, bored, or uninterested.

Looking across the room was a more common activity for many participants (five out of nine participants: Stacy 3:5F, Charles 3:10M, Elizabeth 3:9F, Benjamin 4:0 M, Julia 4:6F). Two males (Charles 3:10 and Kyle 4:4) observed specific people close to them. The two oldest participants, Sara and David (4:10F, 5:0M) did not spend time taking mental breaks looking across the room.

Socializing. Sixty percent of males and 44% overall socialized with peers while working. They often sat at the same table or at an adjacent table to their peers and were

distracted by their peers' activities (George 3:9M, Charles 3:10M, Benjamin 4:0 M, Sara 4:10F).

Two participants (Charles 3:10 M, Benjamin 4:0M) laughed and played with the peers around them. One example is that a four year old male was working on a dressing frame and began putting it over his face and head and then laughing with the peer next to him. The dressing frames are a series of wooden frames with cloth stretched around them. Each frame utilizes a different skill to open and close the cloth (zipping, buttoning, tying). The teacher's questionnaire stated that "when working in the room, [Benjamin 4.0M] can get distracted by his peers, because he usually wants to sit with them and work with the lesson that they already chose" (Teacher, personal communication, April 1, 2014). The teacher also stated in the questionnaire that Charles (3.10 M) "gives up when he sees a friend doing a different lesson" and loses attention "when he is around certain peers and they are influencing him" (Teacher, personal communication, April 1, 2014)

The participant, Sara (4:10F) socialized frequently with those around her and if she was distracted or bothered by her peers at the table, she often times was not able to complete her task. For example, when she was tracing numbers, she said to a boy at the table, "no, you're not invited to my birthday", "only girls are allowed." Sometimes when she was trying to concentrate, she became irritated by her peers. The teacher also reiterated that she "only has difficult when talking to friends" and she "doesn't finish when there is something else to do" (Teacher, personal communication, April 1, 2014).

Patterns of inhibitory control. The participants showed inhibitory control in the following patterns: their movements, use of materials, volume of their voices, and waiting for help from the teacher. Inhibitory control of movements was observed when a

child was intentionally inhibiting his body for a purpose; for example, carrying a tray or slowing body movement down to a walking pace instead of a fast pace.

Movement. Inhibition of movement also had two patterns: the body and care of the materials.

The body. One hundred percent of the participants showed behaviors of inhibitory control with their body movements. The classroom had a rectangle shape made with tape on the floor where the students could walk with an egg in a spoon around the line. Two participants, Elizabeth and Benjamin (3:9F, 4:0M) were observed practicing inhibitory control with this material.

Two participants, Stacy and Julia (3:5F, 4:6F) exhibited different behaviors depending on what they were working on. If they were interested and focused, they showed inhibitory control. But if they were distracted or disinterested, they lost inhibitory control. For example, when the three year old, Stacy (3:5F) is cognizant, she was very careful but when she was distracted or not paying attention she did not control her movements. She rolled her head around, wiggled in her chair, and kicked and swung her feet. When the four year old, Julia (4:6F) was fully engaged in a lesson, she had strong inhibitory control of her movements and voice. However, when she was working on a challenging lesson such as multiplication, she lost concentration and control over her body by wiggling in her chair or on the floor.

One three year, Elizabeth (3:9F), one four year Sara (4:10F) and a five year old, David (5:0M) had strong inhibitory control in movement. When walking with materials, they were cautious about their steps and gentle when using the materials.

Materials. One hundred percent of participants were careful when working with materials. For example, when two participants, George and Elizabeth (3:9M, 3:9F) worked with the sponge squeezing lesson, they had to be careful to not move the sponge before the water stopped dripping. Sponge squeezing involved moving water from one bowl to another on a tray using a sponge. A four year old, Sara (4:10F) was always careful to stack papers when she was done with writing labels. Another example is when David, a five year old (5:0M), was careful when working with the moveable alphabet and neatly placed each letter on the line to form a word.

Voice. Eighty-eight percent of participants used quiet voices as seen by the researcher and the teacher. When speaking to peers or to the teacher, they used quiet voices to convey what they wanted to say. The youngest participant, Stacy (3:5F) had a calm, quiet voice in the classroom; however, at home, her mother described her voice as normal but became loud and screaming if she was interrupted or frustrated. Another participant, Charles (3:10M) did not inhibit his voice when someone was doing something in the classroom that involved not following the rules.

Interrupting. Eighty-eight percent of participants did not interrupt when they needed the teacher's attention and waited by the teacher if they needed her help. They glanced at the teacher to see if she was busy and then returned to their seats if she was not available. Each participant had a varying level of comfort with interrupting the teacher. Most participants walked to the teacher and placed a hand on the teacher's shoulder or in the air to indicate that they needed the teacher's attention. However, two participants, Stacy and Kyle (3:5F, 4:4M) did not interrupt the teacher and often waited at their table until the teacher noticed them.

Sometimes, one participant, Benjamin (4.0M) abruptly interrupted the teacher without waiting by her side when he needed something such as a stapler for his work. The teacher affirmed in the questionnaire that he "is likely to interrupt when he wants something or needs attention" (Teacher, personal communication, April 1, 2014). The parent said in her questionnaire response, "whenever two adults are trying to have a conversation and the focus is not on him," he is likely to interrupt" (Parent 7, personal communication, February 26, 2014).

Insufficient inhibitory control. When the participants showed insufficient inhibitory control, the main behavior that emerged was clumsy movements.

Clumsy movements. One hundred percent of three year olds and sixty-six percent of participants overall had examples of clumsy movements. The researcher observed participants, mainly across three year olds, dropping materials on the floor. Some participants also showed a lack of body control in general. For example, the youngest participant, Stacy (3:5F) turned around in her chair and kicked her legs when she was not engaged in the lesson.

One participant, Julia (4.6F) had the highest frequency of clumsy movements which appeared to fall into three categories: 1) not being careful, 2) low attention, or 3) losing interest in the material or distraction by her peers or other materials. She tripped, fell over, or spilt materials frequently. Her mother explained that "she loves helping at home, though most times she makes a mess" (Parent 5, personal communication, February 26, 2014). The three oldest participants (4:4M, 4:10F, 5:0M) did not struggle with clumsy movements.

Cognitive flexibility. Cognitive flexibility was a difficult component to observe. There needed to be an interaction or situation that caused the participant to respond. In the examples that were observed, the situations centered around problem solving and redirection. When the participant was redirected by a teacher and chose new work, was asked to move to a different table or when a problem arose in the room, such as a spill, the situation made it necessary for the participant to respond.

Problem solving. When a participant was in a situation that required cognitive flexibility, he or she was observed problem solving individually or by asking the teacher or peers for help.

Individually. One hundred percent of participants were observed trying to solve a problem by themselves. The examples of this varied for each individual. One participant, Stacy (3.5F) problem solved in situations over which she had control. For example, when she was trying to unroll her rug, a child's sweater was on the floor blocking the space she needed. She rerolled the rug and tried again and after several tries finally slid the sweater over to make space.

One participant, Elizabeth (3:9F) was observed responding to two peers that started playing with her work. She said "stop" but did not get upset even though they were bothering her. In another example, when she did not have enough space when working next to a peer, she said "I don't have enough room" two times quietly.

The oldest participant, David (5.0M) was hesitant to go to the teacher and tried to problem solve by himself. For example, when he could not untie his apron, he slid it down his legs. When he did not know how to do a more complicated lesson, he either

waited for the teacher or sometimes put it away in his folder until the teacher was available.

Teacher's help. Seventy-seven percent of participants (Stacy 3.5F, Elizabeth 3.9F, George 3.9M, Benjamin 4:0M, Kyle 4:4M, Julia 4:6F, Sara 4:10F) requested help from the teacher or the assistant to solve their problems or to help them move past an obstacle. They went to the teacher or assistant and raised their hand or put a hand on the teacher's leg or arm to wait for the teacher to acknowledge them.

One example was when the youngest participant, Stacy (3:5F) worked on an activity that was initiated by the teacher, she relied on the teacher to help her. For example, she was leaning on the table and looking at another table and the teacher asked if she wanted a glue stick. She nodded and the teacher had to encourage her to pick up the glue stick when her peer was done using it.

One four year old, Julia (4:6F), relied on the teacher to solve her problems. For example, when trying to zip her coat, she went to the assistant and told her she could not figure out how to do it. When working on banana slicing, she also struggled with starting to peel the banana and often told the teacher that she could not do it.

Peer's help. Seventy-five percent of three year olds and 44% overall asked for assistance from their peers. For example, one participant, Elizabeth (3:9F) asked a peer to help her close a Ziploc bag of corn kernels.

Redirection. One hundred percent of the participants across age groups were comfortable with redirection, especially if they were able to work with the teacher. Most of the examples of the participants being redirect regarded being invited to work with the teacher on a new lesson.

Two participants, Charles and Benjamin (3:10M and 4:0M) were redirected when they were not following the rules in the classroom. They both typically responded positively when being reminded what to do. For example, when the four year old, Benjamin (4.0M) was working with the binomial cube, he began stacking the blocks into two towers. He shifted the blocks and watched them fall on the table. The teacher reminded him that this is not the way to use the binomial cube and he should get out the tall tower if he wanted to build a tower. The participant looked behind him and saw that the tall tower was not available on the stand so he put away the binomial cube and got out the broad stair instead. The tall tower and broad stair are both materials practicing size discrimination. At home, the mother of the four year old said the opposite of what was observed—that when he did not want to do something, he often did not comply and that he usually "[cried], [threw] a fit" and that "he [was] very stubborn" and "it's hard to redirect [him]" (Parent 7, February 26, 2014).

Patterns of planning. There were varying behaviors across ages in the ability and strategy of planning. Before a decision was made by the participant to transition to a new activity, the participants' behaviors fell into three patterns: 1) they watched their peers, 2) they used transition time or 3) they verbalized out loud to make decisions. While working on a lesson, all participants across age groups uniformly were able to plan the steps to complete lessons.

Watching peers. The phenomenon of watching peers to aid in decision-making was observed in eighty percent of males (all three and four year old males) and one female.

One female, Elizabeth (3:9F) watched peers while working on her own lesson or sat down with the teacher while she was presenting a lesson to another child. The four boys, ranging in age between three and four years of age, watched peers working on a lesson and often chose that lesson at some point in the morning after the peer had completed it. One three year old male, George (3:9M) watched his peers when he was not extremely engrossed in the lesson that he was working on. For example, he spent some time talking to a four year old about working on the hundred board and then intermittently watched her while he was working. The hundred board is a 10 x 10 grid with 100 tiles labeled 1-100. The children practice putting the tiles in order moving from the top left corner across each row. Two four year old males, Benjamin and Kyle (4:0M, 4:4M) watched their peers and then selected the same material after their peers were finished.

Transition. Sixty percent of males used the time after completing an activity to walk around the room a few times before making their next decision. This was mentioned previously as part of insufficient attention. The examples listed below were categorized as "planning" because there was a direct action after the transition. For example, one three year old, George (3:9M) sometimes walked around the room a few times, looked at the shelves and then made a choice. One four year old, Kyle (4:4M) used transition time to make a new decision coupled with looking at the teacher's availability. He spent time walking around the room glancing at the teacher, waiting for her to look up and redirect him to a new lesson.

Verbalizing planning. The participants exhibited the verbalization of their thoughts to aid them in planning in various ways: by communication with the teacher, by problem solving and by decision making.

Communication with teacher. Fifty-five percent of the participants across age groups communicated with the teacher when planning. They were observed asking for something that they needed from the teacher, such as a specific piece of paper that was not accessible to the children. The three year old male, Charles (3:10) sometimes asked the teacher a seemingly superfluous question such as asking to cut bananas even though it was something available for him to choose. The two oldest participants, Sara and David (4:10F and 5:0M) communicated with the teacher when they needed help sounding out a word that they were attempting to write. For example, when the four year old, Sara (4:10F) was working with the moveable alphabet, she went to the teacher to ask her how to write "egg". She said to the assistant "I need an 'e' and a 'd' so the assistant joined her at her work to help her sound out the word.

When writing with the moveable alphabet, the five year old, David (5:0M) went to the teacher to report what he was going to do next, such as moving on to writing "d" words or to report what he had finished.

Problem solving. Fifty-five percent of participants ranging from three to four years of age were also observed verbalizing problem solving. When two males, George and Charles (3:9, 3:10) and three females, Elizabeth, Julia and Sara (3:9, 4:6, 4:10) encountered something that they did not understand, they tended to talk out loud and make statements or ask questions relevant to the work they were doing. For example, when a three year old, Elizabeth (3:9F) was working on addition, she had the colored

beads out, but only one of each quantity from 1 to 10. The colored beads are beads on individual wires creating quantities 1-10. When working on the equation 2 +2 =, she said to herself "2 plus 2" and got up and walked across the room to get more "two" bead bars. Sometimes when the female, Julia (4:6) was attempting to solve a problem, especially in math, she needed the assistance of the teacher. She also often counted out loud and was able to correct herself when working on the multiplication board, if the teacher was not available. For example, one time she was working on the table of ten and counted to 31. She recounted the beads and said, "30? Not 31, 30!" and wrote down the correct answer.

Making decisions. Sixty-six percent of participants ranging across ages talked to themselves while making decisions and planning. This subset of participants announced out loud to themselves that they were going to begin or end lessons or organize the lesson in a certain way. They all spent time stating out loud different steps in the lesson. This included materials that were necessary for the lesson, next steps in the longer multi-step lessons such as banana slicing or counting to complete an activity in math, such as the hundred board. For example, when a three year old, George (3:9M) was working on cutting an outline on a piece of paper, he went up to a peer who was sitting at his table and said "I'm going to make one for you now, a circle one." Another example was when one four year old, Julia (4.6F), after passing out one tray of bananas, said to herself: "make some more." When working on banana slicing, she was fully engaged in the lesson and talked herself through each step. For example, she said to herself: "wash" "wash" "wash" and then washed the small bowl. As she was cleaning the different materials she said, "swish" "swish" to herself as she washed them. When she was in the middle of drying the materials she said, "dry up." For a five year old, David (5:0M),

when working on the 100 board worksheet and multiplication board, he said the numbers out loud as he wrote or counted them.

Examples of insufficient planning. There were examples of insufficient planning but they were difficult to observe because they were so similar to insufficient attention. Seventy-seven percent of participants had examples of insufficient planning. The three oldest participants only showed examples of planning, not insufficient planning (Julia 4.6F, Sara 4.10 F, David 5.0M). The youngest participant, Stacy (3.5F) was observed when she was not on task, not paying attention, or not completing the task she chose. This specific participant appeared to prefer to have the teacher plan her day and seemed the most attentive when she did not have to make decisions on her own and she could follow directions. When a four year old male, Benjamin (4:0M) needed some time to choose a lesson, he walked around and made laps around the room.

Patterns in Triangulation of Data

While triangulating the data, the fifth finding was the similarities and differences between teacher and parent questionnaires and classroom observations. This section addresses the second research sub-question: what are the differences and similarities in executive function patterns as documented in the researcher's observations, the teacher questionnaires, and the parent's questionnaires? Each component is presented below with the findings from the triangulation of the data. Two components (working memory and planning) were similar for each of the sources of data. Three components (attention, inhibitory control and cognitive flexibility) were similar for the teacher and researcher but different for the parent.

Working memory. The parents, teachers, and researcher's observations indicated across age groups that examples of working memory was seen in the child's routines, level of interest, and the ability to block out distractions. Additionally, confidence in the lesson and observations of peers were also examples that the teacher and researcher observed.

Parents, teachers and the researcher indicated in the responses and observations that across age groups that the participants needed assistance in completing a task when they had disinterest in activity (55% of parents), it involved an unfamiliar instruction (11% of parents), or they were distracted when directions were given (11% of parents). The teacher also reiterated across age groups that cleaning up after one's self was an example of the participants not completing a task. The teacher also highlighted two participants (3:6F, 3:10M) that sometimes had difficulty keeping up with the day's tasks and routines.

Planning. The parents, teachers and the researcher described examples of the component of planning as choosing specific activities (100% of parents), following steps of a lesson, and focusing for a long period of time (11% of parents) as examples of planning. They also indicated that all participants were able to plan many tasks independently such as getting dressed at home or using the bathroom at school (100% of parents). The parents specifically described planning at home as working on projects such as coloring, puzzles, projects (100% of parents). Parents (44% of parents) also mentioned the participant getting out necessary materials or laying out materials before using them. The parents indicated across age groups that the participants were able to

feed themselves, go to the bathroom, brush their teeth, and work with technology such as an IPad (88% of parents).

Attention. The parents, teachers and researcher described the component of attention for participants across age groups as being able to concentrate and complete a task when there was interest (44% of parents) and the appropriate level of challenge in the activity (11% of parents). Interest was also described by the parents, teachers, and researcher across age groups as being observed by repetition, being engaged and being focused on the activity (44% of parents).

At school, the teacher and the researcher indicated the participants lost concentration when faced with peer distraction as well (44% of parents). The parents discussed at home that often one-on-one time and individual attention from the parent led to better concentration from the participant (44% of parents).

Inhibitory control. The component of inhibitory control was divided into the dimensions of voice and interrupting. This component had similar reports from the teacher and researcher and different from the parent.

Voice. The parents had a different perspective on how the participant communicated than the teacher or researcher did. The parents described the participants as being shy, whining, demanding, and pouting especially when upset (44% of parents). The teacher and the researcher described participants across age groups as quietly stating their needs to the teacher. Two participants (3:6F, 4:4M) were described as not speaking up or being difficult to understand by the teacher and researcher.

Interrupting. The parents reported that the participants interrupted in order to get the parent's attention when the sibling or parents were in conversations (44% of parents).

The teacher and the researcher across age groups indicated most participants would not interrupt unless they needed help or to use the restroom and when they did interrupt it was done in a quiet manner.

Cognitive flexibility. Parents indicated that when they asked their child to do something, the child would comply, especially if interested in the task (88% of parents). If the participant was not interested in the task at home, the parents indicated that they might not comply, need to be asked a second time, or given a consequence (88% of parents). The teacher and the researcher indicated that most participants would easily comply. Only one participant, the youngest one (3:6F), was described as inconsistently complying by the teacher.

Parents indicated that the participants did not comply with requests when the child was interested in the current task or needed to transition to new activity such as going to bed, cleaning, eating, or when fatigued (88% of parents). The teacher indicated that the participants do not comply with requests when they do not want to transition to new activity such as Physical Education (PE) or were emotionally upset about something. The researcher only observed one example of a male participant (4:0) who was emotionally upset about a situation and did not follow the teacher's directions.

The parents described the three year old participants (3:6F, 3:9M, 3:10F 3:10M) as typically responding by crying, pouting, screaming, throwing a tantrum, and throwing items when they could not get what they wanted (100% of parents). The four and five year olds would negotiate or show that they are sad about the situation to their parents at home (100% of parents). The teacher and the researcher found across age groups that when a participant could not get his or her way, they could redirect themselves. Only

two participants (4:0M, 4:6F) were described as getting so upset that they could not calm themselves down by the teacher.

The parents described participants being able to redirect behavior best when there was something of greater interest or a reason was given (55% of parents). The parents indicated that the participants had the most trouble when they were tired or hungry (44% of parents). The teachers and researcher also said that redirection works when the participant is interested and not distracted by peers. The participants could have difficulty when they were distracted by peers or are upset.

Summary

The Master Matrix (Table 1) provides a visual chart for the outline of the findings presented in this chapter. Four of the major findings of the patterns of executive function components in the Montessori classroom are summarized below to answer the first research question: what are the patterns of development of executive function that relate to inhibition, working memory, cognitive flexibility, planning and attention, in the minds of three, four and five year old children in the Montessori classroom environment and how do these executive function patterns vary across and within each age group?

There were four findings that were present across age groups: 1) the cluster of *working memory/planning/attention*, 2) patterns of frequency of components, 3) interest and 4) some of the isolated components. The isolated components that were across one hundred percent of participants were: 1) general ability as it relates to the component of attention, 2) taking mental breaks during insufficient attention 3) control of movement, and 4) problem solving and redirection during cognitive flexibility.

The isolated components that were across age groups (but not one hundred percent) were 1) insufficient working memory when a child was developing a skill for the activity pattern and 2) attention when the child showed interest and repetition of a lesson. Every participant did not have the same tactics for taking mental breaks, problem solving, or verbalizing planning. Each individual preferred certain tactics over others. The voice and interrupting patterns of inhibitory control were also found across age groups. Clumsy movements and insufficient planning were also present in 77 percent of participants.

Working memory on incomplete tasks was present in 100% of three year olds. Transitioning during insufficient attention was present in 60% of males across age groups. Eighty percent of males watched their peers and 60% of males used transition time to plan. Needing peer's help during problem solving was present in 75% of three year olds.

The fifth major finding was the similarities and differences among the data triangulation between the parent, teacher and researcher for the five components. This provided an answer to the sub-question: what are the differences and similarities in executive function patterns as documented in the researcher's observations and the teacher and parent's questionnaires. The components of working memory and planning were consistent across the three data sources. However, attention, inhibitory control, and cognitive flexibility were similar across the researcher and teacher but different from the parent's report.

These five major findings provide a new perspective to the quantitative studies done in the past on executive function components. They highlight nuances of each of

the components as seen in a natural setting as well as furnishing new implications for future research.

CHAPTER FIVE

DISCUSSION

This chapter provides a discussion on the findings from Chapter 4 as well as the limitations, recommendations, and suggestions for future studies. The discussion is presented in the same format as the findings in chapter 4, following the Master Matrix (See Table 1).

Introduction

The current literature regarding executive function highlights that new information is being generated, especially for the preschool years, including relevant methodologies and task measurements (Blair et al., 2005; Weibe et al., 2011). Mainly quantitative research saturates the literature and it relies heavily upon laboratory settings, leaving a gap of little or no information on children in natural early childhood settings (Barkley, 2012; Yeager & Yeager, 2013). This study sought to make a contribution to current literature by focusing upon the development of executive function of young children within a natural setting in a mixed methodological study. More specifically, this study focuses on understanding the development of executive function of children three to five years of age, in a Montessori classroom, which research has shown supports the development of Executive Function (Diamond, 2012).

The following research question and subset questions were used to frame the methodology of this study:

3. What are the patterns of development involving the elements of Executive Function—specifically, *inhibition, working memory, cognitive flexibility, planning* and *attention*—exhibited by the behaviors of three, four, and five year-old children in a Montessori classroom context?

    a. How do these EF patterns across each age group vary?
    b. How do these EF patterns within each age group vary?
    c. What are the similarities in executive function patterns as seen in the classroom by the observer and as reported by the teacher and the parent in the questionnaires?
    d. What are the differences in executive function patterns as seen in the classroom by the observer and as reported by the teacher and the parent in the questionnaires?

Overview of Methodology

This mixed methodological study aimed to answer the research questions listed above by using a combination of data sources: researcher observations and questionnaires from the teacher and the parents. The researcher spent twelve weeks in a Montessori primary classroom observing children's frequencies and anecdotal behaviors of five executive function components: *inhibition, cognitive flexibility, attention, planning, and working memory*. The parent and teacher questionnaires were also centered around these five components in order to collect data on the participant's behavior at home and at school.

Findings and Interpretations

Although a single definition of executive function still remains to be agreed upon, most researchers acknowledge that there are three core Executive Function components: working memory, inhibition, and cognitive flexibility (Diamond, 2013; Garon et al., 2008; Yeager & Yeager, 2013). Planning and attention were also mentioned in many current studies and were added as fourth and fifth components in this research study. The main patterns identified in the data were based upon the following components of executive function: *working memory, planning, attention, inhibitory control, and cognitive flexibility*.

The overall finding in the data was that there was no general pattern based on age or gender. The five sub findings of the patterns of executive function components in the Montessori classroom were 1) the cluster of *working memory/planning/attention*, 2) patterns of frequency of components, 3) the role of interest in EF components, 4) patterns within each of the five components and 5) patterns of data triangulation among the parent, teacher and researcher. Each finding is discussed below in reference to the current literature.

Overall Finding

The overall finding of the data did not show strong patterns for age and gender differences. This is an important finding because it highlights that variance in executive function is not necessarily due to age or gender differences. The variance could be due to individual developmental needs or personality. Further research is important to understand which factors influence executive function development and skill level.

Working Memory, Planning, and Attention

The first finding was the emergence of a cluster of three of the five executive function components: *working memory, planning and attention*. A common string in current research studies focuses on identifying an appropriate model (*unitary, two-factor or integrated*) for framing the components of Executive Function (Diamond, 2012; Garon et al., 2008; Weibe, 2011). A *unitary model* is where executive function is broken into many different individual components without dependence on each other for development. An *integrated model* is where the components are related to each other and can imply that one component has to develop first before another component can develop (Garon et al., 2008). The *two-factor model* is closest to the unitary but the components can be related (Miller et al., 2012). The cluster does not clearly align with one specific model, however, the data supports that these three components were the most frequently observed in conjunction with one another and they were seen in all ages. The cluster seems most similar to the *two factor-model* because the components were foundational across all ages but were observed together possibly illustrating a relational component.

There were two specific elements in this cluster: *working on a lesson* and *the ability to complete the lesson*, which are unique to the qualitative lens of research. The cluster of *attention, working memory and planning* was repeated across age groups when the participant was engaged in a lesson. This is similar to Vygotsky's *zone of proximal development* describing a child who is most successful in the classroom when the lesson is familiar and just beyond the mastery level (Mooney, 2000). When the participant was not engaged or did not have the competence to complete the lesson, insufficient working memory, insufficient planning and insufficient attention were observed. These patterns

found in the cluster illustrate the delicate balance a child has in their own development. When the activity is at the appropriate level, they were observed practicing executive function components and when it was below and beyond their level, they were not observed practicing executive function.

As Diamond (2012) mentioned in her research, Montessori classrooms foster the development of Executive Function. This type of classroom environment provides each child with the opportunity to work on lessons repeatedly, as many times as they wish, and to choose the lessons that they want to work with. Each student is able to work at his or her own pace without being required to participate in a group curriculum, as is the current practice in most traditional classroom settings.

Further research could be done by comparing the cluster that appears in children in a Montessori classroom with patterns found in a traditional classroom. This would be an important extension of this research to understand the nuances seen in this qualitative research but also distinguish differences found in a Montessori classroom and specific developmental milestones seen in age three to five in any setting.

Quantitative Analysis & Development

The main finding in the comparative analysis of the quantitative data was that the overall frequencies did not have a pattern based on age or gender. Flander's categorical analysis was used to collect the quantitative data which is a contribution to the current literature. Most research studies rely on Executive function task measurements. Isquith et al. (2004) added to this body of research by using a rating scale to measure everyday behaviors of executive function tasks. However, Flander's categorical analysis allows the frequencies of behaviors to be tracked and observed. Analyzing the data based on the

frequencies of the components showed variances of frequencies that could be compared by age or gender. In the case of this study, these variances were based on other factors independent of age and gender. The causes of these variances are unknown but further research could identify if they are due to personality or developmental differences in the individual.

The multi-age groupings in Montessori classrooms allow children to work individually, at their own pace, and to be exposed to the positive influences of their peers. The dynamic of the multiage setting gives children the opportunity to experience different situations that are not present in a single-age group. For example, a three year old in a Montessori classroom is able to see what the four and five year old children are working on and therefore is being exposed earlier to lessons that she or he will be able to do later on, when it is developmentally appropriate for that child to do so.

Another pattern that emerged within the quantitative data was the observation of the cluster of *attention, planning and working memory* in the highest frequencies as compared to the five isolated components. In the current literature it is unclear why these specific three components would be the most visible in a *natural setting*. It is possible that the inhibitory control and cognitive flexibility have limitations in the way they are observed. For example, the researcher was able to mark the frequency for inhibitory control if the participant was visibly trying to inhibit movement for a purpose. It is possible that these frequencies could have been higher if a different evaluation or observation technique had been used to identify inhibition of movement or cognitive flexibility.

Another finding was that only one ratio was related to age: the ratio between the cluster of *working memory, attention and planning* and *insufficient attention* (see table below*)*. The older participants had lower ratios with higher frequencies of the cluster and lower frequencies of insufficient attention. This illustrates that older participants spent more time in productive behavior and less time in "off-task" behaviors than their younger peers. The younger participants had higher ratios with a smaller gap between their frequencies of the cluster and insufficient attention (see Appendix). This illustrates that the younger participants spent less time than their older peers on productive behaviors and more time on off task behaviors than their older peers.

This finding is supported in the current literature regarding the executive function component of attention. Garon et al. (2008) found that the regulation of attention increased in skill between three and five years of age. Isquith et al. (2004) also found that three year olds had a harder time with regulation of attention. In the present study, attention was seen to develop across ages but the other components did not have an age factor. The ability to concentrate is important to be able to complete tasks, plan and remember ideas. It is possible that the frequencies in the quantitative data were seen as an observation of the component but lack the ability to see the quality of their development. For example, when a child showed a behavior, the component was marked; however the competence or quality of that behavior was not measured between individuals.

A qualitative lens would provide an important addition to the literature, to further understand the intricacies of the regulation of attention in three, four, and five year old children, in the natural setting of a Montessori classroom. A way to quantify the

competence or quality of the behavior is an important addition to the quantitative data collection.

Cluster to Insufficient Attention Ratio				
Age	**Gender**	**WM,P, A**	**A ins**	**Ratio:**
3y 5m	F	94	52	0.55
3y 9m	F	117	35	0.29
3y 9m	M	122	14	0.11
3y 10m	M	94	21	0.22
4y 0m	M	136	22	0.16
4y 4m	M	80	35	0.43
4y 6m	F	192	33	0.17
4y 10m	F	139	13	0.09
5y 0m	M	103	10	0.09

Interest

The third major finding in the data was the role that interest in the activity played for all five of the components of executive function. In Lilliard's (2005) *Montessori: Science Behind the Genius*, she discussed how the role of interest played a part in a child's choices in the classroom. In the preschool classrooms, she summarized the work of Anderson, Mason and Shirley (1984) and Renniger and Wozniak (1985) to illustrate how "interest influences such factors as preschool children's memory, activities, and cognitive organization" and that children "pay attention to, recognize, and recall the world in terms of what most interests them" (p. 120, 121).

Interest also plays a role in the emergence of concentration which leads to competence in a lesson. Csikszentmihalyi's idea of flow describes how people have focused motivation on an activity with goals and progress (Csikszentmihalyi, M., Abuhamdeh, S. & Nakamura, J., 2005). Csikszentmihalyi et al. (2005) discuss how this state of concentration is attainable when the person understands the challenges of the task and their own skills in order to complete it. Interest is the first stage of this emergence of

concentration, leading an ability to complete the lesson. Concentration and ability to complete a lesson are patterns seen in many of the executive function components in this study. For example, the ability to complete a lesson was a pattern seen with attention and working memory.

There are no studies that specifically evaluate the role of interest regarding executive function skill or performance. Further research could be done on the role of interest and the participant's ability to complete the EF tasks that are often used for measurement in quantitative studies.

Isolated Components

A fourth finding in the data was that each of the five components had patterns that were found across age groups or within age groups or gender.

Patterns of insufficient working memory. In the qualitative analysis of the current study, two patterns emerged when a participant was observed with insufficient working memory: (a) the participant did not fully complete a task or (b) the participant was still developing the skill he or she was working on and needed assistance from the teacher. Specifically, it was observed that all three year olds showed insufficient working memory for not completing tasks such as cleaning up their work. It is possible that completing all the steps is a learned behavior and with experience and age in the classroom. The three year olds may need to slowly adapt to remembering all of their responsibilities. Also, the three years olds could be juggling many of the other executive function components to transition to the next task that they forget the simpler jobs of cleaning up.

In the literature, there are three major views that are complementary to each other regarding the component of working memory in three to five year olds. Isquith et al. (2004) described working memory as a foundational component of executive function. Chavelier et al. (2012) found the component of working memory develops at different ages. Burrage et al. (2008) found that the development of working memory was based on experience, not on age. The description of working memory as a foundational component, developing based on age, and based on experience supports the finding that three year olds were not always able to complete tasks. It is possible that the three year old showed more examples of insufficient working memory due to experience or age. In a Montessori classroom, experience does play a part in children's behavior in the classroom. For example, the newer the child is to the room, the more information the child needs to be successful.

A contradictory finding was that Isquith et al. (2004) found that boys had less working memory than girls did which the current study's findings did not align with this— there was an age difference but no gender difference. The study by Isquith et al. used the BRIEF-P scale to collect data about everyday behaviors from the parents and teachers at home and at school respectively. This finding, although relatable to the current qualitative study, is still a quantitative research study and based on the parent and teacher's perspective. Further research is needed to understand the qualitative and quantitative nature of working memory, especially regarding age and gender.

Patterns of attention. In the current research study, there were three patterns of attention that were observed: 1) degree of skill, 2) interest, and 3) repetition. These

findings are unique to observation in a natural setting and are not specifically supported by any current executive function studies.

The pattern of the degree of skill was also seen in the cluster pattern and in the insufficient working memory pattern. Vygotsky's zone of proximal development supports this idea that children learn best when something is in their skill level. Interest and repetition are also similar findings in the cluster pattern. Possibly, the development of the component of attention is aided when it is within the skill level and is of interest to children.

This finding also aligns with Diamond's (2012) finding that a Montessori classroom fosters higher executive function skills. With regard to the attention level being in line with the skill level, Lillard (2007) stated that when children in a Montessori environment "freely choose what they are interested in, [it] is sometimes internally guided by what they need at the moment for optimal development" and "young children are thought to prefer looking at and engaging with material that is just above their current level of competence" (p. 126, 106). These statements support the finding that children have attention and concentration in activities where they have the necessary skills, are interested in the topic, and are given the freedom to choose to repeat the activity.

In the observations of attention, the youngest participant (3:6F) had the lowest frequency of attention. As mentioned previously, both Garon et al. (2008) and Isquith et al. (2004) found in their research that attention was age-dependent and three year olds had-more difficulty with regulation of attention than their older peers. Because this research was done in a natural setting, there are other nuances that emerged from the data

such as the participants concentrated better in specific lessons and subjects than in other subjects based on interest. This could relate to Lilliard's (2012) literature review on the role of interest and choice. Further research can be done on the regulation of attention as it relates to both age and interest.

Patterns of insufficient attention. There were many examples of participants with insufficient attention across the three and four year old age groups with *on task/off task* behaviors such as *transitioning* and *taking mental breaks*. One limitation in the data collected was the difficulty in determining if the "off task" behavior was productive or unproductive. For example, all participants were observed taking a combination of mental breaks during the morning while exploring materials, observing others, looking around the room, showing fatigue or socializing with peers. Although these behaviors were coded as "insufficient attention," these behaviors could be a way of coping and maintaining attention after prolonged periods of time, especially with the same task.

Lillard (2007) reminds us that in a Montessori environment with long working blocks of time, Montessori described several graphs of children's patterns in work. She mentioned that in this cycle of work, children need time to get acclimated to working in the morning by choosing an easy activity at first, followed by "brief moments of rest," and then an intense "great" work is undertaken, followed by a disengagement from work toward the end of the work period (p. 109).

Although this behavior was coded as insufficient attention, it is an important pattern to understand more fully. Because all participants took mental breaks and had different behaviors among the nine participants, this could be a developmental behavior to stay on task. As Lillard mentions that brief moments of rest could be necessary to

prepare for an activity that requires a lot of energy, the off task behaviors in the current such as fatigue or observing others around them could also support longer concentration. Further research could be done to understand how *on task/off task* behaviors, such as mental breaks and transitioning, are productive or unproductive behaviors in learning.

Another aspect of this finding was that transitioning between activities was much more frequent in the three to five year old males than females. This also could be a developmental tool that males use to stay on task. This is supported by Isquith's (2004) research that boys had lower working memory and planning scores than girls. Further research could be done to understand how *on task/off task* behaviors differ between genders.

Patterns of inhibitory control. The participants showed inhibitory control in the following patterns: their movements, use of materials, volume of their voice, and waiting for help from the teacher. As mentioned previously, inhibitory control of movements was only marked when it was observed when a child was intentionally inhibiting his body for a purpose; for example, carrying a tray or slowing body movement down to a walking pace instead of a fast pace. If a different evaluation tool was used, it is possible to get more themes or data from this component.

Across ages, all participants were observed successfully inhibiting their movements and behaviors in the classroom. This is an important finding because the component of inhibitory control is not age dependent for three to five year olds. It seemed to vary based on personality or individual development instead of age or gender. Possibly understanding each child's individual development would increase information on executive function development for this age.

There are varying perspectives in the current literature about the development of inhibitory control. Burrage et al. (2008) cautiously said that inhibitory control is higher with experience and not necessarily age. Chevalier et al., (2012) found that inhibitory control develops at different ages. Isquith et al. (2004) found that inhibitory control was a fundamental component of executive function and that boys had lower inhibitory control. Another pattern within inhibitory control was that most participants were able to consistently use quiet voices, which varies from the work of Carlson et al. (2004) who saw that four year olds performed better on the whisper test than three year olds. Again, this could be an indication of Diamond's (2012) work that the Montessori environment fosters executive function development. Further research would be necessary to understand why in some studies there are age and gender factors and in others, like the current study, show no difference.

Pattern of insufficient inhibitory control. For insufficient inhibitory control, the main pattern that emerged was clumsy movements, mainly across three year olds. In this finding, although inhibitory control was not found to be age dependent, the frequency of insufficient inhibitory control was found to have a pattern by age. This could illustrate, similar to attention, three year olds spend more time exhibiting insufficient inhibitory control than their older peers. This is not to imply that they cannot inhibit their movements, as seen in the previous finding, however, they are still mastering the ability to control their bodies.

In the literature, Burrage et al. (2008) found that inhibitory control could be based on experience. Carlson et al. (2004) found that the Executive function task for inhibitory control, and Bear/Dragon (this task is similar to *Simon Says*), were significantly

correlated with age. This task, Bear/Dragon, is not directly related to clumsy movements however, it does show that three year olds may know rules or understand what they need to do (as in the game) but have a difficult time inhibiting the undesired action compared to their four year old counterparts. This could be a reason why the three year olds were able to inhibit some behaviors but not all.

Although clumsy movements were coded for insufficient inhibitory control, it is difficult to know if the child was not paying attention, experiencing a developmental deficit in body control or possibly tired. This is a limitation in the coding of insufficient attention. Further research would be necessarily to break down inhibitory control further as the current EF tasks address inhibiting voice, following rules, and inhibiting movement are isolated from real life situations and more research should be done in a natural setting with a qualitative lens.

Patterns of cognitive flexibility. There were two patterns of cognitive flexibility that arose from the data: problem solving and redirection. The difficulty encountered in observing cognitive flexibility was a limitation in the study. In order to observe this behavior, an interaction or situation that caused the participant to respond was necessary. Isquith et al. (2004) also said that this was a complex executive function component.

All participants across age groups were observed trying to problem-solve by themselves. Most were observed at some point asking the teacher for help and 75 percent of three year olds asked assistance from their peers.

This finding could be unique to the structure of a Montessori classroom. The multiage setting gives opportunities for three, four, and five year olds to interact which could lead to the dynamic seen in the data that three year olds asked for help from their

peers. The constructivist model of the Montessori environment also supports children problem solving independently and asking the teacher secondarily if they need help. To understand the nuances of executive function from a qualitative lens, observing these components of executive function in different settings such as traditional, other alternative curricula or different socioeconomic groups is a way to further the research.

All participants across age groups were comfortable with redirection, especially if they were able to work with the teacher. This again may be unique to a Montessori classroom with a multiage grouping. The children spend time problem solving for themselves and learn to plan ahead or be flexible when situations arise. Also, working with the teacher individually is a special time for the child which is different from the group lessons seen in traditional schools. Further research could compare traditional classroom settings with Montessori settings to understand the dynamic of cognitive flexibility with different teacher to children ratios, classroom environments, teacher-child relationships and the availability of older peer assistance.

Patterns of planning. There were varying behaviors across all ages in the ability and strategy of planning. Before a decision was made by participants to transition to a new activity, they demonstrated one of three behaviors: they 1) watched their peers, 2) used transition time or 3) verbalized their thoughts to make decisions. While working on a lesson, all participants across age groups uniformly were able to plan the steps to complete lessons.

These patterns in planning, similar to the patterns in insufficient attention, beg the question if children adopt different developmental strategies to aid in their goals. It is possible that the patterns of watching their peers, transitioning around the room, and

verbalizing their thoughts out loud could be a strategy to stay on task and aid in planning the next steps. Watching their peers, walking or talking are behaviors that could be aids or cues for the child.

Chevalier et al. (2012) studied goal representation or planning and found that it could be a foundational component of executive function. However, Isquith et al. (2004) felt that planning is more complicated. Nonetheless, in the current study, all participants were able to plan across ages, individuals used different strategies. Blaye and Chevalier (2011) made the point that planning and goals in the current literature describe goals that have been made for the participant and were not made by the participant himself. This aspect of planning is unique to a Montessori classroom where children have the ability to plan and think through their own activities.

Further quantitative and qualitative research needs to be conducted to increase the understanding of the ability of three to five year olds in planning their own actions. The observation records document the fact that the participants demonstrated their ability to plan by using their peers, by talking out loud and using transitioning time to think through their next steps.

Another pattern observed in the current study was that mainly males watched their peers and used transitioning to make decisions. Isquith et al. (2004) also found that boys have less planning skills. Perhaps males need assistance to make decisions and develop coping skills to make decisions by watching their peers. Further research utilizing qualitative and quantitative strategies would provide more details on how planning for children in any environment could be supported especially in light of the difference in gender.

Examples of insufficient planning. Examples of insufficient planning were difficult to observe because they were so similar to insufficient attention. Most participants, with the exception of the two oldest participants were observed with behaviors of insufficient planning. It is possible that children need cues to be able to plan successfully.

Isquith et al. (2004) described planning as a more complicated executive function component. Possibly, the limitation of planning being easily observed and insufficient planning being difficult to observe is an indication that further research needs to be developed to better evaluate the development of the component of planning within executive function.

Patterns in Triangulation of Data

While triangulating the data, the major finding was the identification of similarities and differences between teacher and parent questionnaires and the classroom observations. Working memory and planning were similar for each of the sources of data at school and at home. Attention, inhibitory control and cognitive flexibility were similar for the teacher and researcher but different for the parent.

Working memory and planning had similar examples from the parent, teacher, and researcher such as working on materials or an activity at home or at school. The responses regarding attention differed between the sources: there were peer distractions at school and the participants desired one-on-one time and individual attention from the parent at home. The environments at home and at school have different levels of structure and expectations. For example, at home, a large group of peers were not present to distract the child and at school, there were not an appropriate number of adults for the

child to expect one-on-one attention. Inhibitory control also differed at school; the participant quietly stated his or her needs and typically did not interrupt, but at home she or he often whined or demanded that the parent meet his needs and interrupted to get the parent's attention, when the sibling or parents were in conversations.

The two environments give the child different expectations. At home, he can be more comfortable as well as expect one on one attention where at school, the child did not expect this. For cognitive flexibility, at home, the child complied with requests if interested and at school, the participants easily complied with any requests. This could be attributed to a response to the expectations in the different environments as well. The parents also described three year olds as crying or pouting and four and five year olds as negotiating when they could not get their way whereas at school they could redirect themselves.

Isquith et al. (2004) was the first to create a questionnaire called the BRIEF-P to assess preschooler's level of executive function. They only found a difference in the inhibition scale attributing the structure of the school as possibly providing monitoring or reminders for the child, whereas at home, the child must use his or her own inhibitory skills to stop inappropriate behavior.

This could also relate to the differences among attention, cognitive flexibility and inhibitory control. School may provide certain cues or reminders that the home does not. The two environments could have different expectations as well leading to variance of behavior.

Recommendations

A number of recommendations, for increasing the understanding of executive function development in three to five year olds children, have emerged from the initial findings of this mixed methodological study. The three main open issues are: 1) the need for valuable information regarding the development of executive function by preschool age children, 2) the need for more qualitative research to help understand the development of executive function in a natural setting and 3) the need for more research leading to the discovery of practical ways in which to support the development of executive function in preschool settings.

Better Understanding of Executive Function and Its Components in Preschool

The first glaring problem is the limited information and the incomplete understanding of executive function across development in the preschool years from the current literature. This is especially important in light of the varying perspectives in current literature of the EF components and their relevance to this age group. It is recommended that more research be conducted to understand the appropriate models, the development and components of executive function, so that these findings eventually can be related in practical terms to educational practice.

For example, in the first major finding of this study, the emergence of a cluster of three of the five executive function components: *working memory, planning and attention* was seen when the participant was working on a lesson and was also competent with the skill level. This cluster was also observed in the highest frequencies of the five year olds in a natural setting. As mentioned previously, the two-factor seems from this data to be

the most relevant but more information is needed to understand is this is the best model for relating the components of EF in three to five year olds.

This research identifies the fact that age and gender do not play a huge role upon the development of many of the components of EF by preschool children. For the components that were age or gender related, such as insufficient working memory in three year olds and specific planning techniques for males, it is important to understand these differences and further identify patterns in development based on age and gender. For those that were not age or gender related, it is important to understand what other factors play a part in the variance seen in the executive function components.

Flanders' categorical analysis also adds a new measurement to studying executive function. This tool is useful for tracking the frequencies of observed behaviors as seen in the classroom, not just reporting ratings on a scale for each behavior as done in Isquith et al.'s (2004) BRIEF-P scale. Flanders' categorical analysis provides detailed information on nuances seen between three to five years of age as well as identifying gaps in the understanding of the current literature available. It is also recommended that additional research focus upon furthering the understanding of the qualitative and quantitative aspects of experiences in different preschool environments, using Flanders' categorical analysis.

More Qualitative Research to Understand the Development in a Natural Setting

To date, the field of executive function studies is virtually composed of laboratory-based, quantitative studies. These studies, although controlled for variables, were often narrow in the specific component and task that was measured. For example,

Blaye and Chevalier (2011) make the point that planning and goals in the current literature describe goals that are being made for the participant, not those that the participant makes for himself. These factors are important to identify because in a natural setting there could be a combination of these two aspects. In a laboratory setting, only the former would be measured.

The use of a qualitative lens would make a valuable contribution to the literature by helping researchers to further understand the intricacies of the developing information on executive function components in the research as well as the frequencies and patterns that appear in a natural setting. In the current study, the qualitative data highlighted new patterns of development that quantitative executive function tasks cannot detect. For example, when analyzing the patterns in planning, it was observed that the participants used their peers, talked out loud and used transition time to think through their next steps. Also, in this study, interest was a finding that emerged when observing components of executive function. These behaviors would be difficult to see in a quantitative, laboratory research setting. Spending time doing field work in a natural setting could help both the quantitative and qualitative findings come to some conclusions.

There are many studies mentioned above that do not have a clear answer for the component's model, developmental age, or gender differences. However, there are limitations in doing qualitative research that would need to be understood and resolved. For example, cognitive flexibility and inhibitory control were difficult to observe unless it was in a specific situation. Both quantitative and qualitative aspects play an important role in understanding executive function development.

Support for Preschool Curricula, Specifically Montessori Programs

As seen through the qualitative lens of this study, the characteristics of executive function in a classroom setting were observed when the children were able to choose interesting and familiar lessons, work repetitively, and work at their own pace. It is recommended to expand Diamond's (2012) and Lilliard's (2012) work on executive function in the Montessori classroom as well as compare it to a traditional classroom to understand the qualitative aspects in varying environments.

It is important for all educators of preschoolers, researchers of executive function and those involved in the development and implementation of curricula with three to five age children, to gain a better understanding of the importance of providing support for the development of executive function to children in this age group.

Suggestions for Further Research

This study used a mixed methodological approach to understanding executive function which could be expanded or implemented with different populations. It is suggested that more qualitative studies be conducted to better understand children's development in a natural setting. This could be easily done with a different socioeconomic group within a Montessori environment as well as by the comparison of Montessori to a traditional preschool group to look for similar or different patterns. A closer examination of the role of interest, *on task/off task* behaviors and planning would be important in a Montessori classroom.

The way the Executive Function components relate to each other is still a huge need in this field as well. It is suggested that further research be done on understanding age and gender factors, especially in planning and attention.

Summary and Conclusion

This mixed methodological study observed executive function components in a Montessori preschool environment for three to five year olds. There were many patterns found during analysis that provides a new understanding to executive function development for this age group. The current literature had varying views on how components interrelate as well as patterns in age and gender. After analyzing the data from the current study, four out of the five findings were across age groups with the exception of some details in the isolated components such as *planning, working memory, attention and cognitive flexibility*.

There were five findings found after analysis: 1) the cluster of *working memory/planning/attention*, 2) patterns of frequency of components, 3) the role of interest in EF components, 4) patterns within each of the five component and 5) patterns of data triangulation between the parent, teacher and researcher.

Recommendations are to invite those stakeholders involved in curricula development and pedagogical practice with preschoolers, as well as those invested in executive function research, to continue building the foundations for understanding executive function as well as for developing ways in which teachers can support the development of EF.

This study has brought to light the importance of the qualitative lens in executive function research and its ability to complement the quantitative research that is currently

available. These findings accentuate the inner development of three to five years of age and the nuances that quantitative work cannot see. This study highlights the need for more information on executive function, how to support children ages three to five as well as the need for comparative EF studies within non-Montessori classrooms.

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APPENDIX A

Parent and Teacher Questionnaires

Parent Questionnaire

Completed by:_____

Child's Name:_____

Please provide four to five detailed sentences for each question and subquestion below.

1. Please describe your child's general personality in terms of mood, characteristics, behavior and attitude.

2. What does your child enjoy doing at home?

3. Please describe your child's behavior when he/she is doing something interesting.

    a. Playing indoors

    b. Playing outdoors

    c. Eating

    d. Other

4. Please describe how your child communicates what he/she needs.

    a. How does he/she speak to you?

    b. What kind of voice does he/she use?

    c. At what times is your child likely to interrupt?

5. When you ask your child to do something, please describe how your child typically responds.

    a. Under what conditions, does he/she remember what to do?

    b. Under what conditions, does he/she need reminders?

6. When does your child not comply with your request to do something? (Turn off the TV or going to bed?)

7. If a situation occurs when your child is not able to “get his/her way”, how does he/she react?

    a. Under what conditions can he/she successfully redirect behavior?

    b. Under what conditions does he/she have difficulty?

8. When your child is playing with his favorite material, please describe how he/she plans out what he/she wants to make or do.

9. Please describe which tasks at home your child is able to do independently (i.e. getting dressed)

    a. When does he/she need your help?

10. Please provide examples when your child is able to concentrate and complete a task.

11. Please provide examples when your child does not want to finish, gives up or chooses a new interest.

12. Please provide some examples of when your child has

a. strong attention during tasks

b. weak attention during tasks

Teacher Questionnaire

Completed by:_____

Child's Name:_____

Please provide four to five detailed sentences for each question and subquestion below.

1. Please describe the child's general personality in terms of mood, characteristics, behavior and attitude.

2. What does this child enjoy doing in the classroom?

3. Please describe the child's behavior when he/she is doing something interesting.

   a. Working in the room

   b. Playing outdoors

   c. Eating

   d. other

4. Please describe how the child communicates what he/she needs.

    a. How does he/she speak to you?

    b. What kind of voice does he/she use?

    c. At what times is your child likely to interrupt

5. When you ask the child to do something, please describe how he/she responds.

    a. Under what conditions, does he/she remember what to do?

    b. Under what conditions, does he/she need reminders?

6. When does the child not comply with your request to do something? (ex. putting away work)

7. If a situation occurs when the child is not able to “get his/her way”, how does he/she react?

    a. Under what conditions can he/she successfully redirect behavior?

    b. Under what conditions does he/she have difficulty?

8. When the child is working on a favorite material, please describe how he/she plans out what he/she wants to make or do.

9. Please describe which tasks the child is able to do independently.

    a. When does he/she need your help?

10. Please provide examples when the child is able to concentrate and complete a task.

11. Please provide examples when the child does not want to finish, gives up or chooses a new interest.

12. Please provide some examples of when the child has

    a. strong attention during tasks

    b. weak attention during tasks

APPENDIX B

Consent form & Other Communication

Email to Parents:

February, 2014

Dear [redacted] Parents:

I am the Curriculum Director [redacted], where I have taught since 2006. Last summer, I transitioned from teaching in [redacted] campus to my current position. I am completing my doctoral degree in education this year at Kennesaw State University and am currently in the dissertation phase, which involves conducting original research.

In order to conduct my research, I will be observing in the [redacted] classroom at [redacted] approximately 7-10 hours per week this spring as a means to understand children's development of Executive Function. I will be placing more information relating to this research in your child's cubby.

I would greatly appreciate your consideration of granting your consent for me to observe your child in the classroom. I am only collecting data from those students who have parental consent. Of course, all participation is strictly voluntary and no child's identity will ever be divulged.

Thank you for your consideration. Please feel free to contact me at [redacted] with any questions.

Sincerely,

Ashley Darcy

Curriculum Director [redacted]

KSU Doctoral Candidate Researcher

February 20, 2014

Dear [redacted] Parents,

I am the Curriculum Director [redacted], where I have taught since 2006. Last summer, I transitioned from teaching in [redacted] campus to my current position. I am completing my doctoral degree in education this year at Kennesaw State University and am currently in the dissertation phase, which involves conducting original research.

In order to conduct my research, I will be observing in the [redacted] classroom at the [redacted] approximately 7-10 hours per week this spring as a means to understand children's development of Executive Function. I would greatly appreciate your consideration of granting your consent for me to observe your child in the classroom. I am only collecting data from those students who have parental consent. Of course, all participation is strictly voluntary and no child's identity will ever be divulged.

If you agree to participate, please complete the following:

1. Please sign the parental consent form indicating you will complete a questionnaire as well as give your permission for me to observe your child in the classroom.
2. Please complete the questionnaire with as much detail as possible.
3. Please place the completed consent form and the questionnaire in the envelope provided.

4. Please label the envelope with my name “Ashley Darcy” and return it to the [redacted] teachers by Friday, February 28. If you need more time, please contact me.

I will be conducting my study from February through May of this semester. Thank you for your consideration to participate in my research.

Sincerely,

Ashley Darcy

[redacted]

KSU Doctoral Candidate Researcher

[redacted]

PARENTAL CONSENT FORM

Title of Research Study: Executive Functions In Early Childhood: Qualitative and Quantitative Patterns of Development among Students within a Montessori Classroom

Researcher's Contact Information:

Ashley Darcy

770.789.2757

adarcy@student.kennesaw.edu

You and your child are invited to take part in a research study conducted by Ashley Darcy, Doctoral Candidate from Kennesaw State University. Before you decide to participate in this study, you should read this form and ask questions about any aspect that requires further clarification.

Description of Project

The purpose of the study is to understand patterns in executive function in three to five year old children in a Montessori classroom environment. Executive function is the higher level functioning in the brain such as working memory, inhibition, and cognitive flexibility.

Explanation of Procedures

The attached questionnaire will help me understand your perspective of your child in the home environment. As the researcher, I will observe the participating children approximately 7-10 hours a week during the morning sessions. I will record observations

on behavior, facial expressions, interactions and dialogue. I will also take some appropriate photographs of the children in the classroom. The teacher will also complete a questionnaire.

Time Required

The questionnaire will take approximately ten to fifteen minutes of your time.

Risks or Discomforts

There are no known risks of participating in this study.

Benefits

The teacher, parents and researcher will know more about the children's abilities and competencies of executive function.

Compensation n/a

Confidentiality

The results of this participation will be confidential. The researcher will keep the consent forms, questionnaires and any observations in a locked office. In the results and discussion sections, the researcher will use pseudonyms to maintain confidentiality.

Use of Online Surveys n/a

Inclusion Criteria for Participation

The participants are parents, teachers and children who are three, four and five years of age.

Parental Consent to Participate

I ,_____, give my consent for my child,_____, to participate in the research project described above. I also would like to participate in completing the questionnaire. I understand that this participation is voluntary and that I may withdraw my consent for myself or my child at any time without penalty.

_____

Signature of Parent or Authorized Representative, Date

_____

Signature of Investigator, Date

PLEASE SIGN BOTH COPIES OF THIS FORM, KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR

Research at Kennesaw State University that involves human participants is carried out under the oversight of an Institutional Review Board. Address questions or problems regarding these activities to the Institutional Review Board, Kennesaw State University, 1000 Chastain Road, #0112, Kennesaw, GA 30144-5591, (678) 797-2268.

TEACHER CONSENT FORM FOR OBSERVATION

Title of Research Study: Executive Function In Early Childhood: Qualitative and Quantitative Patterns of Development among Students within a Montessori Classroom

Researcher's Contact Information:

Ashley Darcy

770.789.2757

adarcy@student.kennesaw.edu

You are invited to take part in a research study conducted by Ashley Darcy, Doctoral Candidate from Kennesaw State University. Before you decide to participate in this study, you should read this form and ask questions about any aspect that requires further clarification.

Description of Project

The purpose of the study is to understand patterns in executive function in three to five year old children in a Montessori classroom environment. Executive function is the higher level functioning in the brain such as working memory, inhibition, and cognitive flexibility.

Explanation of Procedures

As the researcher, I will observe the participating children approximately 7-10 hours a week during the morning sessions. I will record observations on behavior, facial

expressions, interactions and dialogue. I will also take some appropriate photographs of the children in the classroom. Your co-teacher and the parents of the selected children will also fill out a questionnaire. I may also interview you to gain your perspective of the children in the classroom.

Risks or Discomforts

There are no known risks of participating in this study.

Benefits

The teacher, parents and researcher will know more about the children's abilities and competencies of executive function.

Compensation n/a

Confidentiality

The results of this participation will be confidential. The researcher will keep the consent forms, questionnaire and any observations in a locked office. In the results and discussion sections, the researcher will use pseudonyms to maintain confidentiality. .

Use of Online Surveys n/a

Inclusion Criteria for Participation

The participants are parents, teachers and children who are three, four and five years of age.

Teacher's Consent to Participate

I ,_____, give my consent for the researcher to observe my interactions with the students in my classroom as described in the research project. I also understand I may be interviewed. I understand that this participation is voluntary and that I may withdraw my consent at any time.

_____

Signature of Teacher, Date

_____

Signature of Investigator, Date

PLEASE SIGN BOTH COPIES OF THIS FORM, KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR

Research at Kennesaw State University that involves human participants is carried out under the oversight of an Institutional Review Board. Address questions or problems regarding these activities to the Institutional Review Board, Kennesaw State University, 1000 Chastain Road, #0112, Kennesaw, GA 30144-5591, (678) 797-2268.

TEACHER CONSENT FORM FOR OBSERVATION & QUESTIONNAIRE

Title of Research Study: Executive Function In Early Childhood: Qualitative and Quantitative Patterns of Development among Students within a Montessori Classroom

Researcher's Contact Information:

Ashley Darcy

770.789.2757

adarcy@student.kennesaw.edu

You are invited to take part in a research study conducted by Ashley Darcy, Doctoral Candidate from Kennesaw State University. Before you decide to participate in this study, you should read this form and ask questions about any aspect that requires further clarification.

Description of Project

The purpose of the study is to understand patterns in executive function in three to five year old children in a Montessori classroom environment. Executive function is the higher level functioning in the brain such as working memory, inhibition, and cognitive flexibility.

Explanation of Procedures

The attached questionnaire will help me understand your perspective as the teacher of the children in your classroom that have been selected for this study. As the researcher, I will observe the participating children approximately 7-10 hours a week during the morning sessions. I will record observations on behavior, facial expressions, interactions and dialogue. I will also take some appropriate photographs of the children in the classroom. The parents of the selected children will also fill out a questionnaire. I may also interview you and your co-teachers to gain insight on your perspective in the classroom.

Time Required

The questionnaire will take approximately ten to fifteen minutes per child.

Risks or Discomforts

There are no known risks of participating in this study.

Benefits

The teacher, parents and researcher will know more about the children's abilities and competencies of executive function.

Compensation n/a

Confidentiality

The results of this participation will be confidential. The researcher will keep the consent forms, questionnaire and any observations in a locked office. In the results and discussion sections, the researcher will use pseudonyms to maintain confidentiality.

Use of Online Surveys n/a

Inclusion Criteria for Participation

The participants are parents, teachers and children who are three, four and five years of age.

Teacher's Consent to Participate

I ,_____, give my consent for to participate in the research project described above. I understand that this participation is voluntary and that I may withdraw my consent at any time. I also give my consent for the researcher to observe the children in the classroom and my interactions with them.

_____

Signature of Teacher, Date

_____

Signature of Investigator, Date

_____

PLEASE SIGN BOTH COPIES OF THIS FORM, KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR

Research at Kennesaw State University that involves human participants is carried out under the oversight of an Institutional Review Board. Address questions or problems regarding these activities to the Institutional Review Board, Kennesaw State University, 1000 Chastain Road, #0112, Kennesaw, GA 30144-5591, (678) 797-2268.

APPENDIX C

TABLES

Table 1

Quantitative Data Analysis: Findings Master Matrix

		# Participants	% Participants	
1.0	**Working Memory, Planning, and Attention**			
1.1	**Working on a lesson**	**9**	**100%**	
1.2	**Ability to complete a lesson**	**9**	**100%**	
2.0	**Quantitative Analysis and Development**	**9**	**100%**	
3.0	**Interest**	**9**	**100%**	
4.0	**Isolated Components**			
4.1	**Patterns of insufficient working Memory**			
4.1.1	***Incomplete tasks***	***4***	***100% of three year olds, 44% overall***	

4.1.2	***Developing skill for activity***	***5***	***55%***	
4.2	**Patterns of attention**			
4.2.1	***General ability***	***9***	***100%***	
4.2.2	***Interest & repetition.***	***7***	***77%***	
4.3	**Patterns of insufficient attention**			
4.3.1	***Transitioning***	***3***	***66% of males, 33%***	
4.3.2	***Mental breaks***	***9***	***100%***	
4.3.2.1	*Exploration*	*7*	*77%*	
4.3.2.2	*Observing*	*7*	*77%*	
4.3.2.3	*Fatigue*	*7*	*77%*	
4.3.2.4	*Looking out window or across room*	*7*	*77%*	
4.3.2.5	So*cializing*	4	44%	
4.3.3	***Conclusion for insufficient attention***			
4.4	**Patterns of inhibitory control**			
4.4.1	***Movement***			
4.4.1.1	*Body*	*9*	*100%*	
4.4.1.2	*Materials*	*9*	*100%*	
4.4.2	***Voice***	***8***	***88%***	
4.4.3	***Interrupting***	***8***	***88%***	
4.5	**Pattern of insufficient inhibitory Control**			
4.5.1	***clumsy movements***	***6***	***66%***	

4.6	**Patterns of cognitive flexibility**			
4.6.1	***Problem solving***			
4.6.1.1	*Individually*	*9*	*100%*	
4.6.1.2	*Teacher's help*	*7*	*77%*	
4.6.1.3	*Peer's help*	*4*	*75% of three year olds, 44% overall*	
4.6.2	**Redirection**	**9**	**100%**	
4.7	**Patterns of Planning**			
4.7.1	***Watching peers***	***5***	***80% of males, 55% overall***	
4.7.2	***Transition***	***4***	***60% of males, 44% overall***	
4.7.3	***Verbalizing planning***			
4.7.3.1	*Communication with teacher*	*5*	*55%*	
4.7.3.2	*Problem solving*	*5*	*55%*	
4.7.3.3	*Making decisions*	*6*	*66%*	
4.8	**Examples of insufficient planning**	**7**	**77%**	
5.0	**Patterns in Triangulation of Data**	**Parents**	**Teachers**	**Observations**
5.1	**Working memory**	**=**	**=**	**=**
5.2	**Planning**	**=**	**=**	**=**

5.3	**Attention**	≠	=	=
5.4	**Inhibitory control**			
5.4.1	***Voice***	≠	=	=
5.4.2	***Interrupting***	≠	=	=
5.5	**Cognitive flexibility**	≠	=	=

Table 2

Total Frequencies of Executive Function Components over Twelve Weeks												
Age	**Gender**	**WM,P, A**	**WM**	**WM ins**	**P**	**P ins**	**A**	**A ins**	**IC**	**IC ins**	**CF**	**CF ins**
3y 5m	F	94	11	2	3	2	17	52	25	10	14	5
3y 9m	F	117	4	6	6	1	11	35	26	11	16	4
3y 9m	M	122	16	12	13	1	34	14	35	10	24	4
3y 10m	M	94	8	5	7	0	18	21	15	17	10	7
4y 0m	M	136	11	4	9	3	11	22	21	32	21	14
4y 4m	M	80	4	2	5	2	13	35	14	2	6	6
4y 6m	F	192	6	6	8	1	16	33	39	39	23	5
4y 10m	F	139	4	2	6	0	12	13	25	7	14	5
5y 0m	M	103	7	3	7	0	15	10	24	3	19	6

Table 3

Cluster to Insufficient Attention Ratio				
Age	**Gender**	**WM,P, A**	**A ins**	**Ratio:**
3y 5m	F	94	52	0.55
3y 9m	F	117	35	0.29
3y 9m	M	122	14	0.11
3y 10m	M	94	21	0.22
4y 0m	M	136	22	0.16
4y 4m	M	80	35	0.43
4y 6m	F	192	33	0.17
4y 10m	F	139	13	0.09
5y 0m	M	103	10	0.09

Table 4

Inhibitory Control Ratio				
Age	**Gender**	**IC**	**IC ins**	Ratio
3y 5m	F	25	10	0.4
3y 9m	F	26	11	0.42
3y 9m	M	35	10	0.28
3y 10m	M	15	17	1.13
4y 0m	M	21	32	1.52
4y 4m	M	14	2	0.14
4y 6m	F	39	39	1
4y 10m	F	25	7	0.28
5y 0m	M	24	3	0.12

Table 5

Working Memory Ratio				
Age	**Gender**	**WM**	**WM ins**	**Ratio**
3y 5m	F	11	2	0.18
3y 9m	F	4	6	1.5
3y 9m	M	16	12	0.75
3y 10m	M	8	5	0.62
4y 0m	M	11	4	0.36
4y 4m	M	4	2	0.5
4y 6m	F	6	6	1
4y 10m	F	4	2	0.5
5y 0m	M	7	3	0.42

Table 6

Cognitive Flexibilty Ratio				
Age	**Gender**	**CF**	**CF ins**	**Ratio**
3y 5m	F	14	5	0.35
3y 9m	F	16	4	0.25
3y 9m	M	24	4	0.16
3y 10m	M	10	7	0.7
4y 0m	M	21	14	0.66
4y 4m	M	6	6	1
4y 6m	F	23	5	0.21
4y 10m	F	14	5	0.35
5y 0m	M	19	6	0.31

Table 7

Attention Ratio				
Age	**Gender**	**A**	**A ins**	**Ratio**
3y 5m	F	17	52	3.05
3y 9m	F	11	35	3.18
3y 9m	M	34	14	0.41
3y 10m	M	18	21	1.16
4y 0m	M	11	22	2
4y 4m	M	13	35	2.6
4y 6m	F	16	33	2.1
4y 10m	F	12	13	1.1
5y 0m	M	15	10	0.66

Table 8

Planning Ratio				
Age	**Gender**	**P**	**P ins**	**Ratio**
3y 5m	F	3	2	0.66
3y 9m	F	6	1	0.16
3y 9m	M	13	1	0.07
3y 10m	M	7	0	0
4y 0m	M	9	3	0.33
4y 4m	M	5	2	0.4
4y 6m	F	8	1	0.125
4y 10m	F	6	0	0
5y 0m	M	7	0	0